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SEED TREATMENT METHODS AND DURATION EFFECTS ON GERMINATION OF WILD SUNFLOWER

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SUMMARY

The effects were evaluated of six methods and six durations of seed treatment on the germination of wild sunflower (*Tithonia diversifolia*) seeds. The treatments were as follows: (1) hot water at 80 °C, (2) hot water at 100 °C, (3) oven-drying at 80 °C, (4) oven-drying at 100 °C, (5) immersion in concentrated sulphuric acid and (6) immersion in 10% hydrogen peroxide. The durations were 0, 2.5, 5, 10, 15 and 20 min. Treatment with hot water at 80 or 100 °C for 11–14 min, and oven-drying at 100 °C for 20 min all resulted in more than 65% germination 10 d after treatment. Oven-drying at 80 °C, immersion in concentrated sulphuric acid and in 10% hydrogen peroxide resulted in less than 50% germination. Based on the higher cumulative germination, lower cost, and environmental concerns, hot water treatment at 80 or 100 °C for 11–15 min is recommended.

INTRODUCTION

The wild sunflower (*Tithonia diversifolia* (Hemsl.) A. Gray) of the family Asteraceae, also known as Mexican sunflower or tree marigold, was formerly identified as *T. rotundifolia* or *T. tagetiflora* (Dutta *et al.*, 1986). It is a cultivated plant in Egypt (Sayeed *et al.*, 1981). It was introduced into Sri Lanka and parts of India as an ornamental plant but later grew wild (Dutta *et al.*, 1986). In Nigeria, the plant occurs on roadsides and fallow land, and as an invader of field crops in the forest–savanna transition zone. It grows as an annual, a biennial or a perennial plant, depending on the habitat. The plant grows up to 5.3 m in height, branches profusely, and produces variously lobed simple leaves which are organized on the main stem in a combination of tristichous and pentastichous phyllotaxy. Other details of the morphology have been described by Akobundu and Agyakwa (1987).

In south-western Nigeria, *T. diversifolia* is browsed by nomadic and village cattle, sheep and goats. Farmers have fed the forage to these animals successfully as well as to rabbits. The leaf meal is a valuable supplement in diets for laying hens

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and a cheap means of enhancing egg yolk colouration (Odunsi *et al.*, 1996). Acceptability by ruminant and non-ruminant livestock, and the relative abundance of the plant are indications of its potential as a non-conventional animal feed source.

The plant establishes naturally from seed. Attempts to sow the seed for forage production, however, resulted in poor establishment that was traced to inadequate seed germination and seedling emergence. Difficulty was also encountered in control of *T. diversifolia* when it occurred as a weed competing with yam (*Dioscorea* spp.), maize (*Zea mays*), and soyabean (*Glycine max*), as new seedlings of the plant emerged shortly after weeding. These suggest the existence of seed dormancy or hard-seededness and partly account for the plant's adaptation to contrasting climatic and edaphic environments. However, information on seed germination is limited. The purpose of this study was to investigate the relative effectiveness of different treatment methods and durations in improving the germination of *T. diversifolia* seeds.

MATERIALS AND METHODS

Seed source

The experiment was conducted in October, 1995 using 11-month-old seeds harvested at the Teaching and Research Farm of the Ladoke Akintola University of Technology, Ogbomoso, south-western Nigeria. After harvest, the seeds were sun-dried to constant weight and kept in a desiccator at room temperature until the commencement of the experiment.

Experimental design

The experimental design was a split-plot with six replications. Main plots were six treatment methods: (1) hot water at 80 °C, (2) hot water at 100 °C, (3) dry heat at 80 °C, (4) dry heat at 100 °C, (5) concentrated sulphuric acid (H_2SO_4) and (6) 10% hydrogen peroxide. Subplots were six durations of seed exposure to the treatment methods: 0, 2.5, 5, 10, 15 and 20 min. Healthy-looking seeds were counted and made into 36 batches of 720. Each batch was put in a 1-mm tubular wire mesh before immersion in liquid treatments or spread on metal trays before placement in the oven. After treatment, each batch was divided into six lots of 120 seeds each of which was sown in petri dishes as replicates. Seed from only one year was used, on the assumption that the basic mechanisms underlying the effect of the various treatment methods on the induction and release of dormancy would not change with different seed from different years.

Seed treatment

Hot water treatments. The seed batches were immersed in a thermo-regulated water bath at either 80 or 100 °C for the desired duration. Thereafter, the seeds were removed, rapidly cooled under a running tap, and spread out to dry under a gentle fan.

Dry heat treatments. The seed batches were maintained at 80 or 100 °C in an oven, removed at the due time, and allowed to cool under the laboratory fan.

