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Mutagenic Potential Of Lead Nitrate In Inducing Variations In Morphology And Yield Of Medicinally Important Crop- *Linum Usitatissimum* L. In M_1 Generation.

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Abstract: *Linum usitatissimum* L. (Linseed/Flaxseed), is one important crop which offers an exciting opportunity for quality improvement. Varieties of *L. usitatissimum* have been bred specifically for oil purpose or fibre purpose or for both (dual purpose). The oil yielded by plant is high in linolenic acid content. Induced mutagenesis techniques have successfully produced and commercialized quite a large number of new promising varieties in different crops worldwide, including cash crops. Induce mutagenesis pave a way to crop improvement by inferring variations in germplasm. The present study aimed to determine effects of lead nitrate [$Pb(NO_3)_2$)] on cyto-morphological and growth parameters of flaxseeds in M_1 generation. Fresh and healthy seeds of *Linum* were treated with five different concentrations of lead nitrate [$Pb(NO_3)_2$)] i.e., 20, 40, 60, 80, 100 ppm. Seed germination (%), plant survival (%) and pollen fertility (%) were found to be decreased in treated population than control. Morphological parameters like plant height, number of branches, and different yield parameters showed significant dose dependent reduction at the seedling stage as well as at mature stages. Higher concentrations of the lead nitrate were found to be more genotoxic and mutagenic than the lower concentrations as lower doses did not significantly affects the cyto-morphological parameters.

Keyword: *Linum usitatissimum* L., Flaxseed, lead nitrate, mutagenesis, genotoxic

INTRODUCTION

The genus *Linum*, belonging to the family Linaceae, consists of over 200 species showcasing remarkable diversity in their karyotype, biochemical, and morphological traits. Among them, *Linum usitatissimum* L. (2n = 30), commonly known as flax or linseed, stands out as a vital oilseed crop known for its nutritional and medicinal benefits. This plant is rich in omega-3 fatty acids (especially α-linolenic acid), dietary fibers, lignans, proteins, and various antioxidants (Ivanov et al., 2011; Goyal et al., 2014). It is also one of the most important winters (rabi) oilseed crops in India.

However, despite increasing demand for linseed products, production levels have declined even with an expanded harvested area. This discrepancy signals the urgent need for strategies to boost production. One of the most effective approaches is mutation breeding, a proven and cost-efficient method for enhancing yield, productivity, and desirable agronomic traits. Traditional mutation breeding techniques hold great potential to create viable genetic mutations that improve crop plants by inducing point mutations at specific gene loci (Szarejko et al., 2017; Holme et al., 2019). This method has already demonstrated its value in developing superior crop varieties and could be crucial for meeting future agricultural demands.

Heavy metals are among the most toxic and harmful pollutants to the environment, and their prevalence is contributing to the rapid increase in environmental pollution. Common heavy metals such as lead, cadmium, copper, and mercury are particularly abundant and play a significant role in exacerbating pollution issues. Among heavy metals, lead (Pb) is a highly genotoxic element. Numerous studies have demonstrated that the genotoxicity of Pb is directly associated with its impact on the structure and function of DNA. In plants, lead is known to inhibit seed germination and can cause chromosomal aberrations and micronucleus formation (Aslam et al., 2014).

MATERIALS AND METHODS

In *Linum usitatissimum* L. genetic variability induced by using chemical mutagen lead nitrate ($Pb(NO_3)_2$), concentration ranging from 20-100ppm. The healthy and viable seeds were pre-soaked (8 hr) and treated with five different concentration of lead nitrate. The 100 seeds from each treatment along with control in 5 replicates were sown in field and M_1 generation is grown. M_1 population were examined for morphological mutations throughout the growth. Qualitative and other parameters of quantitative traits were observed in this study.

RESULTS AND DISCUSSION

By analyzing the effect of lead nitrate on *Linum usitatissimum,* it was concluded that the mutagen lead nitrate has enormously drastic effect the qualitative as well as quantitative traits of the plant. Seed germination was recorded 95% in control which get reduced from 87% to 61% in treated plants. Plant survival was recorded 92% in control which get reduced from 79% to 62% in treated plants. Pollen fertility was recorded 93.71% in control which get reduced from 85.64% to 65.32% in treated plants (Figure 1). Biological damage in seed germination, plant survival and pollen fertility were recorded, as recorded by Shahwar et al., (2024). This may be attributed to mutagens disrupting both genetic and physiological processes, leading to accelerated cell maturity.

