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Overview of the influence of environmental factors on seed performance

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ABSTRACT

During crop establishment, seed development and storage, seeds are extremely susceptible to damage. The aim of this review was to examine the scientific data on some of the major environmental factors that influence seed quality. Since it was difficult to cover all aspects of production at once, some factors were selected. Based on the findings of many researchers, it can be said that temperature, humidity, draught, soil salinity, soil acidity, etc. are some of the major factors that strongly influence seed germination, vigor, viability and ultimately affect seed yield.

Key words: Seed deterioration, Seed germination, Crop growth, Yield

INTRODUCTION

In agriculture, the word "seed quality" refers to the overall value of a lot of seed for its usefulness (Hampton, 2002). Successful crop production depends on the production of high quality seeds. Lower seed quality leads to weak seedlings, abnormal growth and maturation and further exposes rice seedlings to pests, diseases, weeds and adverse environmental conditions (Ellis *et al.*, 1995). Environmental factors have a major influence on seed yield, germination and vigor during crop growth and development. Although it is well known that environmental stresses such as temperature and moisture extremes reduce seed longevity and viability. Major abiotic factors affecting seed quality such as temperature, humidity, standing water, frost, fog, drought and nutrients. It is well known that seed viability and germination can vary significantly from season to season and from one production site to another (Hampton, 2002). Seed germination can be affected by unnecessary factors such as flooding, tillage, as well as abiotic factors such as drought, light, salt, seed burial depth, soil pH and temperature (Cuneo *et al.*, 2010; Baskin CC and Baskin JM , 1998). One of the most important environmental factors affecting seed quality parameters such as seed mass is the temperature experienced by the mother plants during seed development and seed maturation (Peltonen-Sainio *et al.*, 2011). Environmental factors that occur during seed growth, seed development, and seed maturation have a direct effect on seed quality (Copeland and McDonald, 2001; TeKrony *et al.*, 1984).

According to studies, two of the most important environmental factors for promoting seed germination are light and alternative temperature regimes (Baskin CC and Baskin JM, 1998; Presotto A *et al*, 2014; Vanderlook F *et al*). Maximum germination percentage and germination rate are considered to be most affected by temperature, and germination usually occurs only in certain temperature ranges (Garcia-Huidobro et al. 1982, Hardegree, 2006., Mattana *et al.*, 2010). Water stress during pollination and early stages of seed development can affect pollen transport and fertilization in maize and also increases early grain abortivity. Environmental stress early in the vegetative growth phase of maize can reduce yield because the developing reproductive primordial, which determines the number of kernel rows and the number of kernels per row, are so sensitive to stress (Slayter, 1969).

A review study was carried out to make most of the harmful effect of some environmental factors on seed performance which are listed below:

Temperature

Seed viability, seed vitality, seed development, crop physiological maturity, proper crop ripening and ultimately harvest of quality seed etc. are greatly affected by temperature. Long-term effects of temperature on seed development and maturation may ultimately affect seed viability. In the case of lettuce, where seeds ripen at high temperatures, Koller (1962) observed that germination occurred at a lower temperature in the dark (260°C) than similar seeds ripened at low temperature. Dormancy patterns in wheat seeds have also been modified by changes in temperature during ripening (Van Dobben, 1947; Kramer, Pest and Witten, 1952) and rice (Ghosh, 1962). Both developing and mature soybean seeds are significantly affected by increasing temperature. When soybean plants are ready for harvest, the ideal temperature ranges from 15 to 22 °C at emergence to 20 to 25 °C at flowering (Liu *et al.*, 2008). Increasing the temperature at the seed filling stage from 29/20 °C to 34/20 °C resulted in lower soybean seed yield (Dornbos and Mullen, 1991). Soybean seed production is maintained on the main stem and branches that originate from the nodes of the main stem (Board, 1987). Most of the vegetative growth of the branch occurs after the growth of the developmental stage (Fehr *et al.*, 1977). The greatest reduction in seed production occurs when stress slows crop growth between growth stages (Linkemer *et al.*, 1998). According to studies on oilseed rape (Aksouh *et al.*, 2001), instantaneous heat stress reduced seed mass more than continuous heat stress during the grain filling phase. Every component of the seed was lost, resulting in a lower yield. In Australia, cool-season legumes are particularly susceptible to cold or chill damage to reproductive organs, particularly buds that develop only a flower or flowers, reducing seed yield and resulting in poor seed germination, and when in the reproductive stage, field pea. is the pulse most susceptible to frost damage (Siddique *et al.*, 1999). The plant contains some morphological adaptations and changes to protect the leaves from extreme heat. For example, drought and heat tolerance focus exclusively on the same adaptations, such as reflective leaf hairs and waxes, leaf curl and vertical leaf orientation, and the growth of small, highly dissected leaves to reduce boundary layer thickness and thereby maximize convection. and heat loss by conduction (Taiz & Zeiger 2006). The nutritional quality of the seeds is also important for the tin living plant, such as the embryo, when the nutritional quality is reduced, then the seedlings may be abnormal. In oilseeds, the concentration of linolenic acid, protein, phosphorus and oil content is lower at higher temperature (Thomas *et al.*, 2003).

