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Solar Heat: It's Use for Controlling Seed Borne Fungal Infections of Wheat

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Abstract: The effectiveness of solar heat in controlling seed borne fungal infections of wheat was tested by drying of seeds on concrete floor, brown paper and mixing with sand (50:50) for 0, 4, 8 and 12 hours. It was observed that the seeds dried with sand mixture always yielded lowest number of seed borne infections of all the fungi followed by concrete floor and brown paper. Reduction rate of fungi achieved in all the treatments differed significantly from that of control. Twelve hours was the best period in inhibiting the seed borne infections. However, in some cases both 12 and 8 hours treatments behaved equally. Reduction of total seed borne infection and increase in seed vigour positively correlated with the increase in drying period. Therefore, to minimize the seed borne infections, it would be advisable to use seed dried with sand mixture for 12 hours under direct solar heat.

Key words: Solar heat, control, seed borne infections, wheat

Introduction

Wheat, next to rice, is the most important cereal crop in Bangladesh. It provides more nourishment for the nations of the world than any other food crops. Though wheat is an important cereal crop in Bangladesh, its yield and seed quality is low compared with that of the advanced countries in the world (FAO, 1987). The area and production of wheat in Bangladesh is 0.9 M ha and 2.0 M ton, respectively (BBS, 2000). Use of unhealthy seeds is one of the cornerstone factors that affects the production. Reports on seed borne diseases of wheat in Bangladesh have been depicted by several authors. Of these wheat alone suffers from 29 different seed borne diseases (Fakir *et al.*, 1991). It is unquestionable that proper disease control measure can substantially improve the quality of seeds. Among the practices used, seed treatment is the best way to control seed borne diseases. The control of seed borne pathogens with chemicals is a common practice in the world. However, continuous use of chemicals causes serious health hazards as well as decreases in soil fertility and develop tolerance of the pathogen. In addition, the fungicides are very expensive and cause environmental pollution. As an alternate means of avoiding these problems, solar heat is now being used in many developed countries for combating the diseases with the aim of increasing food production (Katan *et al.*, 1980). Solar heat treatment of seed has also been proved to be very effective against loose smut of wheat (Luthra, 1941 and Guldhe *et al.*, 1985) and cover smut of barley (Bedi, 1957). But its effectiveness on commonly occurring seed borne fungi of wheat was not investigated extensively. As solar heat treatment is easily practiced and less expensive. In view of the above facts, the present study was undertaken to observe the effectiveness of solar heat on seeds in controlling the major seed borne fungal pathogens of wheat and to identify the congenial solar heat methods and length of drying period that effectively reduced the infection of fungi associated with seeds.

Materials and Methods

The experiments pertaining to the present investigation were carried out in the laboratory and glass house of the Department of Plant Pathology, Bangladesh Agricultural University, Mymensingh, Bangladesh during the cropping season 1998-1999. Seed sample of wheat (var. Kanchan) were collected from a farmer of Boyra village near Bangladesh Agricultural University (BAU) Campus, which was freshly harvested. The seeds were then dried through solar heat treatment by three different ways viz. (M_2) spreading the seeds thinly on brown paper (M_3) seeds mixed with equal volume of coarse sand (50:50) and (M_1) seeds just spreading on concrete floor. Around 300 g seed samples were taken and divided into 3 groups for 4 (T_1), 8 (T_2) and 12 (T_3) hours drying. Then the seeds were kept under direct solar heat for 4 hours of drying (11:00 hrs. to 15:00 hrs.). In case of 8 and 12 hours drying, the seeds were dried as above consecutively for 2nd day and 3rd day, respectively. During drying time, both the air temperature and temperature generated within the seeds were recorded. After drying, all the seed samples were assayed for seed-borne fungal pathogens following blotter method (ISTA, 1976).

Vigour index of the seeds were determined on the basis of seed germination and it was calculated using the following formula (Agarwal, 1996).

$$\text{Vigour Index (VI)} = \frac{\text{No. of seeds germinated at 1}^{st}\text{ count}}{\text{Days of 1}^{st}\text{ count}} + \frac{\text{No. of seeds germinated at 2}^{nd}\text{ count}}{\text{Days of 2}^{nd}\text{ count}} + \frac{\text{No. of seeds germinated at last count}}{\text{Days of last count}}$$

The collected data of different parameters were analyzed statistically using MSTAT-C package programme. The significance of the difference among the means was computed by Least Significant Difference (LSD).

