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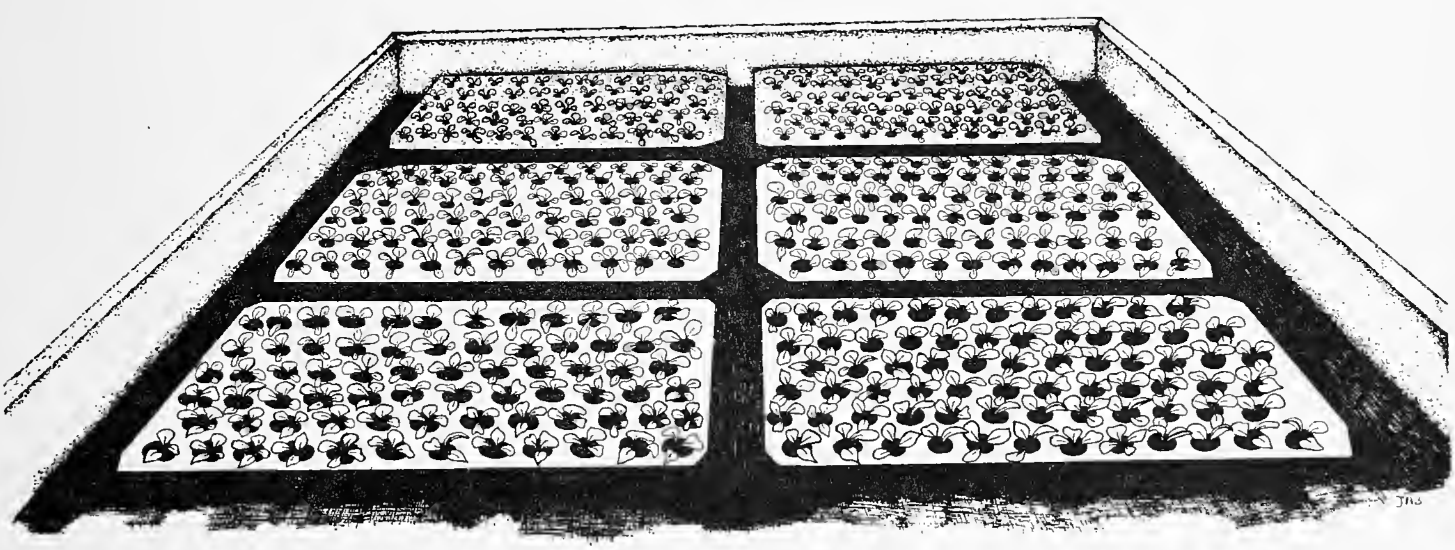

THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION NEW HAVEN

Growing Tobacco Seedlings in Multipot Trays

By H.C. De Roo and G.S. Taylor

Growers of shade tobacco have recently changed their method of growing seedlings. Instead of using broadcast-seeded ground beds covered by sash to produce their seedlings, they have begun using mechanically seeded plastic trays sheltered in plastic houses. Because this is a new method, we have conducted experiments to learn the optimal growing conditions.

The most popular system employs 96-hole Multipots (Multipot Company of America, 3325 Lawndale, Chicago, Ill. 60623). The seeds are coated with clay to increase their diameter to 1.5 - 2mm to allow automatic seeding equipment to be used. Once seeds are in the tray, germination may be affected by environmental factors such as light, water supply and temperature; and by the nature of the potting mixture and fertilization.

To study the effects of the clay shell on germination, we placed 50 unpelleted and 50 pelleted tobacco seeds (strain WS-117, Brown) in each of five petri dishes at 23°C (75°F). Our daily counts show that germination of pelleted seed is delayed about three days. However, the effect of pelleting on overall germination (98%) was negligible. (Fig. 1.)

Water. Salts in water can affect the growth of seedlings. Well water may contain nitrate or other salts which, together with fertilizer, may increase soluble salts in the soil solution to injurious levels. Water with a Solubridge reading below 0.75 millimhos/cm and a pH near 6.0 is satisfactory. We also found that it is important for the trays to be level. If they are not, some cups will flood and others will dry out. Thus, some seedlings may die from too much water and others in the same tray may die from lack of water.

