Subirrigation and Fertilization Of Cigar-Wrapper Tobacco Beds[1]

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Transparent plastic film used as plant bed covers for tobacco seedlings the time required from seeding to transplanting and provides protection from low temperatures. However, the plastic must be removed for water and pesticide applications. Perforated plastic makes it possible to apply water without removing the plant bed cover, but pesticides would be difficult to apply effectively without cover removal. A subirrigation system would eliminate the need to remove covers for irrigation. Fungicides and insecticides would not be washed off during irrigation, thus should reduce the number of applications of these materials. Inflated plastic covers now coming into use should be easily adapted for subirrigation.

Smith et al. (2) found that under plastic lower rates of fertilizer were required for maximum seedling production than under cloth, and higher fertilizer rates retarded germination. Steffens and Miles (3) observed that each increase in fertility level resulted in higher levels of soil NO_3-N, potassium, and electrical conductivity (soluble salts) in plastic-covered beds as compared with cloth-covered beds. Conductivity and potassium levels were generally higher for the higher fertilizer rates, but differences among rates were small in cloth-covered beds as compared with plastic-covered beds. A highly significant negative correlation between percent stand and conductivity of soil extract was noted by Hoyert (1). The plastic cover prevents leaching from heavy rains and water from subirrigation moves soluble salts to the surface. Therefore, fertilizer rates were expected to be an important factor in germination of tobacco seeded under plastic with subirrigation.

Materials and Methods

This experiment was conducted in 1968 at the North Florida Experiment Station, Quincy. Two cold frames (four feet by 30 feet) were constructed and provided with a transparent nonperforated plastic cover of four mil thickness which could be removed when temperatures were unfavorably high. Six 30-foot lengths of perforated plastic pipe were placed underground in such a manner as to provide subirrigation for the plant beds. Three pipes were located in each bed on 16 inch centers. Water was supplied by gravity flow from a sunken tank with a float system to control the water level, which was maintained just high enough to keep pipes full. Pipes were intended to be seven to eight inches below the surface but actually varied from four and one-fourth to nine and one-half inches. This can be corrected with more precise grade control and increased soil compaction in the trenches provided for the pipes. Actually the variation of pipe depth was fortunate because it made possible a comparison of the effects of pipe depth on germination.

Five fertilizer treatments were applied January 22 in randomized complete blocks with four replications. Fertilizer materials were mixed into the soil to a depth of three inches and all plots were uniformly seeded the same day with *Nicotiana tabacum* cv. Florida 17 at the rate of one-third ounce per 100 square yards. Fertilizer treatments were as follows: (1) N = 400 lbs/A (all organic), P_2O_5 = 474 lbs/A, K_2O = 298 lbs/A and total mix was applied at the rate of 1.50 pounds per square yard. (2) N = 134 lbs/A, P_2O_5 = 180 lbs/A, K_2O = 300 lbs/A and total mix was applied at the rate of 0.24 pound per square yard [N-P_2O_5-K_2O were supplied exclusively by ammonium polyphosphate (15-60-0)[3] and potassium nitrate (15-0-44)]. (3) N = 250 lbs/A (all inorganic), P_2O_5 = 200 lbs/A, K_2O = 300 lbs/A and total mix was applied at the rate of 0.36 pound per square yard. (4) N = 100 lbs/A (all inorganic), P_2O_5 = 80 lbs/A, K_2O = 120 lbs/A and total mix was applied at the rate of 0.17 pound per square yard. (5) N = 133 lbs/A (all organic), P_2O_5 = 158 lbs/A, K_2O = 100 lbs/A and total mix was applied at the rate of 0.50 pound per square yard. Organic nitrogen was supplied as cottonseed meal (24%), tungnut meal (34%) and urea-formaldehyde (42%). Inorganic nitrogen was supplied as ammonium nitrate and potassium nitrate. Concentrated superphosphate (47% P_2O_5) was the phosphorus source in treatments one, three, four, and five. Potassium sulfate was the potassium source in treatments one and five. Treatments two, three, and four had potassium nitrate as the source of potassium. In addition each treatment had MgO applied as magnesium sulfate at the following rates (1) 240 lbs/A, (2, 3 and 4) 50 lbs/A and (5) 80 lbs/A. Each fertilizer plot covered an area three feet by four feet.

