Canada

Department of Forestry

FOREST RESEARCH BRANCH

- Progress Report 1962 -

THE DEVELOPMENT OF A PHYTOMETER METHOD IN THE RELATIONSHIP OF LOCAL CLIMATE AND REGENERATION IN THE B-18a SECTION OF ALBERTA

(Project A-63)

by

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Calgary, Alberta
December, 1961

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INTRODUCTION

Project A-63 was established near Smith, Alberta in 1960. In a millsite clearing trays of conifer seedlings were exposed to the effects of local climate throughout the growing season. A standard controlled location was used. Germination and survival were compared on five seedbed types. An optimum seedbed was selected, for use in the subsequent stages of development, on the basis of number of seedlings surviving. Moisture holding capacity of the medium was a limiting factor. This report covers the 1961 growing season when the optimum seedbed medium was used at various regional locations to test the sensitivity of the method.

Because of poor germination and a number of other circumstances, results of this phase of the study are inconclusive. However, much has been gained by examination of the data and comparisons between locations are presented. Modification has been made necessary which will be incorporated in the future development of the project.

METHODS

A phytometer layout consisting of five trays filled with a standard loam, 60 per cent sand, 25 per cent silt, and 15 per cent clay with 35 per cent humus by volume added, was set up at the following locations:

1. Smith, B-18a mixedwood section, Boreal region. Elevation 1,975 feet, latitude 55°15'.N., longitude 114°W.

2. Hinton, B-19a lower foothills section, Boreal region. Elevation 3,300 feet, latitude 53°20'.N., longitude 117°45'W.

3. Kananaskis Forest Experiment Station, Subalpine region.Elevation 4,520 feet, latitude 51°00'.N., longitude 115°5'W.

4. Crowsnest, Subalpine region. Elevation 5,500 feet, latitude 49°40'.N., longitude 114°30'W.

On June 25, 1961 at all locations, 50 white spruce and 50 lodgepole pine seed were sown in each tray and covered with a 1/8" layer of fine sand. Weekly tallies were made of germination and survival, and records were kept of rainfall and maximum temperatures between tallies. The Smith location was again equipped with a hygrothermograph. An anemometer was obtained in late July. A further test of a medium of sand, vermiculite, peat moss and fertilizer was run at Smith. Arrangements were made for records to be kept by Forest Research Branch and Alberta Forest Service personnel.

Instruments used at all locations were identical and specifications for set-up and siting were standardized. Rodent fencing was prefabricated and distributed from Kananaskis Forest Experiment Station. Seeds were from 1958 collections and the same lots were used as for the 1960 tests. Germinants were marked with plastic toothpicks and cause of mortality was noted where this could be determined. Minimum thermometers proved unreliable at Hinton and Smith. Minimum temperature readings at Hinton were supplied from local records while those at Smith were discarded. Records to August 1st from Blairmore were destroyed but are replaced by comparable data from adjacent instruments. Maximum and minimum radiation temperatures were recorded with the thermometer bulb just touching ground surface.

RESULTS AND DISCUSSION

Germination at Hinton, Kananaskis, and Crowsnest locations was negligible or absent. However, climatic variation (Figure 1) is sufficient to warrant examination and discussion. Only at Smith were conditions suitable for germination and growth throughout the study period.

a. Crowsnest (Blairmore).

Seeding was followed by variable climatic conditions. Less than an inch of rain fell throughout the first twenty-five days and ground surface temperature varied from freezing point to a maximum of 120°F. Thereafter, maximum temperatures rose even higher with a peak of 131°F. No germination took place until the first week in August but the three pine seedlings which emerged, survived until the end of observations. They appeared following a rainfall of over one inch which was accompanied by the persistent high daily temperature maxima. Frosts occurred in each month and became severe by the end of August. In comparison, natural seedlings in the area were observed on north-facing sheltered sites, but few or none appeared on sites exposed as was the phytometer. Figure 1 shows that rainfall distribution throughout the season was favourable but the extremely high temperatures experienced counteract the benefits of moisture availability.

b. Hinton.

