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MORPHOLOGY AND PRODUCTIVITY RESPONSE OF *Lens esculentus* (LENTIL) UNDER THE STRESS OF CADMIUM CHLORIDE ($CdCl_2$)

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ABSTRACT

Seeds of *Lens esculentus* (lentil) were treated with 0.1%, 0.25%, 0.5% & 1% concentration of $CdCl_2$ before sowing and the resulting plants were considered as M_1 generation. The seeds obtained from M_1 generation under different treatments were further treated with the corresponding concentration of $CdCl_2$ to obtain M_2 generation. The germination percentage of seeds, number of branches per plant, plant height, number of pods per plant and weight of 100 seeds on the treatment of various concentrations of $CdCl_2$ showed a decrease in both the generations but the losses incurred were recovered slightly in M_2 generation. The plants of M_2 generation however showed a little gain over the control, particularly at the lowest concentration i.e. 0.1%. It suggests that the studied plant sp. is likely to overcome the deleterious effect of $CdCl_2$ under constant exposure in the generations to come.

KEYWORDS : *Lens esculentus*, $CdCl_2$, Morphology, Productivity

India is the world's largest producer as well as largest importer of pulses. In spite of that the per capita availability of pulses has reduced to 30 gram. However each adult requires about 150 gram of pulses, 435 gram of cereals & 295 gram of vegetables per day for proper health as per dietician's directive.

Many pulses are cultivated in India. *Lens esculentus* is an important pulse which is cultivated in all the states of plain area. The crop is susceptible to many pathogens. Many fungicides and insecticides are used to control them but spray of these fungicides and insecticides also influence the host crop. Besides unmanaged other human activities like grazing, logging and intentional fire also results in environmental degradation. Burning of fossil fuel, flooding, mining and eutrophication further deteriorate the environment.

Many high yielding varieties have been introduced but the common man is totally unaware of the fact that such varieties are disease prone because several fungal disease have been detected under natural conditions. Several fungicides and other chemical compounds are used to control these diseases which in turn have adverse impact on seed germination, height of plants, number of branches, time taken for flowering, number of pods per plant, weight of seeds, period of harvesting etc.

Some worker reported that atrazine caused abnormalities in sorghum including multinucleated cells, bridges and increased chromosomal number. As well as also reported that the mitotic index and chromosomal aberration in *Allium sativa* roots under the influence of two fungicides PCBN & Vitavex (0.1 to 10 mg/ml). PCBN (Pentachloronitrobenzene) acted as mitotic index repressor. The repressive effect was increased with the increase of concentration of fungicide.

Amer and Ali*,* (1974) reported the effect of 2,4,5-Trichlorophenol and 2,4-Dichlorophenol on the meiosis, pollen viability & yield of *Vicia faba*. Most dominant type of abnormalities were stickiness, lagging chromosomes and chromosomal fragmentation. Several workers have exhibited reduction in mitotic index, both in physical & chemical mutagens (Amer and Farah, 1985). Patra et al.,(2001) reported several chromosomal aberrations and sister chromatic exchange in vegetable crops near Calcutta.

Muhammad et al., (2008) reported the effect of Lead and Cadmium on the germination and seedling growth of Leucaena leucocephala and it's tolerance. Yasir and Ahmed, (2006) have reported that the germination of seeds and growth inhibition of roots and the mitotic abnormalities increased with increasing Cd concentration. Jaffer et al (1999), Wierzbica and Obidzinska, (1988) reported inhibitory effect on germination and plant's growth due to lead toxicity.

Metals have drawn special attention with respect to their toxicological effect on human health, plants and animals (Azevedo and Lea, 2005). Cadmium is a toxic element of primary importance (Breckle and Kahle, 1992).

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Table 1: Morphology & productivity of *Lens esculentus* in M_1 generation under the stress of $CdCl_2$.

