Shodhshauryam, International Scientific Refereed Research Journal
© 2020 SHISRRJ | Volume 3 | Issue 4 | ISSN : 2581- 6306

Effect of Salinity and Cadmium on germination of seed of Plantao ovata and Brassica juncea

Vivek Singh[1], Vijay Pratap Tiwari[2]
[1]Research Scholar, Department of Botany, R.S.K.D.P.G. College, Jaunpur, Uttar Pradesh, India
[2]Guide, Department of Botany, R.S.K.D.P.G. College, Jaunpur, Uttar Pradesh, India

Abstract- Heavy metal contaminant mixes with agricultural land and pollutes it. Due to their pollution, plants have to face different types of damage. The most abundant heavy metal contaminants are usually sodium and cadmium that pollute India's agricultural land. Indian mustard plants, sunflower plants etc. become weak due to high salinity and dry up and die. Although plants have also developed many types of coping mechanisms to deal with unavoidable situations, but those mechanisms can withstand heavy metal contamination only to a limited extent. Due to their pollution, the germination capacity of plant seeds decreases. In the present paper, we will study the toxicity of sodium chloride and cadmium on the germination of seeds of P. ovata and B. juncea.

Keywords : - P. ovata, B. juncea, Salinity, Cd, NaCl, Soil Pollution

Introduction- One of the most significant ecological issues on a global basis is heavy metal contamination of the air and agricultural land. Sodium and cadmium are the toxic elements of primary importance. Metal contaminants can frequently build up in large proportions in plant tissue and reach concentrations that are harmful for plant development and growth. More cadmium and sodium is now being found in the ground as a result of the rectification of atmospheric deposition, sewage irrigation, chemical fertilizers, sludge (Ranieri et al., 2005). Under salt stress, stand establishment and rapid seed germination are essential for crop output (Ashraf M. et al., 2005). Osmotic potential created by the requirement to restrict water intake or the impact of Na^+ and Cl^- ions on the growing seed are two ways that soil salinity can affect seed germination (Khajeh Hosseini M et al., 2003). According to Rahimi et al., (2006) salinity can severely hinder Plantago ovata seedling establishment. Seed priming may enhance seedling emergence and seed germination during salt stress (Ghassemi-Golezanik et al., 2008). By controlling pre-germination metabolic activity before the radicle emerges, "seed priming is a pre-sowing technique that improves seedling establishment" and, in general, increases germination rate and plant performance (Foti R et al., 2012). Many crops, including sunflower, lentil, rapeseed, and cucumber can benefit from salt priming to guarantee successful stand establishment (Hussain M., 2006).

The biochemical and physiological abnormalities caused by increasing salt, make the Indian mustard plant vulnerable and unable to live. A range of metabolic alterations, including changes in photosynthetic activity and enzyme activity are brought on by higher salinity. Mg^{++}, Ca^{++}, Na^+, $SO4^-$ and Cl^- are the primary ions in excessive dissolved salts in soils that inhibit crop growth at levels by:

(i) Reducing the water availability because of the soil solution's high osmotic pressure.
(ii) Making vital minerals and nutrients out of balance,
(iii) Producing certain ion toxicities (Morgan, 1984).

In order to deal with inevitable challenges, plants have evolved a variety of coping mechanisms. For B. juncea growth and production, Salinization contamination of cultivable soils and surface water is getting worse (Mishra S.N. et al., 1996). According to Mane A.V. et al. 2011 that "Ion toxicity, oxidative bursts, and nutritional imbalances may all contribute to decreased seed germination, biomass, root and shoot length, and photosynthetic pigment production". In B. juncea, sodium considerably inhibited growth (length of shoot and root, dry mass and fresh mass of root, shoot and leaf area) in a concentration-dependent manner at both 60 and 30 DAS. With reference to the majority of the mustard plant growth characteristics, the salt concentration with highest values showed the greatest decrease.