Seeding was followed by a four-week drought accompanied by high temperatures and low humidity. This was a devastating fire season for the region and it ended only after more than four inches of rain fell over a two week period at the end of July. This rain was followed by a further drought with temperatures again peaking. Drying winds swept the area from

west to east blowing through the nearby mountain passes. Only three lodgepole pine seedlings germinated and none survived to the end of the period of examination. Periods of relatively high rainfall resulted in accelerated growth of established natural seedlings in the area, but new germinants were scarce or absent.

c. Kananaskis.

Seeding at Kananaskis was followed by little or no rain, moderately high temperatures and occasional frosts. A few germinants appeared in August and fifteen pine survived. Drying winds were common throughout the season and their effect may have prevented germination. The pattern of climatic variation at Kananaskis is almost identical to that at Crowsnest (Blairmore). The same disturbances affected both stations. There was wider daily variation in temperature at Blairmore, with consistently higher maxima and lower minima. Rainfall was slightly higher at Kananaskis. These factors were sufficient to cause the variation in seedling performance between the two stations.

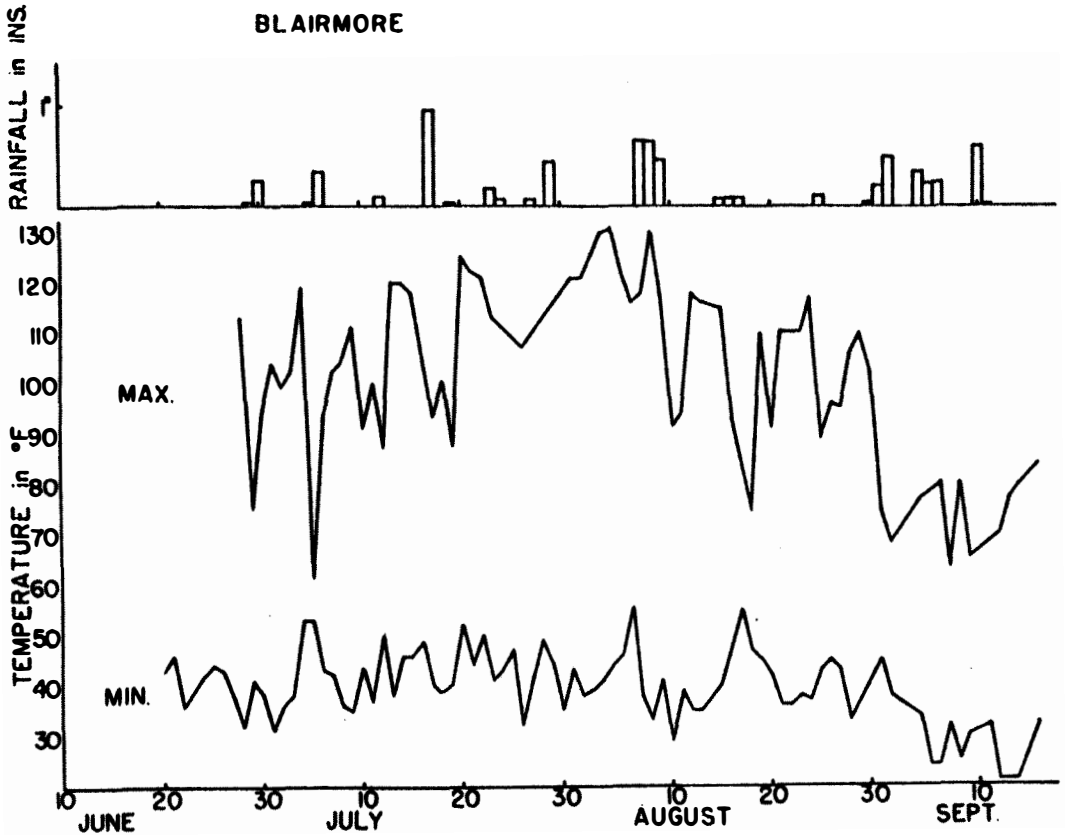
d. Smith.

Conditions for germination and survival at the Smith location were comparatively good. Seedling performance was much better than on the other locations although it was poorer than in 1960. The lodgepole pine was again more successful than the spruce. Rainfall was less evenly distributed than in the previous year and there was a marked increase for the summer months. From June 1st to September 19th, figures were:

1960 - 8.22 inches

1961 - 12.9 inches.