Light. To test for reaction to light we placed 100 seeds on wet filter paper in each of four petri dishes. Two dishes were wrapped in transparent plastic and two in black plastic sheeting. Germination at 20°C (70°F) is shown in Fig. 2. Darkness retarded germination, but the

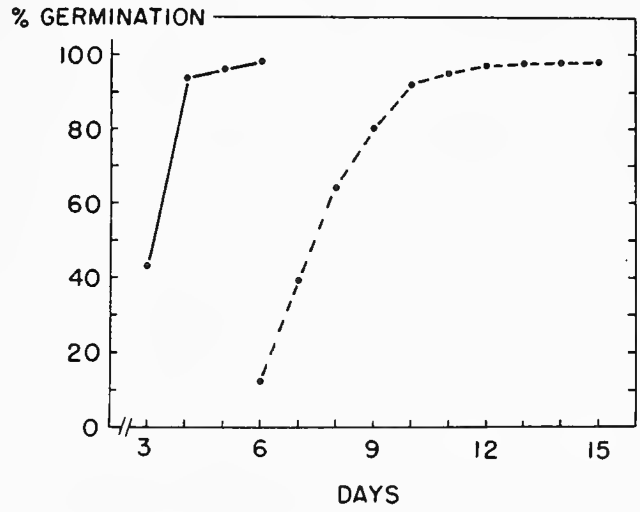

Fig. 1. The germination of 250 unpelleted (unbroken line) and 250 pelleted (broken line) shade tobacco seeds moistened and incubated at 23°C (75°F).

final germination rate was the same for seeds in the dark as for seeds in the light.

Temperature. Although tobacco seed is tolerant of temperatures as high as 35°C (95°F), satisfactory germination occurs at 20°-26°C (70°-80°F) (5). We placed two petri dishes containing 100 pelleted seeds each in a germination chamber at 24°C (76°F). After 7 days they were removed to a greenhouse with a minimum night temperature of about 15°C (60°F). Two other petri dishes containing 100 pelleted seeds each were placed in the greenhouse immediately for comparison. Fig. 3 shows that germination is earlier at the higher temperature. However, after 24 days, the overall germination rate was the same for both treatments.

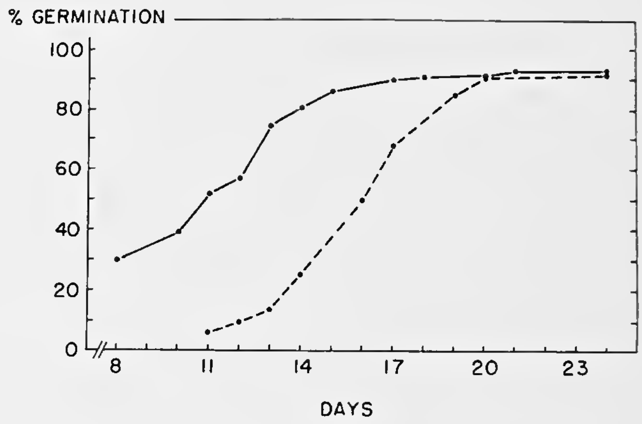

Fig. 3. The germination of 200 pelleted tobacco seeds that were moistened and incubated at two different starting tempertures: 7 days at 24°C (76°F), thereafter in a greenhouse at a minimum night temp of 15°C (60°F) (unbroken line); started and kept in a greenhouse at a minimum night temp of 15°C (60°F) (broken line)

COMPOSITION OF MIXES

Tobacco germinates and grows best in a relatively fine textured, uniform medium. A good medium is openstructured and well-aerated, but still capable of holding water and moving it by capillarity. A good medium also should be free of insects, pathogenic organisms and weed seeds, and be light in weight to facilitate handling.

Chemical Properties. Standard media are made up of sphagnum peat moss, combined with sand or perlite, and some vermiculite. As these materials are generally free of pathogens, weed seeds, and insects, they do not have to be sterilized. The media are amended with lime, gypsum, and superphosphate, and supplemented with standard fertilizer materials.

The Cornell peat-lite mixes, (2) containing peat and vermiculite or perlite are satisfactory for tobacco from germination to transplanting. These mixes are amended with 5 lbs of ground limestone, 1-2 lbs of 20% superphosphate, and fertilized with 1-1.5 lbs of calcium, potassium, or ammonium nitrate per cu yd. Two to three oz of a wetting agent, combined with a few gallons of water, are added to reduce dust and facilitate wetting. Jiffy Mix, Premier's Pro Mix, and Heco Mix are commercially available alternatives. The principal ingredient of these mixes is peat that has been limed and fertilized. We used Heco mix in our trials because it is readily available and is used by several tobacco growers.

