Physiology of Oil Seeds. VI. A Means to Break Dormancy of Peanut (**Arachis hypogaea** L.) Seeds in the Field[1,2]

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ABSTRACT

Peanut seedling emergence is not uniform in some years. Lack of uniformity is most prevalent among the large-seeded peanut types (Virginia and Runner). Variations in the degree of dormancy of the large-seeded peanuts are a contributing factor. A procedure is described that will aid in increasing uniformity of large-seeded peanut seedling emergence by overcoming the dormancy factor.

A dust formulation of Ethrel (15%/W) was diluted with fungicide (Orthocide/Botran, 60-20 S.P. dust PN 5213) and applied to dry, Virginia-type 'NC-13' peanut seeds by shaking in a plastic bag. Concentrations of 0.5, 1, 3 and 5% Ethrel were tested for their effects on rate and total emergence of dormant seeds from vermiculite/sand potting mixtures and from 3 different soils. Also, seeds were stored after treatment and then planted at monthly intervals in soil to test the stability of the Ethrel-fungicide mixture, as indicated by the emergence of the initially dormant seeds.

All concentrations of Ethrel released the seeds from dormancy and achieved at least 90% emergence, except at the 0.5% concentration. Compared to the other concentrations, 1% Ethrel provided the most rapid rate of emergence. Growth of the hypocotyl-radicle of afterripened, NC-13 seed samples treated with the 1% concentration was initially slower than that of the controls, but recovery had occurred by the 5th day from planting. However, emeregnce of nondormant 'Starr', Spanish-type seedlings was retarded by 1%, but not by 0.5% Ethrel. The Ethrel-fungicide mixture remained stable in storage for 6 months. Field plantings at two locations of dormant, 1% Ethrel-treated seeds resulted in greater than 95% emergence, but the rate of emergence was slower at one location. The data suggest that the Ethrel dust could be combined with the usual fungicide treatment of peanut seeds to stimulate germination of dormant seeds in the field.

Additional Index Words: Ethrel, Ethylene, Groundnut, Germination, Seedling Emergence, Fungicide.

Ethylene is a natural metabolic product of plant tissues, organs and a variety of seeds (4-7, 11-14). It breaks primary dormancy of peanut, *Arachis hypogaea* L., (7, 8) and other seeds (5, 6). Ethylene production by peanut seeds, particularly during the phase of hypocotyl-radicle emergence, is correlated with seed germinability and seedling vigor (9, 10). Ethylene aided germination of cocklebur seeds with naturally reduced germination capacity (6) and increased the rate of germination of rape seeds that were artificially deteriorated or "aged" (14), although total germination was not increased.

The liquid substance, 2-chloroethylphosphonic acid (Ethrel or Ethephon), which breaks down to ethylene, phosphonate and chloride (16), was found to break dormancy of peanut (1, 8) and other seeds (3, 4, 15). Bailey and Bear (1) used an Ethrel-Thiram [bis (dimethylthiocarbamoyl) disulfide] slurry as a preplanting seed treatment to break dormancy of Virginia- and Runner-type peanuts. Treated seeds were planted immediately or up to 8 weeks after treatment with equal effectiveness in breaking dormancy. However, the procedure of wetting with a slurry and redrying the seeds is not readily adaptable to present commercial practices for preplanting seed treatments with fungicides. The dry treatment with Ethrel dust described below could be easily incorporated into present preplanting seed treatment procedures, particularly if fungicide mixtures were already being used as a seed treatment.

Despite research progress, peanut producers continue to experience a lack of uniform emergence of large-seeded peanut seedlings. At present, there is no means to predict whether this will occur in a given crop year. Lack of uniform emergence can be attributed partially to varying proportions of dormant seeds in seed lots due to natural growing season effects on dormancy of the seeds (2). This report describes a convenient preplanting seed treatment to aid in obtaining more uniform seedling stands from seed lots that contain dormant peanut seeds.

Materials and Methods

Seed Germination. All experiments were performed either with 'NC-13' (NC Acc. 344) Virginia-type peanut seeds or with 'Starr', Spanish-type seeds. The seeds of NC-13 and other Virginia-type peanut varieties have a high percentage (80-100%) of dormancy after curing. This dormancy largely remained after 5-6 months of storage at 4.4C (2). Generally, fifty seeds were planted in 30x26x12 cm plastic pans perforated for drainage. The seeds were uniformly planted at a depth of 6 cm and incubated at 30±1C. The initial planting medium was a mixture of vermiculite/agricultural vermiculite/sand 1:1:1 v/v. Subsequent plantings were in a soil/sand 1:1 v/v mixture, pH 8.5, and a sandy soil, pH 6.7, collected where a future field test was conducted. Details concerning experiment and sample replications are given in Table notes and Figure legends.