FIGURE 1. CLIMATIC VARIATION - 1961



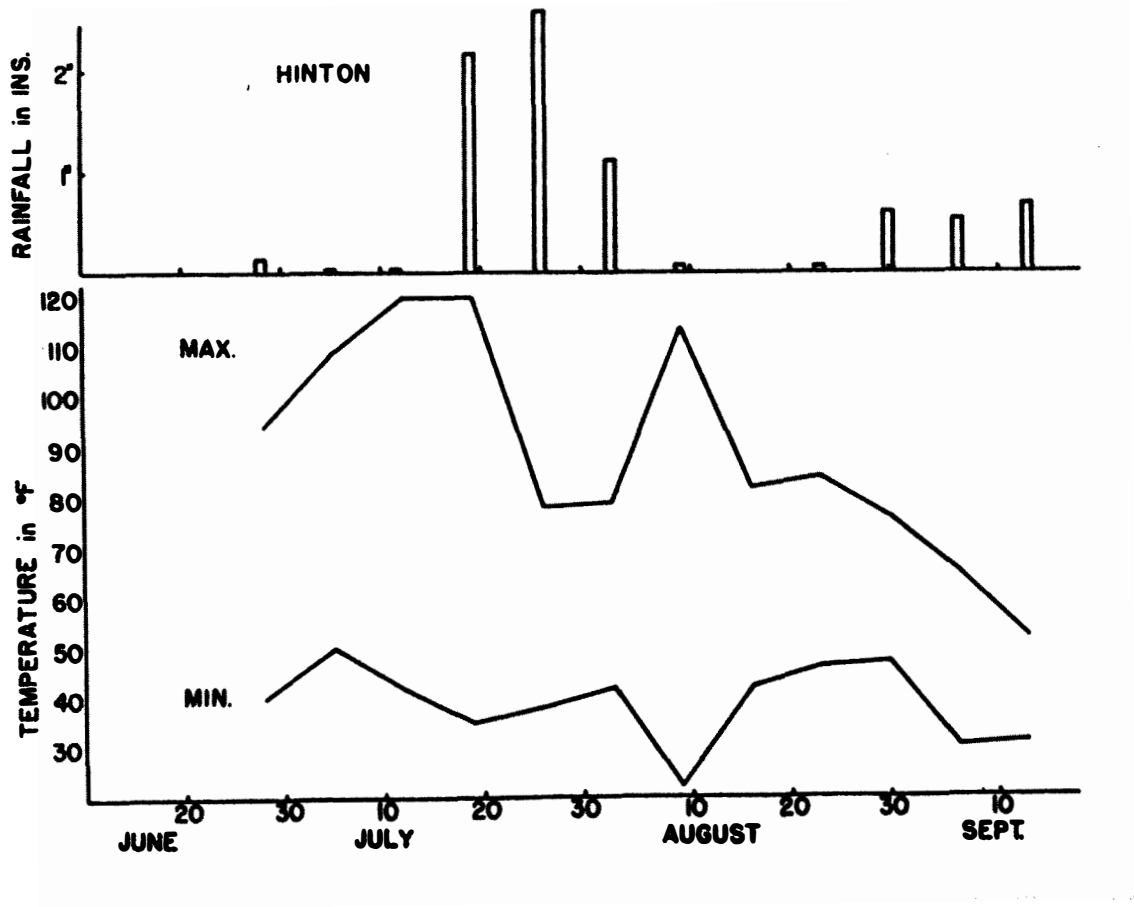
