CONTROL OF SEED DETERIORATION IN SUNFLOWER (*HELIANTHUS ANNUUS* L.)

WITH the introduction of the high oil-yielding cultivars from the East European countries, sunflower is steadily gaining in popularity in India. In eastern parts of India, however, the spread of sunflower is seriously impeded as the cultivaters are finding it very difficult to preserve sunflower seeds under the ambient hot and humid conditions. The development of an inexpensive method of sunflower seed preservation would therefore be most welcome to sunflower growers and seed merchants. In view of the great efficacy of the hydration-dehydration method of seed treatment developed in this laboratory for seeds of a number of crop plants[1–4], a systematic investigation was taken up with sunflower seeds and in this communication the results of the different experiments are described and discussed.

Seeds (achenes) of sunflower (*Helianthus annuus* L. cv. EC 68414) were obtained from the Calcutta University Experimental Farm immediately after harvest, dried in the sun to a moisture content of about 9% and then stored under ambient conditions in unsealed metal containers. The methods followed for the soaking-drying treatments were similar to those described earlier[1,2]. The treatments of the present study are shown in Tables I and II. Stored seeds were soaked in double the volume of water or solutions of chemicals for 2 hours and then dried in a current of hot air at 35° C to get the original weight. The control seeds were dried without soaking. The final moisture content of seeds after the treatments was brought to the same level ($7{\cdot}2 \pm 0{\cdot}2\%$ on wet weight basis) by storing in a desiccater over fused calcium chloride for one week. The seeds were thereafter subjected to natural ageing by storing in paper packets which were kept in an unsealed metal container under ambient room conditions for 8 months or subjected to accelerated ageing at 100% RH and 40° C for 8 days and 30% RH and 45° C for 25 days to determine the treatment effects. Germination tests of seeds stored under different conditions were done at 28° C on moist blotters spread on 23 cm × 15 cm glass plates[4]. Data on germination percentage and length of root and shoot of seedlings were recorded after 6 days and analysed statistically for evaluating the treatment effects.

The hydration-dehydration treatments effectively slowed down the deterioration of sunflower seeds stored for 4–6 months. Treatment of harvest-fresh seeds or old deteriorated seeds was ineffective. When seed germinability was studied immediately after treatment only a minor improvement in germination was noted. The treatments, however, showed significant beneficial effects after ageing at 100% RH and 40° C and 30% RH and 45° C and after natural ageing in unsealed containers under the ambient warm-humid conditions (mean RH 64 ± 9%, temp. 25 ± 4 C during storage).

In the accelerated ageing at 100% RH and 40° C, all the soaking-drying treatments very effectively controlled the loss of vigour and viability of seeds (Table I). However, none of the chemicals showed any significant effect over water in germination percentage and root and shoot length. In the relatively slow ageing under 30% RH and 45° C (low humidity and high temperature), the chemicals, however, gave distinct advantages over hydration alone in the maintenance of seed viability (Table II). *p*-Hydroxybenzoic acid, considerably reduced the loss of vigour and viability of seeds stored under ambient conditions in unsealed metal containers. Similar effects were also obtained with oxalic acid, tannic acid and sodium phosphate.

The present mid-storage seed treatment is different from previously reported presowing seed hardening treatments[5] in that the soaking duration was much shorter and the treatments were much less effective when given shortly before sowing. While treatment of harvest-fresh seed is ineffective for maintaining vigour and viability, the timing of the stored seed treatment should be such that there would be a sufficient time-gap between treatment and sowing. The ineffectiveness of fresh seed treatment would indicate that germination advancement[6] is not an important factor in the present situation.

Earlier reports from this laboratory indicated the possibility that the beneficial effects of seed treatment could be due to their antifungal and anticatabolic roles and to leaching out of toxic metabolites from the seed[1]. At 30% RH and 45° C, the deterioration of sunflower seeds cannot, however, be attributed to fungal invasion as at that low humidity and high temperature the storage microflora would not play a major role. As regards the possibility of leaching of inhibitory substances from the seed it has been noted that hydration of stored sunflower seeds unaccompanied by leaching, as in moisture equilibration with a saturated atmosphere for 24–48 hours followed by drying, would greatly reduce seed deterioration.