Treatments with $CdCl_2$	Germination of seeds in the field	Height (cm)	No. of branches	Days taken for first flowering	Period of harvesting (days)	No of pod /plants	Weight of seeds (gram)
0.1%	82%	26.1±9.2	7.7±2.1	52-59	106-113	40.3±12.2	2.788±0.04
0.25%	52%	23.6±4.7	7.2±2.8	52-59	106-113	38.5±14.7	2.700±0.04
0.50%	50%	22.3±5.9	5.7±2.8	52-59	106-113	36.4±6.9	2.436±0.03
01%	36%	20.9±5.3	5.4±2.9	50-59	106-113	29.3±7.5	2.328±0.04
Control	97%	34.7±9.6	9.0 ±5.4	52-59	110-120	43.7±22	2.282±0.11

It is one of the highly dispersed metal by human activities (Kabata-Pendias and Dudka, 1990) and widely used in industry and consumer products like batteries, pigments, metal coating, plastics etc.

Several workers have reported the effect of cadmium on different plants (Breckle and Kahle, 1992; Iqbal and Mahmood, 1991; Kabate-Pendias and Dudika,1990) considering particular activities but its overall impact on the germination, morphology and productivity of plants in field condition has not been studied so far. The purpose of the present endeavor is to evaluate the impact of cadmium on Lens esculentus in considering seed germination, plant height, number of branches, time taken for flowering, number of pods per plants, period of harvesting and weight of seeds in M_1 & M_2 generations.

MATERIALS AND METHODS

Seeds of *Lens esculentus* (2n=14) were procured from Indian Institute of Pulse Research, Kanpur. Healthy seeds of equal size & shape were selected for treatment with $CdCl_2$. Molecular weight of $CdCl_2$ is 183.32 (Cd-61.32% & Cl-38.68%). Before sowing in the field the seeds were first treated with water for 4 hours and thereafter 100 seeds were placed in separate petridishes containing concentration of 0.10%, 0.25%, 0.50% & 01% of $CdCl_2$ for two hours in the laboratory and then the treated seeds were sown in the experimental plots (field) under protect in lines keeping distance of 15cm between the plants and 25cm between the lines.

The emergence of hypocotyls and cotyledon above the surface of the soil was taken as an index of germination. Arrangements were made for regular weeding and irrigation. Neither any chemical nor fertilizer were used. The seeds were sown in the first week of November and harvesting was done in the last week of March. The morphological characters were studied with respect to plant height, number of branches, date of initiation of flowering, number of pods per plant. On maturity weight of hundred seeds were recorded. This was considered as M_1 generation.

Mature seeds of M_1 generation from the plants treated with different concentrations were harvested and stored separately to have four sets. These seeds were used next year in the same way after giving treatment of different concentrations of $CdCl_2$ and the resulted crop was considered as M_2 generation. The seeds of each set were treated with corresponding concentration of $CdCl_2$. Morphological characters were recorded in M_1 & M_2 generations and finally the phenotypic variability and pod productivity were calculated.

RESULTS AND DISCUSSION

The results obtained in the present experiment have been shown in Table 1 & 2 and Figure, 1. (A-E) and expressed together with the discussion in separate heading as under:

Effect on Seed Germination

The data given in table 1 & 2 have shown that the percentage of seed germination was 82%, 52%, 50% & 36% in M_1 generation whereas in M_2 generation, it was 95%, 92%, 57%, and 50% under the treatment of 0.10%, 0.25%, 0.50% and 01% concentration of $CdCl_2$ respectively. Higher decline was recorded in the case of seeds treated with 0.50% & 01% concentration of $CdCl_2$ in both the generations. It is also noticed that in M_2 generation, the seeds treated with 0.10% & 0.25% concentration have shown a very little loss (Figure,1A) indicating that the studied plants (*Lens esculentus*) has developed adaptation up to some extent against the stress of $CdCl_2$.