Seed Treatment. A dormant and a non-dormant (afterripened at room temperature for about 2 months) control treated only with fungicide were compared to the Ethrel plus fungicide treatment in each test. The Ethrel formula-

[1]Cooperative investigations of the Southern Region, Agricultural Research Service, U.S. Department of Agriculture and the Texas Agricultural Experiment Station.

[2]Mention of a trademark or proprietary product does not constitute endorsement by the United States Department of Agriculture or Texas A&M University and does not imply its approval to the exclusion of other products that also may be suitable.

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tion was AMCHEM 72-A152 dust, 15% Ethrel, a product of AMCHEM Products, Inc. Ethylene is rapidly released from liquid Ethrel at pH values above 6.0 (16) and the same results were found for the Ethrel dust formulation (unpublished data). The fungicide mixed with Ethrel in these tests was Orthocide/Botran, 60-20 S.P. dust PN 5213. The 15% Ethrel was diluted by weight with fungicide to concentrations of 0.5, 1, 3 and 5%. Fifty seeds weighing about 42g were shaken in a plastic bag with 0.3g of fungicide or Ethrel-fungicide dilution until they were thoroughly coated. The dry, treated seeds were planted in soils containing adequate moisture for germination.

Field Tests. Two field trials were made; one on the Pott's Farm, College Station, Texas and the other at the Texas A&M University Plant Disease Research Station at Yoakum. The soils were a light sandy type, pH 6.7, and a heavier sandy loam, pH 6.0. These soil pH values are in the range that results in rapid release of ethylene from Ethrel, but a slower release of ethylene also occurs at pH values of 5.0 to 6.0. Five replicates of fifty seeds each were planted, evenly spaced, in 150 cm plots for each treatment at College Station and in 610 cm plots at Yoakum. Planting depth was about 6 cm at both locations.

Results and Discussion

Figure 1A shows that all concentrations of Ethrel broke dormancy of the seeds planted in the vermiculite/sand mixture. Final emergence was about 90% or greater as compared to 10% for the dormant control. However, the rate of seedling

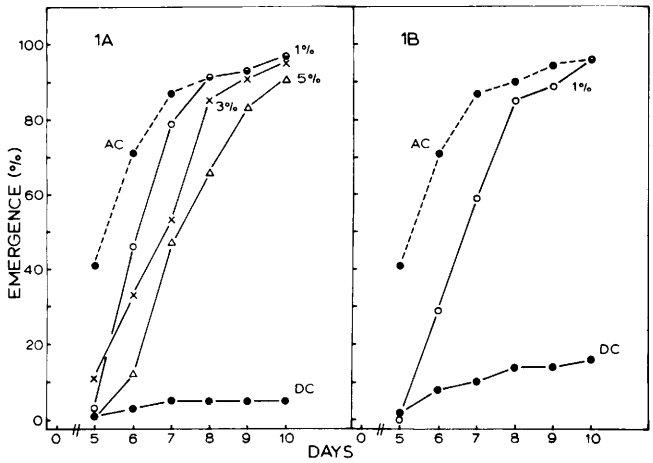

Fig. 1 Emergence of 'NC-13' Virginia-type peanut seedlings from dormant, Ethrel-treated seeds planted in vermiculite/sand mixture. Abbreviations: AC, afterripened control; DC, dormant control. Open circles, 1%; X, 3%; and .., 5% Ethrel. One-half open symbols indicate common points. Figure 1A. Data are the means of three experiments of each concentration of Ethrel with 50 seeds per experiment. Standard Deviations (SD) of the mean at 10 days were ±1, 3 and 4, and 3 and 1% for 1, 3 and 5% Ethrel, and AC and DC, respectively.

Fig. 1B. Data are the means of three replicate samples of 50 seeds each per treatment. SD's were±4 and 3% for 1% Ethrel and AC, respectively.

emergence (emergence was considered to have occurred when the cotyledons reached the soil surface) varied with different Ethrel concentrations. The 1% Ethrel concentration provided the fastest rate of seedling emergence, and emergence was equal to that of the afterripened control at 8 days from planting. In the replicated test of the 1% Ethrel-treatment (Fig. 1B), emergence of the seedlings was slightly slower but attained about 95% emergence in 10 days, which was equal to the afterripened control.

