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Peanut Seed Treatment with Hot Calcium Hydroxide Solutions[1, 2, 4]

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ABSTRACT

Peanut seed treatment with hot water (50 C for 20 min.) or hot aqueous solutions of $Ca(OH)_2$ were found to stimulate the rate of peanut germination and increase final stand counts in laboratory and greenhouse trials. In field germination trials, seed soaked in hot $Ca(OH)_2$ solutions and dried, were found to perform almost as well as seed treated with commercial fungicides. It is theorized that the soaking process may remove chemicals responsible for seed dormancy, and initiate germination processes, giving seed soaked in hot water a more rapid emergence. The rapid rate of emergence can lead to seedling escape from disease, which is assisted by the antifungal properties of $Ca(OH)_2$.

Key Words: Groundnut, *Arachis hypogaea*, seed dormancy, seed protectant

Hot-water treatment is known to enhance germination and growth of the seedling roots of several crops (2, 7, 12). In addition calcium has been reported as an important factor for peanut (*Arachis hypogaea* L.) seed germination (6). The rate of calcium uptake by peanut seedlings is related more to the rate of root growth than to that of the shoot (14). Practically any improvement in germination and seedling growth rate can be significant in reducing the amount of seed needed per acre and also in minimizing the incidence of seedling disease. The present investigation was undertaken to evaluate the germination behavior of peanut seeds after treatment with hot water and hot soluble Ca $(OH)_2$.

Material and Methods

The effect of hot water treatment on Florunner peanut seed germination was evaluated by immersing seed in aqueous solutions. The following seed treatments were evaluated: 1) immersion in hot water 50 C; 2) soaked in a hot (50 C) solution of $Ca(OH)_2$ 1,580 mg/L; 3) hot $Ca(OH)_2$ 158 mg/L at 50 C; 4) hot Ca $(OH)_2$ 79 mg/L at 50 C; 5) cold $Ca(OH)_2$ 158 mg/L at 25 C for 20 min.; 6) immersion in cold water (25 C); and 7) dry seed (untreated control). All soaking treatment had a duration of 20 minutes.

Seed germination was determined by spreading seeds in 31.0 x 22.0 cm pans lined with absorbent paper. Each pan contained 50 seeds and there were 10 replicates per treatment.

Pans with seeds were kept in plastic bags to minimize water loss and were incubated at 26 C for 72 hr.; 10 ml of demineralized water was added daily to each pan. The number of germinated seeds was counted after 24 and 48 hr., and root length was determined after 48 hr.

The effect of drying the seeds after treatments was studied, following essentially the techniques described by Truelove *et al.* (17). Treated seeds were dried by subjecting them to a current of warm air at 40 C for 48 hr. The germination percentage and the root length were determined as previously described.

The effect of storage on the effectiveness of the treatments was also evaluated after mixing the seed thoroughly with polyvinyl polymer (Nalcotrol, Nalco Chemical Co, Chicago, IL) to retain the seedcoat, because it was observed that the treatments led to splitting of the testa. The polymer used has no effect on germination (Abdel Rehim, unpublished data, 1980). Germination of dried seed was evaluated after 0, 7, 14, 21, 28, and 35 days after treatment.

The effectiveness of treatments on seed borne fungi was determined using pretreated dried seeds following the same procedure used for germination tests. Numbers of moldy seeds, and major genera of damaging fungi were determined.

The same treatments were tested in the greenhouse in pots, 25 cm in diameter, filled with sandy-loam soil infested with *Rhizoctonia solani*. Each pot received 15 seeds and 20 pots served for each treatment. Field experiments were conducted at Auburn University's Wiregrass substation at Headland, AL. on a sandy-loam soil. For these experiments, cold $Ca(OH)_2$ and cold water treatments were not made. The cultivar planted was Florunner, and a standard fungicide treatment captafol-DCNA 60% - 20%, Chevron Chemical Co. was added. Seeds were planted 10 cm deep at 8 to 10 cm spacing in one-row plots with each treatment replicated 8 times and planted in a randomized complete block design. Three weeks following planting the emerged seedlings were counted.

All the data obtained were analyzed following the standard procedures for anlaysis of variance and the means were compared using Duncan's new multiple range test (16).

Results

Results on the effects of hot water, hot $Ca(OH)_2$ at different concentrations as well as cold $Ca(OH)_2$ on seed germination and root length are presented in Table 1. The data indicate that all hot treatments significantly increased germination after 24 hr., but after 48 hr. the germination of cold-water treated seed didn't differ from seed treated with hot solutions. Data also indicate that all soak treatments significantly increased the number of seedlings with long roots (more than 3 and from 2 to 3 cm long).

Table 2 shows the data on the effects of post-treatment seed drying on seed germination and root length. Hot-water treatments affected significantly the number of seedlings with root length from 1 to 3 cm and $Ca(OH)_2$, 1,580 mg/L have significant effects on increasing the number of seedlings with root lengths of 1 to 2 cm. Seed dried following treatment with hot solutions still exhibited more rapid germination when examined after 24 and 48 hr. than did nontreated seed (Table 2). This was apparent both in numbers of seed emerged and in rootlet length.