Effect on Plant Height

The average height of fully developed plants was found to be 34.70 cm & 34.00 cm in M_1 & M_2 generations respectively in control. The seeds treated with 0.10%,

Table-2: Morphology & productivity of *Lens esculentus* in M_2 generation under the stress of $CdCl_2$

Treatments With $Cdcl_2$	Germination of seeds in the field	Height (cm)	No. of branches	Days taken for first flowering	Period of harvesting	No. of pod/plants	Weight of seed (gram)
0.1%	95%	36.9±3.4	7.7±2.1	62-69	111-118	47.6±11.0	2.599±0.09
0.25%	92%	34.4±5.8	7.3±1.0	62-69	111-118	41.3±9.7	2.497±0.04
0.50%	57%	33.1±5.4	6.9±3.0	62-69	111-118	36.6±6.4	2.337±0.04
01%	50%	31.4±4.0	6.4±1.0	60-67	111-118	32.1±10.8	2.325±0.05
Control	100	34.0±5.9	9.3±3.4	62-69	115-122	47.3±21.7	2.533±0.15

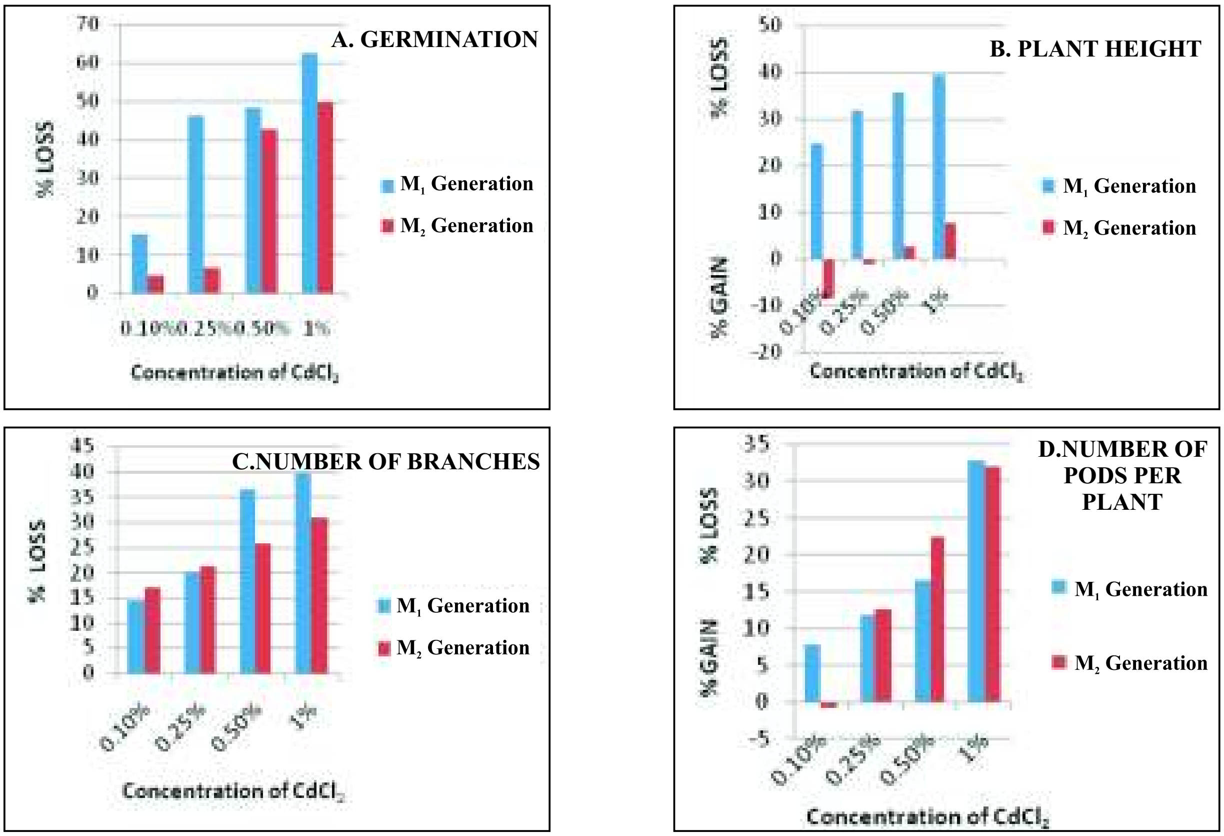


Figure 1 (A-E) : Percent variation in morphological & reproductive traits of *Lens esculentus* under the stress of $CdCl_2$