It was clear from observation of the seedlings that the 3% and 5% Ethrel concentrations were retarding seedling growth. Therefore, a test was made to determine whether the 1% concentration was also affecting seedling growth. Table 1 shows that during early seedling development (3 and 4 days from planting, but before seedling emergence) there was more seedlings in the slower growing categories in the 1% Ethrel-treatment than in the controls. However, by the 5th day, when the first seedlings can be expected to emerge (Fig. 1A), seedlings from the 1% Ethrel-treated seeds had attained the same growth range as the controls. Thus, the seedlings overcame the slight retardation of early growth and the beneficial effects (breaking of dormancy and the resulting

Table 1. Effect of 1% Ethrel on growth of the hypoctotyl-radicle of seedlings from afterripened Virginia-type 'NC-13'peanut seeds

Treatment	Length of Hypocotyl-Radicle in mm			
	20-50	50-75	75-100	>100mm
		% at 3 days		
Control	17*	63	20	0
1% Ethrel	40	60	0	0
		% at 4 days		
Control	0	27	73	0
1% Ethrel	6	30	63	0
		% at 5 days		
Control	0	0	7	93
1% Ethrel	0	0	3	97

*Data are the means of 3 replicate samples of 10 seeds each. Seeds were planted in pots containing a mixture of Coarse Vermiculite, Agricultural Vermiculite and sand (1:1:1 v/v). Three pots were harvested at the times shown and length measurements of 30 seedlings were made.

Table 2. Effect of 0.5% Ethrel on emergence and seedling growth of non-dormant 'Starr' Spanish-type peanuts.

Treatment	Emergence at Days from Planting			Seedling Height
	5	6	7	
		%		cm
Control	22*	82	96	3.4+
0.5% Ethrel	8	84	98	3.7

*Seeds were planted in 20 cm diameter plastic pots that contained a mixture of vermiculite/agricultural vermiculite/sand 1:1:1 v/v. Seedlings were grown in the greenhouse.

+Height of the seedlings was measured at 14 days from planting by the length of the first 2 internodes of the main axis beginning at the cotyledonary node. Data are the means of seedlings emerged from five replications of 10 seeds each. Students t-test indicated no significant difference at the .05 level of confidence.

seedling emergence) of the 1% Ethrel-treatment were realized. However, in preliminary observations not reported here, 1% Ethrel seriously retarded emergence of seedlings of a non-dormant Spanish-type variety. This was avoided by lowering the Ethrel concentration to 0.5% (Table 2). Thus, it will be necessary to consider the variety-type when selecting an Ethrel-fungicide concentration as a preplanting seed treatment. This information is presented to indicate the differential sensitivity of peanut varieties to ethylene. In practice, a non-dormant variety would not require treatment unless another benefit, other than breaking dormancy, from the treatment could be established.

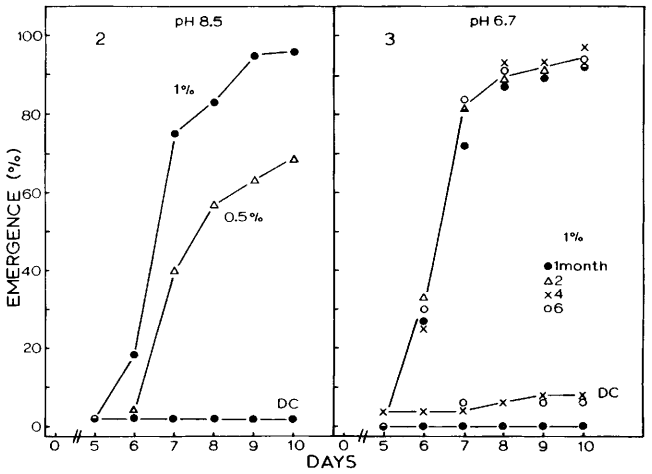

Fig. 2. Emergence of 'NC-13' Virginia-type peanut seedlings from dormant, Ethrel-treated seeds planted in soil/sand 1:1 v/v mixture, pH 8.5. Abbreviation: DC, dormant control. Solid circles, 1%; and . ., 0.5% Ethrel. Data are the means of three replicate samples of 50 seeds each for both Ethrel concentrations. SD's at 10 days were ±22, 4 and 1% for 0.5%, 1% and DC, respectively.

Fig. 3. Emergence of 'NC-13' Virginia-type peanut seedlings from dormant, 1% Ethrel-treated seeds planted in sandy soil, pH 6.7. Abbreviation: DC, dormant control. Seeds were stored at 3C after treatment with the Ethrel-fungicide mixture or fungicide only (DC) for 1 month, solid circles; 2 months, ; 4 months, X; and 6 months, open circles. Data are the means of three replicate samples of 50 seeds each for each storage period. Maximum SD at 10 days was ±6% for seeds stored 6 months.

Figure 2 shows that 0.5% Ethrel was not as effective as 1% Ethrel in promoting emergence of seedlings from dormant, NC-13 seeds, even when the seeds were planted in soil with a pH of 8.5. At this high pH, ethylene is more readily released from Ethrel. However, the 1% Ethrel-treatment was as effective as in previous tests, and emergence was more uniform at this concentration than at the other Ethrel concentrations (Fig. 1A, 1B and 2); particularly, the 0.5% Ethrel-treatment which had a high standard deviation of the mean (Fig. 2). Since ethylene is rapidly released from Ethrel at pH values above 6.0, this suggests that the amount of Ethrel, i.e. ethylene, was the critical factor in breaking dormancy and obtaining rapid, uniform seedling emergence.