The effect of seed storage on the pretreated, dried pea-

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Table 1. Effect of peanut seed treatment with hot water and $Ca(OH)_2$ on germination and root length.

Treatment	% germination after 24 hr.	% germination after 48 hr.	Root length after 24 hr. (% of total in class) > then 3cm	from 2 to 3cm	from 1 to 2cm	< 1 cm
Hot Water 50 C 20 min.	69.75 a*	88.75 b	18.50 a	21.50 c	18.00 b	30.75 de
Hot $Ca(OH)_2$ 1,580 mg/L at 50 C for 20 min.	40.25 c	77.00 c	19.25 a	12.50 e	10.50 d	34.50 bc
Hot $Ca(OH)_2$ 158 mg/L at 50 C for 20 min.	53.50 b	97.75 a	20.75 a	22.25 b	22.50 a	32.25 cde
Hot $Ca(OH)_2$ 79 mg/L at 50 C for 20 min.	57.25 b	94.00 ab	15.25 b	29.75 a	15.00 c	34.00 bcd
Cold $Ca(OH)_2$ 158 mg/L at 25 C for 20 min.	2.75 e	94.00 ab	19.00 a	8.75 f	21.00 a	30.00 e
Cold Water 25 C for 20 min.	22.50 d	87.00 b	10.25 c	17.00 d	20.25 ab	39.50 a
Dry Seeds	3.25 e	40.50 d	0.75 d	1.25 f	2.00 e	37.00 ab

* Duncan's Multiple Range Test (P = 0.05) means within columns followed by the same letter are not significantly different.

Table 2. Effect of peanut seed treatment with hot water and $Ca(OH)_2$ followed by drying at 40 C for 48 hrs on germination and root length.

Treatment	% germination after 24 hr.	% germination after 48 hr.	Root length after 24 hr. (% of total in class) > then 3cm	from 2 to 3cm	from 1 to 2cm	< 1 cm
Hot Water 50 C for 20 min.	32.75 a*	89.75 a	10.75 b	16.00 a	15.25 b	47.25 c
Hot $Ca(OH)_2$ 1,580 mg/L at 50 C for 20 min.	26.00 ab	84.25 b	7.75 c	6.75 c	18.75 a	51.00 bc
Hot $Ca(OH)_2$ 158 mg/L at 50 C for 20 min.	21.75 abc	84.75 b	12.75 a	9.25 b	15.25 b	47.50 c
Hot $Ca(OH)_2$ 79 mg/L at 50 C for 20 min.	24.50 ab	86.00 b	9.75 b	9.50 b	12.25 c	55.75 ab
Cold $Ca(OH)_2$ 158 mg/L at 25 C for 20 min.	27.25 ab	80.00 c	5.00 d	9.50 b	11.75 c	48.75 bc
Cold $Ca(OH)_2$ 79 mg/L at 25 C for 20 min.	12.75 bc	77.75 c	4.00 d	5.50 c	4.75 d	61.25 a
Dry Seeds	4.75 c	78.25 c	5.00 d	9.75 b	14.00 bc	49.50 bc

* Duncan's Multiple Range Test (P = 0.05) means within columns followed by the same letter are significantly different.

nut seed germination is illustrated in Table 3. These data show that all the tested treatments significantly increased 24 hr. germination (P = 0.05) over the control irrespective of the decrease in numbers of germinating seeds by time.

The effect of hot water and hot $Ca(OH)_2$ 1,580 mg/L on the seed microflora is shown in Table 4. Results reveal that such treatments were effective in decreasing the number of moldy seeds, and that $Ca(OH)_2$ greatly reduced *Rhizopus* spp. the major peanut seed pathogen in the seedlot tested.

Table 5 shows the effect of the peanut seed treatments on emergence when seeds were planted in greenhouse soil infested with *R. solani.* The data indicate that hot water and hot $Ca(OH)_2$ at 1,580 mg/L lead to an increase in numbers of emerged seedlings and plants 7 and 40 days after planting. Other treatments showed consistent but non-significant increases in emergence.

Results of field experiments on the effects of the tested treatments as compared with captafol-DCNA (60%-20%) and the nontreated seeds are shown in Table 6. The data indicate that hot $Ca(OH)_2$ 1,580 mg/L treatment is as good as the commercial fungicide treatment in improving peanut emergence. Seeds treated with hot water and fungicide or a $Ca(OH)_2$ solution (1,580 mg/L) emerged signifi-

Table 3. Effect of storage of dried pretreated peanut seeds on percent germinability after 24 hr.

Treatment	Storage period in days 0	7	14	21	28	35
Hot Water 50 C for 20 min.	27.33a	26.00a	23.00a	20.33a	17.66a	14.00a
Hot Ca(OH)2 158 mg/L 50 C for 20 min.	26.00a	25.33a	24.66a	20.66a	16.66a	11.66a
Dry seeds	4.00b	4.66b	4.66b	4.33b	4.00b	3.66b

* Duncan's Multiple Range Test. P = 0.05. Means within columns followed by the same letter are not significantly different.