After accumulating above threshold level, non-essential heavy metal cadmium causes diverse harmful reactions in P. ovata due to increasing pollution and greater enrichment ratios (Gill et al., 2010). Compared to other heavy metals, cadmium is far more mobile in the soil and is absorbed by plants to variable degrees (Varo et al., 1980). Numerous biochemical and physiological activities in plants are impacted by the environment's rising Cd levels (Sanita di G. et al., 1999). Crops planted in soil with moderate levels of Cd contamination showed reductions in both chlorophyll content, biomasses, shoot and /or root length, nutritional quality and productivity (Cotbine et al., 1976). After Cd exposure in the medium, morphological alterations in the root and shoot length were extremely noticeable. Roots were more negatively impacted than the shoots. In P. ovata, shoot length was drastically decreased below one fourth at the higher Cd dosages, whilst the root length being significantly decreased below one twenty-fifth as compared to the control. Under mild Cd stress, the seedlings also developed many roots. In a dose-dependent way, treatment with cadmium caused the root and shoot length of 10-days-old, P. ovata seedlings to significantly decrease (Kajhai H. et al., 2014). Similar to other researcher's findings, high cadmium dosages in P. ovata primarily inhibited radical development (Corradi M.G. et al., 1993).

Cd builds up in all plant sections of "B. juncea plants growing in cadmium-contaminated soil", which changes chloroplast molecular structure, hinders plant growth, affects nutrient intake, prevents photosynthesis, deactivates CO_2 fixation enzymes, activates lipid antioxidant and peroxidation machinery (Gill S.S. et al., 2011). Agricultural soil's legal Cd limit is 100 mg Cd kg^{-1}, yet due to human and industrial activity, this limit is rapidly increasing. Most key crop plants are dangerous to Cd at concentrations more than 5-10 µg Cd g^{-1} leaf dry weight, with the exception of a few Cd-hyper accumulators, which can withstand Cd concentrations of 100 µg Cd g-1 leaf dry weight. (Reeves et al., 2000). Increased Cd levels in the soil had a negative impact on the mustard plant's yield, metabolism, photosynthesis and growth. All growth traits, including root length, shoot length, plant dry mass, and foliage area, were significantly reduced by 150 mg Cd kg^{-1} soil. However, B. juncea and other species' photosynthetic and growth features were unaffected by Cd at a concentration of 25 mg Cd.kg^{-1} soil (Gill's S et al., 2011). All mustard cultivars had significant Cd buildup in their leaves and roots and this buildup tended to increase as soil Cd concentrations rose. ,In all cultivars, the roots always had a higher concentration of Cd, after each Cd treatment, than leaves.

Treatment with Cd had no discernible influence on the rate of germination of seeds in mustard plants. Both dry and fresh weight dropped as cadmium levels in the soil increased, despite the fact that it inhibits growth in the shoots and roots. The decline in shoot and root length on 7^{th}

days of sowing was 75% under salinity, 60% under Cd stress which reached to 80% under multiple stress (NaCl+Cd+Pb), (Lakra N. et al., 2016).

For study growth of P. ovato and B. juncea under stress of salinity and Cadmium, we analyze the Impact of NaCl and $CdCl_2$ on germination of seed of B. juncea and P. ovata.

Effect of Salinity and Cadmium on germination of seed of Plantago ovata and Brassica juncea

Seed germination of P. ovata and Brassics juncea are slightly affected by heavy metal sodium and cadmium. An experiment carried out at the Banaras Hindu University's green house, in Varanasi, India. Plant seeds were purchased from the Indian Agricultural Research Institute in Pusa , New Delhi, India.

Materials and Methods

Some variety of seeds of Plantago ovata and Brassica juncea were properly cleaned with distilled water after being surface sterilised for 20 minutes with a dilute sodium hypochloride solution (20% w/v). The seeds were planted in 15-cm Petri dishes lined with filter paper, heated to 25°C, and exposed to 1500 lx of artificial light, which was maintained in a cycle of 16 hours of light as well as 8 hours of darkness over the course of two days. Every petri dish contained NaCl solution (10 ml) of different concentration control, 10, 20, 50, 100, 150mM solution of NaCl. For each cadmium chloride and sodium chloride solution three different tests were conducted on quantity over 100 seeds. All the three replicants perform simultaneously for P. ovata and Brassica juncea. Germination (protrusion time for the radicle by 1mm) was recorded in daily intervals (Ghassemi et al., 2010).