Chemical treatments. The appropriate seed batches were dipped in either concentrated sulphuric acid or 10% hydrogen peroxide for the required durations, withdrawn, rinsed under the running tap, and dried under the fan.

Seed germination test

Treated seeds were sown in petri-dishes lined with two layers of filter paper (Whatman 12.5 cm) and watered to its moisture-holding capacity without allowing any film of water around the seed. The petri-dishes were arranged on a laboratory bench according to the experimental design. Preliminary investigations had shown that the radicles of non-hard seeds could emerge within 24 h of sowing while most seeds destined to germinate would do so within 10 d. Therefore germination counts were commenced 48 h after treatment and were conducted every other day up to 10 d after treatment.

Statistical analysis

Data were analysed according to techniques outlined by Gomez and Gomez (1984) using the General Linear Model (GLM) procedure of the Statistical Analysis System package (SAS, 1988). Regression models were fitted to assess the effect of the duration of each seed treatment on the percentage germination after 10 d of treatment for each method.

RESULTS

The interaction between method and duration of seed treatment, and days after treatment was significant for cumulative germination (Fig. 1). With the exception of concentrated H_2SO_4 for 20 min, all treatment methods resulted in relatively higher cumulative germination compared with the seeds which were not treated (control, zero time) from day 2 to 10. The gap between the treated and non-treated seeds was markedly wider with the hot water treatments than with the other treatment methods (Fig. 1a and 1b). In general, hot water treatment at 80 and 100 °C (Fig. 1b) and oven-drying at 100 °C (Fig. 1d) resulted in relatively higher cumulative germination than oven-drying at 80 °C (Fig. 1c), immersion in concentrated sulphuric acid (Fig. 1e), or in 10% hydrogen peroxide (Fig. 1f).

Fig. 2 shows the effect of the interaction between method and duration of seed treatment on cumulative germination after 10 d. Regression equations for the responses shown in Fig. 2 are presented in Table 1. Cumulative germination showed a curvilinear response to duration of treatment for all treatment methods except oven drying at 100 °C, which showed a linear trend (Fig. 2d).

Predicted optimum cumulative germination and duration of scarification required for attaining it are presented in Table 2. Hot water treatment for 11–

