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Studies on the influence of uranyl nitrate on seed germination and early seedling growth of sunflower

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SUMMARY

As no biological role of uranium is known, its chemical toxicity, which leads to biological hazards, necessitates its behaviour in reference to biosystem. The effects of various uranium concentrations on sunflower were studied by observation of seed germination, analysis of various growth and biochemical parameters. Influence was also measured in terms of tolerance index, seedling vigour index and grade of growth inhibition. Late starting of seed germination was observed but ultimate germination was not affected by all the uranium concentrations. Shoot-root length, shoot-root fresh and dry weight, chlorophyll contents, tolerance index and seedling vigour index showed gradual decrease with an increase in uranium concentrations. A significant positive correlation was observed between applied uranium concentrations and leaf soluble protein contents, total phenol contents and grade of growth inhibition. Disturbance in seed germination period, growth and biochemical parameters as well as certain indices shows that uranium is toxic to the sunflower.

Key words : *Helianthus annus* L., Uranyl nitrate, Seed germination, Early seedling growth, Biochemical constituents, Tolerance index, Seedling vigour index, Grade of growth inhibition.

Germination may be defined as the sequential series of physiological and morphogenetic events that result in the transformation of an embryo in to a seedling (Berlyn, 1972). A number of environmental factors together with the make-up of a seed affect germination phenomenon. Lot of work has been done on seed germination and behaviour of crop plants under moisture stress (Asana, 1975 and Hadas, 1976), temperature stress (Kearns and Toole, 1939) and salt stress (Aceves *et al.,* 1975) but only a few studies have been carried out on effect of heavy metals on seed germination and early seedling growth in India (cf. Aery and Sarkar, 1990; Sarkar *et al.,* 1990; Jagetiya and Aery 1994a, b; Aery and Jain, 1995; 1996; Jain and Aery, 1996). Aery and Jain (1995 and 1996) and Jain (1996) studied effect of uranium on seed germination and early seedling growth of *Vigna radiata* (L.) Wilczek and *Triticum aestivum* L.

Uranium is a normal component in organism and its concentration in plants, soil, water and animals has been estimated (Canon, 1960; Aten *et al.,* 1961; Goldberg, 1965 and Gulati *et al.,* 1979). It is the heaviest trace element in nature and is the most mobile element in the uranium decay series in the surficial environment (Dyck and Boyle, 1980). There is contradictory information on the toxicity of soil uranium to plants (cf. Sheppard *et al.,* 1992). Stoklasa and Penkava (1928), Bevilotti (1945), Becquerel and Rousseau (1947), Fevilli (1948), Drobkov (1951), Canon (1952), Sultanbeav (1971), Morishima (1976) and Sheppard *et al.,* (1992) reported that low levels of uranium concentration stimulated plant growth while Jain and Aery (1996), Jain (1996), Aery and Jain (1997), Hafez and Ramadan (2002) showed detrimental effects of uranium.

Keeping the above in view the present studies were conducted to assess the effect of uranium on seed germination, early seedling growth and biochemical constituents of sunflower.

MATERIALS AND METHODS

Seeds of sunflower (*Helianthus annus* L. var. Sungold double orange) were selected for uniformity. Seeds were surface sterilized with 0.2% $HgCl_2$ solution for five minutes and thoroughly washed under running tap water for one hour. Ten seeds were placed on two layers Whatman No. 1 filter paper discs in Perti plates that were moistened with fixed amount of freshly prepared solutions of various concentrations of uranyl nitrate [$UO_2(NO_3)_2.7H_2O$]. A randomized block factorial design with four concentrations of $UO_2(NO_3)_2.7H_2O$ (1, 10, 100 and 1000 mg ml^{-1}) was used. Three replicates for each treatment were kept in dark humid condition at a constant temperature (24° C). Streptomycin sulphate (1.25 mg ml^{-1}) was included in all solutions to suppress microbial growth. Seed germination was noted after every two hours.

Seedlings were transferred to an improvised nylon mesh suspended in darkened wide mouthed polystyrene bottles of 300 ml capacity with the help of corning tube cut on both the ends. The bottles contained various concentrations of $UO_2(NO_3)_2.7H_2O$ and 0.5 g l^{-1} as basic growth medium.

After ten days of treatment, plants were harvested and washed immediately. After washing, shoot-root length as well as shoot-root fresh and dry weight was measured. Chlorophyll contents, soluble proteins and total phenols were estimated after Arnon (1949), Bradford (1976) and Pirie and Mullins (1976), respectively. Following indices were also calculated:

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