After the first day of the experiment, germination of seed rate was monitored every day for up to 12 days. The radical of a seed was regarded to have germinated when it reached a length of 1 mm, and the following calculations were used to determine the germination percentage:

$$\text{Germination }\% = \frac{\text{Number of germinated seeds}}{\text{Total number of seeds}} \times 100$$

Ellis and Roberts' formula was used to compute the rate of seed germination (R).

$$\overline{R} = \frac{\Sigma n}{\Sigma(D \times n)}$$

D is the number of days since the test's start, and n is number of seeds that germinated on that day.

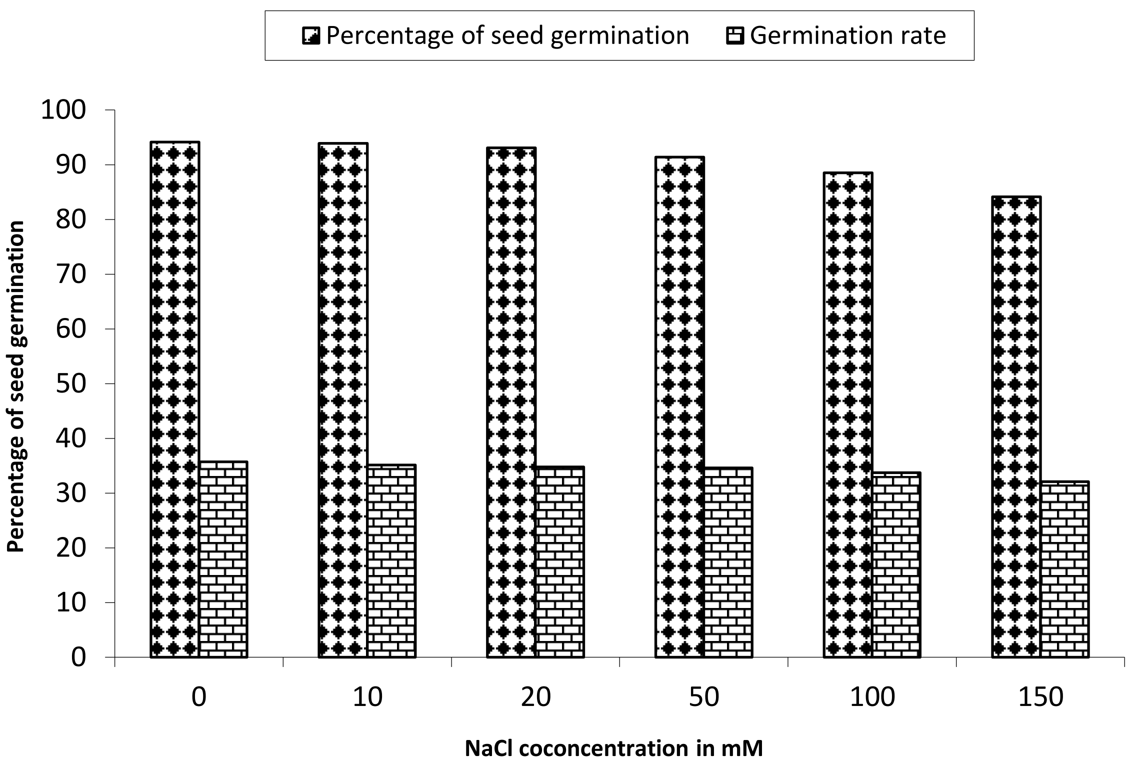
1. Effect of salinity of seed germination of Plantago ovata

The most common cause of injury in dry and semi-arid regions is salinity, which results from an excessive accumulation of NaCl. Seed germination of Plantago ovata can be successfully assured by salt priming. There was no discernible impact on the frequency of seed germination from dilute concentration of NaCl up 10-50 mM. When concentration of salinity increases more than 50 mM it affect seed germination of P. ovata along with seed germination rate. In control seed germination percentage was 94.10% where as it decreases 93.90%, 93.10%, 91.40%, 88.50% and 84.10% as NaCl concentration increase 10 mM, 20 mM, 50 mM, 100, mM and 150 mM respectively. The rate of Seed germination 0.357 in control which it decreases to 0.351, 0.348, 0.346, 0.337, 0.321 in corresponding to NaCl increasing concentration.

