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Soybean Seed Germination: Factors Affecting and Ways to Minimize Germination Loss

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Soybean is most important *Kharif* crop of central India. Poor germination potential of soybean seed and faster deterioration of its seed quality under ambient storage are major problem. Higher seed rate per hectare and more instance of re-sowing cause increase in cultivation cost thus reducing benefit to farmers. Germination potential can be improved by manipulating environmental factors. Post harvest care during processing and storage of seed is very important in soybean seed. In this article, the cusses of seed deterioration during crop season and in storage condition have been explained with discussion about the measures to reduce degradation of seed quality and germination potential of soybean seed.

Introduction

Soybean crop was introduced in Madhya Pradesh with just 0.03 mha ha area replacing fallow land during rainy season but by the year 2017, its cultivation was spread to such an extent that the crop stands first in oilseed production of India with production of 11.49 mt from an area of 10.97 m ha area. Soybean cultivation brought improvement in socio-economic conditions of small and marginal farmers of the country. Its seed contains high oil (16-20%) and protein (36-40%) making it furthermore important source of oil and protein. This crop contributes about 25 per cent of the total edible oil produced in the country and earns substantial amount of foreign exchange by exporting defatted oil cake (Bhatia *et al.*, 2010). Low germination ability of soybean seed was always an important problem. Seed of soybean is inherently prone to loss of viability and has been grouped as least storable among all the grain crops. Germination rate of soybean seed generally varies between 50-70%. Low germination rate leads to increase requirement of seed and higher seed rate resulting in higher cost of seed adding to cost of cultivation. Germination ability of any seed is combination of its genetic potential and environmental factors. Soybean is known to lose its germination potential very fast, its seed has maximum germination potential at physiological maturity then it starts losing its germination potential till harvest. But harvesting of seed at physiological maturity is also not possible because of high seed moisture content (50-55%) at that time. Seed traits such as seed size, hardness, seed coat thickness and permeability, oil content etc. (associated with germination ability) are under genetic control. In tropical countries such as India environmental factors i.e. disease, pest, high temperature, water stress, high humidity during seed filling and maturation period brings down the germinability (Jyoti and Malik, 2013).

Factors Determining Seed Germination Potential

Pre-harvest condition and field weathering: For getting good quality seeds, soybean crop should be grown by following recommended package of practice such as seed rate, spacing, nutrient & weed management, and plant protection measures in right quantity at right time. Plant should be maintained free of disease and pest during crop growth period. Plants grown with poor management and suffering from diseases generally bears seed of low quality and poor in appearance with low germination or dead seed. Exposure of seed to unfavorable condition such as high temperature, drought, attack of viruses, aphids, bean leaf beetles at the time of seed development and maturation stages lead to seed deterioration causing decrease in seed viability and loss of seed quality with time. It is a natural process which involves physical, cytological, physiological and biochemical changes in seeds.

Weather condition during the seed development and maturation are major determinant of seed quality in tropical environment. High relative humidity combined with high temperature, repeated wetting and drying cycle during seed maturation causes substantial loss in germination ability. Deterioration occurs due to field weathering, at the time of harvest and during storage. Loss of seed vigor, as well as viability, due to high temperature and high relative humidity between the stages of seed physiological maturity and harvesting is referred to as field weathering (Tekrony *et al*., 1980). Development of field weathering resistant varieties should be an important objective for soybean breeding programs in the tropics. Changes associated with seed deterioration include depletion in food reserve, increase enzyme activity, increase fat acidity and membrane permeability. High moisture in environment can cause seed to germinate on plant and also create conducive environment for seed borne diseases.

Physiology and biochemistry of seed deterioration: During the process of seed deterioration seed undergoes various biochemical and metabolic changes. Degradation of cellular membranes occurs which is associated with loss of membrane permeability and increased electrolyte leakage. Impairment of energy-yielding process, biosynthetic mechanisms and enzymes activity is also altered. Activity of enzymes such as lipase, ribonuclease, acid phosphatase, protease, β and α amylase, diastase, DNase and dehydrogenase enzymes shows immense increase. Higher accumulation of highly unstable reactive oxygen species (ROS) such as hydrogen peroxides, superoxide radical, hydroxyl radical occurs in deteriorating seed. Substantial decrease in activity of antioxidant enzymes i.e. superoxide dismutase, catalase and peroxides is well known with ageing. Accumulated ROS cause damage to lipid, protein and stored carbohydrates in seed. Leading to alteration in DNA/RNA folding, lost elasticity of proteins and membrane lipids. Seed storage compounds composition is also changed as there is decrease in protein, oil content and total sugars and increase in free fatty acids and reducing sugars. Seed deterioration is also associated with chromosome fragmentation, bridges, fusion, ring formation of chromosomes and change in nuclear size. Impairment of biosynthetic process due to seed deterioration results in loss of various seed performance attributes such as reduced germination rate, reduced field emergence, increased numbers of abnormal seedlings and finally seed death. Such damage at physiological, biochemical and molecular level leads to reduction in quality of seed in terms of germination ability and storability.

Means of Improving Seed germination

Cultural: Planting of soybean should be done with recommended seed rate at proper time as early planting expose developing seed to high moisture environment and late planting expose seed to dry and high temperature condition both of which negatively affects seed quality.

Planting should be done by maintain proper row-row (40 cm) and plant to plant (10 cm) distance. Recommended dose of farm yard manure and fertilizers (25:60:40:20; N:S:K:P) should be applied. Irrigation should be provided at critical stage in case of long dry spell. Care should be taken about proper weed, disease and pest management during whole crop growing season. Plant grown with proper management and cultural practices are healthy and give seed with good germination ability.