Humidity :

Soybean seed quality can be affected when seed moisture drops from 50% to 15% during the drying phase between physiological maturity and harvest maturity due to warm and humid weather (Howwell, Collins, & Sedgwick, 1959; Tekrony, Egli, & Balles, 1980; Tekrony, Egli and Philips, 1980). According to seed storage research, high storage temperatures and high relative humidity have been associated with seed damage and senescence. As a result, seeds will age when exposed to high temperatures and high moisture levels. This technique is widely used in laboratories to hasten the ageing process of seeds. Such pregermination treatments to seeds could reveal important details about their vigour, longevity, and loss of seed viability (A. A. Powell and S. Matthews, 1977). According to studies, drying has its limits and life cannot be prolonged by lowering moisture content below a certain threshold level (C. W. Vertucci *et al*, 1994).

Drought Stress :

Drought stress is a significant factor affecting pulse productivity. The potential production of faba beans could be reduced by up to 70% as a result of the drought (Siddique *et al*., 1999). Soybean (*Glycine max* L.) and wheat germination abilities may both be affected by water shortages during the seed filling stage (Ghassemi-Golezani *et al*. 2012 and Tarawneh *et al*., 2019).Drought stress will have an affect on the seeds' quality and yield during germination. For instance, rapeseed (*Brassica napus* L.) can efficiently produce less seed when drought is applied during sexual reproduction (Ahmandi and Bahrani, 2009). After a lengthy period of water constraint, a plant experiences drought stress, which causes permanent wilting and death may occur (O'Toole, Reference O'Toole1982). It seems that quality of seed is poor by drought stress during seed development (Barnabas *et al*.,2008 ; Stagnari*et al*., 2016). Because of the drought stress during seedfill, diligent researchers have documented declines in soyabean seed germination capacity and vigour (Drummond, Robb, and Melville, 1983; Smiciklas *et al*., 1989; Dornbos and Mullen, 1991).

Soil :

1. Soil temperature:

Seed germination, crop growth, seed development, and quality of seed are adversely affected by high soil temperature during summer and low soil temperature during winter season. Solar radiation is the primary cause of soil temperature. Temperature of the soil is measured using a thermometer. Seasonal and daily variations in soil temperature may be caused by variations in radiant energy and energy transfer through the soil surface (Chiemeka, 2010). It affects the biological processes such as availability of nutrition, germination of seed, seedling establishment, and plant root growth (Probert, 2000). Uncontrolled ion outflow is the result of irreversible membrane damage caused by severe changes in temperature in nonhardened plants (Plazek, A.; ˙Zur, I, 2003 and Uemura, M *et al*., 2006). The ability of plants to absorb water and nutrients is greatly influenced by the soil's temperature (Toselli*et al*.,1999).

2. Soil pH :

Macro and micro elements availability in soil is dependent on Soil pH. Acidity in soil reduces the soil's ability to absorb a number of elements, including calcium, magnesium, and phosphorus, and increases the availability of manganese, aluminum, and iron as well as potentially heavy metals like copper and nickel, which can result in the intake of toxic amounts. There are numerous reports of nutrient disorders on high pH and calcareous soils across cold season pulses, including Fe insufficiency in chickpea, lentil, and field pea, as well as Zn shortage in field pea, chickpea, and lentil (Siddique *et al*., 1999). Al, Fe, and Mn are usually an excess in acidic soils, while Ca, Mg, K, P, and Mo levels may be insufficient (Bradshaw & Chadwick 1980). It has been shown that the poisonous levels of Al contained in acidic soils (Ragland & Coleman 1959) having been shown to prevent seed germination (Hackett 1964) and inhibit root growth (Hackett 1965; Chadwick & Salt 1969; Davies &Snaydon 1973). Nitrification is greatly slowed down and ammonia oxidation proceeds more quickly than nitrite oxidation due to the sensitivity of nitrate bacteria are more (Smith *et al*., 1997). As a result, nitrite builds up in the soil, which can be poisonous to plants and microbes (Black 1957; Shen *et al*., 2003).

3. Soil Salinity

In coastal belts of our country, soil salinity is one of the most important factors for hampering seed germination and proper growth of several crops, as a result quality seed production programme is not done. However, this has a unique set of negative impacts. In arid regions, a large portion of the water in the saline solution evaporates, leaving its salts, like sodium chloride, in the top soil, where they are then present as dissolved salts in irrigation water. Salinization is the term for the buildup of these salts, which can hamper crop growth, reduce crop yield, and eventually kill the crop, making the soil unsuitable for farming. Salinity is considered to affect around 7% of the world's land, and about 20% of the 230 million ha of irrigated land is considered to be salt-affected (Cuneo P et al., 2010). Salinity stress greatly reduces the percentage of seeds that germinate in a range of plants, such as cultivars of Hordemvulgare that affect dry weight (Movafegh S *et al.*, 2012), In cotton (Gossypumhirsutum), by affecting its various growth parameters such as fresh weight, root and shoot lengths, as well as in Brassica juncea or other plants (Singh P.K *et al*, 2015; Saleh B, 2012; Jamil M. and ShikRha E, 2013), and rice genotypes by delaying its leaf area (Ali Y *et al.*, 2004). Currently, 30 crop plants—known as glycophytes—produce 90 percent of the plant-based food consumed by humans. The bulk of these crops are salt-sensitive or even not salt tolerant (Sonar B.A., et al,2011). These crops have seen yield loss when exposed to moderate salinity (EC 4–8 dS m1, or 40–80 mMNaCl (Zörb C et al., 2019).

CONCLUSION

Having revised the overall picture on effect of environmental factors on seed performance, it is clearly mentioning the negative impact at different stages of seed growth and development, crop establishment and yield. Therefore, farmers and growers those are engaged in seed multiplication programme for obtaining good quality seed, should be aware primarily about the reaction of temperature, relative humidity, excess draught, soil salinity, soil temperature and pH of soil for applying better management practices.

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