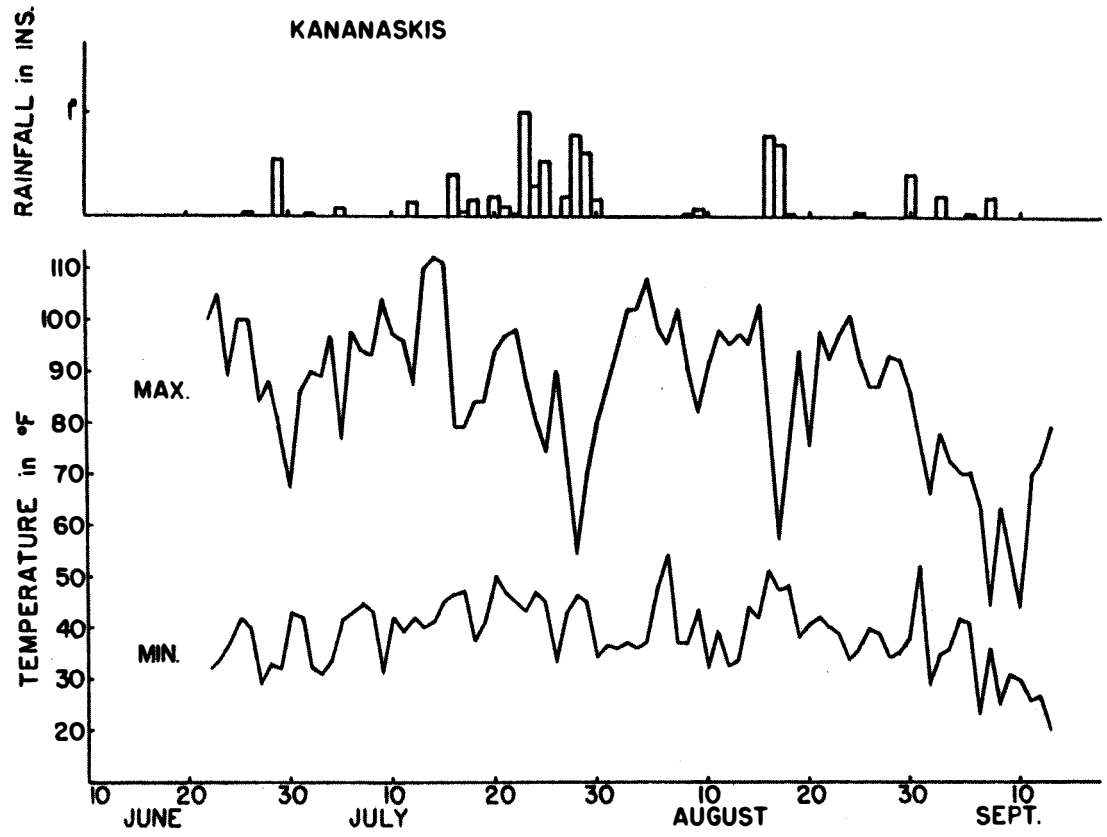
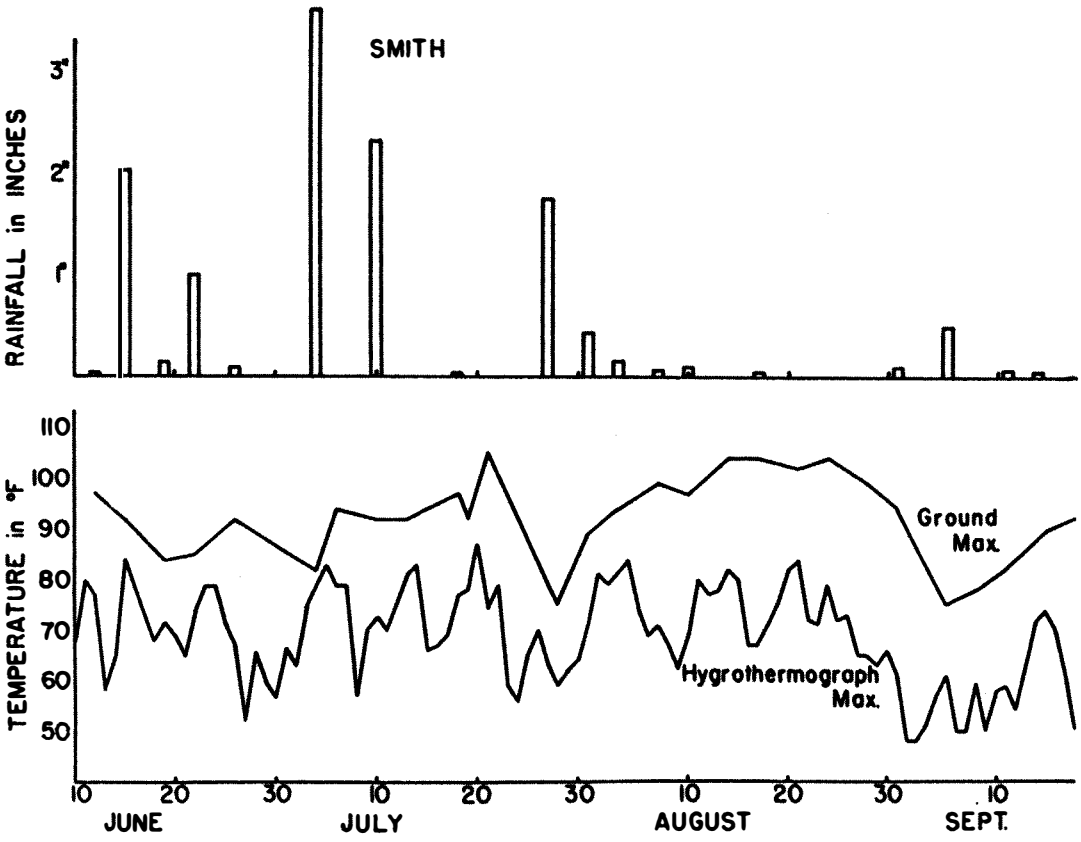