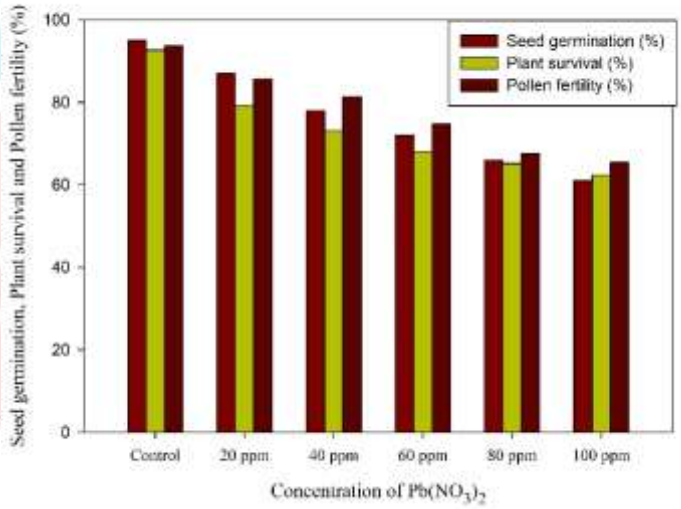

Figure 1 Seed germination, Plant Survival, Pollen fertility (%)

In investigation, the plant height of the control was recorded as maximum of average 95.17 cm which get reduced to 52.87 cm in plants of 100ppm treatment. Number of branches also get reduced in variants plant from average of 5 (control) to 3.6 in treated plants (Figure 2). Similar reduction was observed by Hasan et al., (2022).

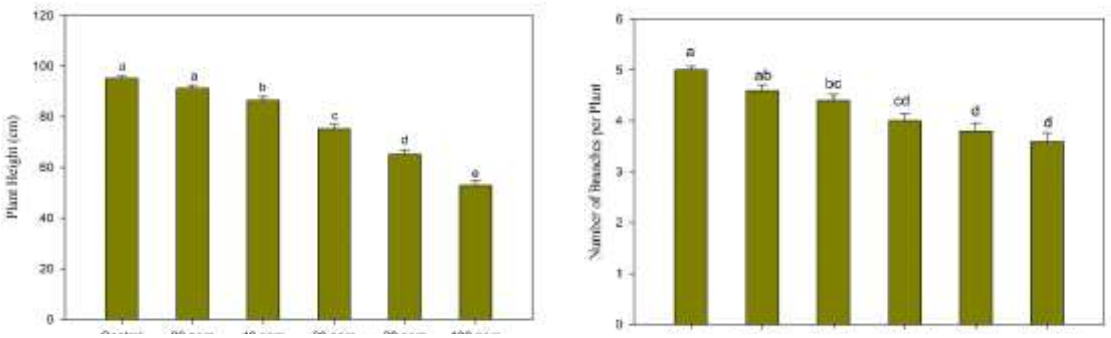

Figure 2 Plant height and Number of branches per plant, alphabets indicate the significant test according to DMRT at ($p<0.05$)

Yield parameters (Number of capsules per plant, number of seeds per capsule, 1000 seed weight and total yield) also get reduced in the investigation (Figure 3). Similar reduction in yield was reported by Chaudhary et al., 2012, Naaz et al., (2024). This may be due to chromosomal damage induced by mutagen.

