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Impact of Mechanical Damage on Viability of Soybean

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Abstract

Investigations were carried out on commonly grown three varieties of soybean (PS-1092, PS-1042 and PS-1029) to observe the effect of mechanical damage on seed viability. Impact of damage for different time interval i.e. 20, 40, 60 and 80 min at 1,200 rpm was also investigated on seedling length and seed vigor index on the basis of root and shoot length. It was observed that germination percentage was significantly influenced by mechanical damage due to horizontal vibrations. Various mathematical models were attempted to correlate the mechanical damage and germination percent and seed vigor index. Linear relationship was found out between the time of impact and germination percentage.
Key words : Mechanical damage, Soybean, Germination, Horizontal impact, Seed.

Soybean is the world's primary source of dietary vegetable oil and is nutritionally an excellent and inexpensive source of protein for human as well as for animals. The lower yield potential of the traditional cultivars has restricted its larger scale adoption. Among the other constraints hindering soybean production are the deterioration of the seed quality under ambient storage conditions and several biotic and abiotic factors. Thus preventing loss of seed viability that results into poor crop stand has been identified as one of the soybean research priorities. Viability of the seed is another factor responsible for the proper establishment of seed in the soil. Several factors effect seed vigor from seed inception to its ultimate use. One of the most serious and probably the best understood of the causes of low seed vigor is mechanical injury during threshing, cleaning, handling or planting. Various factors are responsible for the occurrence of mechanical damage which may be height and number of drops, seed moisture content, the level of seed deterioration at the time damage, the seed unloading system, seed size etc. Susceptibility of the seed to mechanical damage is also affected by degree of deterioration, height of seed free fall (1). It was also observed by Sosnowski et al. (2) that the seed energy and germinability decreased with the increase in the extent of mechanical damage. Viability that results into poor crop production. None of the earlier research workers have worked on effect of mechanical damage caused by horizontal vibrations on germination percent, seed vigor index. Hence the present study was undertaken with the objective to see the effect of horizontal impact on germination of soybean.

Methods

Three varieties (PS-1029, PS-1042 and PS-1092) of soybean (2002 season harvested) were selected for the study. The procured soybean varieties were thoroughly cleaned by using air screen cleaner cum grader in the lab. Seeds were dried in shed so that optimum moisture content (9 ± 1% db) for germination and for all the three varieties was found to be 10.8 ± 1% db at the time of procurement. The dried soybean (9 ± 1% db) were placed in double layer polythene bags and stored in air tight containers to avoid moisture migration. To investigate the size of soybean, physical properties length, width, thickness Geometric mean diameter, and sphericity were determined prior to start of the experiment. Experiments were designed to vary the time of vibrations from 0—80 min at an interval of 20 min. The impact was generated on soybean seeds by using horizontal vibrators at constant 1200 rpm. The three varieties of soybean (PS-1029, PS-1042 and PS-1092) of 500 g were

Table 1. Physical characteristics of experimental variety of soybean.

Varieties	Statistical parameter	Length	Width	Thick-ness	GMD	Spheri-city
PS-1029	Maximum	7.41	6.42	5.61	6.24	0.90
	Minimum	5.8	4.62	4.00	4.85	0.77
	Mean	6.51	5.58	4.63	5.52	0.84
	Median	6.54	5.60	4.62	5.53	0.85
	Mode	6.2	5.50	5.00	5.20	0.85
	Skewness	0.255	– 0.14	0.12	– 0.14	– 0.51
	Variance	0.202	0.10	0.08	0.13	0.0003
	St.deviation	0.349	0.32	0.28	0.35	0.017
PS-1042	Maximum	7.81	6.93	5.82	6.63	0.84
	Minimum	4.4	5.36	4.40	5.59	0.76
	Mean	7.332	6.37	5.48	6.14	0.80
	Median	7.35	6.45	5.54	6.13	0.80
	Mode	7.62	6.54	5.54	6.33	0.809
	Skewness	–1.117	– 1.13	–1.47	– 0.34	– 0.088
	Variance	0.115	0.08	0.11	0.03	0.0009
	St.deviation	0.339	0.28	0.33	0.19	0.030
PS-1092	Maximum	8.35	6.72	5.41	6.65	0.91
	Minimum	7.05	4.81	4.45	5.48	0.78
	Mean	7.662	6.00	5.03	6.34	0.14
	Median	7.64	6.02	5.00	6.36	0.80
	Mode	7.74	6.33	5.10	6.16	0.86
	Skewness	0.369	–1.22	– 0.07	– 1.37	– 0.31
	Variance	0.155	0.08	0.03	0.05	0.0007
	St.deviation	0.294	0.28	0.17	0.21	0.027

