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Vegetation in Group-Selection Openings: Early Trends

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Abstract

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Nine openings that ranged from 0.2 to 1.6 acres and were grouped into small, medium, and large size classes comprised the initial group-selection cut on the Boggs Mountain State Forest in north central California. Five growing seasons after site preparation by pile and burn, 81 plant species in 35 families were present. Forbs, ferns, graminoids, manzanita, other shrubs, and ponderosa pine seedlings were sampled in a variety of environments that ranged from the surrounding forest to near plot centers. Few statistically significant differences were found among opening sizes, but developing trends suggest that significant differences will occur in the near future. Many statistical differences were present when the location of the vegetation in the forest and openings was tested. In general, the density of manzanita, other shrubs, and ferns in the openings was greater than that in the forest. Cover of pine seedlings, manzanita, ferns, and forbs showed similar trends. Ponderosa pine seedling height was significantly larger near plot centers.

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Increasing evidence worldwide substantiates that the composition and dynamics of plant species govern the magnitude of competition in young conifer plantations, and that competing vegetation has a strong negative impact on conifer seedling survival and growth.[1,2,3] However, almost all documentation of this knowledge has been from studies in clearcuttings. Research on alternative silvicultural cutting methods is needed.[4] Group selection is one such alternative. Group selection is the preferred method for managing California spotted owl habitat in the National Forests in the Sierra Nevada of California.[5]

But key information on the group-selection method is missing. Specifically, knowledge is needed on the species composition, density, and development of competing vegetation and conifer regeneration in group-selection openings.[6,7] Crucial questions are whether the desired species become established and develop satisfactorily in the group-selection environment,[8] and how this development compares to that achieved with other cutting methods. Another need is to determine whether group selection is feasible as an *indirect* vegetation management technique for controlling undesirable vegetation.[9] Manipulating the *environment* to the point that normally aggressive but intolerant shrubs and other plant species grow poorly, but conifer seedlings grow well, is an intriguing possibility that could have application in forest vegetation management.

The group-selection method, which is part of an uneven-aged silvicultural system, involves the removal of groups of trees to create small openings up to about 2 acres. Several of these openings, scattered throughout a stand, usually are harvested together on a cyclic basis. The cycle often is 10 or 15 years. There is no rotation, and cutting continues in perpetuity, usually removing clusters of mature trees. The group-selection method often is perceived as being "gentle" on the land, its vegetation, and its creatures, and hence is applied where the landowner desires to harvest some trees periodically, but where logging damage is slight and most ecosystem processes are not disrupted.[6] Smith[10] noted that group selection has wide application because "the ecological requirements of most species can be met within its framework."

This cutting method, however, is not without significant professional, financial, and biological problems. These include the time and skill to achieve the desired diameter distribution,[11] higher cost of timber harvesting,[12] the trend toward an overabundance of shade-tolerant species,[13] and the high propensity for damage from prescribed fire.[14]

This research note describes the early plant community in three general sizes of group-selection openings; quantifies the density and development of several categories of vegetation (tree seedlings, shrubs, *Retrieval Terms:* group-selection cutting method, north central California, opening size, plant community development, ponderosa pine

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forbs, ferns, and graminoids) within these opening sizes; and portrays plant density and development in forest, opening-edge, and near opening-center environments.

Methods

The study site is located on the Boggs Mountain State Forest, about 15 miles southeast of Lakeport, in north central California. Before harvest in 1987, the forest was mostly young-growth (40- and 85-year-old) ponderosa pine (*Pinus ponderosa* Dougl. ex Laws. var. *ponderosa*) with scattered sugar pine (*Pinus lambertiana* Dougl.) and Douglas-fir (*Pseudotsuga menziesii* [Mirb.] Franco var. *menziesii*) and occasional hardwoods such as canyon live oak (*Quercus chrysolepis* Liebm.) and California black oak (*Quercus kelloggii* Newb.). The Society of American Foresters forest cover type is Pacific ponderosa pine,[15] and stand basal area averages about 175 ft^2 per acre. A few shrubs of the genera *Arctostaphylos* and *Rhamnus* were scattered in more open places along with a few forbs, graminoids, and ferns. None were abundant on the deep layer of pine needles and other organic debris on the forest floor. After site preparation in June 1988, these species plus many forbs and grasses appeared.

