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Impact of polluting agents on seed quality

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Abstract
The green revolution and the industrialization effectively led to the sustainability in the food production and economy. But as their impact, the pollution rate increased by the use of chemicals and by the increase in the agrochemical industries. The polluted environment adversely affects the crop production, especially in the initial stages of the plant growth, which is very sensitive to the environmental factors. As the basic input, the seeds are the crucial part and their germination and the growth are highly determined by the environmental factors. The quality of seed is deteriorated by the increase in pollutants in the atmosphere. So these factors should be studied in detail and the keeping the seed quality even in the presence of the pollutants is crucial. When the level of tolerance of the seeds to several pollutants was studied, it was revealed that the industrial wastes in lower concentration not only maintains the seed quality but also can increase the initial vigour. So this strategy can be used for the seed quality enhancement and also to reduce the pollution by effective utilization of the waste materials.

Keywords: Seed, germination, pollution, heavy metal, seed quality, industrial effluent

Introduction

Crop production and productivity depends on several environmental factors among which air and water quality plays a major role. The indiscriminate use of natural resources led to increase in pollution rates. The pollutants consist of organic compounds along with inorganic complexes and other non-biodegradable substances. These pollutants not only alter the quality of ground water and soil but also pose threat to human kind. The influence of pollutants on seeds need to be studied elaborately as the seed is the basic input in the agriculture system and thus serve as an important factor for sustainability of human life.

Pollutants interfere with enzyme and hormonal systems. A modification of biological and reproduction functions due to this interference lead to the decrease in viability and germination of the seed materials. The alteration of physicochemical characteristics of the pollen surface and change in cellular chemical constituents and physical structure will have major effect on seed development. As a consequence of these alterations, there will be reduced production and metabolic changes which ultimately results in growth retardation. Acute, instant tissue degeneration affects plant ability to produce and store food in seeds. Oxidative stress is the most critical impedance for quality seed production. Ganatsas *et al.* (2011) [12] observed that seeds of *Pinus Spp.* collected from shorter distances from the main road were of good viability and germination than that of seeds collected from longer distances. Kalaiselvi *et al.* (2009) [14] reported that soap factory effluent was toxic to seed germination and seedling growth of finger and pearl millet, but when the effluent was diluted to 2.5 to 5.0% it improved the seed germination and seedling growth. Mehta and Bharadwaj (2012) [19] reported that chickpea seeds treated with industrial effluents showed maximum levels of electrical conductivity, total dissolved solids and chlorides. Root and shoot length were reduced due to the treatment. They concluded that *Cicer* was more sensitive towards effluent application as compared to *Vigna*.

Review of work done by the various authors revealed that irrespective of the type of effluent, these could be well utilized for betterment of agricultural crops on proper dilution to evade the lethality of the pollutants. This diluted effluent could be used both for invigorating the seed and for further irrigating the crop or the nursery in case of tree seeds depending up on the availability of the effluent specific to site as the case may be giving way to utilize the waste material for betterment of the mankind without causing ill effects to human and animals. The effluents on proper dilution can be also materialized as cash by proper sale of the product thus the review fresh up the idea of motility of waste material.

Pollution is the major problem in existing crop production and also the seed production. The soil is adversely affected due to the continuous irrigation of industrial waste water, dyeing industry effluent. The mine spoiling leads to high heat generation, ash sedimentation on crops, affecting the fertilization (affect the pollen viability) thereby affect the seed filling. The ill filled seeds will be poor in germination and establishment of the crops. The continuous sedimentation of mine ash on the earth's surface affects the water quality and the environment. Even the relative humidity is reduced due to continuous heat generation activities as a result of mines. The optimum temperature and the relative humidity is important factor which influence the seed production.

Due to the vehicle emission the atmospheric heat was developed, and it affects the pollination and seed filling. The spillage of fuel in soil will affect the soil microbes which will help the growth and development of the seed growth and development. The pollen viability also affected by the automobiles emission in the urban areas.

So the anthropogenic actions are adversely affecting the environment. The environmental influences greatly change the crop production especially through the seeds by altering several pathways of metabolism. The effects of several environmental factors are reviewed to know their impacts on the seed quality.

The effect of water quality on Seed Growth

Water is a major factor deciding the seed germination and growth. The amount of salts dissolved in the water determines the imbibitions rate and the water potential will decide the availability of water for the metabolic activities. The adequate amount of fresh water is not available for irrigation. So the extent of salts in the irrigation water will affect the quality of water and thereby the metabolic activities in the seed.