The data shown in Figure 3 demonstrate two additional important points concerning the Ethrel-fungicide preplanting seed treatment; (1) it is effective at a soil pH of 6.7, which is more typical of soils used for peanut production, and (2) the 1% Ethrel-fungicide mixture applied to dormant seeds was stable in storage at 3C. Dormancy of planted seeds was released after storage for 1 to 6 months (Fig. 3), and seedling emergence from seeds after storage was equal to that of seeds treated and planted immediately (Fig. 1A, 1B and 2).

The experiments described thus far, were conducted under controlled germination conditions.

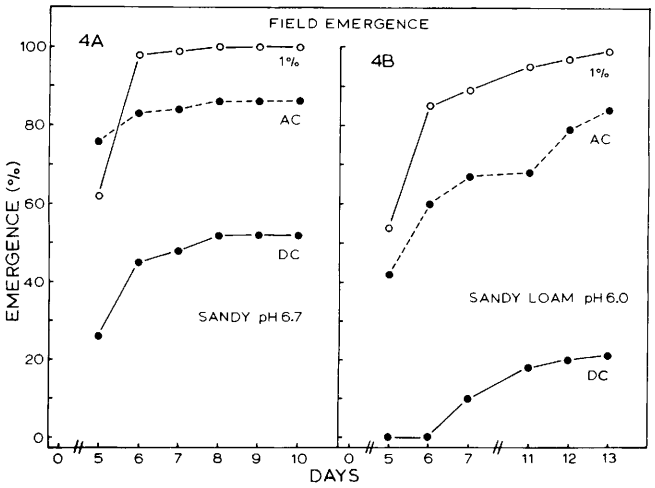

Fig. 4 Field emergence of 'NC-13' Virginia-type peanut seedlings from dormant, 1% Ethrel-treated seeds. Figure 4A. Seeds planted in a sandy soil, pH 6.7, at College Station, Texas. Figure 4B. Seeds planted in a sandy loam soil, pH 6.0, at Yoakum, Texas. Abbreviations: AC, afterripened control; DC, dormant control. Data are the means of five replicate plots of 50 seeds each at both locations. SD's at 10 days for seeds planted at College Station were ±1, 3 and 4% for 1% Ethrel, AC and DC, respectively. SD's at 13 days for seeds planted at Yoakum were ±1, 9 and 8% for 1% Ethrel, AC and DC, respectively.

However, Figure 4 shows that the Ethrel-fungicide preplanting seed treatment was also effective under field conditions at two locations. Total emergence of the Ethrel-treated seeds was greater at both locations than even the afterripened seeds (Fig. 4). At College Station, emergence was very rapid. Both the afterripened control and the dormant, treated seeds attained maximum emergence in 6 to 7 days (Fig. 4A). Also, the treated seeds attained an additional 20% emergence above the afterripened control (Fig. 4A and 4B). This suggests that some residual dormancy remained in this seed sample that was broken by Ethrel, but not by merely letting the seeds afterripen at room temperature. Thus, storage at ambient temperatures may not always be sufficient to completely break dormancy of all of the seeds in a given seed lot.

The rate of emergence of seeds planted at Yoakum was slower than that at College Station, but the final emergence percentages were nearly equal (Fig. 4A and 4B). Since the rates of emergence

of the treated and afterripened control seeds were comparable at Yoakum, the difference between emergence rates at the two locations was apparently due to local environmental conditions or to the heavier, sandy loam soil at Yoakum. At the pH of this soil, which was 6.0, the Ethrel-treatment broke dormancy of the seeds and seedling emergence was about 85% in 6 days and nearly 100% in 13 days. Thus, the Ethrel-treatment resulted in excellent field stands of uniform seedlings from seed lots containing a high proportion of dormant peanut seeds.

The 1% Ethrel-fungicide mixture applied to dry seeds is a convenient and effective preplanting seed treatment for breaking dormancy of dormant peanut seeds under controlled conditions or in the field. The mixture was effective over a pH range of 6.0 to 8.5 in different soil types and was stable in storage at 3C for up to 6 months. Where dormancy is exhibited by seeds of a peanut variety, the treatment should improve uniformity of emergence and total seedling stands in the field.

Acknowledgments

The author thanks Dr. T. E. Boswell, Director of the Texas A&M University Plant Disease Research Station at Yoakum, and Dr. O. D. Smith, Soil and Crop Sciences Department, Texas A&M University, College Station, Texas, for their cooperation in conducting the field tests and Mr. Douglas Wood for technical assistance.

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