Site quality is above average (65 feet in 50 years[16]); annual precipitation is 71 inches, mostly rain; the elevation is 3,550 feet; the aspect is west; and slopes range from 10 to 25 percent. The soil is of the Aiken series and is deep and well drained.

The treatment was size of opening. Nine openings were created, each a different size. Openings were devoid of trees, irregular in shape, and spanned the range of sizes characteristic of group-selection cutting. They were randomly located on land that could be logged by a tractor, and were 0.25 to 1.0 mile apart. Because differences in plant community development are more easily seen in well-differentiated opening sizes,[17] and because foresters are searching for the "best" opening size,[18] we grouped the openings into three general size classes (acres):

large	(0.72 to 1.61)
medium	(0.54 to 0.70)
small	(0.20 to 0.49)

and used analysis of variance and Tukey tests[19] as our analytical tools. The experimental design was split plot with the main plot being opening size. There were three replications. Significance in all tests was at $\alpha = 0.1$.

Vegetation within each opening (plot) was sampled along four permanent transects that were perpendicular to opening edges and extended toward the opening center. A cluster of three circular quadrats, each 10.8 ft^2, was located just inside the plot edge, and up to eight additional clusters were placed along the transect toward the center, varying with transect length. Clusters were 13 feet apart. A similar arrangement with four clusters quantified vegetation up to 50 feet into the forest. Thus, sampling intensity was 48 to 108 quadrats within and 48 quadrats outside of each opening. To further vegetational analysis, we created three zones: forest, outer edge of opening, and near the opening center. The outer-edge-of-opening zone extended inward from the plot edge up to 26 feet, and the near-opening-center zone extended inward from 40 to 66 feet.

Individual species and groups of species (ponderosa pines, manzanita, other shrubs, ferns, graminoids, forbs) were sampled annually in mid- to late May for density, foliar cover (the sum of shadows that would be cast by leaves and stems of individual species expressed as a percentage of the land surface[20]), and average dominant height (average of three tallest stems).

Internal moisture stress of ponderosa pine and hoary manzanita (*Arctostaphylos canescens* Eastw.) seedlings was measured with a Scholander pressure chamber[21] in late summer-early fall 1991-1993 to determine maximum plant moisture stress. At this time of year, the seedlings were physiologically stressed because of high moisture deficits and could indicate the relative status of soil moisture in each opening size.

Sampling began well before dawn and continued through late afternoon. Because of time and distance considerations, sampling took place in a randomly selected opening in each of the three opening size classes. For this reason and because of the ever-changing amount of xylem sap tension in the plant, no statistical analysis of differences among treatments was attempted. Sampling intensity was five randomly selected planted ponderosa pines and closest hoary manzanita plants in each selected opening. Two fascicle bundles per pine and two twigs per manzanita were tested in the pressure chamber at five measurement times throughout the day. Fascicle bundles and twigs were placed in sealed plastic bags during transit from plant to pressure bomb. "Plant moisture stress" in atmospheres is used in this paper to express pressure chamber values[22] because it is positive, direct reading, and familiar to foresters and biologists.

Results

Internal Plant Moisture

Plant moisture stress is presented for ponderosa pine and hoary manzanita seedlings on a clear hot day in early September that was typical of the California climate. Predawn values for pine seedlings ranged from 9.4 to 10.9 atmospheres, and afternoon values from 17.1 to 19.4 atmospheres and showed little difference among opening sizes *(fig. 1).* Predawn and morning values for manzanita seedlings indicated generally lower stress than were those for pine seedlings, but higher stress than for pines in the afternoon. Only minor differences in moisture stress among opening sizes were noted.