Waste water can be used extensively for irrigation and sometimes, waste water even provides positive benefits to the farming sector. Hari *et al*, (1994) [13] and Srivastava (1991) [40] studied the paper mill and chlor-alkali plant effluent on germinability of radish and onion in different concentrations of effluents and his findings revealed that the germination percentage was better with lower concentrations of the effluents when seeds treated for one to five days. Radish seeds treated with 10 % concentration reduce the mean seedling length and secondary roots as than control, while no secondary root emerged in 100% concentration of CAP effluent. Low dissolved oxygen linked with high mercury and residual chlorine content in effluent was the reason for negative germination and later growth of seedlings. In okra the percentage of germination was better in 15% with tap water and 25% with spent wash (Hari, *et al*, 1994) [13].

Ramana, *et al* (2002) [29] studied the effect of different concentrations (0, 5, 10, 15, 20, 25, 50, 75 and 100%) of distillery effluent on the performance of vegetable seed crops viz., tomato, chilli, bottle gourd, cucumber and onion. There was no negative effect on germination at low concentration of distillery effluent except in tomato, but in onion the germination was much higher (84%) at 10% concentration. Above 63%, complete crash of germination was noted. 5% concentration was critical for germination in tomato and bottle gourd and 25% in the rest of the crops.

Dixit, (2003) [10], studied the toxicity of raw and diluted distillery effluent on seed germination, growth of seedling and pigment content of sugar beet. For that the seeds kept moist in different dilutions (1, 5, 10, 20 and 30%) of effluent solution, with double distilled water, which served as the control. The concentrations greater than>5% of effluent were found to be toxic. Sharma, *et al* (2002) [35], studied the effect of fertilizer factory effluents (0, 1, 2, 5, 10, 25, 50 and 100%) on seed germination of three tomato varieties. Increasing the concentration of effluent leads decreased germination percentage. Germination improved with 25% effluent concentration and 50 and 100% showed negative impact on germination. Soundarrajan and Pitchai (2007) [39] revealed that application of spent wash at higher concentration has increased germination per cent age of okra. Yadav and Meenakshi (2007) [43] revealed that rising of the effluent concentration affect the germination percentage and seedling performance of Radish and Bhendi. Decreased germination, root and shoot length from 42 to 32%, 2.10 to 1.49 cm and 2.08 to 1.49 cm, respectively was observed in 100 % sewage concentration but in 10%, there was maximum seed quality (Muthalagi and Mala, 2007) [21], and the same was noticed by Behera and Misra, (1982) [6] in rice. The chlorophyll A and B decreased with increasing in the effluent concentration. The carotenoid content continued to increase up to 5% effluent concentration, Sahai, *et al*, 1983 [31]. Increase in effluent concentration cause delayed primary root emergence in rice seeds (Dixit, *et al*, 1983) [9]. Inorganic constituents present in the distillery effluent like ammoniacal nitrogen, chemicals and traces of heavy metals noticeably suppressed the germination per cent and early growth of the rice seedling (Rajaram and Janardhanam, 1998).

Rajannan, *et al.* (1998) [27] also studied the seed germination of rice treated with different concentrations of tannery effluent *viz*., 25, 50, 75 and 100% and found that the germination was affected by 25 and 50% effluent and fully inhibited by 75 and 100% effluent. It also reduced the chlorophyll and protein contents of plants. Karunyal, *et al*, (1994) [15]. Rani and Alikhan (2007) [30] revealed that the per cent age germination and seedling energy of rice and wheat reduced significantly with a raise in the concentration of spent wash.

With all these studies, it is revealed that the industrial effluents or the waste water can be effectively utilized for irrigation with minimal effects in the seeds by diluting it to the desirable concentrations. If properly diluted, the salts in the effluents not only retain the seed quality but also enhance the germination and vigor of the seedlings.

Effect of heavy metal pollution on seed

The heavy metals are the potential pollutants which are present in the most of the industrial effluents. This will not only pollute the environment, but also toxic to the plants, especially at the initial stages. The impact of heavy metal on seeds are evidenced by reduced germinability, seedling growth dry matter production and decreasing protein content, (Sahu *et al*., 2004), membrane integrity, altered metabolism, loss of nutrients which can all together leads to the toxicity on seeds and thereby lead to the loss of yielding ability (Ahmad *et al*. 2011 and Pourrut *et al*. 2011) [25]. Wang *et al* (2003) [42] reported that, metal components and the chemicals at higher concentration hinder the germination, growth and development of crops due to their interference with the biochemical, physiological and genetic elements of the plant. The effects of the different heavy metals are summarized in Table 1.