Table-1 : Salinity's impact on Plantago ovata seed germination

Concentration of NaCl (mM)	Percentage of Seed germination	Germination rate (per day)
Control (0)	94.10	0.357
10	93.90	0.351
20	93.10	0.348
50	91.40	0.346
100	88.50	0.337
150	84.10	0.321

Fig. 1: Graphical presentation of different concentration of NaCl on seed germination of Plantago ovata



P. ovata seedling growth and seed germination benefit from osmo-priming with KNO3, according to research by Kazem et al., (2011). Decline in percentage of seed germination on high concentration of NaCl may result from early protein, RNA and DNA production during salt hydration process. This effect ultimately led to increased seed germination energy (Bewley and Aquila, 1989). Rapid germination of seed may eventually result in growth of big seedlings which does not survive in high salinity.

2. Cd Effect on germination of seed of Plantago ovata

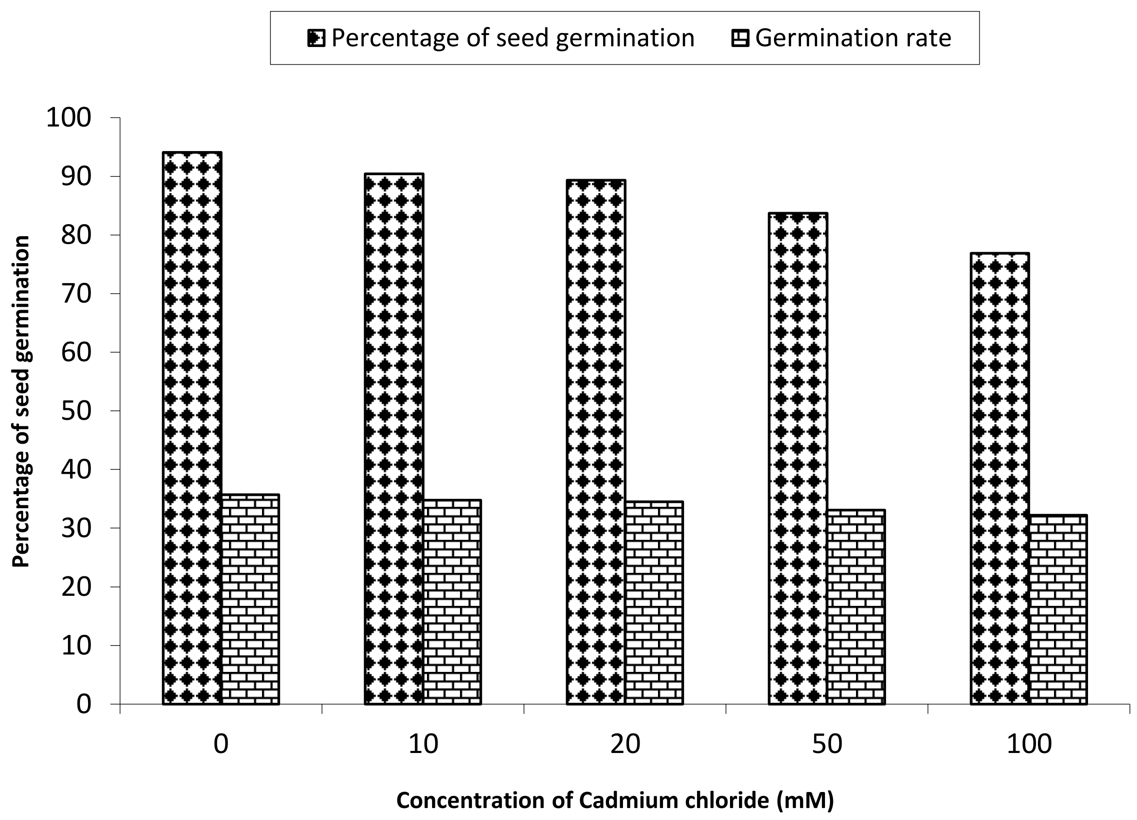
After sterilization 25 seeds of isabgol were tested in six separate set of experiments. For Cadmium stress study, control had zero $CdCl_2$ and experimental group had 10 mM, 20 mM, 50 mM and 100 mM concentration. Every petri dish contained $CdCl_2$ solution (10ml) of varying concentration 10 mM, 20 mM, 50 mM and 100 mM.

