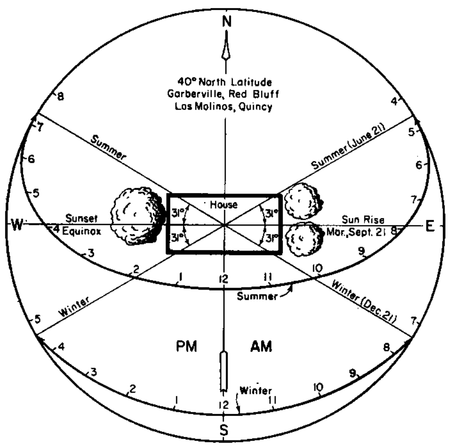
Control of Solar Radiation

housing comfort in both summer and winter can be improved by construction designed to take advantage of solar angles

L. W. Neubauer

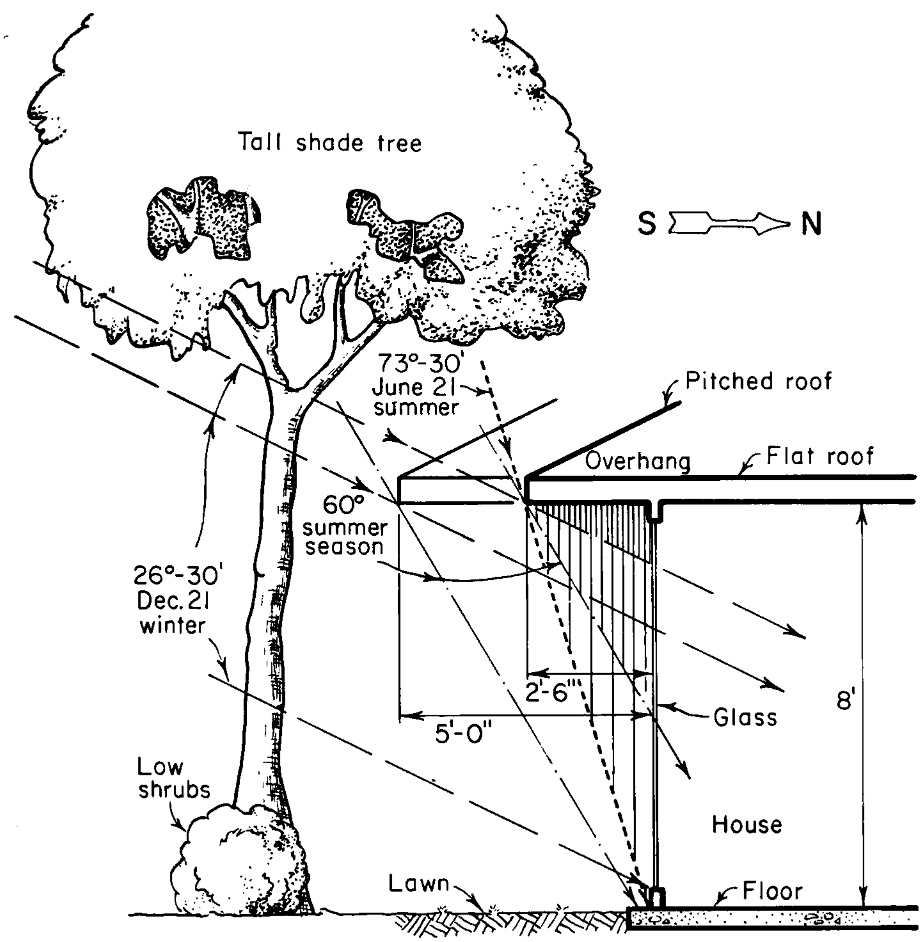


PLAN OF SOLAR ANGLES

Shade—cast by roof overhangs, projections, louvers, trees—can be used to control the sun's heat in residences, machine sheds and livestock buildings or enclosures.

To benefit from the warm radiant heat of the sun during the winter, large windows, exposed to the south, will admit much solar heat.

In the summer, when the day is almost twice as long as a winter day, the sun is high overhead at noon and it is never low in the south. Shade trees to the east and west are needed for protection against the extreme solar radiant heat during the long mornings and long, hot afternoons.



