Effects of Chlorethanol and Thiourea on the Germination and Relative Yield of the Yam (*Dioscorea alata*) L.[1]

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INTRODUCTION

Yams are an important article of our diet and bring relatively good prices in stores in Puerto Rico. Florido[3] yam (*Dioscorea alata*) L. is one of the most widely and commonly planted varieties in the Island, and is perhaps second in popularity to the Habanero variety. In general, yam seeds (tubers) are noted for their prolonged rest or dormant period. In the Florido variety it is considered necessary to wait for about 3 or 4 months after harvest, before they can be expected to germinate after planting.

Dormancy is convenient from the marketing and storing standpoint, because it gives the farmer more time to dispose of the crop. Dormancy can be increased further by piling the newly harvested roots in cool, shady places and subsequently covering them either with sand or charcoal dust. Paraffining them also tends to increase their storage life. However, agronomically speaking, dormancy considerably limits the opportunity or possibility of initiating new plantings from freshly harvested yams. In fact, after selecting the seeds for the next planting, farmers have to keep them stored throughout the duration of the prolonged rest period of some months. In addition to the inconvenience of waiting during the long storage periods the seed tubers are exposed to pests and diseases. Customarily farmers wait until the seed start to germinate before they are planted in the field. Yam seeds are selected from among the smallest roots, usually weighing 6 to 8 ounces each.

OBJECTIVE

This long delay in starting new plantings, caused by the long dormancy of the seed, forces yam growers in Puerto Rico to plant at about the same date within all their respective areas. Accordingly, the harvesttimes for the current-year crops from all areas more or less coincide. This creates

[1] The word "yam" as used here is the English equivalent of the *ñame* in Spanish or *nyami* in Senegalese to designate the tuberous root from *Dioscorea* spp.

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[3] The Florido variety was being used in research along other lines and a good supply of seed was at hand for these studies. It should be noted that other varieties have the same habit of long dormancy that is so well known in Florido.

relatively low prices to the growers, since their produce will reach the market in large quantities all at the same time. This unfortunate glut is wasteful and results in rot and market losses. If any high prices are obtained, they will exist for short periods only at the beginning and at the end of the cropping season, when yams are scarce. Thus, overcoming the rest period in the Florido or any other important yam variety by some chemical means would be of considerable economic importance to farmers. By so doing it would be possible for them to schedule or spread their future plantings through a longer season, which would have a corresponding effect upon the harvesttime and market outlook. Such was the major objective of this investigation.

MATERIALS AND METHODS

Chemicals have been extensively used to solve dormancy problems in other crops, such as: Potato tubers, gladiolus bulbs, and Jerusalem-artichokes. Quite a number of chemical products have received attention from research workers in this respect (*1*)[4]. Among them the following can be mentioned: Ethylene chlorohydrin, (chlorethanol); sodium, potassium, and ammonium thiocyanates; thiourea, ether, ethylene, and chloroform. The dip, soak, and vapor methods were studied in evaluating their effectiveness.

Work was started in 1955 at this Station to determine whether a similar response could be induced in the Florido yams through application of chemicals, and two were selected as very promising for this purpose, ethylene chlorohydrin and thiourea. However, in a preliminary test Florido yam had not responded to the separate or individual applications of either chemical. Similar results had previously been secured by Denny (*4*) with some gladiolus varieties. On the other hand, when he treated them simultaneously with the chlorethanol and thiourea solutions, they germinated promptly. Following Denny's approach Florido yams were used to study the effects of more detailed consecutive treatments with the chemicals.

Each chemical was dissolved in water at three different concentrations: Chlorethanol at 40, 50, and 60 ml./liter of solution and thiourea at 0.5, 1, and 2 percent. The above sets of solutions were factorially combined into nine different treatments, all of which are shown in table 1.

A group of 50 medium-sized uniform yams were treated under each combination of solutions. They were first immersed in the chlorethanol solution for 5 minutes, after which they were transferred to the corresponding thiourea solution where they remained for 2 hours. One lot was soaked in tapwater without chemicals for 2 hours also. At the end of the soaking

[4] Italic numbers in parentheses refer to Literature Cited, p. 208.

TABLE 1.—*Effect of treatments on the germination and number of sprouts developed by Florido yams, 1955*

Treatments	Yams treated	Germination and sprouts by date					Average sprouts per yam	Yield (cape)[1]
		Jan. 31	Feb. 4	Feb. 25	Mar. 23	Apr. 30		
	Number	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Pounds*
Chlorethanol 40 ml./liter of solution, thiourea 0.5-percent solution	50	1	4	14	30	149	2.98	18
Chlorethanol 50 ml./liter of solution, thiourea 0.5-percent solution	50	8	11	22	37	158	3.16	17
Chlorethanol 60 ml./liter of solution, thiourea 0.5-percent solution	50	10	12	30	57	215	4.30	22
Chlorethanol 40 ml./liter of solution, thiourea 1-percent solution	50	1	1	12	23	171	3.42	14
Chlorethanol 50 ml./liter of solution, thiourea 1-percent solution	50	3	7	19	31	201	4.02	22
Chlorethanol 60 ml./liter of solution, thiourea 1-percent solution	50	5	6	17	33	170	3.40	26
Chlorethanol 40 ml./liter of solution, thiourea 2-percent solution	50	8	15	31	58	211	4.22	24
Chlorethanol 50 ml./liter of solution, thiourea 2-percent solution	50	4	12	28	43	180	3.60	28
Chlorethanol 60 ml./liter of solution, thiourea 2-percent solution	50	3	15	29	43	184	3.68	12
Check	50	—	—	—	4	113	2.26	4

[1] Preliminary harvest or "cape" of yams is normally made about 8 months after being planted.

period yams were removed from the solutions or tapwater and placed in paper bags and labelled. Those soaked in tapwater were kept in the open. The rest, after soaking and then drying, were stored for a period of 24 hours in a tightly closed compartment in the laboratory. Next day (Jan. 7, 1955) they were planted in the field according to established agronomic practices.