FIGURE 1A. CLIMATIC VARIATION - 1961





In 1961, 11.5 inches of rain fell in June and July alone, causing widespread flooding throughout the region by July 1st. The phytometer trays were severely washed but not immersed for any length of time. Many new emergents, however, died following washing-out. Those surviving into August were well established. Maximum temperatures at ground surface were generally 20 degrees Fahrenheit above those recorded on the hygrothermograph. Survival is presented in Figure 2 for Smith, showing 1960 and 1961 values, and for Kananaskis showing 1961 values.

Curves of pine and spruce mortality are shown for Smith in Figure 3. Also illustrated are relative himidity recorded at 2:00 p.m. each day, and wind movement for the latter part of the season. Early mortality is the result of washing-out following heavy rain, and of the ensuing hot dry period when there was no rain for 17 days. This period from July 10th to 27th was accompanied by low relative humidity, and maximum temperatures of over 100°F. at ground surface. Light rains in August supplied sufficient moisture to maintain growth, and the mortality curves level off during this period. White spruce mortality on August 23rd and September 7th is accompanied by values of less than 40 per cent relative humidity, moderate wind movement, little or no rain, and ground temperature maxima of over 90°F. and 80°F. respectively. The lower maximum at the later date is accompanied by increased wind movement, producing similar severe drying conditions.

The presentation of these data does not reveal significant relationships between climatic variation and seedling survival, but where information for the growing season is complete, it substantiates the trends in behaviour which have been observed to date.

Figure 2.