SOLAR WINDOW
40° North Latitude at Noon

The position of the sun—with respect to a building to be shaded—varies by the hour, from east to west; by the season, winter to summer, in vertical angle and in horizontal location; and by the latitude of the location.

The small diagram on this page indicates a typical situation at a latitude of about 40° north, in the range of California cities such as Garberville, Red Bluff, Los Molinos and Quincy.

The common pattern is to see the sun rise in the east at 6:00 a.m.—standard time—and set in the west at 6:00 p.m., but this occurs only at the equinox—about March 21 and September 21—and is of less significance than the sun's position in summer and winter.

One extreme develops at the winter solstice, about December 21. The day is short—about nine hours—with the sun rising about 7:30 a.m., at 31° south of east, and setting about 4:30 p.m., at 31° south of west. Large windows—single or double glazed—with a south directional exposure will admit much of the sun's heat. Shade trees should be east or west of the building to avoid obstructing the sun's rays.

Another extreme occurs during the summer—conspicuously about June 21—when the sun is high and days are long. The sun rises 31° north of east at about 4:30 a.m. and sets 31° north of west at about 7:30 p.m. It is in the north nearly as long as it is in the south. Shade trees to the south of the building provide no protection from the sun, but to the east and west such trees will give protection from solar radiant heat during the long hours of high temperatures.

The larger diagram indicates a building wall 8′ high, with large windows or glass doors facing the south. The noon vertical angles of the sun are shown for three seasons at a location of 40° north latitude.

Winter Warmth

The extreme low winter angle of the sun at noon is 26.5°, and is less than this at all other hours. The sun shines deeply into the room, heating up the floor, walls, and furniture. Only tall trees and low shrubs should be placed at the south, to avoid obscuring the solar light and

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PEACHES

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Decay control was evaluated on both the second and fourth days after inoculation because decay development is rapid on mature fruit and canning peaches are seldom held more than a few days before processing.

The percent decay reductions of five tests—18 samples averaging 50 fruit per sample—are combined in the graph on page 7 according to the quantity of ammonia used and the resulting range of ambient ammonia concentrations in the fumigation chambers. Relatively low ammonia concentrations—167–234 ppm—retarded decay for two days following inoculation, and fruit held four days required relatively large amounts of ammonia—500–740 ppm—for good decay control. Typical examples of the fruit two days after inoculation are shown in the photograph on this page. Fruit injury due to the ammonia was not apparent in any of the tests.

Effectiveness

The effects of one and of two independent 6-hour ammonia fumigations are presented in the table on page 7. Although the second fumigation did not appear to improve the ammonia treatment as evaluated two days after inoculation, the four day counts indicated a definite advantage of the two fumigations at the two higher dosages. The results show good control by both the one and the two fumigations. Slight fruit injury developed following two 6-hour fumigations at 500 ppm amount concentration ammonia.

Sampling Necessary

The data obtained in these studies show that ammonia gas fumigation is effective in controlling Rhizopus rot of peaches. However, with the severe inoculatioin procedures used, comparatively high ambient concentrations were required for good control. Under conditions of less severe inoculation, effective control should be possible with two 6-hour fumigations with an average ammonia at about 250 ppm concentration. Any fumigation must be accompanied by sampling to determine the ambient ammonia concentration in the chamber. Commercial treatments require extensive field testing and statistical evaluation of the test results.

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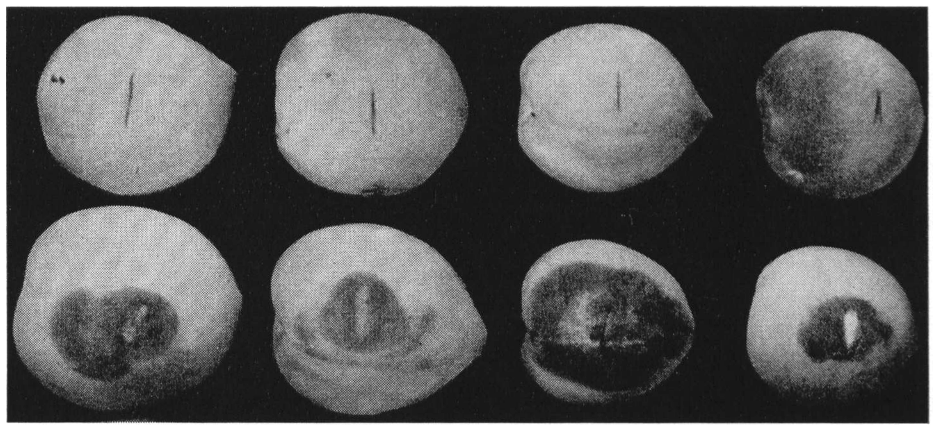
Peaches two days after inoculation. The top row of fruit received a 6-hour fumigation at an average ammonia concentration of 170 ppm. The bottom row of fruits were untreated.