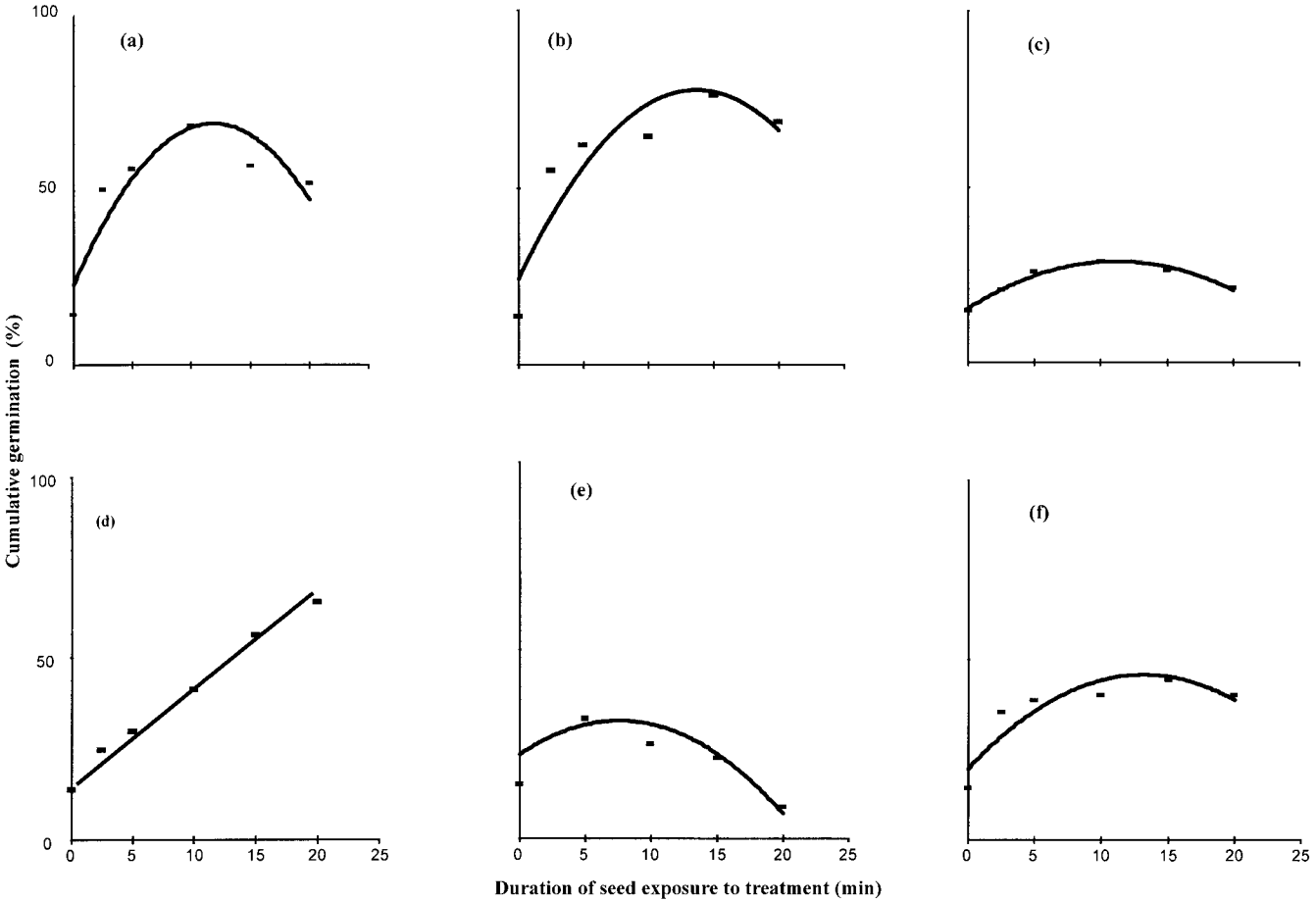

Fig. 1. Cumulative germination (%) responses of wild sunflower seeds to treatment with (a) hot water at 80 °C, (b) hot water at 100 °C, (c) dry heat at 80 °C, (d) dry heat at 100 °C, (e) concentrated sulphuric acid and (f) 10% hydgrogen peroxide and durations of treatment from 2 to 10 days after treatment.