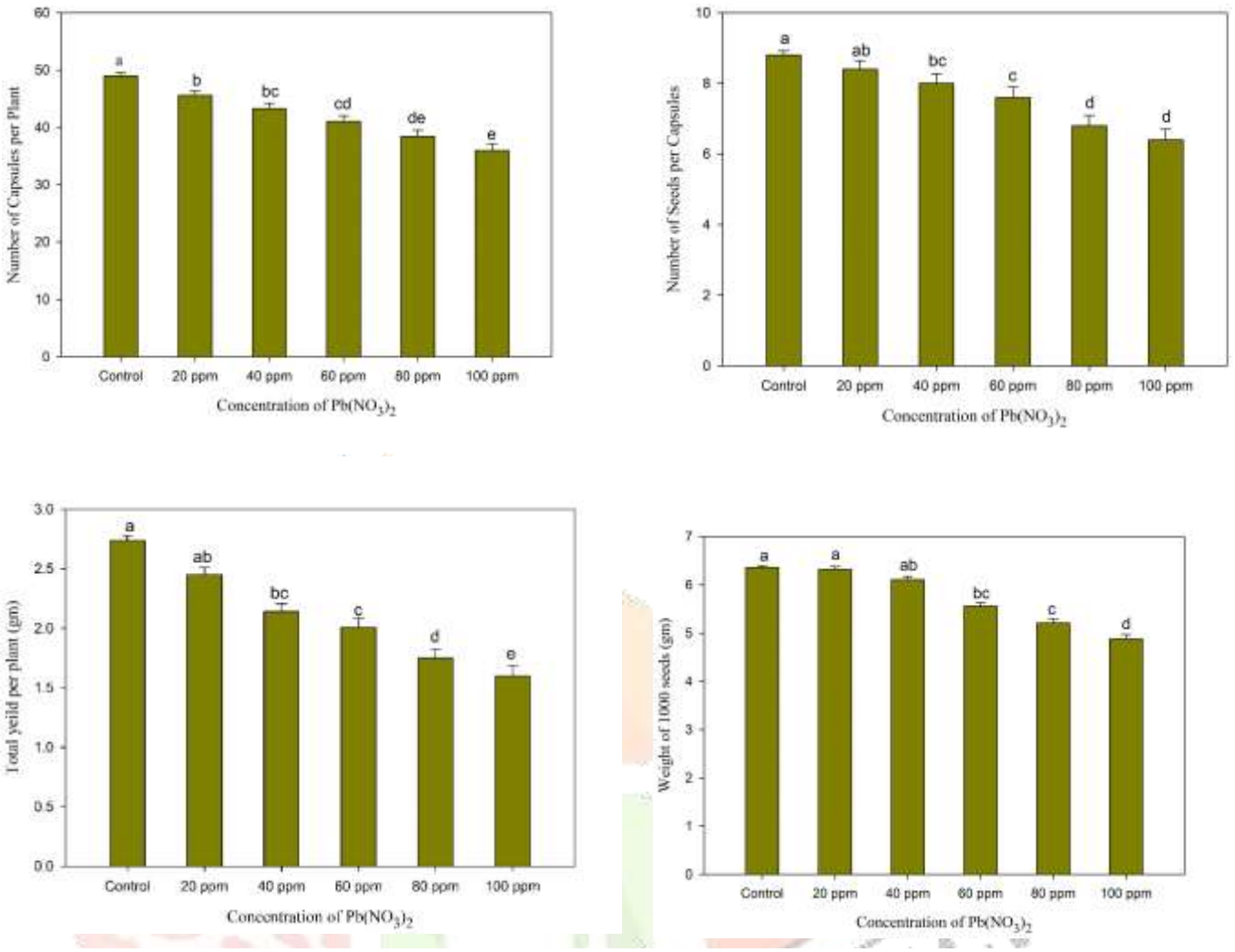

Figure 3 Yield parameters (Number of capsules per plant, number of seeds per capsule, total yield, and 1000 seed weight), alphabets indicate the significant test according to DMRT at ($p<0.05$)

Morphological variants of cotyledons and vegetative leaves with different and altered shape and size were observed (Figure 4). Plant variants selected in M_1 generation shows vigorous reduction in growth habit, as plant become semi-dwarf and dwarf with decreased or no branching. Chlorophyll mutant plants with no branching and reduced yield were observed in higher concentrations (Figure 5). Control flower is pentapetalous with purple-blue colour. Flower variants displayed in Figure shows variation in number (hexapetalous), color (dark violet, white) and arrangement of petalous (distorted shape) in flowers of M_1 generation (Figure 6). Capsule size and colour were normal in control while, capsules of M_1 variants shows decreased size, with highest reduction at 100ppm. Seeds variants also showed similar reduction with variation in seed shape and colour (Figure 7). Similar morphological variants have been reported by Sharma et al., (2022). These may be due to chromosomal damage induced by mutagen.

Figure 4 Cotyledonary and Vegetative leaves control and variants

Figure 5 Plant control and variants

Figure 6 Flower control and variants

Figure 7 Capsule and seeds variants

CONCLUSION

Mutagenesis refers to a sudden, heritable genetic alteration that caused spontaneously or by chemical or physical mutagens. These agents trigger morphological changes and yield parameters. In this study, treatment with lead nitrate cause variety of visible morphological changes and the parameters related to yield also get affected. This showed the mutagenic potential of lead nitrate in inducing variations in morphology and yield of *Linum usitatissimum*.

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