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heat. A roof overhang of several feet will still permit most of the sun's rays to enter the room. Double glazing is often used on the windows for better insulation, to aid in maintaining the warmth in the interior of the building.

Summer Shade

The other extreme—in summer—is indicated at an angle of 73.5° above the south horizon. This is the lowest position of the sun toward the south, since at the other hours it is higher or toward the north. Trees to the south are not required, but they are especially useful to the east or west, as well as over the roof. A roof overhang of only 28″ or 30″ will completely shade the whole window-wall. No direct sunlight will enter the south windows.

During the intermediate seasons, some radiation may enter the room. A vertical solar angle of 50° or 60° may require protection or shade, and this may

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Solar Angles for a South-Facing Window-Wall and Roof Overhang required to shade an 8-foot wall or window from the south sun. (cities of similar latitude in California)

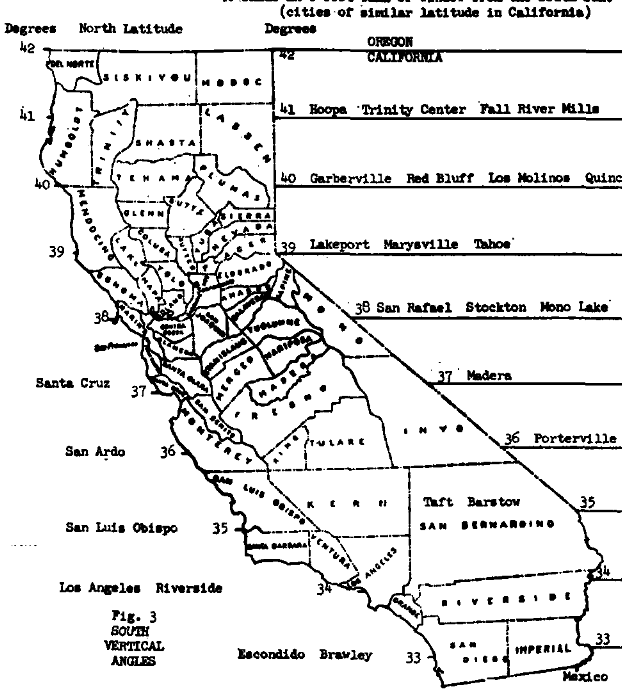

Fig. 3 SOUTH VERTICAL ANGLES

Degrees	Noon South Vertical Angle, Degrees			Roof Overhang, Inches	
	Dec. 21	Equinox	June 21	Minimum June 21	All summer Mar.-Sept.
42 OREGON / CALIFORNIA	24 1/2	48	71 1/2	32	86
	25		72	31	
41 Hoopa Trinity Center Fall River Mills		49			83
	26		73	29	
40 Garberville Red Bluff Los Molinos Quincy		50			81
	27		74	28	
39 Lakeport Marysville Tahoe		51			78
	28		75	26	
38 San Rafael Stockton Mono Lake		52			75
	29		76	24	
37 Madera		53			72
	30		77	22	
36 Porterville		54			70
	31		78	20	
35 Taft Barstow		55			67
	32		79	19	
34		56			65
	33		80	17	
33	33-1/2	57	80-1/2	16	62

Gibberellin on Zoysia Grasses

plant growth regulator did not improve establishment of slow growing turf grass in either greenhouse or field experiments

Victor B. Youngner

Gibberellic acid—one of several similar growth promoting substances—produces a rapid abnormal elongation of shoots and leaves in many plants at dilutions as low as one ppm—part per million.