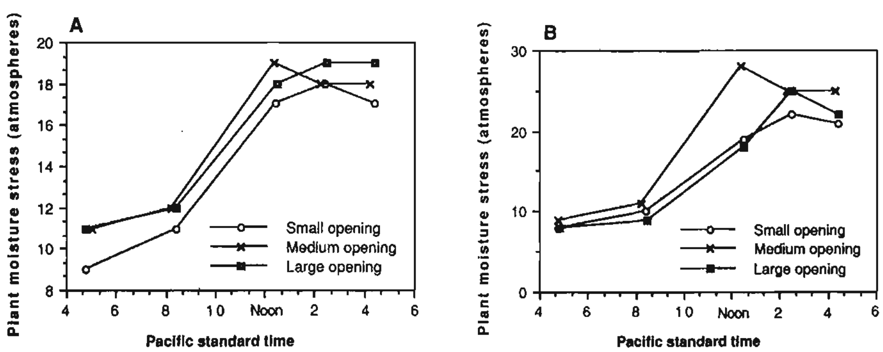


Figure 1—Diurnal trend of internal moisture stress for ponderosa pine seedlings (A) and hoary manzanita seedlings (B) in three sizes of openings at Boggs Mountain State Forest, September 4-5, 1993. Standard errors applicable to differences among opening sizes could not be estimated.

The Plant Community

Total plant species in group-selection openings for four complete growing seasons after site preparation numbered 81 and consisted of 54 forbs, 12 graminoids (including 1 sedge), 1 fern, 6 shrubs, and 8 hardwoods and conifers. Thirty-five families were represented. Five species of forbs and one conifer species appeared after the initial survey in 1990. Opening size, in general, had little effect on species presence.

Plant Density and Development

Data for various categories of vegetation were examined first for differences among opening sizes, and then for differences among locations (zones) in the opening and the forest. Results are presented for 1992 or four complete growing seasons after site preparation. These data include plants from more than one seed crop.

Mean density of the various categories of plants ranged from more than 4,000 graminoids per acre in small openings to more than 266,000 forbs per acre in medium openings. Density of graminoids and ferns was highest in large openings, manzanita and forb density was highest in medium-sized openings, and that of other shrubs and pine seedlings was highest in small openings. However, only ponderosa pine seedlings with significantly more plants in small openings than in the other two opening sizes were statistically significant *(fig. 2)*. This difference is more likely a consequence of cone production in nearby trees than a difference in the environment of the various opening sizes.

Mean foliar cover of the various categories of vegetation, which ranged from 0.2 to 10 percent, was recorded independently of the overstory (crowns of trees adjacent to the openings that extended over them). Overstory cover amounted to 18 percent, 7 percent, and 7 percent in small, medium, and large openings. For the various categories of vegetation, mean foliar cover was greatest in large openings for forbs, graminoids, and ferns; greatest in medium openings for manzanita and other shrubs; and almost similar among opening sizes for pine seedlings. Foliar cover did not differ significantly among opening sizes *(fig. 2)*.

Although the height of individual plants increased with age, average height, which also included new seedlings, ranged only from 0.2 to 1.2 feet. This was especially true for ponderosa pine seedlings whose mean height was affected by new seedlings from each seed crop. Mean stem height of all vegetation except manzanita followed the general trend of being tallest in large openings. No vegetation, however, was significantly taller in a given opening size *(fig. 2)*.

After all plots were combined and divided into zones, mean density of the various categories of vegetation generally increased with distance toward the plot center. Forbs were the exception, with more individuals in the forest. Slightly more pine seedlings were found on the edge of the opening than in the center. Statistically significant differences among zones were realized for manzanita, other shrubs, and ferns *(fig. 3)*. Manzanita had about two and one half times more plants per acre in the opening (8,610) than in the forest (2,950), other shrubs had more than twice as many (6,010 versus 13,760), and ferns were almost four times more numerous near the center of the opening (17,120) than in the forest (4,710).

As before, mean foliar cover of the various categories of vegetation was recorded independently of the overstory. Overstory cover in the forest amounted to 49 percent; near the opening edge, 13 percent; and near the center, about 1 percent. For the various categories of vegetation, mean foliar cover generally was greater within openings than in the forest, and significantly greater for pine seedlings, manzanita, ferns, and forbs *(fig. 3)*.

Height of vegetation in the three zones is a product of vigorous plants with adequate site resources (as in the sunlit centers of large openings) and of plants sacrificing crown development for stem elongation to avoid being overtopped (as in the forest and in small openings). In general, average dominant height of all categories of vegetation was greater near plot centers than in the forest. The only statistical difference among zones for plant height was for ponderosa pine. Seedlings near the plot center were taller than those in the forest *(fig. 3)*.