Table 1: Effect of several heavy metals on germination and growth of seeds

Heavy metal elements	Kind of effects by heavy metals	Reported by
Nickel (Ni)	Affects germination inducing hormones like amylase, enzymes responsible for protein synthesis, growth and development the seed	Ahmad *et al*., 2012 [3]
	Restrict the mobilization of food resources and hydrolysis of food such as carbohydrate and protein and germination affected	Ashraf *et al*., 2011
	Reduced growth factors, dry weight photosynthetic pigments and enzyme activity addition of Ni with NaCl, loss of growth and development, yield loss affects the photosynthetic system. Decrease proline content and electrolyte leakage. loss of membrane integrity	Ahmad *et al*., 2007 [4] Siddiqui *et al*., 2011 [36] and Yusuf *et al*., 2012 [46]
Lead (Pb)	Adversely affecting the physiology and morphology of seeds. it hindering the emergence and root and shoot elongation, growth and development of plants alteration in photosynthetic pigments, inhibition of metabolic cycles, Iron and magnesium uptake get damaged and its encourage co2 deficiency because of closure of stomata. lowering the productive enzymes and changing the genomic DNA, reduced antioxidants activity	Pourrut *et al*., 2011 [25] Singh *et al*., 2011 [37] and Mohamed, 2011 [38]
Copper (Cu)	Inducing ROS activity and its leads to oxidative stress, decreased antioxidant activity, reducing the rate of germination and down regulation of alpha-amylase activity	Singh *et al*., 2007 [38] Sfaxi *et al*., 2010 [33] Pena *et al*., 2011 Lyanguzova, 2011 [17]
Cadmium (Cd)	Delayed germination, affects membrane integrity, affects food resources mobilization and physiological and metabolic events	Ahsan *et al*., 2007 [5]
Cobalt (Co)	It affects entire metabolic events and mobilization of food resource	Zhang *et al*., 2007 [45]

Air pollution and its effects on seed quality

The emergence and establishments of a crop is affected by several environmental factors among which the air is an important one (Shafiq and Iqbal, 2012) [34] and the air around the crops contain many harmful elements due to several anthropogenic actions (Ewen *et al*. 2009). The seeds sown under area with industrial air pollution accounted the four days delayed germination than the control and the pollution did not affect the seed initial vigour and releasing of dormancy (Lyanguzova 2011) [17]. Zhang *et al.* (2016) [44] reported that seed of soybean exposed under bisphenal A at low concentration will not affects the seed and seedling characters, but at higher concentrations it lead to the loss of membrane integrity, lipid peroxidation and restriction in the activity of antioxidants. *Pongamia pinnata* and *Dalbergia sissoo* seeds collected from polluted urban area caused deleterious effect on germination than the clean area (Mehmood and Iqbal, 1989; Qadir and Iqbal, 1991) [18, 26]. Presence of heavy metals in air can affect the reproductive ability of the tree species (Fuentes *et al*., 2007, Onder and Dursun, 2006) [11, 22]. Seeds of *Betula papyrifera* collected from $CO_2 + O_3$ elevated condition shows significant seed mass reduction (Darbah *et al*., 2008) [8]. Li *et al*., (2005) [16] reported that embryo length of *P. brutia* not affected by keeping the plant away from the city area. The dust and diesel particles emitted from the vehicles act as physical constrains for seed germination and growth. The fuel which forms a thin layer on seed surface acts as a physical barrier for germination (Adam and Duncan, 2002) [1]. The plant of *C. siamea* found as a good pollution indicator in urban areas (Pandian *et al*., 2009) [23]. Agrawal *et al.* (2006) [2] reported that the seed quality of mung bean which lead to biomass production and yield significantly affected by increasing the concentration of SO_2, NO_2 and O_2 at a minimum (ppb) level. Taia *et al* (2013) [41] studied the crop response under filter and non-filtered ambient air condition and they found that impairment of germination of pollen and the pollen growth was significantly affected in the seeds kept under non-air filtered chamber and the adverse environment affects the pollen growth and development and its leads to poor seed set and decreased seed quality (Black *et al.*, 2000) [7].

Conclusion

The impact of the pollutants and the industrial effluents should be studied in detail as it adversely affects most of the metabolic pathways in the seeds. But they can be utilized for betterment of the seed quality if utilized in an effective way. The permissible limit of each component should be determined and should be effectively used as nutrient source for the seeds. By this way, we can increase the nutrient source to seeds and also can reduce the environmental pollution by effectively utilizing the waste materials.

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