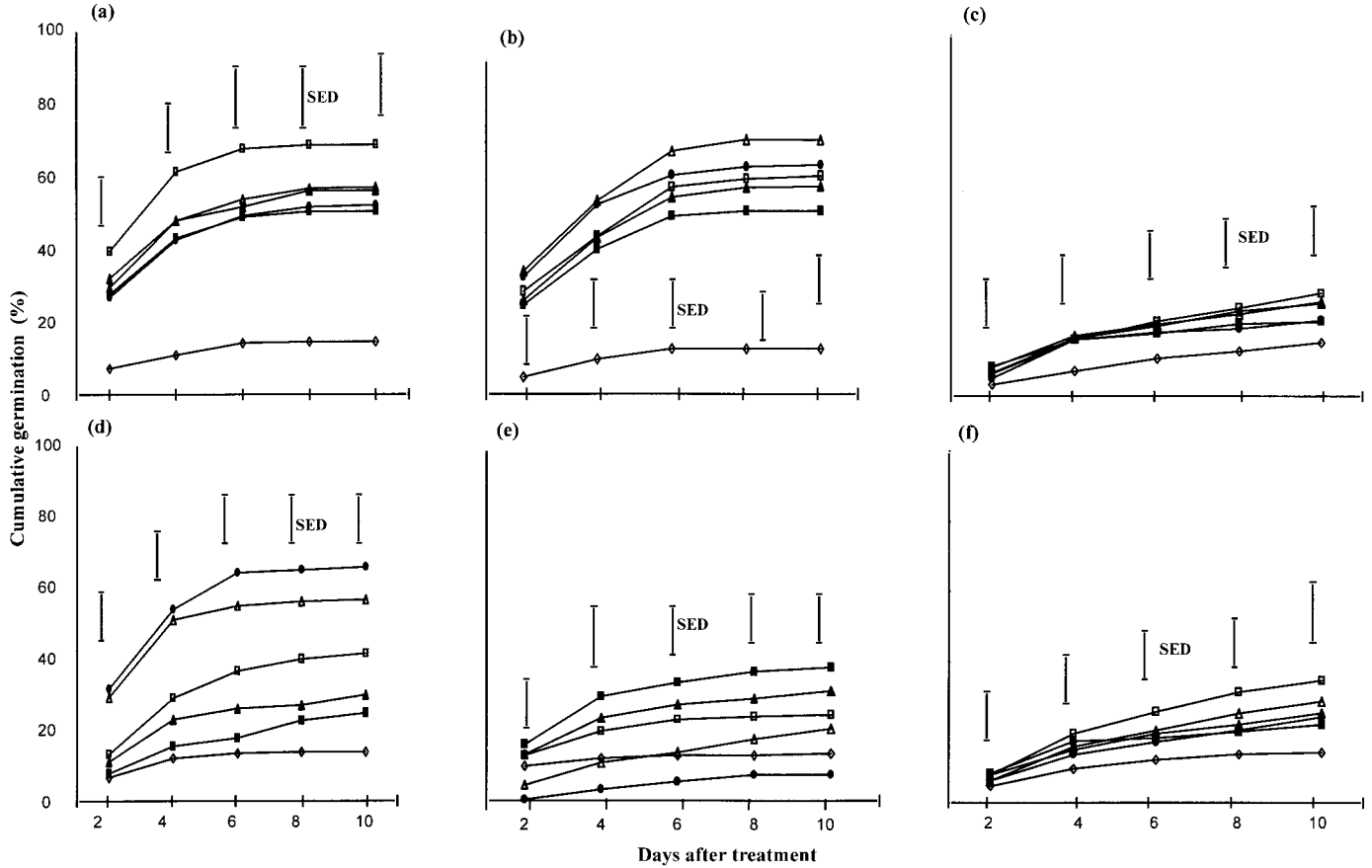

Fig. 2. Effect of duration of treatment (—◇—, 0 min; —■—, 2.5 min; —▲—, 5 min; —□—, 10 min; —△—, 15 min; —●—, 20 min) with (a) hot water at 80 °C, (b) hot water at 100 °C, (c) dry heat at 80 °C, (d) dry heat at 100 °C, (e) concentrated sulphuric acid and (f) 10% hydrogen peroxide on cumulative germination (%) of wild sunflower seeds 10 days after treatment.

Table 1. Regression equations for predicting cumulative germination (Y, %) from duration of treatment (X, min) of wild sunflower seed 10 days after treatment with hot water, dry heat, concentrated sulphuric acid, and 10% hydrogen peroxide.

Treatment	Regression equation	R^2
Hot water, 80 °C	$Y = 23.10 + 7.78X - 0.33X^2$	0.83
Hot water, 100 °C	$Y = 24.39 + 7.89X - 0.29X^2$	0.84
Oven-drying, 80 °C	$Y = 15.53 + 2.38X - 0.12X^2$	0.97
Oven-drying, 100 °C	$Y = 16.23 + 2.25X$	0.98
Concentrated sulphuric acid	$Y = 22.23 + 2.37X - 0.16X^2$	0.64
10% hydrogen peroxide	$Y = 19.73 + 3.96X \times 0.15X^2$	0.83

Table 2. Effect of treatment methods on predicted optimum cumulative germination (%) and the duration of treatment (min) required to attain it in wild sunflower seeds.

Treatment	Cumulative germination	Duration
Hot water, 100 °C	77.9	14.1
Hot water, 80 °C	68.9	11.8
Oven-drying, 100 °C	65.4	20.0
10% hydrogen peroxide	45.9	13.2
Concentrated sulphuric acid	31.2	7.6
Oven drying, 80 °C	28.9	11.2

15 min and oven-drying at 100 °C for 20 min resulted in more than 65% germination while the other methods resulted in less than 50% germination.

DISCUSSION

The principles underlying the induction and release of dormancy, which includes embryo dormancy and seed-coat-imposed dormancy, have been built around such observations as (1) the barrier effects of seed-coat and permeability changes, (2) the presence of inhibitors and the selective role of growth regulators, (3) light and phytochrome effects and (4) metabolic changes (Khan, 1987). The curvilinear increase in cumulative germination in response to the duration of treatment with hot water at 80 and 100 °C, dry heat at 80 °C and immersion in concentrated sulphuric acid or 10% hydrogen peroxide suggested that germination was stimulated by these treatments through all or some of the above processes up to a point when the damage to the embryo cancelled out effects on seed-coat. The linear relationship between cumulative germination and duration of exposure to dry heat at 100 °C suggested that higher germination could be achieved after 20 min possibly through the positive effect of the treatment on the above principles underlying the release of dormancy. Further studies on dry heat treatment at 100 °C for more than 20 min is warranted to establish the duration of treatment required to achieve optimum germination.

In conclusion, the results of this study suggest that immersion of wild sunflower seeds for 11–15 min in hot water at 80 or 100 °C or dry heat at 100 °C for 20 min could result in more than 65% germination and these methods are recommended for use on wild sunflower seeds. However, small-scale farmers do not have access to thermo-regulated water baths for hot water treatment at 80 °C and ovens for the dry heat treatment at 100 °C. Therefore, the boiling water treatment method (hot water at 100 °C for 11–14 min) seems to be a viable option for adoption by small-scale farmers. Field studies on this treatment method are warranted, initially on an experimental basis, but subsequently on a commercial scale, to assess its value under field conditions.

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