Table-2 : Cadmium Effect on germination of seed of Plantago ovata

Concentration of $CdCl_2$ (mM)	Percentage of Seed germination	Germination rate (per day)
Control (0)	94.10	0.357
10	90.40	0.348
20	89.30	0.345
50	83.70	0.331
100	76.90	0.322

Result: Lower concentration of cadmium does not affect rate of seed germination in P. ovata (Fig.-2) Cadmium inhibited the growth rate. A significant interactive effect of Cd stress treatment was found by previous workers (Ghassemi G. et al., 2010). The rate of seed germination was significantly affected as concentration of $CdCl_2$ increased in germinating seeds. In control group of P. ovata seed germination percentage was 94.10 whereas it decreases 90.40, 89.30, 83.70 and 76.90 as concentration of $CdCl_2$ increase 10 mM, 20mM, 50mM and 100 mM respectively.

Fig. 2: Graphical presentation of different concentration of Cadmium chloride effects on Plantago ovata seed germination



`

The rate of seed germination 0.357 in control group which continuously decreases 0.348, 0.345, 0.331 and 0.322 in $CdCl_2$ treatment of concentration 10 mM, 20mM, 50mM and 100 mM respectively. The alteration of protein and sugar metabolism and it's titre along with free amino acid under cadmium stress is considered as an indicator of stress.

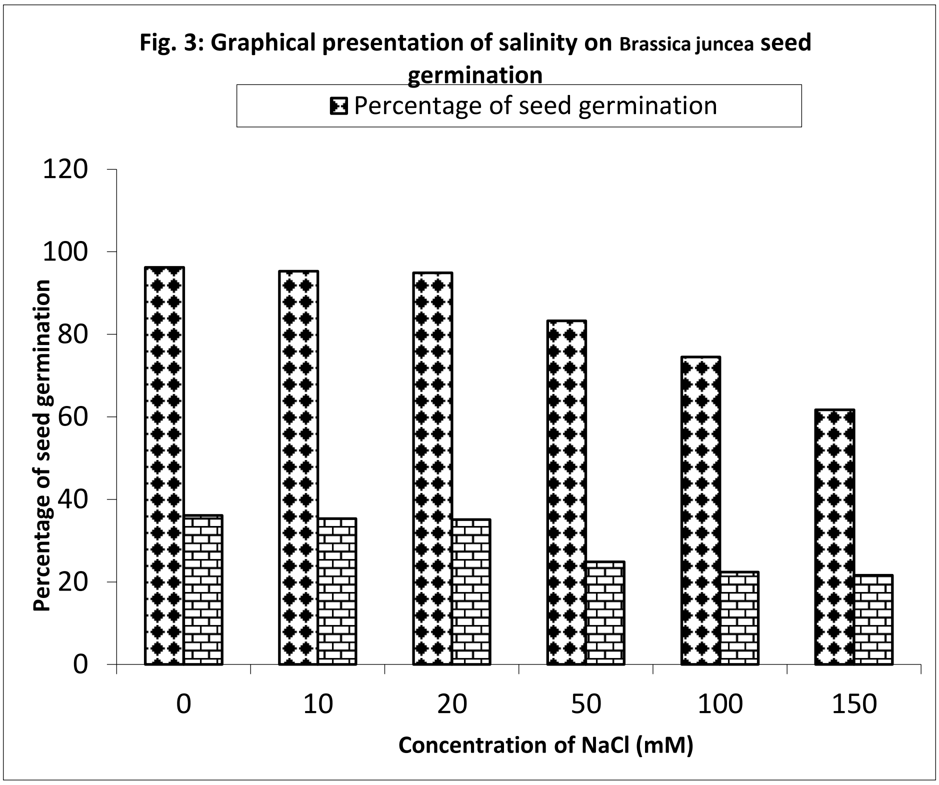
3. Salinity effect on germination of seed of B. juncea