Periodic sprout counts were made as sprouts emerged from the soil. This was carried on for 5 months and then discontinued. Eight months from the planting date a "cape" was performed. A cape is the usual preliminary harvest of well-developed yams from good vines approaching maturity. These are often somewhat out of season and are sold at a high price, or may be saved for planting purposes. Roots from the cape were weighed and the weights considered as a criterion to evaluate the effect of treatments upon yields.

RESULTS

Table 1 shows the data gathered on the effect of the various treatments on the germination, number of sprouts, and yield of Florido yams. As can be observed, all the chemically treated yams, irrespective of the chlorethanol-thiourea combination received, started to sprout in about a month, or shortly after they were planted. From there on sprouting continued steadily until counts were discontinued on April 30. However, it took nearly 4 months for untreated roots to germinate (see fig. 1). The chemically treated yams not only germinated sooner than the untreated ones, but they produced a larger number of sprouts as well. In some instances this difference amounted to more than 40 percent.

Apparently the chlorethanol-thiourea treatments not only stimulated early sprouting, but also induced several shoots to grow from each eye. Both chemicals have proved to be capable of inducing such reactions by Denny (*2,3*), who observed the formation of multiple sprouting of potato and gladiolus after treatment with thiourea and chlorethanol, respectively. According to his results, not all of the shoots developed fully; some died back. In our experiments with yam this did not take place since all shoots grew into healthy vines (see fig. 1,B).

The yield differences between the treated and untreated yams were striking. The untreated yams produced 4 pounds, while the lowest yield for the chemically treated ones was 12 pounds of edible roots. This occurred under the strongest chlorethanol-thiourea combination. The highest yield, on the other hand, occurred under the treatment consisting of 50 ml. of chlorethanol and 2 percent of thiourea. The wide differences in yield among treated and untreated seeds would seem to us to be attributed to the fact that the former started growth earlier and more profusely than the latter (see fig. 2).

FIG. 1.— A, Plot of untreated Florido yams, 4 months after planting; B, same as in A, but treated with chlorethanol and thiourea.

The effects of the various chemical treatments upon the number of sprouts were not too consistent. However, there was a tendency for the number of sprouts to increase with an increase in the chlorethanol concentration. The trend also was towards more sprouts as the concentration of thiourea was raised.

On the other hand, the differences in yield as influenced by variations in the chlorethanol concentrations were somewhat more conclusive. Again

FIG. 2.—This picture shows the difference in growth between untreated (left) and treated yams (right) before the cape was performed.

the tendency was for the yield to increase from the lower to the highest chlorethanol level. The production of edible yams was not appreciably affected by the level of the thiourea used. However, if we refer to table 1, we notice that the best and third-best production of roots occurred under medium and low chlorethanol-high thiourea treatments. Conversely, the lowest yield came under the highest chlorethanol-thiourea solution. Thus, it seems probable that this treatment resulted in a somewhat toxic effect upon the development of edible roots, even though the number of sprouts produced was relatively high.

CONCLUSION

According to the above-described results it can be concluded that the most effective combination of chlorethanol-thiourea solutions for breaking the rest period in the Florido yam variety, and at the same time attaining a large number of sprouts, and a high yield of roots, are the medium chlorethanol-high thiourea or the high chlorethanol-medium thiourea solutions.

SUMMARY

Groups of 50 medium-sized uniform Florido yams were consecutively treated with various factorially combined chlorethanol-thiourea solutions. The chlorethanol was used at rates of 40, 50, and 60 ml./liter of solution, while the thiourea solutions were prepared at 0.5-, 1-, and 2-percent concentrations. The most important results were as follows:

1. All treated yam "seed" started to sprout in about a month, or shortly after they were planted in the field. It took nearly 4 months for the untreated seed to germinate.

2. Besides stimulating early sprouting the chlorethanol-thiourea treatments also induced several shoots to grow from each bud.

3. Yield differences between treated and untreated yams were outstanding. Untreated yams produced only 4 pounds, while the lowest yield for the chemically treated yams was 12 pounds of edible roots.

4. There was a tendency for the number of sprouts and the yield to increase with an increase in the chlorethanol concentration. No such effects were apparent from the thiourea concentrations.

RESUMEN

Se trataron varios grupos de 50 tubérculos de ñame de la variedad Florido, cada uno de tamaño mediano, con soluciones de cloretanol y tiourea consecutivamente, de acuerdo con el sistema factorial. El cloretanol se usó a razón de 40, 50 y 60 ml. por litro de solución, mientras que la tiourea se preparó a base de 0.5, 1 y 2 por ciento. Los resultados más importantes que se obtuvieron se mencionan a continuación:

1. Todas las "semillas" de ñame que recibieron los tratamientos empezaron a germinar un mes más tarde, o sea, poco después de sembrarse en pleno campo. Por el contrario, las semillas sin tratar tardaron 4 meses en geminar.

2. Además de estimular una germinación temprana, los tratamientos con cloretanol y tiourea también indujeron el desarrollo de varios brotes por yema.

3. Las diferencias en rendimiento entre los ñames tratados y los no tratados fueron considerables.

4. Los resultados indicaron que a mayor concentración de cloretanol,

mayor fue la tendencia a aumentar el número de brotes y el rendimiento. En cambio, la tiourea aparentemente no causó tales efectos.

LITERATURE CITED

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