Discussion

The small openings traditional to group-selection cutting are characterized by an environment that is affected by slope and aspect, sun angle, height and size of adjacent vegetation, and proximity of this vegetation to the opening. Crowns of adjacent trees affect the amount of light that reaches the opening, and their roots extract soil moisture for an unknown distance into the opening.

Figure 2—Average density (A), cover (B), and height (C) by opening size for various categories of vegetation, Boggs Mountain State Forest, 1992. Standard errors for each vegetation category and size of opening ranged from 822 to 37,231 plants/acre for density; from <1 to 2 percent for cover; and from <0.01 to 0.5 feet for height.

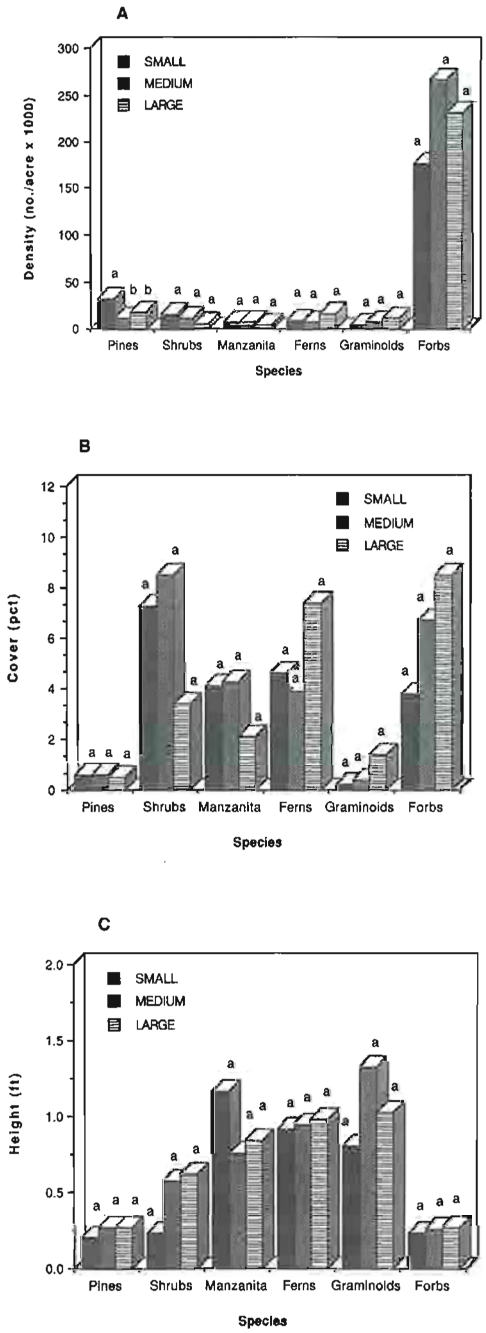
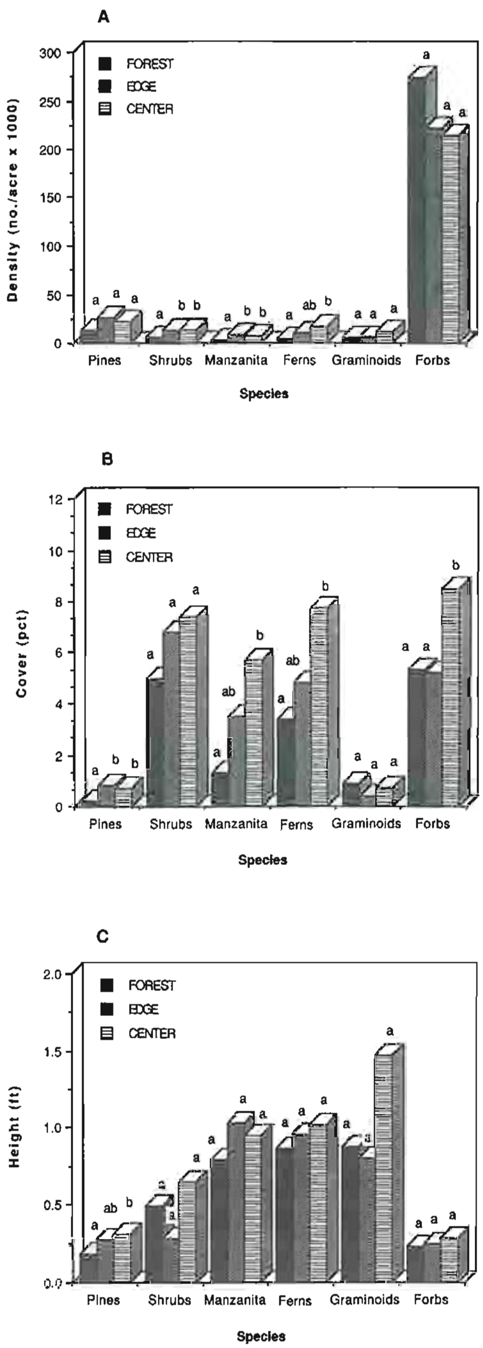