During their life cycle in their natural environment, mustard plants must contend with the stress of salinity. Here, we noticed a sharp drop in seed germination and seedling growth due to salinity stress (Table-3 and Fig.-3). According to Theriappan et al. in 2011 that research on salt and heavy metal stress in cauliflower supports B. juncea's reaction. Salinity (NaCl 150 mM) stress led to a greater reduction in germination than Cd/Pb (2 mM) stress. Putrescine (1mM) supplementation protected the germ inability of weed under salinity stress.

Table-3 : Salinity Effect on germination of seed of Brassica juncea

Concentration of NaCl (mM)	Percentage of Seed germination	Germination rate (per day)
Control (0)	96.20	0.361
10	95.30	0.353
20	94.90	0.351
50	83.30	0.249
100	74.50	0.224
150	61.70	0.216

Salinity affect seed germination mostly though osmosis. High concentration of seed germination (150 mM) checks seed germination in B. juncea. Salinity and heavy metals (Cd/Pb) increased the endogenous burden in seedlings. In control group B. juncea seed germination percentage was 96.2 where as it decline 95.30, 94.90, 82.30 and 61.70 as concentration of NaCl increases 10mM, 20mM, 50mM & 150mM respectively. The rate of seed germination was 0.361 in control group and 0.353, 0.351, 0.249, 0.224 and 0.216 in different concentration of salinity i.e. 10mM, 20 mM, 50 mM, 100 mM and 150 mM respectively Table-3 & fig.3.



Metabolism of stored sugar in mustard seed is different in comparison to P. ovata which show faster seed germination in Indian mustard seed.

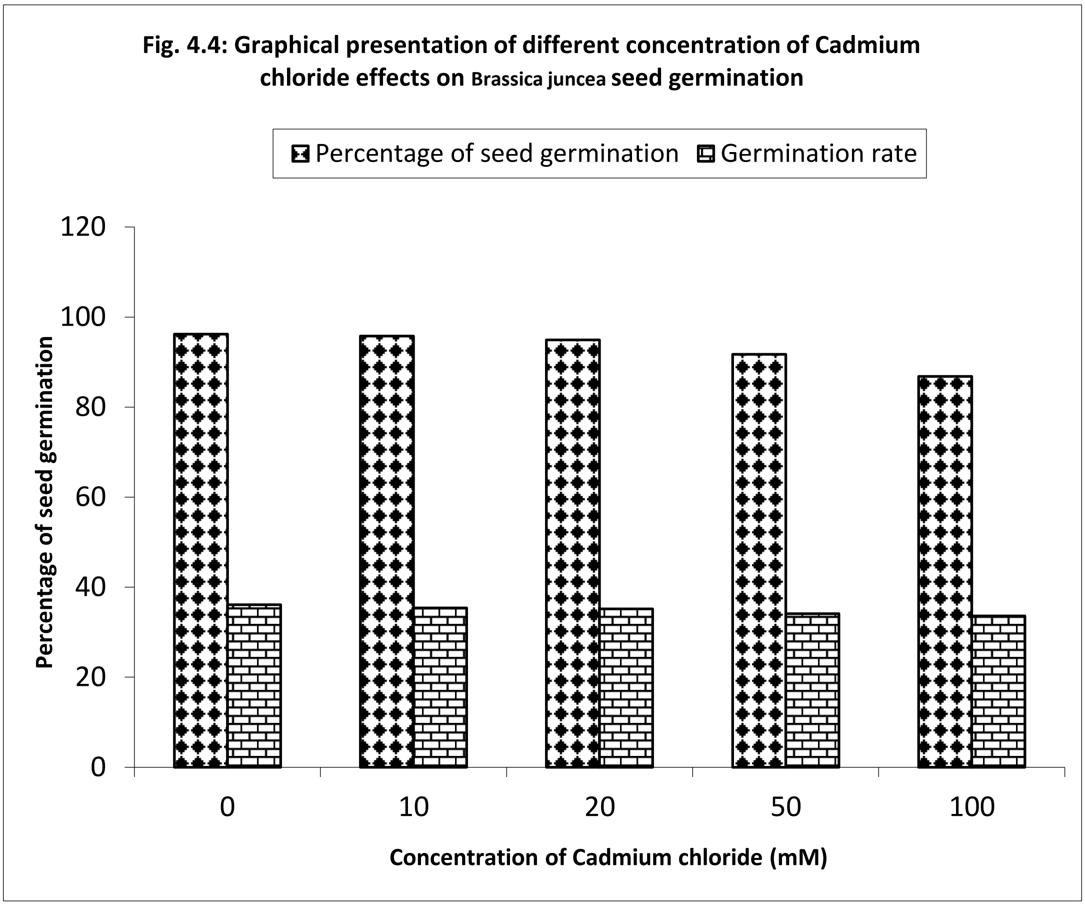
4. Effect of Cadmium on seed germination of B. juncea

