germination brought about by the hot water indicates the removal of some condition that was present and affecting the rate of germination. Thus, while a commercial variety may be commonly known to be free of hard seed, an inhibiting factor(s) may still be present but of insufficient intensity to retard germination.

On the other hand, hard seed is easily recognized in the wild cotton species G. thurberi, since no germination normally takes place within a limited time either in the laboratory or in the field. The seed of this variety is so hard that mechanical scarification of fresh seed will usually give less than 10% germination. Following hot water treatment, germination proceeds at a high rate and a relatively high percentage (it is common to have 10 to 20% non-viable in this species). Sufficient inhibition to germination was removed by the hot water treatment to make its rate almost equal to Acala 4-42.

It is the "hard seed problem" in a commercial variety such as Pima S-1 that causes difficulties for the farmer as well as the breeder. In this variety some of the seeds germinate immediately like Acala 4-42, some very slowly, and some may behave in a similar manner to hard seeded G. thurberi. In some instances percentages of a seed lot fall into the slow germinating or "hard seed" categories depending on the cultural practices under which the crop was produced. Such seed is therefore considered "intermediate" in hard seed quality. Germination of "intermediate" hard seeded Pima S-1, hard seeded G. thurberi, and non-hard seeded Acala 4-42 following hot water were about the same. Hence the hot water treatment essentially removes the hard seed condition in cotton over a range that extends up to extreme hard seededness.

The results also indicate that the treatment is effective up to at least 2 months following treatment. From this, it can be deduced that the treatment has, perhaps permanently, destroyed or removed an inhibitor of germination. Likewise, the similarity in germination immediately after and 2 months after treatment indicates that there is a single primary cause of hard seededness in such widely diverging species of Gossypium as G. hirsutum var. Acala 4-42 and G. thurberi.

While various temperatures, especially low temperatures, have long been known to regulate dormancy in a number of species of seeds, the present application of a relatively high temperature over a short period of time to overcome dormancy is apparently new, especially to cotton. Agronomically and physiologically the lasting effect of the treatment is interesting in that it suggests a rapid removal of a water soluble germination inhibitor, and, or the destruction of a heat unstable one, whose presence completely inhibits or slows an otherwise rapidly germinating seed.

(Immediate treatments with a number of species and lots of cotton seed indicate similar but varying responses following water temperature variations of from 80° to 90° C. for 1/2 up to 2 minutes duration. Acid delinting the seeds is recommended since it assists in obtaining more uniform treatment.)

Materials and Methods

A virgin Norfolk sand known to be free of crimson clover Rhizobium trifolii was screened and air-dried in the greenhouse. Dolomitic lime at the rate of 1 ton per acre, 0-12-22 at the rate of 100 pounds per acre per were thoroughly mixed with this soil. The above rates were calculated, assuming 2 million pounds of soil per acre. New 4-inch clay pots were filled within one-half inch of the top with uniform quantities of the soil-fertilizer mixture. Three adherents-water, black strap molasses at a rate of 1/4 cups per 100 pounds of seed, and black strap molasses at a rate of 3/4 cups per 100 pounds of seed were used. The seeds moistened with these adherents were then thoroughly mixed with 1, 2, and 6 times the recommended amount of a commercial peat-type inoculum, respectively. This treatment caused the seeds moistened with molasses to fall apart so that they could be easily planted with commercial seeders. The inoculated seeds were then planted at a uniform rate in the 4-inch pots of dry soil. In half of the pots, the seeds were not covered. In the other half, enough soil was removed and sprinkled back over the seeds to cover them to a depth of 3/4 inch. The seven watering treatments described in table 1 were begun on Oct. 12, 1954. Four uninoculated checks were provided by planting seed sterilized with Chloxo. All other treatments were carried in the greenhouse in duplicate. Excellent stands were obtained in all pots as soon as the watering treatments began. Greenness ratings, forage yields, forage protein content, and root yields were taken as indices of the success of the various inoculation treatments on Feb. 18, 1955. These data have been analyzed and are presented in table 1.

Results

The data in table 1 indicate that water is as good an adherent as molasses, and covering crimson clover seed is unnecessary for optimum inoculation and growth where planting is followed immediately with adequate rainfall. It often happens that fall-seeded crimson clover germinates after a light shower and then does during the drought that follows. Rains coming later will usually give stands from

IMPROVING THE INOCULATION OF CRIMSON CLOVER PLANTED UNDER UNFAVORABLE MOISTURE CONDITIONS

Most Georgia soils do not carry the Rhizobium trifolii required to inoculate crimson clover. Soils are frequently dry during the fall—the normal planting season for this winter annual legume. Poor inoculation often results when crimson clover is seeded for the first time in such soil. Several workers, including the writer, have experienced fewer failures when syrup or black strap molasses has been used as an adherent for the inoculum carried in moist peat.

In the fall of 1954, the State Highway Department of Georgia became interested in exploring the possibility of seedling crimson clover into recently completed road shoulders and back slopes. From their standpoint, it would be advantageous to seed as soon as a construction job is completed. In many instances, this would require seeding in dry soil that might remain dry for a month or more. Grass and legume seed planted in such soil would, of course, germinate with the first good rain. The clover inoculum, however, might be dead by that time, in which case the clover would fail due to inadequate inoculation. The following experiment was conducted in an effort to discover inoculation and planting methods that would permit seedling in dry soil.