The rate of capillary rise was determined from soil samples taken from the plot area before initiating the experiment. Air-dry soil taken from the zero to 6 inch depth was placed in duplicate one-inch diameter glass columns with the lower

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[3] *An experimental fertilizer courtesy of The Tennessee Valley Authority, Muscle Shoals, Alabama.*

end submerged in a pan of water. The distance from free-water level to the wetting front was measured periodically to determine the rate of capillary rise.

Soil samples for conductivity measurements were collected March 22. Six cores one and three-fourths inches in diameter and one inch deep were obtained from each plot. Fifty grams of air-dry soil were placed in 250 ml of deionized water and shaken intermittently by hand for one hour. Samples were then filtered and the conductivity of the filtrate measured with a dip cell and conductivity bridge. In addition, water soluble and ammonium acetate (pH 4.8) extractable phosphorus levels were determined colorimetrically for the zero to one inch depth of soil.

Percent stand as used in this report was derived March 27 from two independent ratings and represents the percent of ground cover at that time. Perhaps, percent of ground cover would be a more exact term, however, the amount of ground cover was directly related to plant population. Therefore, percent stand seems to be a more meaningful expression. Plant count would have produced additional information, but it did not appear to be enough to warrant the time involved.

The average depth of subirrigation pipe in each replication was determined at the end of the study. Narrow trenches were dug in the second and fourth plots of each replication so as to expose all three pipes and several depth to pipe measurements were taken and averaged.

Table 1. Summary of fertilizer treatments, acre rates of major nutrient elements or oxides of the elements and rate of fertilizer mix applied in each treatment.

Treatment[a]	Pounds per Acre N	P_2O_5	K_2O	Pounds per square yard
1. Organic-N[b]	400	474	298	1.50
2. (NH_4)-polyphosphate and KNO_3	134	180	300	0.24
3. Inorganic-N[c]	250	200	300	0.36
4. Inorganic-N	100	80	120	0.17
5. Organic-N	133	158	100	0.50

[a] *Concentrated superphosphate (47% P_2O_5) was the phosphorus source in all treatments except No. 2.*

[b] *Organic-N was supplied as cottonseed meal (24%), tungnut meal (34%) and urea-formaldehyde (42%).*

[c] *Inorganic-N was supplied as NH_4NO_3 and KNO_3.*

Table 2. Effects of fertilizer treatments on stand, soluble salts, water soluble P and ammonium acetate extractable P in a tobacco plant bed.

Treatment	Percent[a] stand	Specific conductance 1:5 soil-water extract μmhos/cm.	ppm P in Soil: Water soluble	NH_4OAc(pH 4.8) extractable
1	20a	1020	42	80
2	83 b	518	31	63
3	53ab	648	31	64
4	72 b	477	16	54
5	54ab	552	20	63

[a] *Treatment means for percent stand followed by different letters are significantly different at the 5% probability level according to Duncan's new multiple-range test.*

Results and Discussion

A brief summary of fertilizer treatments is shown in **Table 1.** Treatments two and four produced the greatest plant density. As shown in **Table 2,** these treatments were lowest in conductivity of soil-water extract. High salt concentration appeared to be the primary factor causing poor stand in treatment one. Treatment one conforms to common practice of plant bed fertilization in the Florida-Georgia cigar-wrapper tobacco area. Percent stand for treatments three and five were practically the same, however, soluble salts in treatment three were about 500 ppm higher than treatment five. It was suspected that decomposition products from the organic nitrogen sources adversely affected germination in treatments one and five. Treatments three and four were different rates of the same fertilizer materials, and the difference in percent stand between these treatments appeared to be due to a difference in soluble salt content of the soil. The soil-water extract of treatment two had an electrical conductivity between those of treatments four and five, but percent stand was greater for treatment two than for either four or five. **Table 2** shows that treatment two had almost twice as much water soluble P in the soil as treatment four but only about 1.2 times as much NH_4OAc extractable P. The highly soluble ammonium polyphosphate probably furnished a higher proportion of water soluble P than the concentrated superphosphate throughout the study.