Figure 3—Average density (A), cover (B), and height (C) by zone for various categories of vegetation, Boggs Mountain State Forest, 1992. Standard errors for each vegetation category and zone ranged from 162 to 53,584 plants/acre for density; from <1 to 3 percent for cover; and from <0.02 to 0.43 feet for height.



After disturbance, development of the plant community in the group-selection openings in this study was dynamic and subject to rapid change. Meaningful trends were hard to discern and sometimes masked by opposing factors and high variation. The natural vegetation that became established was influenced by prior and surrounding species, and by seeds that were carried into the openings by wind and animals. Early revegetation was from buried seeds in the soil (manzanita, other shrubs, some forbs), from root crowns (*Rhamnus* spp.), from rhizomes (ferns, a few forbs), and from surrounding seed trees (ponderosa pine seedlings). Together, plants from these regeneration strategies constituted a large variety of species and developmental potentials. For a given species, plants often were dense and scattered, tall and short, and changed dramatically in 2 or 3 years. New plants from successive seed crops also influenced quantified parameters. For example, average dominant height was lowered when a few new plants appeared in quadrats where they were not present before. No wonder, then, that few statistically significant differences were found among opening sizes.

Four years after site preparation, the vegetation in the group-selection openings in this study was characterized by many species and several categories of vegetation, a huge number of plants, and limited horizontal (cover) and vertical (height) development. Vertical development was lowered by successive waves of new plants. Thus, the normal chaos of the early plant community is not only present in group-selection openings, but it is even more pronounced as plants from successive seed crops find it easy to become established in the more moderate environment inherent to small sheltered openings.

In addition to providing a base for determining trends in plant succession, the data on plant species composition, density, and development give the forest land manager an idea of the composition and potential competition to naturally seeded ponderosa pines on similar sites. The study also begins to show the different developmental potentials of the various categories of vegetation relative to position in the opening and the forest. In general, vegetation was better developed near the center of openings—a location where more sunlight and probably more soil moisture were available. Mean cover and height of ponderosa pine seedlings near the plot center were significantly higher than elsewhere in the opening or forest. The practical significance of this is that an opening with high total area relative to circumference seems advantageous to growth.

Being able to control vegetation that competes with conifer seedlings by manipulating such environmental factors as light, organic matter, and soil moisture has obvious potential in vegetation management. It has special appeal in ecosystem management with its promise of a more gentle human imprint on the land. In California, most of the aggressive competitors to conifer seedlings are shrubs, particularly species of manzanita and ceanothus, that grow well in disturbed areas having full sunlight. The shady group-selection openings in this study should be anathema to such shrub species. We hope that one of the opening sizes that we are testing will provide the specific environment where light and moisture limit development of the most aggressive competing species, but affect development of ponderosa pine seedlings only slightly. Future work will attempt to define this opening size.

End Notes and References

[1]Gjerstad, Dean H., ed. 1993. ***Proceedings of the international conference on forest vegetation management***; 1992 April 27-May 1; Auburn, AL. Auburn, AL: Auburn University School of Forestry; 310 p.

[2]McDonald, Philip M.; Fiddler, Gary O. 1989. ***Competing vegetation in ponderosa pine plantations: ecology and control.*** Gen. Tech. Rep. PSW-113. Berkeley, CA: Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 26 p.