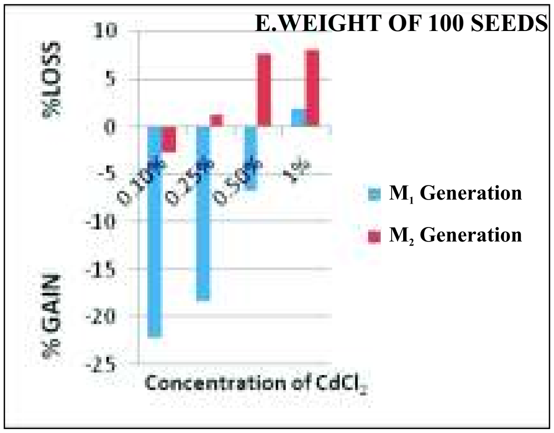
0.25%, 0.50% & 01% concentration of $CdCl_2$ showed an average height of 26.1 cm, 23.6 cm, 22.3 cm & 20.9 cm respectively in M_1 generation. The plant height showed considerable variation in M_2 generation because at low concentrations, the height increased as compared to control but thereafter at other concentrations, it succumbed a little. Thus it is clear that the plant height was reduced with the increased concentration of $CdCl_2$ in M_1 generation but this effect was completely disappeared or reduced considerably in M_2 generation (Figure, 1B).

Effect on Number of Branches

The average number of branches per plant also decreased with an increase in the concentration of $CdCl_2$ in both M_2 & M_2 generations (Figure, 1C). In M1 generation, the number of branches showed maximum loss i.e. 40% while in M_2 generation, the maximum loss was 31.18% under the stress of the same i.e. 01% concentration of the $CdCl_2$. This variation indicates that the increase in the dose of $CdCl_2$ reduced the number of branches at higher level but the losses incurred were declined in M_2 generation as compared to control. It is probably due to the development of some tolerance against the treatment of $CdCl_2$.

Effect on Pod Per Plant

There is no noticeable change in the number of days taken for flowering and also in the period of harvesting as compared to control in both M_1 & M_2 generations.



In M_1 generation, the average number of pods per plant faced a loss of 7.78%, 11.89%, 16.70% & 32.95% under the treatment of 0.10%, 0.25%, 0.50% & 01% concentration of $CdCl_2$ respectively (Figure, 1D). In M_2 generation, the loss was found to be 12.68%, 22.62% & 32.13% in the plants treated with 0.25%, 0.50% & 01% concentrations respectively whereas a gain of 6.34% was observed under the stress of 0.10% dose of $CdCl_2$. Thus, the average number of pods per plant decreased with the increased concentration of $CdCl_2$ in both the generations except 6.34% gain in M_2 generation treated with 0.10% $CdCl_2$.

Weight of Hundred Seeds

In M_1 & M_2 generations, the weight of 100 seeds was 2.282 gm & 2.533 gm respectively in the control, while it was 2.788, 2.700, 2.436 & 2.328 gm in M_1 generation and 2.599, 2.497, 2.337 & 2.325 gm in M_2 generation under the treatment of 0.10%, 0.25%, 0.50% & 01% concentration of $CdCl_2$ respectively. It is evident from the obtained data that the weight of 100 seeds faced a setback in both the generations with increasing concentration of $CdCl_2$ except those plants which developed from the seeds experienced 0.10% dose in M_2 generation (Figure,1E).

On the basis of the data recorded in the present investigation, it may be inferred that the treatment of the seeds of *Lens esculentus* with $CdCl_2$ impaired the growth and productivity of plants and the losses incurred in M_1 generation were recovered in M_2 generation probably due to the development of tolerance towards the stress of the $CdCl_2$. It is apparent that a single dose treatment of seeds with $CdCl_2$ affects the germination, morphology & productivity of plants and thus, it is safely concluded that the cadmium is very harmful to *Lens esculentus* but it's constant exposure may result positive response in the generations to come which experience the stress constantly.

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