Results and Discussion

Effect of drying methods on the occurrence of seed borne fungi Depending on the methods of seed drying, seed borne infections of fungi varied significantly. Six fungal pathogens viz. *Bipolaris sorokiniana, Alternaria tenuis, Fusarium* spp., *Curvularia lunata, Aspergillus* spp. and *Penicillium* spp. were detected after incubation of seeds on blotter paper. Among the drying methods, the lowest percentage of fungi observed when seeds were dried on sand mixture having 4.66%, 3.67%, 2.41%, 5.50%, 6.92% and 10.0% infection of *Bipolaris sorokiniana, Alternaria tenuis, Fusarium* spp., *Curvularia lunata, Aspergillus* spp. and *Penicillium* spp. respectively, which significantly differed from concrete floor and brown paper. However, infection of *Fusarium.* spp. recorded in the seeds dried on concrete floor and sand were statistically similar. All the test methods differed significantly from that of control (Table 1).

In the three methods of drying, it was observed that temperature raised quickly within the seeds when it was dried in sand mixture compare to concrete floor and brown paper. The high temperature

Table 1: Effect of different methods of seed drying on the occurrence of seed borne fungi in wheat

Treatments	% seed borne infection					
	Bipolaris sorokiniana	*Alternaria tenuis*	*Fusarium* spp.	*Curvularia lunata*	*Aspergillus* spp.	*Penicillium* spp.
Concrete floor	5.92	5.33	2.79	8.13	10.92	14.75
Brown paper	6.54	5.50	3.29	7.95	11.33	14.63
Sand	4.66	3.67	2.41	5.50	6.92	10.00
Untreated control	8.61	7.50	4.11	10.33	14.00	17.00
LSD (p= 0.01)	0.65	0.71	0.68	1.25	0.83	0.77

Each value is an average of three replications

Table 2: Effects of drying length of seeds on the occurrence of seed borne fungi in wheat

Treatments	% seed borne infection					
	Bipolaris sorokiniana	*Alternaria tenuis*	*Fusarium* spp.	*Curvularia lunata*	*Aspergillus* spp.	*Penicillium* spp.
Untreated control	8.61	7.50	4.11	10.33	14.00	17.00
4 hours	6.67	6.50	3.17	8.22	11.78	14.73
8 hours	4.57	3.17	2.39	6.61	8.17	12.33
12 hours	3.00	2.18	1.67	3.61	4.94	8.44
LSD (p= 0.01)	0.75	0.82	0.78	1.44	0.97	0.88

Each value is an average of three replications

Table 3: Interaction effects of different drying methods and length of drying of seeds on the occurrence of seed borne fungi in wheat

Treatments	% seed borne infection					
	Bipolaris sorokiniana	*Alternaria tenuis*	*Fusarium* spp.	*Curvularia lunata*	*Aspergillus* spp.	*Penicillium* spp.
$M_1 \times T_0$	8.67	7.33	4.00	10.50	14.00	17.00
$M_1 \times T_1$	7.00	7.00	3.00	9.67	13.33	16.03
$M_1 \times T_2$	5.00	4.33	2.50	7.67	11.00	15.00
$M_1 \times T_3$	3.00	2.67	1.67	4.67	5.33	11.00
$M_2 \times T_0$	9.17	8.00	4.50	10.83	14.33	17.50
$M_2 \times T_1$	7.00	8.00	3.83	9.00	15.00	16.67
$M_2 \times T_2$	6.00	3.67	3.17	8.50	9.50	14.00
$M_2 \times T_3$	4.00	2.33	1.67	3.50	6.50	10.33
$M_3 \times T_0$	8.00	7.17	3.83	9.67	13.67	16.50
$M_3 \times T_1$	6.00	4.50	2.67	6.00	7.00	11.50
$M_3 \times T_2$	2.67	1.50	1.50	3.67	4.00	8.00
$M_3 \times T_3$	2.00	1.50	1.67	2.67	3.00	4.00
LSD (p= 0.01)	1.29	1.42	NS	2.50	1.67	1.53

NS = Not significant Each value is an average of three replications

M_1 = Concrete floor, M_2 = Brown paper, M_3 = Sand, T_0 = Untreated control (0 hr.), T_1 = 4 hrs. drying, T_2 = 8 hrs. drying and T_3 = 12 hrs. drying.