Studies conducted in 1957 were designed to determine what practical value gibberellic acid might have in increasing the rate of establishment of grasses planted vegetatively. Zoysia was chosen because it is notorious as a slow growing grass.

The first studies were on uniform size plugs of Emerald Zoysia planted in pots of pure sand in a greenhouse kept at 65°F minimum. The plugs were watered daily with a complete nutrient solution. Approximately two weeks were allowed for the plugs to recover from the transplanting shock before treatments were begun.

Treatments

Solutions of gibberellic acid—0, 1, 10 and 100 ppm—were applied in equal volumes with a small atomizer which thoroughly wet all the foliage. All treatments were replicated four times. Measurements of the height of the grass were made at the five- and seven-week periods after the first treatment. Also, the tops were clipped at the times of measurement and the clippings oven dried and weighed. Immediately after clipping, the plugs were again given the gibberellic acid treatments, making a total of three treatments during the experiment. Ten weeks after the start of the experiment the plugs were removed from the pots; the sand washed off the roots; tops and roots separated, oven dried and weighed.

Three days after the first treatment a pronounced increase in plant height was observed in the 100 ppm treatment and to a lesser degree in the 10 ppm treatment. The increase in height was accompanied by a lightening of the green color. By the time of the first clipping, the plants treated with 10 and 100 ppm of gibberellic acid were significantly taller than the untreated plants. The plants receiving 100 ppm were significantly taller than all other treatments. The same increase in height was observed at the time of the second clipping. Gibberellic acid at 1 ppm had no significant effect on top growth.

Effects of Gibberellic Acid Treatments on Emerald Zoysia Growth

Treatment G. A. ppm	Mean height inches		Mean total dry weight (grams)	
	1st clip	2nd clip	clippings	roots
Check	1.50	2.13	6.72	4.27
1	1.63	2.50	7.90	5.93
10	1.94	2.94	7.93	6.05
100	4.38	4.00	9.64	5.40
LSD*	0.58	0.32	1.11	2.21

* Least significant difference at 5% probability level.

No treatment produced a significant increase in horizontal spread over the check during the course of the experiment. At the time the plugs were removed from the pots all were still essentially the same diameter as at the time of planting.

Dry Weights

All concentrations of gibberellic acid significantly increased the dry weight of clippings over the untreated. None of the treatments had any effect on the dry weight of the roots produced during the time the experiment lasted. It is possible that additional gibberellic acid treatments over a longer period of time might significantly increase or decrease the weight of the dried roots.

Field plantings of Meyer strain of *Zoysia japonica* and two selections of *Z. matrella* were established in the summer of 1957 to further test the effects of gibberellic acid on Zoysia. The planting material was washed in water to remove all soil. Half of the material was then dipped in a 100 ppm solution of gibberellic acid and half was untreated. Planting was done with uniformly spaced sprigs.

All the sprigs turned brown after planting and showed no new growth for approximately two weeks. New growth appeared first in the plots from the untreated materials of all varieties and could be clearly seen throughout before any appeared on the plots from the treated material. Early growth was lighter green on treated material than on the untreated, despite regular applications of nitrogen. The gibberellic acid appeared to have reduced slightly the per cent survival of the sprigs.

Plant Growth

The effects of the initial injury and growth retardation were evident throughout the summer. The plots planted with the untreated material had a higher per cent cover than the treated plots by the time low temperatures in the fall stopped growth.

The studies showed that treating Zoysia planting material with gibberellic acid did not improve the rate of turf establishment. The increased top growth demonstrated in the greenhouse studies may be little value as far as turf is concerned.

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call for a roof projection of 60″–80″. Such an amount will fully control the summer sunlight without interfering unduly with the winter radiation. Because of the difference in heat conditions in March and in September, some roof projections are made adjustable or removable. Thus the long overhang for September or October can be removed to admit more solar heat in March and April.

California extends north and south over more than 9° of latitude—from 42° to less than 33°—which makes a significant difference in solar angles and in the amount of roof overhang necessary in varying localities. The map shows the range of latitudes, together with typical cities in each region, the noon solar angles and common roof overhangs suitable for sun control in those latitudes during the different seasons.

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