Where subirrigation has been employed in the production of tobacco seedlings under plastic high rates of fertilizer reduced germination. Apparently fertilizer rates of less than 0.30 pound per square yard should be used if inorganic sources of nitrogen are applied and less than 0.50 pound per square yard in the case of organic nitrogen. These figures may vary with soil texture and fertility levels prior to fertilizer application.

Depth of subirrigation pipe below the soil surface had a very significant effect on germination of tobacco seed. Each point on the curve in **Figure 1** is the average pipe depth in a replication. In this particular soil (Norfolk loamy fine sand) the highest percent stand was obtained where the average depth to pipe was 6 inches. The reason for this is shown by the rate of capillary rise in **Figure 2.** The rate curve levels off just past 6 inches, rising very slowly thereafter. Therefore, rate of moisture movement was not great enough above this point to provide an adequate supply for maximum germination. Below this point the soil became wetter and germination was reduced. The data indicate that the proper depth for subirrigation can be determined from laboratory measurements of rate of capillary rise in soil samples. Best results were obtained at the inflection point depth on the capillary rise curve. It is assumed that this point would be most satisfactory with other soils of medium to light texture. However, inflection point depth may be too deep for heavier textured soils.

Tobacco transplants can be successfully produced with subirrigation under plastic if certain precautions are taken. Rate of fertilizer application should be relatively low. Depth of pipe below the soil surface should be carefully controlled and pipes should be installed reasonably level. A sunken tank with a float system appears to be a satisfactory method of supplying water and the water level should be high enough to keep the pipes full at all times until germination is complete. After plants emerge, the water supply may be turned off and the soil allowed to dry some to promote root development. Subirrigation can be continued intermittently after plants have emerged.