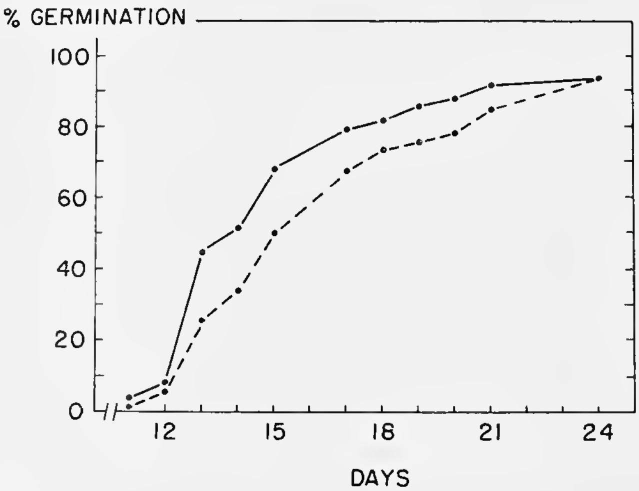

Fig. 2. The germination of 200 pelleted tobacco seeds moistened and incubated at 20°C (70°F) in the light (unbroken line) or in the dark (broken line).

Nutrient analysis using Morgan's methods (6) indicated that Heco mix generally contains too much fertilizer. High fertilization is shown by a high concentration of soluble salts. We found soluble salt levels of about 2.2 millimhos/cm using a Solubridge according to the saturated-soil-extract method, which measures electrical conductance at 25°C (1). We have found that tobacco seed germinates best at a salt index of 0.8; seedling development is satisfactory when fertilization does not raise the salt index beyond 1.8, a level which allows ample nutrients. The pH of the Heco mix varied between 5.3 and 6.2, which is satisfactory.

An experiment clearly demonstrated the inhibitive effect of a high salt concentration. We diluted Heco mix with 1 part and with 3 parts of peat and compared growth in these mixes to growth of seedlings in undiluted Heco mix and in unfertilized peat moss. We added lime to all media to bring their pH to the 5.3 of the Heco mix. No fertilizer was added. In half of two 96-hole Multipot trays 12 cups were filled with each medium and seeded with 2 pelleted seeds per cup. Thus, there were four replicates. The trays were placed in the greenhouse on

June 3rd for 10 weeks. The soil was wetted with tapwater as needed, and liquid fertilizer (Rapid-Gro) was applied twice.

At five and one-half weeks, leaves of seedlings in undiluted Heco mix were less than half as long as those in the other three media. Clearly, they were stunted by the high salt content (2.8 millimhos/cm). The number of plants and the total fresh weight in each cup are shown in Table 1. The best growth was obtained with a mix of 1 part Heco and 1 part peat.

Table 1. Growth of tobacco during 10 weeks in multipot trays containing Heco mix and various dilutions with sphagnum peat moss.

	5½ weeks	10 weeks	
Variations	Longest leaf (mm)	Mean fresh wt per cup (g)	Mean fresh wt per plant (g)
1 Heco: 0 Peat	0.72	1.54	0.77
1 Heco: 1 Peat	1.64	2.31	1.24
1 Heco: 3 Peat	1.65	1.94	1.07
0 Heco: 1 Peat	1.43	1.93	1.15
L.S.D.	0.27		

Physical Properties In other tests we attempted to create an optimal physical environment for seed germination and seedling growth. We experimented with peat and rice hull amendments to keep the media loose and open-structured after heavy watering. The mixes used and their measurable physical properties are shown in Table 2. As indicated by the bulk densities (BD), all mixes are light in weight. The total pore space (TPS) shows that they are also porous. We consider 75% to be sufficient.

Retention of water by the media, following a saturating watering, provides additional information about their suitability for tobacco seed germination and seedling growth (3, 4). Since oxygen is necessary for germination and root growth, an important standard is the amount of air that can enter the pore space after drainage of free water by gravity. We measured this air volume by measuring the water retained at a low tension of 15 cm. The results in Table 2 (column AIR) indicate that, after irrigation, the aeration of the pure peat mixes, Heco and 1:1 Heco-peat is less than the 15% we consider sufficient. A range of about 15-25% air-filled pore space is desirable.

The amount of water retained by the mix that is readily available to roots is also an important property. The RAW column of Table 2 indicates that rice hulls did not significantly reduce the volume of readily available water. The data in column WBC indicate that the all Heco mix released less water between tensions of 50 and 100 cm to the roots than did most of the other mixes, although more water was still available.

From these data it appears that a rigid material that does not decay readily, such as rice hulls or perlite, is needed to keep the peat moss of Heco (medium 1) and Heco-peat (medium 2) open-structured and well aerated.

Surface characteristics of the media such as texture and structure also have a great effect on the germination of pelleted tobacco seed. If, during the seeding of a tray, a pelleted seed lands on a rice hull, germination will often be delayed, abnormal, or incomplete because the developing rootlet encounters the rigid rice hull and is prevented from penetrating the medium. This action, combined with the stretching of the hypocotyl, makes the clay shell still clinging to the seed leaves (cotyledons) appear to "pop up" from the medium surface. To counteract this effect we covered the seeded rice hull mixtures with a thin layer of screened, fine, peat moss. A thick layer will become solid after irrigation and will delay or restrict germination and stimulate the growth of algae.

