May 1984 Dick Schwecke and I set up a paired study to try to answer the question, what kills tree seedlings on hot dry sites. Whether the droughty nature of the soils, the high evapotranspiration levels the sites required, or the temperature due to high solar radiation, was the primary cause of seedling death.

METHODS:
Two study sites were picked one in Whiteman Creek and the second in Ophir Creek. Both were areas where a number of planting failures had occurred. The habitat type at the Whiteman Creek site is PIPO/AGSP on a southeast aspect and at the Ophir Creek site PSMB/CARU on a south aspect. At each site three soil temperature and moisture monitoring stations were installed. Two stations were put in a unvegetated area of the clearcut. One with no shading and the other with two shade cards at the base of the station. The third station was put in a natural stand as close as possible to the clearcut. Soil moisture was measured using gypsum blocks at 6 and 12 inches. Soil temperature was measured with a metal thermometer at the surface and at 3 inches, and at 12 inches with a thermistor.

Measurements were taken on a non-scheduled basis as early in the spring as the roads were passable until the soil moisture was depleted from the site. No readings were taken in 1985 due to a severe early season drought.

RESULTS:
Soil moisture levels for the two sites are graphed on pages 3 thru 10. Bars tension are used to reflect the plants work to get the soil water. Fifteen bars is considered wilting point for plants and 1/3 bar is the soil's field capacity or very near saturation. A value of 3 bars is considered roughly when most tree seedlings become stressed. Calendar day reflects the Julian date.

"A common guideline for soil moisture requirements for survival of transplanted seedlings is given by Krueger and Trappe (1967). They estimate that seedlings will survive if they have an adequate supply of soil water for a 28 days following transplanting."(1) Childs states that over a 6 week period, "transplanted seedlings change components of the plant water balance in order to survive in the transplanted environment. The most marked adjustments are a decreased shoot to root ratio and decreased stomatal conductance."(1). In other word if the seedling is not stressed in the first 28 to 42 day, it has adapted to it new environment and has a better chance of withstanding moisture stress at that time.

One can assumes that normally most transplanting on warm dry sites will start to occur about May 1. Therefore on both study site in 1984 there was 75 days from the start of the planting season until the soil reached a
moisture tension of 3 bars. In 1986 the Ophir Creek site reached a 3 bar tension after 55 days. The Whiteman Creek site in 1986 reached a 3 bar tension after 30 days. It is apparent to in most years that soil moisture is not limiting to the seedlings before physiological adaptation occurs.

The surface soil temperature for the sites is graphed together and appears on pages 11 and 12. The 3 and 12 inch temperature data is available but is not shown here. Levitt (1972) stated that, "injury was induced in the 113 - 140 degrees F range. And that at temperatures above 140 degrees F injury occurred because of the breakdown of proteins." (2) "Lorenz (1939) found that the cortical parenchyma cells of several species of angiosperms and gymnosperms were killed within 30 minutes when exposed to temperatures between 135 - 138 degrees F." (2)

The graph of the Whiteman Creek surface temperatures shows that each time the a measurement was taken in the clearcut station, the readings were in the injury or death zone. The reading at the Ophir Creek clearcut station reflect almost the same type of situation. This information brings me to the conclusion that in most years surface temperature is the cause of seedling death, not moisture stress. This is assuming standard planting procedures are followed. It should be noted also that the shade cards provided a 20 - 40 degrees F buffer.

There are 3 points to that can made with this information: (1) The added cost of "microsite planting" and on some areas shade cards may be a very economical management tool. (2) The need to leave adequate material on cutting units during slash disposal cannot be over emphasized, especially on warm aspects. (3) I feel there is a need in our area to look at the amount of overstory canopy left during shelterwood harvests; so that enough canopy is left to keep surface temperatures below the injury zone.


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6 INCH SOIL MOISTURE OPHIR CK.YR 1984
SITE #21—CLEARCUT #22—SHADECARDS #23—NATURAL

BARS TENSION

CALENDAR DAYS

- 21
- 22
- 23
12 INCH SOIL MOISTURE OPHIR CK.YR 1984
SITE #21–CLEARCUT #22–SHADECARDS #23–NATURAL

CALIBER DAYS

BARS TENSION

0 1 2 3

130 160 190 220

21
22
23
6 INCH SOIL MOISTURE OPHIR CK.YR 1986
SITE #21-CLEARCUT #22-SHADECARDS #23-NATURAL

CALENDAR DAYS

BARS TENSION

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

21
22
23
12 INCH SOIL MOISTURE OPHIR CK.YR 1986
SITE #21—CLEARCUT #22—SHADECARDS #23—NATURAL

BAR TENSION

CALENDAR DAYS

21
22
23
6 INCH SOIL MOISTURE WHITEMAN CK.YR 1984

SITE #18—CLEARCUT #19—SHADECARDS #20—NATURAL

![Graph showing soil moisture tension over calendar days for different sites.]
12 INCH SOIL MOISTURE WHITEMAN CK.YR 1984

SITE #18-CLEARCUT #19-SHADECARDS #20-NATURAL
6 INCH SOIL MOISTURE WHITEMAN CK.YR 1986
SITE #18—CLEARCUT #19—SHADECARDS #20—NATURAL

The diagram illustrates the calendar days and bars of tension for different sites:
- Site 18
- Site 19
- Site 20

The graph shows the progression of bars of tension over calendar days.

- Site 18 starts at a bar tension of 3 and remains constant.
- Site 19 starts at a lower tension and shows a slight increase.
- Site 20 has a lower starting tension and shows a more pronounced increase over time.
12 INCH SOIL MOISTURE WHITEMAN CK.YR 1986
SITE #18-CLEARCUT #19-SHADECARDS #20-NATURAL

BARS TENSION

CALENDAR DAYS

18
19
20
SURFACE TEMP. OPHIR CK. YRS. 1984 & 1986
SITE #21—CLEARCUT #22—SHADECARDS #23—NATURAL

DEATH ZONE

INJURY ZONE

TEMP. DEGREES F

0

20

40

60

80

100

120

140

160

130

160

190

220

CALENDAR DAYS

21

22

23
SURFACE TEMP. WHITEMAN CK. YRS. 1984 & 1986

SITE #18—CLEARCUT #19—SHADECARDS #20—NATURAL

TEMP.

DEATH ZONE

INJURY ZONE

160

140

120

100

80

60

40

20

0

TEMP.

DEGREES F

CALENDAR DAYS

130

160

190

220

18

19

20