

Effects of X-ray Radiography on the Germination of Groundnut Seeds

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Abstract Alternative use of the X-ray test to evaluate seed quality has become increasingly diverse. This study was performed primarily to establish experimental procedures and verify the effectiveness of the X-ray test to detect damage or abnormalities in groundnut seed structure associated with germination. The primary objective of detecting hidden infestation in the groundnut has been achieved with investigations on different combinations of input factors of X-ray radiography viz., the voltage in kilovolts (KV), current in milliampere (mA) and period of exposure in seconds (s) to radiation. X-rays emanating from the voltage and current intensities used to detect the hidden infestation are soft X-rays

and do not affect the viability of the seed materials. Twenty seeds per each combination were exposed to 5–32KV, 5–9 mA and an exposure period of 12 seconds. The exposed seeds were then subjected to germination tests in paper towel method. exposed seeds were placed in moist paper towel and kept it for germination for 8–9 days in an incubation chamber where light and dark cycles of 12 h each are maintained with a temperature of 15–20°C. Hence the germination percentage for different X-ray combinations are 100% in case of lower exposure values and the germination percentages are 90% in case of higher exposure values.

Keywords X-ray radiography, Germination, Groundnut seeds.

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Introduction

The objective of including the X-ray test in Rules for Seed Testing was to complement information provided by the germination test. Before the germination test seeds may be previously exposed to X-rays and classified as well formed, empty or damaged. The exposition period, together with a fixed milliampere of the X-ray unit, regulates the dose of X-rays that determine the radiograph density and the degree of contrast and image quality. In this way,

Table 1. Effect of different combinations of X-ray exposure on germination of groundnut.

Combinations			No. seeds taken	No. of seeds germinated	Germination percentage (%)	Combinations			No. seeds taken	No. of seeds germinated	Germination percentage (%)	
KV	mA	s				KV	mA	s				
5	5	12	20	20	100	25	5	12	20	20	100	
5	6	12	20	20	100	25	6	12	20	20	100	
5	7	12	20	20	100	25	7	12	20	20	100	
5	8	12	20	20	100	25	8	12	20	20	100	
5	9	12	20	20	100	25	9	12	20	20	100	
10	5	12	20	20	100	26	5	12	20	20	100	
10	6	12	20	20	100	26	6	12	20	20	100	
10	7	12	20	20	100	26	7	12	20	20	100	
10	8	12	20	20	100	26	8	12	20	20	100	
10	9	12	20	20	100	26	9	12	20	18	90	
15	5	12	20	20	100	28	5	12	20	20	100	
15	6	12	20	20	100	28	6	12	20	20	100	
15	7	12	20	20	100	28	7	12	20	20	100	
15	8	12	20	20	100	28	8	12	20	20	100	
15	9	12	20	20	100	28	9	12	20	18	90	
20	5	12	20	20	100	30	5	12	20	20	100	
20	6	12	20	20	100	30	6	12	20	20	100	
20	7	12	20	20	100	30	7	12	20	20	100	
20	8	12	20	20	100	30	8	12	20	20	100	
20	9	12	20	20	100	30	9	12	20	18	90	
22	5	12	20	20	100	32	5	12	20	20	100	
22	6	12	20	20	100	32	6	12	20	20	100	
22	7	12	20	20	100	32	7	12	20	20	100	
22	8	12	20	20	100	32	8	12	20	20	100	
22	9	12	20	20	100	32	9	12	20	18	90	
				Control						20	20	100

different voltage/exposition periods have been adopted in seed radiography according to the plant species, X-ray equipment, and sensitivity of the available radiographic film [1]. Furthermore, X-ray analysis is a non-destructive, quick method that is relatively simple to perform. Morphological aspects of seeds possibly associated with viability may be evaluated by the X-ray test. For this reason, several researchers have reported relations between seed structure and germination or seedling morphology, obtaining information that varies according to the species. Among these are *Capsicum anuum* [2,3], embaúba- *Cecropia pachystachya* Trec. [4], *Eugenia pleurantha* [5], and papaya - *Carica papaya* L. [6]. In addition, the radiographic images of the northern red oak's (*Quercus rubra* L.) acorns according to the degree of cotyledon - cotyledon and cotyledon

pericarp separation and demonstrated the potential of X-ray image analysis to provide a rapid and non-destructive estimation of acorn viability and its relation with seed desiccation tolerance [7]. A lack of information on the association of X-ray analysis and seed viability in legume i.e., groundnut to evaluate seed viability emphasizes the need for research in this area. The objective of this study was to evaluate the potential of the X-ray test in identifying damage and abnormalities in groundnut seeds as well as possible relationships with germination. When a beam of X-rays passes through seeds, a permanent image of them is formed on a film. The images can present a higher or lower degree of radio capacity (light) and radio luminescence (dark) depending on the absorption level of X-rays by the seeds, which is determined by factors such as composition, thickness