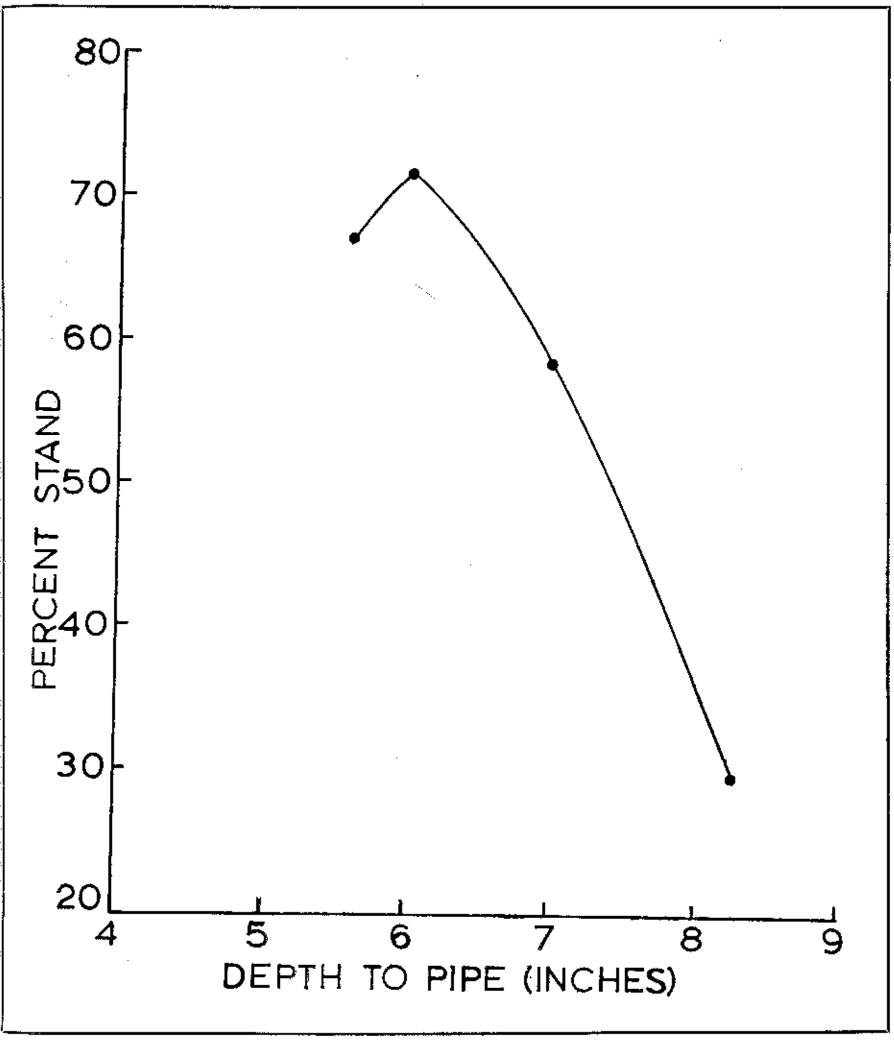

Figure 1. Effect of depth of subirrigation pipe on plant stand in a tobacco bed.

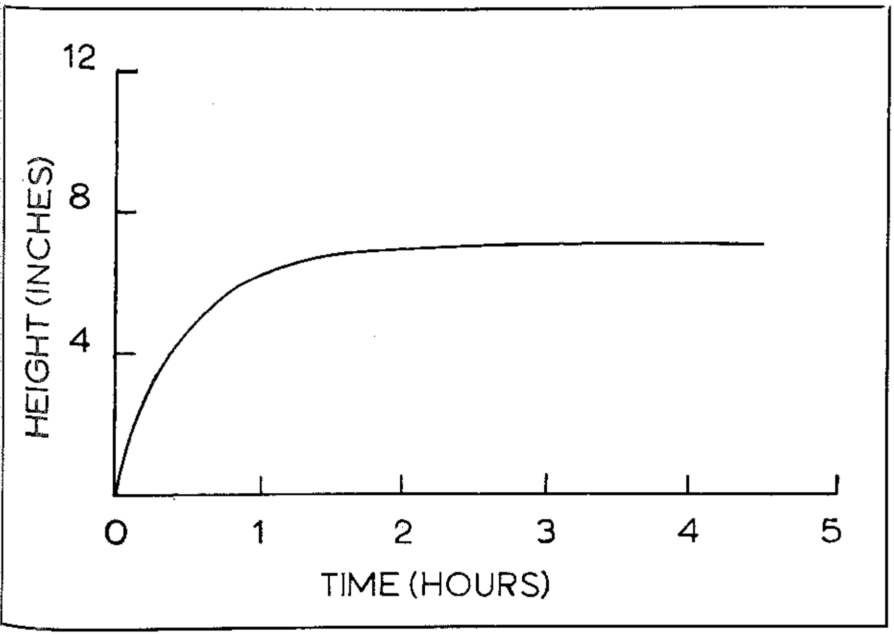

Figure 2. Rate of capillary rise in soil columns from 0 to 6 inch layer of tobacco plant bed soil.

Summary

The subirrigation system consisted of perforated plastic pipe 16 inches apart placed lengthwise of the plant bed under the soil surface. Pipes were connected to a sunken tank with water-level controlled by a float mechanism. A non-perforated transparent plastic cover was used to protect the plants from low temperatures.

Five fertilizer treatments replicated four times were applied. Two of the treatments were different rates of a formulation containing all organic nitrogen, 2 treatments were different rates of a formulation containing all inorganic nitrogen and 1 treatment had N-P-K supplied by ammonium polyphosphate and potassium nitrate. Maximum plant density was obtained with ammonium polyphosphate and potassium nitrate. Poor germination occurred with the higher rates of fertilizer due to excessive soluble salts.

A pipe depth of 6 inches produced the highest percent stand for this particular soil (Norfolk loamy fine sand). This depth is in agreement with capillary rise data taken from air-dry soil samples placed in glass columns with the lower end in water.

Literature Cited

1. Hoyert, J. H. Germination (emergence) of tobacco seed and its relationship to total soluble salts as measured by electrical conductivity of the soil. Tobacco Science Vol. XII: 35-36, 1968.
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