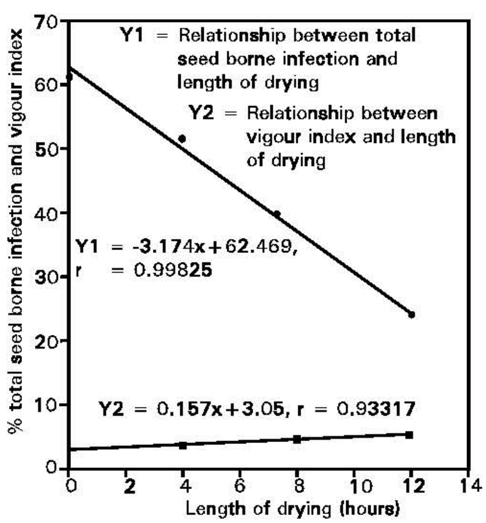

Fig. 1: Relationship of total seed borne infection and vigour index with drying length of wheat seeds.

might become lethal to pathogens that causes inhibition of infection of seed borne organisms. According to Katan (1980), solar heating efficiently reduced the incidence of *Fusarium* spp. Other workers also reported effective reduction of *Fusarium* spp. (*F. oxysporum* f. sp. *niveum*, *F. oxysporum* f. sp. *vasinfectum*, *F. oxysporum* f. sp. *conglutinans* and *F. solani*) through solar heat treatment (Kodama, 1989 and Sarhan, 1991). It has been reported that the soil solarization reduced *Macrophomina phaseolina* (Mihail and Alcorn, 1984). These findings are similar to the present observation.

Effect of length of drying on the seed borne infections of fungi: Infection of fungi viz. *Bipolaris sorokiniana*, *Alternaria tenuis*, *Curvularia lunata*, *Aspergillus* spp. and *Penicillium* spp. was drastically reduced in seeds dried for 12 hours. At 12 hours dried seeds, the infection of these fungi were 3.0, 2.18, 3.61, 4.94 and 8.44% respectively. These infections were statistically different from that observed at 8 hours treated seeds which were 4.57, 3.17, 6.61, 8.17 and 12.33% respectively to the corresponding fungi. However, significantly higher infection appeared at 4 hours treated seeds followed by 8 hours treated seeds, but it was also statistically different in comparison with control. As regard to *Fusarium* spp. there was no significant difference between 8 hours (2.39%) and 12 hours (1.67%) (Table 2).

This reduction might be due to the fact that with the start of drying temperature that acted primarily on the fungal propagules lying on the surface of the seeds as contaminants and with the increase of drying period temperature generated within the seeds and kill the fungal parts embedded deeper and deeper in the seeds. So the present findings showed that growth of all the major seed borne fungi significantly inhibited by solar heat treatment. These results agreed with the report of Mohinder *et al.* (1994). According to them solar heat was most effective against seed borne pathogen of wheat and completely reduced the infections.

Interaction effect between drying methods and drying period on the prevalence of seed borne fungi: Results on interaction effects between drying methods and length of drying periods are shown in Table 3. Among different interactions, the lowest number of *Bipolaris sorokiniana, Curvularia, Aspergillus* and *Penicillium* were counted in M_3 X T_3 where the seeds were treated in sand mixture for 12 hours. Statistically similar results were obtained in M_3 X T_2 treatment except *Penicillium* spp.. In case of *Alternaria, Curvularia* and *Aspergillus,* 12 hrs. drying period on concrete floor (M_1 X T_3) and brown paper (M_2 X T_3) showed equally significant infection of fungi. The highest numbers of seed borne infections were found in M_1 X T_0, M_2 X T_0 and M_3 X T_0 treatment i.e. untreated control. As regard *Fusarium* spp. the result was insignificant. The philosophy of using solar heat in both soil treatment and seed treatment was similar. Because heat was also generated within the seeds by using concrete floor, brown paper and sand.

Effect of length of drying on seed vigour: In this experiment, seed treated with sand mixture were tested to observe the seed vigour. The result showed that the untreated control seeds showed lowest vigour (3.31). In case of seeds treated for 4, 8 and 12 hrs. The vigours were gradually increased and highest vigour was obtained in seeds treated for 12 hrs. Total seed borne infection was negatively correlated with the increase in drying period. On the other hand, seed vigour was positively correlated with the increase in drying period (Fig. 1).

It is noted that seed borne infections greatly reduced the percent germination. But seed vigour was determined on the basis of seed germination. Therefore, reduction of germination means, vigour also reduced. The possible causes of increase in vigour might be the killing or inactivating the seed borne fungi due to the solar heat treatment and ultimately seed vigour is increased.

Solar drying of wheat seeds was found very effective in controlling seed borne infections of fungi associated with seeds. Among the various methods of seed drying, sand drying method yielded significantly lowest infection of fungi compare to seed drying in concrete floor and brown paper. This experimental result advocated a suggestion of using solar heat in inhibiting the seed borne infections of fungi of wheat by drying the seeds for 12 hours in mixture with sand under direct solar heat.

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