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Effect of Emerging Pollutant Phenol on growth of Pigeon pea

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Abstract: In the present study was carried out to investigate effect of three concentration of phenol on pigeon pea germination and overall growth of plant. Seeds treated with 0.025%, 0.05% and 0.075% concentration of phenol showed a significant inhibition in the percent seed germination as compared to control. The germination observed was 89%, 63% and 48% at 0.025%, 0.05% and 0.075% concentrations on 7th day of incubation. Three different concentrations of phenol showed a significant difference in root and shoot length over control, similarly in biomass.

Keywords: Phenol, pigeon pea, germination, toxicity

Introduction

Phenolics constitute the 11th of the 126 chemicals, which have been designated as priority pollutants by the United State Environmental Protection Agency (Caturla *et al.,* 1998). Phenolics pollutants associated with pulp mills, coal mines, gasoline, petrochemicals, pesticides, insecticides, herbicides, detergents, solvents, polymeric resin production, plastic, rubber proofing, disinfectants, pharmaceuticals, metallurgicals, explosives, textiles, dyes, the coffee industry, domestic waste, agricultural run-off, and chemical spills (Bulbul and Aksu 1997; Aksu and Yener 1998; Gupta *et al.,*1998; Loh *et al.,*2000; Sung *et al.,*2000). Phenol in wastewater is highly toxic for animals and plants (Bandhyopadhyay *et al.,* 1999), although effluent can be diluted and then discharged in to the waterways, this approach is not feasible as the chemical toxicity at 5-25 mg/l is hazardous.

Among the legumes pigeon pea or red gram (*Cajanus cajan* (L.) Millspaugh) occupies an important place in rain fed agriculture. Globally, it is cultivated on 4.79 M ha in 22 countries. In Asia, India (3.58 M ha) produce considerable amounts of pigeon pea, India accounts for 90 percent of world output with an area of 3. 23 million hectares and production of 2.37 million tones of grains (FAO, 2008). In Karnataka pigeon pea is grown in an area of 5.83 lakh hectares with a production of 2.57 lakh tones. It is largely grown in the northern parts of the state specially in Gulburga which is called "pulse bowl of Karnataka" (Sidaram *et al.,* 2010).

The pollution with heavy metals, xenobiotics, organic compounds and other contaminants is a growing environmental concern that harms both terrestrial and aquatic ecosystems. Higher plants act as one of the key producers in ecosystems with important roles in sustaining the integrality of ecosystems. However, increasing application of chemicals in contemporary agriculture, especially the use of various xenobiotics, inevitably damages some normally physiological and biochemical metabolisms in plants. As a result, the growth of plants is inhibited and the survival of plants threatened. These toxic effects of agrochemicals on higher plants not only bring out many of uncertain and adverse changes through biochemical mechanisms such as toxic transportation and magnification in the food chain, but also decrease the diversity of species with the death of some plant species (Wang and Zhou, 2006). This study was to explore the toxicity of varying levels of phenol concentration on pigeon pea germination and growth. Determining the toxicity of the contamination toward the plants is essential. Therefore, a successful approach requires the selection of plant seeds that have high resistance to the pollutants.

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Materials and Methods

Pigeon pea (*Cajanus cajan* L. Millsp) variety ICPC-87119 (Asha) seeds were collected from Agriculture Research Station, Gulbarga. The seeds were surface sterilized with 1% of $HgCl_2$ for one minute. After thorough washing with distilled water, hundred seeds were soaked in each concentration of phenol solution (0.025%, 0.05% and 0.075%) for 12 h. Distilled water was used in place of phenol in control. The soaked seeds were incubated in petri plates lined with moist blotter at 28°C ± 2°C in dark place. The filter papers lined in petri plate were also moistened with respective concentrations of phenol. The data on seed germination was recorded at an interval of 24 h for 7 days. However, the shoot and root length and biomass were measured on 7th day of incubation.

Results

Effect of phenol on seed germination

Pigeon pea seeds treated with different concentrations of phenol showed a significant inhibition in percent seed germination as compared to control. On 7th day of incubation, the germination observed was 89%, 63% and 48% at 0.025%, 0.05% and 0.075% concentrations, respectively as compared to 100% germination in control (Fig. 1 & 2).

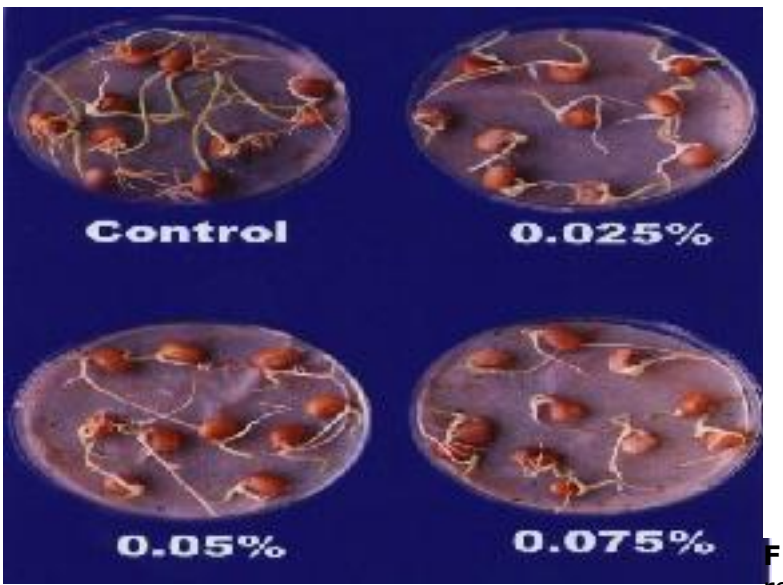

Fig. 1: Effect of three concentrations of phenol on seedling growth in pigeon pea