SEEDLING SURVIVAL

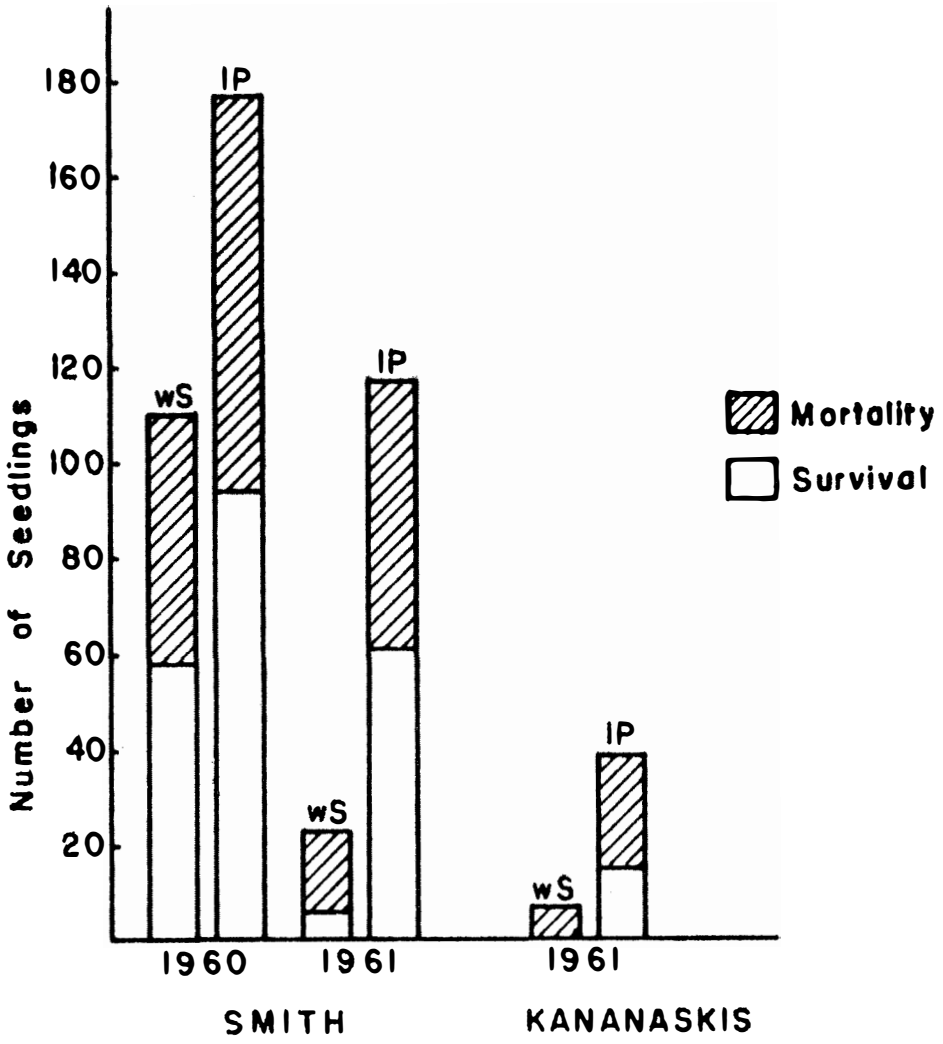
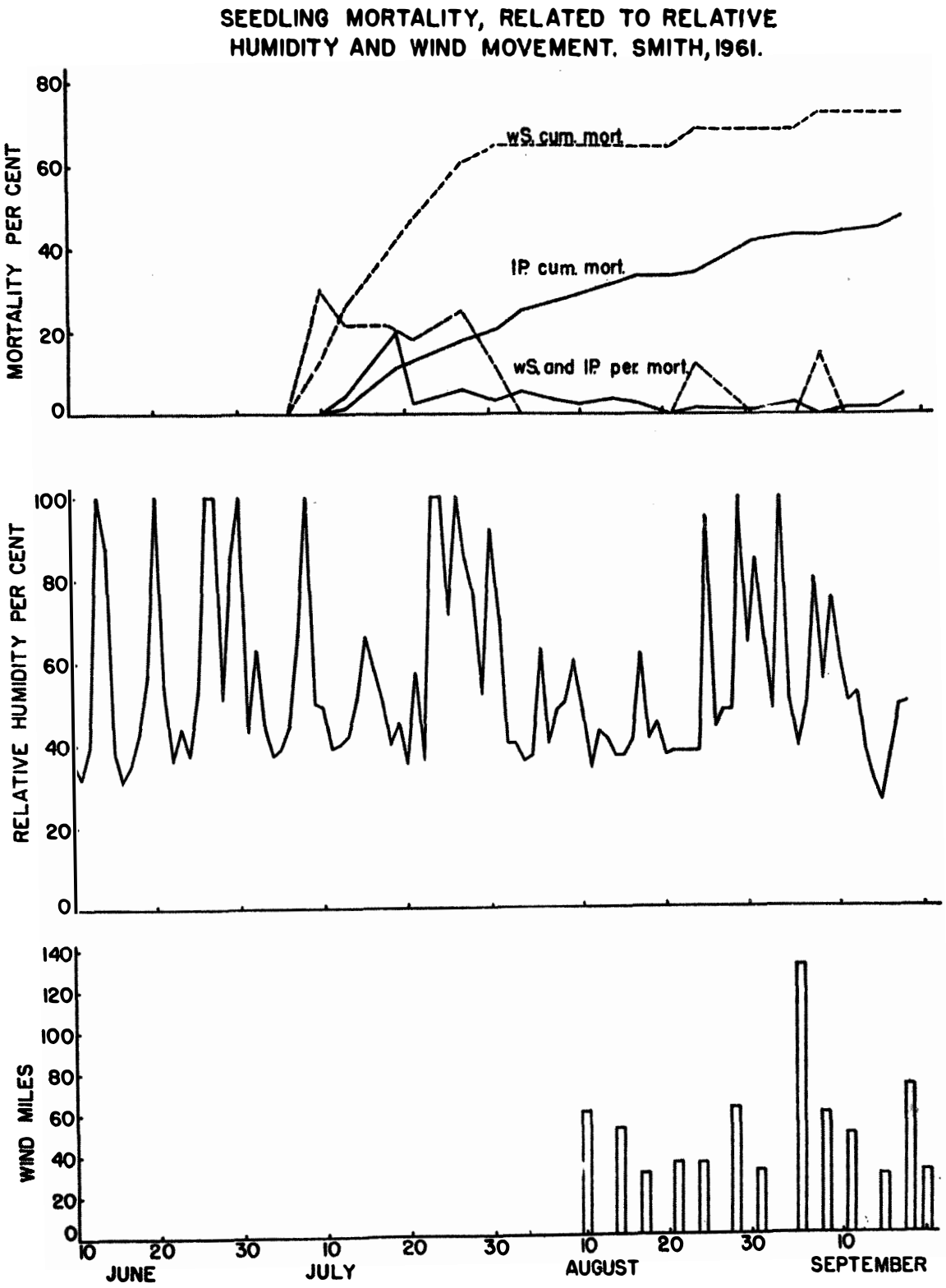


