Studies on Cytological Changes Induced by Muriate of Potash in *Allium cepa*

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Potassium is an essential element influencing plant growth and productivity. Potassium present in nature is known to originate from the disintegration of potassium bearing minerals. Based on their availability to plants, soil potassium is reported to exist in non-available and readily available forms to crops. Though the amount of potassium present in mineral form is known to vary from 5000 to 25000 ppm, the readily available level to crops varies from 1 to 10 ppm only (Tisdale *et al.* 1985). Thus, most of the soil potassium is known to be in unavailable forms to plants and the release of potassium from mineral forms available in nature is too low to support maximum crop production. In tropical soils, the total content of potassium is known to be comparatively low because of the high rain fall and continued low temperature.

As the potassium requirement of the plant is high, potassium fertilizers are applied to the soil and consist of potassium in combination with chloride, sulphate, nitrate *etc.* Potassium chloride is used for direct application to the soil in the commercial name “muriate of potash”. Muriate of potash, which gets easily dissolved in soil moisture, is the most widely used potassium fertilizer in many countries.

Fertilizer toxicity in plants is well known. But the influence of excessive amounts of fertilizers on cell divisions in exposed roots has not received much attention yet. Concern over the adverse effect on cells and cell divisions due to accumulation of fertilizers in soil has prompted research in this field. The present study provides information on the cytological changes produced by different concentrations of muriate of potash in mitotic cells of *Allium cepa*.

Materials and methods

Technical grade potassium chloride manufactured by BDH for serving industrial, academic and research purposes was used for the studies. The *Allium cepa* root meristem assay is considered widely as a practical reliable system for the screening of environmental mutagens and carcinogens (Fiskesjo 1985, Stich *et al.* 1975). Preliminary studies showed that concentrations above 2000 ppm exerted toxic effects on cells while concentrations below 200 ppm did not produce abnormalities in cell divisions. Hence, during the present study, the influence of muriate of potash on cell divisions was assessed by restricting the treatments to three non-toxic concentrations (200 ppm, 1000 ppm, 2000 ppm). The abnormalities induced by the treatments were compared against those present in untreated controls. The aberration frequency data presented are based on 300 metaphases and anaphases in each treatment. Detailed methodology relating to preparation of test solutions, treatment procedures, cytological techniques, scoring of cytological abnormalities and analysis of data was given in earlier publications (Abraham and Devi 1988, Abraham and Nair 1988).

Results and discussion

Cytological studies in the untreated materials of *Allium cepa* clearly showed 16 chromosomes at the metaphase stage of mitosis. Cell divisions in the roots treated with muriate of potash revealed the presence of a wide spectrum of abnormalities. The salient findings of the study are presented in text fig. 1. Clastogenicity of the fertilizer was manifested as chromosome fragments and exchange configurations. As may be observed from Fig. 1, fragments of different sizes were observed. The number of fragments in a cell was found to vary from one to many. Spindle abnormalities leading to disturbed anaphases were frequently observed (Fig. 2). Occurrence of c-mitoses and multipolar anaphases yielding polyploid and aneuploid cells respectively was also observed in the different treatments. In the highest concentration studied, cells showing clumping of chromosomes indicating toxic effects of the fertilizer were present (Fig. 3). Chromatid breaks and achromatic lesions were also noticed occasionally. As may be observed from the text figure, clastogenicity appeared to be dose dependent, more damages in higher concentrations were observed.

The results of the study clearly indicate that though muriate of potash is capable of inducing both reversible and irreversible changes in cell divisions, the most significant effect in all the treatments was chromosome breakage and subsequent deletions and rearrangements. In a recent study conducted at this centre it has been observed that the fertilizer zinc sulphate exhibited toxic effects on cells at 20 ppm level (Abraham 1997). On the other hand, in studies using muriate of potash, cytotoxicity was manifested by much higher concentrations only. This is to be expected as plants can tolerate high levels of potassium, as the potassium requirement of the plant is comparatively high. However, as is well known, if excessive amount of this fertilizer is present in the soil, plants will absorb potassium far in excess than that required for optimum yield. This "luxury absorption" can produce cytological changes which may have its impact on subsequent cell divisions. The production of cytological abnormalities may be more in periods of drought or when the soil moisture content is low.

In the past few years, pollution of the rivers due to discharge of agrochemicals and fertilizers has been widely reported (Friligos 1987, Albanis 1992). Such studies have shown that the toxic effects of chemicals released in the environment are more detrimental than their possible mutagenic effects (Falandysz *et al.* 1994). It is well known that the capacity of plants

Text fig. 1. Spectrum of abnormalities induced by different concentrations of muriate of potash in *Allium cepa*.

Fig. 1-3. 1. Metaphase showing chromosome fragments. 2. Disturbed anaphase showing unequal groupings at the opposite poles. Note the presence of a lagging chromosome. 3. Pollen mother cell showing chromosome clumping and sticky bridge.

to grow well on heavily fertilized soils depends on a number of interrelated factors such as root volume, stage of growth, physiological and genetic nature of the plant and moisture content of the soil. In studies using manures and fertilizers, it has been observed that these substances which ensure efficient crop production, are also capable of inducing abnormalities in cell divisions, when present in high proportions and concentrations in the soil (Abraham 1965, Abraham and Nair 1988). During the present study, roots were exposed to known concentrations of the fertilizer, whereas in agricultural practices, plants are exposed to an environment containing varied quantities of the fertilizer. This study indicates that in order to maintain normal cell divisions in plants, attention should be paid to avoid fertilizer levels that induce cytological abnormalities.

Summary

The cytological abnormalities produced by muriate of potash were evaluated using *Allium cepa* root meristem assay. Studies using different concentrations of the fertilizer showed that concentrations ranging from 200 ppm to 2000 ppm produced significant increase in chromosomal aberrations and other abnormalities over the control. This study indicates that the fertilizer is capable of upsetting normal cell divisions if excessive amounts are present in the soil.

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