Seed longevity is considerably prolonged in imbibed storage because an enzymatic cellular repair system would be operative in seeds stored in fully hydrated condition[7]. In dry storage, no repair of biochemical lesions would be possible and the damage would accumulate leading ultimately to the loss of viability. Whether in the present short-term soaking-drying or moisture equilibration-drying treatments the cellular repair system would play a major role is yet to be elucidated.

According to Basu and coworkers[8] a counteraction of free radical-induced lipid peroxidation may

TABLE I

Germinability of sunflower seeds of different physico-chemical treatments before and after accelerated ageing at 100% RH and 40° C for 8 days

Soaking-drying treatments	Before ageing			Ageing at 100% RH and 40° C		
	Germination (%)	Mean shoot length (mm)	Mean root length (mm)	Germination (%)	Mean shoot length (mm)	Mean root length (mm)
Control	89[a]	84[a]	162[a]	41[b]	44[b]	60[b]
Water	94[a]	82[a]	170[a]	72[a]	63[a]	93[a]
Sodium chloride	96[a]	83[a]	188[a]	73[a]	70[a]	110[a]
Sodium dihydrogen phosphate	95[a]	87[a]	178[a]	73[a]	67[a]	101[a]
p-Hydroxybenzoic acid	89[a]	85[a]	187[a]	75[a]	65[a]	107
Tannic acid	92[a]	89[a]	180[a]	73[a]	63[a]	94[a]
Oxalic acid	93[a]	84[a]	171[a]	77[a]	65[a]	106[a]

Soaking-drying treatments were given to 5-month-old seeds which were stored under ambient conditions (av. RH 75 ± 9%, temp. 30 ± 1° C) in an unsealed container before treatment. Concentration of chemicals: sodium chloride and oxalic acid 10^{-3} M; sodium phosphate and tannic acid 10^{-4} M; *p*-hydroxybenzoic acid 10^{-5} M. Data on germinability were recorded after germination for 6 days. Within a column mean values scored by the same letter are not significantly different ($P = 0.05$); for germination percentage values, the data were first transformed to corresponding angles (arc-sin) and then subjected to analysis of variance.

TABLE II

Germinability of sunflower seeds of different physico-chemical treatments after accelerated ageing at 30% RH and 45° C for 25 days and natural ageing under ambient conditions for 8 months*

Soaking-drying treatments	Ageing at 30% RH and 45° C			Natural ageing*		
	Germination (%)	Mean shoot length (mm)	Mean root length (mm)	Germination (%)	Mean shoot length (mm)	Mean root length (mm)
Control	59[d]	63[a]	89[c]	74[d]	56[b]	89[d]
Water	71[c]	70[a]	127[c]	81[c]	68[a]	134[c]
Sodium chloride	82[ab]	72[a]	150[a]	80[cd]	70[a]	147[bc]
Sodium dihydrogen phosphate	79[bc]	68[a]	144[a]	87[b]	70[a]	145[bc]
p-Hydroxybenzoic acid	82[ab]	74[a]	152[a]	92[a]	74[a]	164[ab]
Tannic acid	83[ab]	73[a]	127[b]	87[b]	74[a]	158[ab]
Oxalic acid	89[a]	70[a]	142[a]	89[ab]	71[a]	150[bc]

* Average RH 64 ± 9%, temp. 25 ± 4° C during storage. Other details same as in Table I.

be a primary reason of the beneficial effects of the physico-chemical treatments. The effective chemicals may control lipid peroxidation and free radical reactions either directly, or indirectly by synergizing antioxidants in the seed. Further studies on the mode of action of the physico-chemical seed treatments in sunflower are considered very necessary.

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FERONIA LIMONIA—A NEW HOST FOR *MELOIDOGYNE INCOGNITA*

DURING 1977–78, poor growth of wood apple (*Feronia limonia* Swingle), a near relative of citrus and used as citrus rootstock, growing in the nursery beds of the orchard of Punjab Agricultural University, Ludhiana was observed. Examination of the affected plants, revealed heavy infestation of root galls (Fig. 1) with numerous brownish pin head shaped egg masses attached to them. A large number of glistening white females of root-knot nematodes was teased out under stereoscopic microscope and identified, on the basis of permeal pattern, as *Meloidogyne incognita*. The egg masses collected from these roots when kept at 25 ± 2° C for 24 h gave out a large number of second stage larvae of this nematode.