Seed treatment: Seed treatment with recommended dose should be followed to improve seed germination and field emergence by protecting the seed from internal as well as external fungal infections. There are reports of as high as 30 seed borne fungi which infect soybean seed (Sinclair, 1982). Most prevalent field fungi associated with soybean seed to cause seed borne disease were *Phomopsis sps*., *Cercospora* and *Colletotrichum sps*. Under Indian condition infection by *Cercospora kikuchii* (Purple stain of seed), *Diaporthe phaseolorum* var. *sojae, Myrothecium roridum, Macrophomina phaseolina, Colletotrichum truncatum* are major cause of low seed quality. The incidence of seed borne diseases not only affects the seed crop; it is transmitted through the infected seed to the next crop. Diseases thus disseminated hamper the soybean production. Seed crop should be free from viral diseases like soybean mosaic viruses. Seed can be treated with Carbendazim (3 g/Kg seed), thiram + carbendazim (2+1 g/Kg seed), carboxin (3 g/Kg seed).

The texture of soybean seed coat is very smooth. Therefore, loss of chemical applied to seed through powder formulations is very high. Seed treatment sometimes becomes non-effective if the chemical is not fixed to seeds and it does not enter into the seed to give systemic effect. Seed polymer coating is most advanced technique to make seed treatment most effective and economical. This polymer coating technique binds the beneficial chemicals on the surface of the seed and does not allow the chemical to get shed out of the seed neither during seed handling, sowing nor during seedling emergence. Treatment of seed with *Bradyrhizobium* culture and *Trichoderma* will be further more beneficial for plant growth.

Genetic improvement: Soybean varieties such as JS 20-34 and JS 97-52 show good germination on the other hand, variety such as NRC 7 are very poor germinator. Most popular varieties such as JS 335 and JS 95-60 posses moderate germination ability. Breeding efforts in the India are still in progress for improving germination ability. SSR markers governing seed longevity has been identified and should be used in developing varieties (Singh *et al*., 2008).

Harvest and Post Harvest Loss of Seed Germination Potential

Time of harvest is very important as delay in harvesting brings down germination percentage significantly. Moisture content of seed, seed size, hard seededness, seed coat thickness and permeability, hull percentage, oil content etc., are the important characteristics determining seed quality of seed. Soybean should be harvested once the pod turns to black or brown depending upon the variety as soon as possible. Harvested pods should be kept in open field condition under shade drying for 2-3 days to bring down moisture content to optimum level, if the seeds are not properly dried, the high moisture content may reduce the seed viability by promoting fungal growth thus affecting viability and germination ability of soybean seeds. Soybean seeds are highly susceptible to physical damage and mechanical injury during post-harvest handling because of papery seed coat. Threshing should be done with proper care to avoid any damage to seed coat. Packaging needs to be done in jute bags. Delayed harvesting extends the field exposure of seed to unfavorable condition and increases susceptibility to mechanical damage and disease infection. Field weathered soybean seed is further more prone to mechanical damage

because of its papery seed coat and position of haulm during threshing, processing, seed collection, handling, transporting and drying. Physical damage and fracturing of seed also happens at the time of post harvest processing.

Damage of seed during storage is inevitable. Seed tends to lose its germination or, viability and vigour when stored at inappropriate storage environmental conditions. The longevity of seeds in storage is influenced by four major factors viz., i) Genetics ii) Quality of the seed at the time of storage iii) Moisture content of seed or ambient RH iv) Temperature of storage environment (Shelar *et al*., 2008). Aging in soybean seeds is result of deteriorative changes in membranes, probably via peroxidation reactions involving unsaturated fatty acids (Parrish and Leopold, 1979). Biotic factors such as fungus and insect attack also cause reduction in seed germination ability. Inappropriate storage condition also affects germination ability of seed. Field weathering during seed development further increases susceptibility of seed to quality deterioration.

Storage Condition

For maintaining the good physical and physiological condition of seed it has to be stored in right packaging material under optimum storage condition. Seeds can be stored in piles, single layers, sacks (not more than four bags) or closed containers, under shelter in well ventilated store at least for several months. Maintaining appropriate storage condition i.e. temperature (25°C), relative humidity (50-55%), and gaseous composition of storage environment is highly effective in maintaining high germination ability for long duration. Storing soybean seeds at subfreezing temperatures (10-15°C) and low relative humidity can maintain the germination ability of soybean seed up to10 years. Therefore, low temperature and relative humidity synergistically minimized aging reactions. Low oxygen pressure in storage atmosphere increases seed viability by reducing rate of seed deterioration and growth of bacteria and fungus on stored seed. Storability of seeds is mainly a genetically regulated character but it is also highly influenced by quality of the seed at the time of storage, pre-storage history of seed (environmental factors during pre and post-harvest stages), seed moisture content, storage environment, duration of storage and biotic agents (Khatun *et al*., 2009; Biabani *et al*., 2011).

Conclusion

The low germination rate of soybean seed encourages high seed rate and hence high cost of cultivation. The seed deterioration results in loss of various seed performance attributes such as reduced germination rate, reduced field emergence, increased numbers of abnormal seedlings and finally seed death. Seed deterioration can be minimized by taking proper care of crop such as planting of soybean at proper time and with proper seed treatment resulted in good quality seeds. Harvesting at right time will be reducing loss of seed quantity due to pod shattering and loss of seed quality due to field weathering. With this pre-harvest care right post-harvest care such as maintaing safe, clean and ambient environmental condition in storage will help in achieving good seed quality in soybean crop.

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