For our observations of this aspect of germination we used the first four media shown in Table 2. Media 1, 2, 3, and 4 were amended to a pH of about 5.6, with respectively 0.5, 1.5, 2.0, and 2.5 lbs of hydrated lime per cu yd of mix. Each cup was seeded with one pelleted seed.

Table 2. Physical characteristics of various media for tobacco seed germination and growth to transplant size, or volume weight (x 62.42 = dry weight in lbs/cu ft); TPS = total pore space, % by volume; AIR = air space at 15 cm water tension; RAW = readily available water, released between 15 and 50 cm water tension; WBC = water buffer capacity, water released between 50 and 100 cm tensions.

Media			BD	TPS	AIR	RAW	WBC
No.	Ingredients	Vol. ratios	g/cc	Vol. %			
1.	H	—	.11	92	9.8	22	2.4
2.	H:P	1:1	.09	94	5.2	20	6.4
3.	H:P:R	3:3:2	.12	91	22	20	4.3
4.	H:P:R	2:2:1	.11	93	22	17	6.9
5.	H:R	6:1	.11	93	25	18	5.2
6.	P:V:G	2:1:1	.14	88	28	15	4.5

After seeding, one flat of medium 3 and 4 was covered with a thin layer of fine screened peat moss. The flats were kept in a greenhouse with a minimum night temperature of about 15°C (60°F). After 6 days we added another set of flats. The observations and counts made during both experiments were averaged and are summarized in Table 3. About 2 weeks were required in January-February 1975 for the first seeds to germinate. The "popping up" count of media 3 and 4 vs. media 3C and 4C clearly shows that the thin cover of fine, screened peat moss nullified the undesirable effect of the rice hulls. The "popping up" of medium 1 was probably caused by the relatively high concentration of the Heco mix which inhibited the penetration of this medium by the rootlets. A dilution with unfertilized peat moss reduced the "popping up" from 25% to 9%.

The germination percentage after 5 weeks tends to reflect the abnormal, early germination in the various media. Although all germination percentages are acceptable, it is clear that those in the rice hull mixes were improved by the surface dusting and in the Heco mix by dilution with peat moss. The uniformity of the stand of the tobacco seedlings was evaluated after 6-7 weeks. The ratings on a scale of 1 to 4 reflect the germination pattern. The higher the "popping up" percentage, the lower the germination tends to be; and the more irregular is the size of the tobacco transplants.

USE OF FERTILIZERS

Finally, we observed a fertilizer problem which we believe is related to the aeration problem presented in Table 2. During the tobacco seedling season of 1977, extensive periods of cloudy, relatively cold weather were experienced. As a result, seed germination and seedling growth was slowed and many Heco mix samples were submitted by growers for soil testing. The nitrogen levels generally were high, particularly in ammonium nitrogen, which are known to be phytotoxic at high fertility levels. Under conditions of low light intensity, cool temperatures, and the rather low air and high water contents of the Heco mix, oxidation of the ammonium nitrogen to nitrate nitrogen by soil bacteria was apparently suppressed. Under such weather conditions, fertilizers high in nitrate nitrogen should be more satisfactory. An example might be a 15-0-15 made up of 1 part potassium nitrate and 2 parts of calcium nitrate (by wt). Commercial grades such as 16-32-16 or 20-20-20 contain about 65 to 72 percent ammonium nitrogen and might be less satisfactory. For continuous fertilization every 1 to 2 weeks, about 2 lbs. of 15-0-15 to 100 gallons of water should be satisfactory.

SUMMARY

An open-structured medium that did not collapse and stayed well-aerated, and that was amended and fertilized in a controlled manner, produced satisfactory tobacco seedlings.

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Table 3. Germination of pelleted tobacco seed and seedling growth as affected by media and treatment. Media mixtures are described in Table 1; Pc = seed covered with screened fine peat moss. popping up = pelleted seed raised above media surface, adversely affecting germination. Index 1 = very uneven; 2 = uneven; 3 = moderately uniform; 4 = uniform.

Media	Ingredients	Popping up %	Germination %	Seedling development
1	All H	25	78	2
2	1 H: 1 P	9	82	3
3	1 H: 1 P: R	15	74	2
4	2 H: 2 P: 1 R	17	81	2
3c	1 H: 1 P: 1 R+Pc	0	82	3
4c	2 H: 2 P: 1 R+Pc	0	88	3