taken and kept in polythene bags loosely packed and subjected to vibrations on vibrating table for different duration of time 20, 40, 60 and 80 min at fixed rpm 1,200. After impact, germination was carried out for each variety. Seedling length and seed vigor index was calculated on the basis of root length, shoot length and germination percent. For determining root length, shoot length, ten seeds from each sample in three replications were washed with tap water. Thirum treated seeds were planted on two moist towel paper kept over a butter paper. Seeds were then covered with another sheet of moist towel paper, rolled and fastened with a rubber hand. The rolled towel papers were placed in germinator in an upright position, maintained at 20 ± 1 C. To measure the seedling length ten normal seedlings were randomly selected on day 8 and their length was measured from root tip to shoot tip and the mean value was reported in centimeter per seedling. Seed vigor index was calculated by

$$SVI = GP \times SL$$

Where, SVI = seed vigor index, GP = germination percent and SL = seedling length.

Results and Discussion

Soybean seed have a tendency to deteriorate

Table 2. Effect of time of impact on germination percent of soybean varieties PS-1029, PS-1042 and PS-109.

Variety	Time of impact, min at 1200 rpm 20 min	40 min	60 min	80 min
	Germination (%)			
PS-1029	93.5	92.0	87.5	83.0
PS-1042	89.0	84.0	79.5	73.5
PS-1092	90.5	88.0	84.0	79.5
	Seedling Length (cm)			
PS-1029	18.5	18.3	17.4	17.7
PS-1042	20.4	18.9	18.5	18.4
PS-1092	18.7	18.5	18.2	18.2
	Seed Vigor Index (%)			
PS-1029	1732.1	1685.9	1518.1	1464.9
PS-1042	1815.6	1589.7	1468.7	1352.4
PS-1092	1699.1	1630.2	1528.8	1446.9

under biotic and abiotic stresses during their production and storage. This leads to a rapid decline in the quality of seeds. Seed vigor is an important element for the quality of seeds and important to predict seed longevity which can be affected by mechanical damage and this damage cause rapid seed deterioration. The geometric mean diameter of three experimental soybean varieties were computed as cube root of three mutually perpendicular dimensions (LWT) and sphericity was calculated using the following equation suggested by Mohsenin (3). The average values of 100 kernels for geometric mean diameter and sphericity for experimental varieties shown in Table 1 and maximum range was for PS - 1029. The variety PS - 1029 falls between PS - 1029 and PS - 1042. On the basis of GMD the experimental variety of soybean may be classified as ascending order of boldness. The standard deviation was in the range of 0.193 to 0.352 for experimental variety of soybean. It was observed that the frequency distribution had a somewhat resembling normal distribution but considerable skewness was also associated. It was observed that for all three varieties of soybean the mean, mode and median values were considerably different. The overall range of sphericity of soybean for three varieties considered in this study as from 0.801 to 0.866. Effect of mechanical damage by subjecting the grain to horizontal vibrations was investigated at different timings i.e. 20, 40, 60 and 80 min at 1,200 rpm. The values of germination percentage, seedling length and seed vigor index are reported in Table 2. The germination percentage observed varied from 83 to 93.5% for PS-1092 at different time intervals. The root length and shoot length provided an estimate of vigor. Vigor refers to the strength of seedling and their ability to survive. In root length, PS-1092 showed highest values (13.3 mm) and variety PS-1029 showed lowest value (911.55 mm). Seed vigor index was also observed high for PS-1042. Thus the genotypes exhibited sufficient differences for vigor also. The germination percentage varied from 73.5 to 93.5% for the range of time of impact i.e. 20—80 min showing significant effect of mechanical damage. Table 2 shows that when the seed is subjected to 20 min of impact, there is sudden drop in germination percentage but after 20 min, the decrease rate was comparatively low. Similar results were observed with seedling length and seed vigor index also. This, therefore, underlines the importance of impact at different time interval. The maximum germination percent after impact of 20 min was observed for PS-1029 and minimum for PS-1092. This also shows that small seeds are less prone to mechanical damage and retain their viability up to some extent. The pattern of germination percent with time of impact ruled out the possibility of a logarithmic and exponential relationship between germination percent and time of impact. It was observed that for almost all the genotypes linear model had better *r* value ranging from 0.97 to 0.99. The general form of the linear model is as follows.

$$Y = Mx + C$$

Where Y, denotes the germination percent, X denotes the time of impact and C is the constant. The pattern of seedling length with time of impact ruled out the possibility of logarithmic relationship between seedling length and time of impact. It was observed that for almost all the varieties logarithmic model had better regression coefficient ranging from 0.85 to 0.97. Similarly the pattern of seed vigor index with time of impact ruled out the possibility of exponential model. The value of *r* ranged from 0.97 to 0.99 for all the varieties.

Conclusion

On the basis of experimental results it can be concluded that seedling length, seed vigor index and germination percentage are affected by time of impact. Lesser the time of impact, better will be the germination percentage.

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