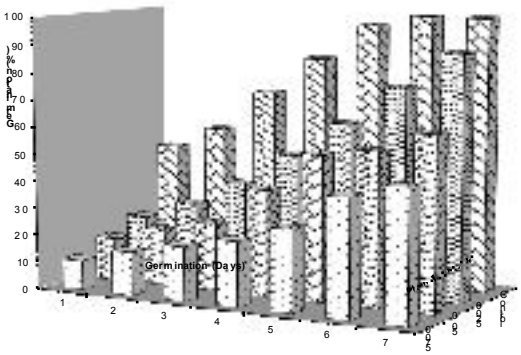

Fig. 4.2: Effect of three concentrations of phenol on seed germination in Pigeon pea

Fig. 2: Effect of three concentrations of phenol in pigeon pea germination.

Effect of phenol on root and shoot length

Seeds treated with phenol showed a significant difference in root and shoot length as compared to control (Fig. 3). On 7th day of incubation root length was inhibited by 1.6 cm, 1. 2 cm and 1.0 cm and shoot length by 2.9 cm, 1.9 cm and 1.3 cm at 0.025%, 0.05%, 0.075% and 0.1% concentrations, respectively as compared to 1.8 cm and 4.0 cm of root and shoot length in control.

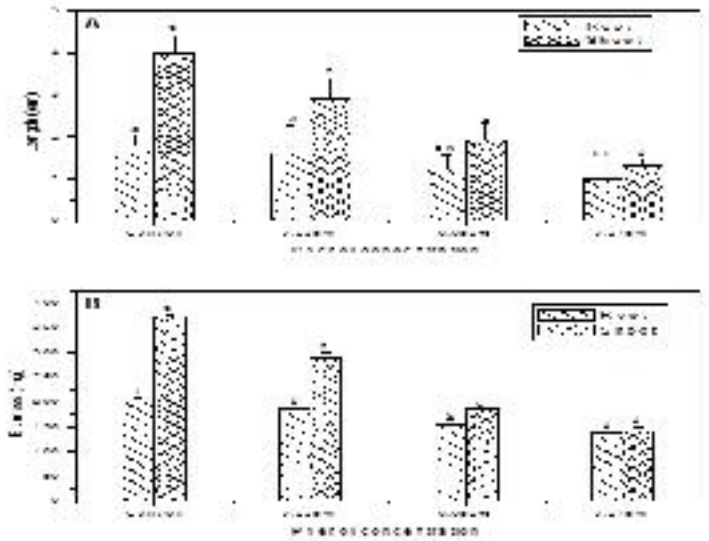

Fig. 3: Effect of phenol concentration on (A) root and shoot length and (B) biomass in pigeon pea. Data are mean ± SD (n=3). Different letters indicate that the mean value is significantly different (P < 0.05).

Effect of phenol on biomass

In pigeon pea, the effect of phenol on root and shoot biomass was also estimated (Fig. 3). On 7th day of incubation, the seeds treated with 0.025%, 0.05% and 0.075% concentrations of phenol showed 186 mg, 156 mg and 138 mg of root and 291 mg, 186 mg and 143 mg of shoot as compared to 202 mg root and 373 mg shoot in control, respectively.

Discussion

Three different concentrations of phenol tested were proved to be inhibitory over seed germination, shoot and root length and biomass production in pigeon pea. A significant difference was observed between each concentration. Maximum decrease in seed germination, shoot and root length and biomass production was recorded at higher concentrations. Negi and Prasad (2001) reported that higher concentration of salicylic acid decreased the rate of germination in soybean and similarly in chickpea by Keshamma *et al.,* (2004).

Muscolo *et al.,* (2001) reported that certain phenolic compounds bioassayed affected the germination of *Pinus laricio* seeds, and the effects were variable in regard to the phenolic compounds utilized and their concentration. Vijaykumari *et al.,* (1993) reported the inhibition of seed germination of certain millets and pulses by soap factory effluents. As the salinity increased, the percent seed germination decreased in sorghum varieties (Gill and Sharma, 1990). The growth disturbance in sorghum seedlings treated with sodium fluoride was reported by Vijayawargiya and Pande (1991). Similarly, Rajannan and Oblisamy (1979) suggested, the interaction between various constituents of effluents are responsible for inhibition of seedling growth. The root and shoot length and biomass production of *Albizia lebbek* was adversely affected by certain metals at higher concentrations (Tripathi and Tripathi, 1999).

The present study concluded that, three concentrations of phenol viz. 0.025%, 0.05% and 0.075% were proved to be inhibitory over seed germination, shoot and root length and biomass production in pigeon pea.

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