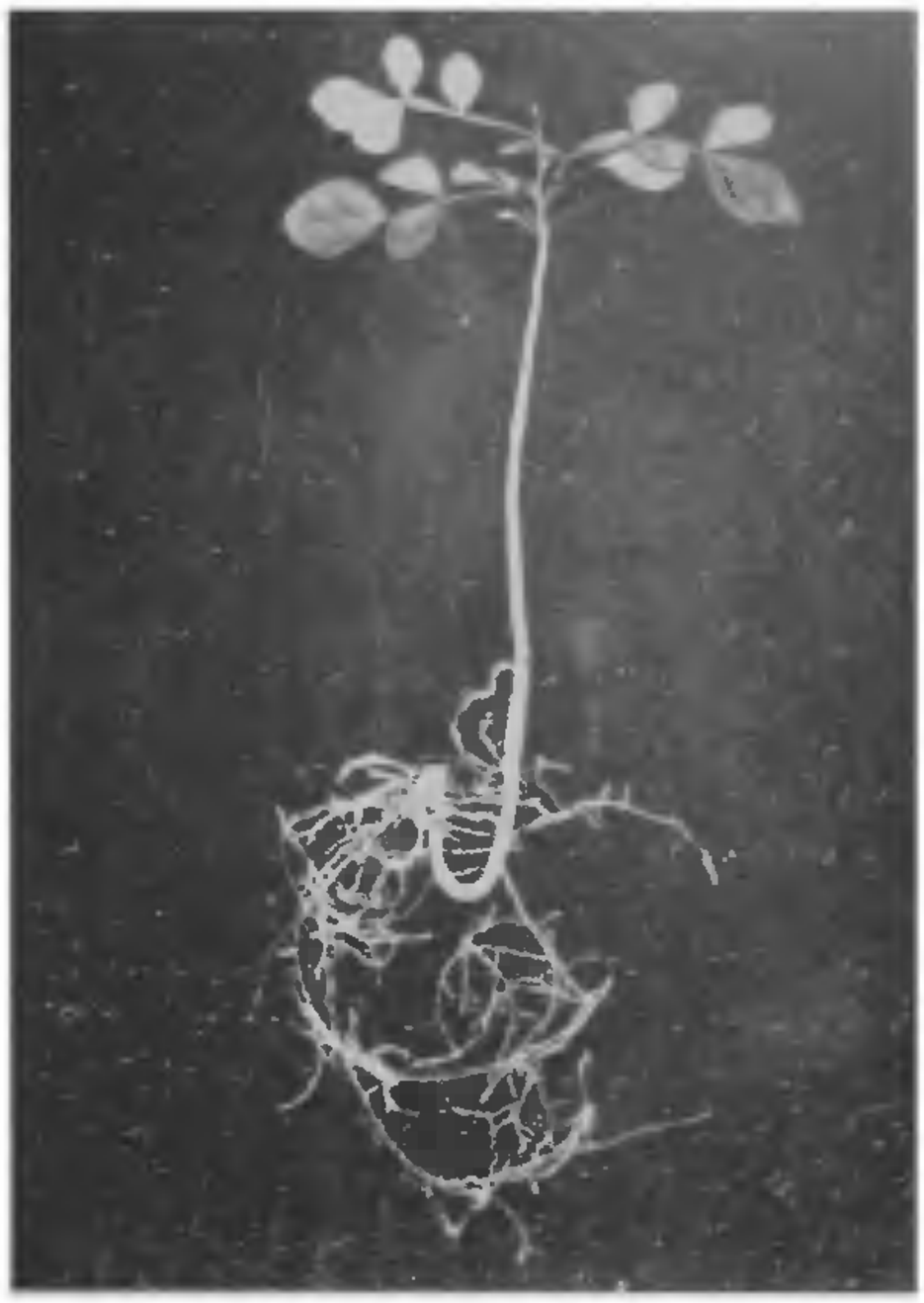

FIG. 1. *Feronia limonia* plant infected with root-knot nematode.

This is the first report of *Meloidogyne* on *Feronia limonia* in India and elsewhere[1–4].

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IN VITRO MULTIPLICATION OF *GLYCYRRHIZA*

Glycyrrhiza glabra (liquorice or yashti-madhu) is in considerable demand in India. The entire requirement of India is being imported and the plant is not known to be growing in wild in our country. Among the seeds of three cultures received from U S S R. through the National Bureau of Plant Genetic Resources, New Delhi, during 1975 76, only seeds of culture E.C. 111263 germinated, though sparingly. The plants