[3]Stewart, Ronald E.; Gross, Larry L.; Honkala, Barbara H. 1984. ***Effectiveness of competing vegetation on forest trees: a bibliography with abstracts.*** Gen. Tech. Rep. WO-43. Washington, DC: Forest Service, U.S. Department of Agriculture (looseleaf).

[4]Aune, Philip S. and others. 1989. ***Developing an ecological perspective for managing forests.*** Priority research program. Washington, DC: USDA Forest Service; 10 p.

[5]U.S. Department of Agriculture. 1995. ***Managing California spotted owl habitat in the Sierra Nevada National Forests of California, an ecosystem approach***. Draft environmental impact statement and appendices. Washington, DC: Forest Service, U.S. Department of Agriculture.

[6]McDonald, Philip M.; Fiddler, Gary O. 1991. ***Vegetation in group-selection openings: ecology and manipulation***. In: Proceedings of the 12th annual forest vegetation management conference; 1991 May 14-16; Redding, CA. Redding, CA: Forest Vegetation Management Conference; 97-106.

[7]Phares, Robert E. 1978. ***Research gaps and research needs for the western forest regions***. In: Proc. Uneven-aged silviculture and management in the United States. Washington, DC: Forest Service, U.S. Department of Agriculture; 231-234.

[8]Guldin, James M. 1991. ***Uneven-aged BDq regulation of Sierra Nevada mixed conifers***. Western Journal of Applied Forestry 6(2): 27-32.

[9]McDonald, Philip M.; Fiddler, G.O. 1993. ***Feasibility of alternatives to herbicides in young conifer plantations in California***. Canadian Journal of Forest Research 23(10): 2015-2022.

[10]Smith, David Martyn. 1962. ***The practice of silviculture***. 7th ed. New York: John Wiley and Sons, Inc.; 578 p.

[11]Hann, David W.; Bare, B. Bruce. 1979. ***Uneven-aged forest management: state of the art (or science?)***. Gen. Tech. Rep. INT-50. Ogden, UT: Intermountain Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 18 p.

[12]Shaffer, R.M.; Brummel, K.R.; Reisinger, T.W.; Stokes, B.J. 1993. ***Impact of group selection silviculture on timber harvesting productivity and cost in Appalachian hardwood timber stands***. Northern Journal of Applied Forestry (4): 170-174.

[13]Franklin, Jerry F. 1978. ***Effects of unevenaged management on species composition***. In: Combined proceedings of two inservice workshops on uneven-aged silviculture and management in the United States. Washington, DC: USDA Forest Service; 169-175.

[14]Fiske, John N., and others. 1992. ***Effects of a group-selection strategy for the Sierra Nevada mixed conifer***. Internal Report. San Francisco: Pacific Southwest Region, USDA Forest Service; 29 p.

[15]McDonald, Philip M. 1980. ***Pacific ponderosa pine***. In: Eyre, F.W., ed. Forest cover types of the United States and Canada. Washington, DC: Society of American Foresters; 120-121.

[16]Dunning, Duncan; Reineke, L.H. 1933. ***Preliminary yield tables for second-growth stands in the California pine region***. Technical Bulletin 354. Washington, DC: U.S. Department of Agriculture; 24 p.

[17]Sousa, Wayne P. 1984. ***The role of disturbance in natural communities***. Annual Review Ecological Systems 15: 353-391.

[18]McDonald, Philip M.; Abbott, Celeste S. 1994. ***Seedfall, regeneration, and seedling development in group-selection openings***. Res. Paper PSW-RP-220. Berkeley, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture; 13 p.

[19]Wilkinson, L. 1989. *SYSTAT: The system for statistics*. Evanston, IL: SYSTAT, Inc.; 822 p.

[20]Daubenmire, R.F. 1968. ***Plant communities: a textbook on plant synecology***. New York: Harper and Row; 300 p.

[21]Scholander, P.F.; Hammel, H.T.; Bradstreet, E.D.; Hemingsen, E.A. 1965. ***Sap pressure in vascular plants***. Science 148: 339-346.

[22]Waring, R.H.; Cleary, B.D. 1967. ***Plant moisture stress: evaluation by pressure bomb***. Science 155: 1248-1254.

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