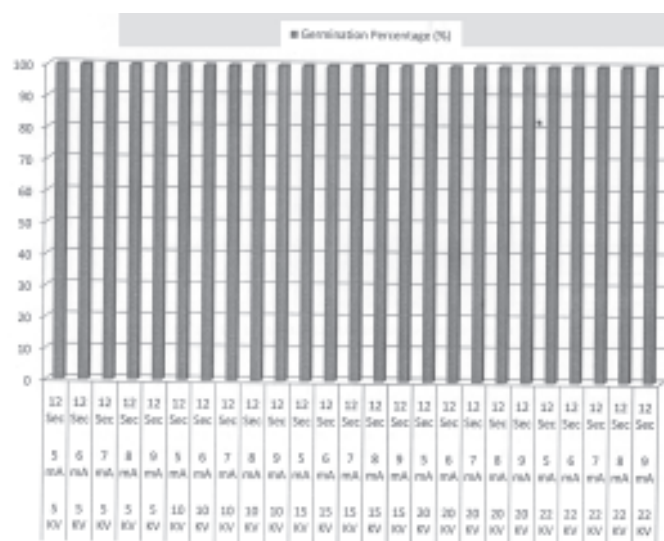


Fig. 1. Effect of different combinations of X-ray exposure on germination of groundnut.

and density of the tissues, and wavelength of the ionizing radiation [8].

Materials and Methods

In order to study the effect of harmful radiation, if any, with these intended combinations with varied degree of X-ray radiation on seed germination, the healthy seeds were exposed to the X-rays of different combinations. The exposed seeds were then subjected to germination tests in paper towel method. Exposed seeds were placed in moist paper towel and kept it for germination for 8-9 days in an incubation chamber where light and dark cycles of 12h each are maintained with a temperature of 15-20°C. The germination rate increases to values greater than 90% at a temperature of 35°C. Thus, the optimum temperature for germination is 35°C [9]. One control line was also maintained with seeds that were not exposed to the X-ray radiation. The germination percentage was then arrived at by using the formula :

$$\text{Germination percentage} = \frac{\text{Number of seeds germinated}}{\text{Total number of seeds taken for the germination test}} \times 100$$

Results and Discussion

When groundnut seeds were subjected to germination test after the exposure to X-ray radiation of different combinations of voltage, current and exposure period, it was observed that the germination percentage of groundnut seeds varied from 90—100% (Table 1, Figs. 1 and 2). Among two hundred different combinations, the X-ray combination values at 26 kilovoltage, 9 milliampere for 12 seconds; 28 kilovoltage, 9 milliampere for 12 seconds; 30 kilovoltage, 9 milliampere for 12 seconds and 32 kilovoltage, 9 milliampere for 12 seconds expressed 90% germination. This observation indicated that at each voltage of maximum current level with an exposure period of 12 seconds exhibits little effect on germination, whereas the X-ray combination values at 5 kilovoltage, 9 milliampere for 12 seconds; 10 kilovoltage, 9 milliampere for 12 seconds; 15 kilovoltage, 9 milliampere for 12 seconds; 20 kilovoltage, 9 milliampere for 12 seconds; 22 kilovoltage, 9 milliampere for 12 seconds and 25 kilovoltage, 9 milliampere for 12 seconds resulted in 100% germination. These results indicated that at low voltage with high current with an exposure periods of 12 seconds resulted in no impact on viability

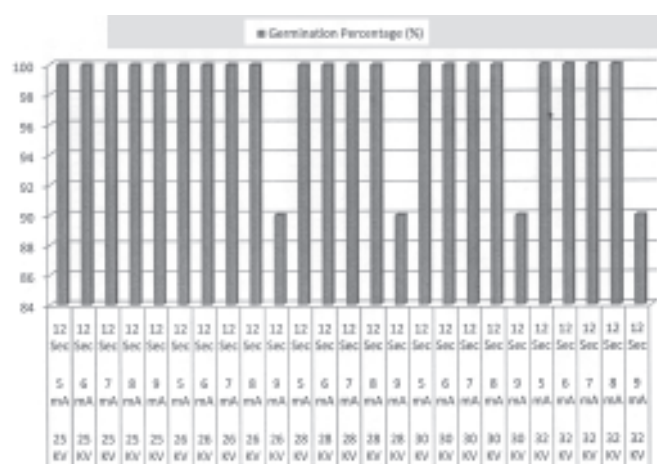


Fig. 2. Effect of different combinations of X-ray exposure on germination of groundnut.

in view of resultant 100% germination of the seed exposed to radiation.

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