FIGURE 3.


SEEDLING MORTALITY, RELATED TO RELATIVE HUMIDITY AND WIND MOVEMENT. SMITH, 1961.
MORTALITY PER CENT
80
60
40
20
0
wS. cum. mort.
IP. cum. mort.
wS. and IP. per. mort.
RELATIVE HUMIDITY PER CENT
100
80
60
40
20
0
WIND MILES
140
120
100
80
60
40
20
0
10
20
30
JUNE
10
20
30
JULY
10
20
30
AUGUST
10
SEPTEMBER

The general trends of local weather conditions presented in Figure 1 for all locations, supports the opinion that unless the moisture content of the seed can be maintained at a consistently high level through contact with the soil, germination will not take place. Intermittent rainfall in amounts as measured on at least three of the locations does not seem to meet this requirement. This is particularly pertinent where high temperatures and drying winds reduce the effectiveness of rainfall. It appears that little short of the "wet blotting paper" type of seedbed environment will facilitate germination. The phytometer should reflect such conditions as they occur in the field. In order to parallel more closely natural conditions, the phytometer should be sown earlier, giving the seedlings the same chance as natural germination to benefit by further early rainfall. Survival through the early droughts might thus be improved at all locations.

Failure of seedlings on the artificial medium, despite a most promising start, is thought to have been caused by excess application of the total nutrient fertilizer, "Liqui-Life", as a surface dressing. A check will be made with the distributors to improve this treatment.

The performance of the spruce seedlings in the phytometer trays paralleled that of natural seedlings sampled under associated projects at Smith. Spruce survival in the stands examined in 1961 was poorer than in 1960.

FUTURE WORK

Similar records will be kept in 1962. At Smith, advantage will be taken of local Department of Transport meteorological records and readings will commence prior to seeding. Instrumentation will include maximum

and minimum thermometers, hygrothermograph, anemometer and actinograph. Since the artificial medium is so promising, every effort will be made to improve handling techniques for 1962. Provided that the phytometer trays will consistently reflect differences at various locations, it is planned to correlate regeneration performance in the field with phytometer germination and survival levels. As a preliminary step in this correlation a control series of five phytometer trays will be set up nearby under partially-cut stands. This set-up would have been the first part of phase 3 of the study but will now form only a pilot experiment until phase 2 is repeated and complete. By reflecting what constitutes a"good" year for white spruce germination and survival, phytometer values may provide a useful guide to local foresters who are currently working on regeneration problems. It is anticipated that values could be extended to include second year survival.

Instrumentation will be continued at an intensive level at Smith in order to provide information on cause of mortality. Results are integrated with those of other regeneration projects in the area. Once set up, the phytometer is tallied easily and quickly at each recording date. Tally schedule co-incides with that of nearby associated project A-58.