Table 4. Percent of moldy peanut seeds, and dominant seed pathogens in germination trials conducted after seed drying*

Treatment**	% Moldy seeds	Types of fungi on seed
Hot water	22.0 b	Rhizopus sp.
Hot $Ca(OH)_2$ 1,580 mg/L	15.5 c	Aspergillus sp. + Penicillium sp.
Dry seeds	28.5 a	Rhizopus, Aspergillus and Penicillium spp.

* Treated seeds were dried at 40°C for 48 hrs.

** Four replicates served for each treatment, 50 seeds each

Table 5. Peanut seed treatment emergence test in pots infested with *Rhizoctonia solani*.

Treatment	% Emergence 7 days	40 days
Hot water	43.33 a*	36.6 b
Hot $Ca(OH)_2$ 1580 mg/L	42.3 a	56.6 a
Hot $Ca(OH)_2$ 158 mg/L	17.7 b	30.0 bc
Cold $Ca(OH)_2$ 158 mg/L	22.2 b	34.4 bc
Dry seed	11.1 b	16.0 c

* Duncan's Multiple Range Test (P = 0.05) Means within columns followed by the same letter are not significantly different.

Table 6. Effect of peanut seed treatment on peanut seed emergence in field tests.

Treatment	% Emergence**
Hot water 50 C for 20 min. + P*	34.0 c
Hot water + Captafol-DCNA 60-20 + P	54.25 ab
Captafol-DCNA 60-20	57.20 a
Hot $Ca(OH)_2$ 1,580 mg/L + P	62.40 a
Hot $Ca(OH)_2$ 158 mg/L + P	46.80 abc
Dry seed	34.0 c

* P = Polyvinyl polymer

** Means followed by the same letter are not significantly different (P = 0.05) using Duncan's new multiple range test.

cantly better than the control, and were not significantly different from the commercial fungicide.

Discussion

Experiments carried out to study the effect of hot water and hot and cold $Ca(OH)_2$ on seed germination and seedling growth in the laboratory showed that treatments with hot water or hot $Ca(OH)_2$ solutions at 50 C for 20 minutes significantly enhanced germination as well as root elongation. The enhancement of germination was most pronounced after 24 hr., supporting earlier observations on the effects of hot water (2, 7, 12). These results may come about due to hot water extraction of inhibitory chemicals (dormancy factors) in the seedcoat. In addition, hot water has long been used for reducing pathogen severity (4,10); Ivanoff (8) reported that rots of unshelled peanut seeds were controlled by presoaking the seeds in water.

Calcium has been reported as an important factor for germination (3, 6) but it has not been used as a seed protectant. The stimulatory effect of hot water and hot $Ca(OH)_2$ on germination and seedling vigor was not affected by drying the pretreated seeds. Such results correlate with the findings of Orphanos and Heydecker (13) and Truelove *et al.* (17) working with bean, watermelon, soybean, cucumber, and corn. Berrie and Drennan (5), Sen and Osborene (15) and Vincent and Cavers (19) had shown that tomato, oak, rye, and curlydock (*Rumex crispus*) seeds when imbided, dried, then reimbided in water, took less time to germinate than untreated seeds. Moreover, the hot water and $Ca(OH)_2$ seed treatments proved to be effective in reducing the severity of seed rot caused by *Rhizopus, Aspergillus, and Penicilliuim* spp.

The field experiments supported the effectiveness of hot $Ca(OH)_2$ at 1,580 mg/L treatment but not of hot water treatment. This indicates the posibility of using $Ca(OH)_2$ seed treatments as a substitute for seed treatment by fungicides. This would serve to decrease costs and reduce the pollution of the soil with chemicals. These results support the findings of Cox *et al.* (6) who reported that addition of Ca in the form of gypsum to the soil resulted in a consistent peanut yield increase and improved seed germination.

The mode of action of hot water increasing germination and root elongation has been discussed by Abdel Rehim *et al.* (2) and Elarosi *et al.* (7), who came to the conclusion that this effect was attributable to the accumulation of certain free amino acids as a result of heat treatment. An alternative explanation was proposed by Koller *et al.* (11) who suggested that thermolabile complex compounds were modified by temperature changes and stimulated initiation of seed germination. Also, Ketring and Morgan (9) suggested that germination of dormant groundnut seeds is controlled by ethylene and an inhibitor. Consequently the presence of an inhibitor which might affect germination and its subsequent extraction by hot water treatment could explain improved germination of the treated seeds. This suggestion is supported by Vaithialingam and Rao (18) who reported the presence of an inhibitor in dormant groundnut seeds which affected water absorption. Moreover, the hot $Ca(OH)_2$ was demonstrated to be superior because of the additive effect of Ca to the

beneficial effects of hot-water treatment.

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