B. juncea seeds have more accumulation of fatty acid in comparison to proteins. Metabolism of fatty acid in mustard seed affect seed germination and decline seed germination percentage upto 9.77 in comparison to control. In freshly growing plant cells, cadmium poisoning promotes lipid peroxidation and fat, typically by raising the content of malondialdehyde (MDA), (Ehsan et al., 2014). When exposed to cadmium stress, more reactive oxygen species are produced, which is fatal for newly germinating mustard seeds.

Table-4: Effect of Cadmium on seed germination of Brassica juncea

Concentration of $CdCl_2$ (mM)	Percentage of Seed germination	Germination rate (per day)
Control (0)	96.20	0.361
10	95.80	0.354
20	94.90	0.352
50	91.70	0.341
100	86.80	0.336

The percentage of seed germination of B. juncea in control group was 96.20 whereas it decreases 95.80, 94.90, 91.70 and 86.80 as concentration of $CaCl_2$ increase 10 mM, 20 mM, 50 mM and 100 mM respectively.



The rate of seed germination in control group was 0.361 which decreases 0.354 to 0.336 on increasing concentration of $CdCl_2$ from 10mM to 100mM as represented in Table-4 and Fig.-4.

CONCLUSION- Thus we have seen that heavy metal contamination mixing in agricultural land is harming the crops. We observed that the germination of seeds of P. ovata and Brassica juncea was not significantly affected by the heavy metals sodium and cadmium, only marginally. We have shown the effect of sodium chloride and cadmium on the germination of the seeds of the above plants by Table 1 to 4. In both cases, we found that as the concentration of heavy metal salts increased in the soil, the germination rate decreased, and the percentage of seed germination also decreased.

References

1. Foti R. Abureni K., Tigere A., Gotosa J. and Geren J. (2008). The efficacy of different seed priming osmotica on the establishment of maize (Zea mays L.). caryopses J. Arid. Environ. 72: 1127-1130.
2. Morgan J.M. (1984). Osmoregulation and water stress in higher plants. Annu. Rev. Plant Physiol. 35: 299-319.
3. Mishra S.N., Singh D.B and Choudhary A. (1996). Nitrate and ammonium modulation of seedling growth in Indian mustard under salinity stress. Indian J. Plant physiol. 39: 93.
4. Mane A.V., Deshpande TV, Wagh VB, Karadge BA and Samant J.S. (2011). A critical review on physiological changes associated with reference to salinity. Int J. Environ sci. 1: 1192.
5. Gill S.S. and Tuteja H. (2010) Reactive oxygen species and antioxidant machinery in abiotic stress tolerances in crop Plants. Plant Physiol. Biochem. 48: 909-930.

6. Varo P. O.L. Hdm. M. Nuurtano, S. Saari and P. Koivi-stonets (1980). Mineral element composition of finish foods VII Potato vegetables, fruits barries, nuts, mushrooms. Acta Agricultural Scandinavica suppl. 22: 89-113.
7. Sanita di Toppi L. And R. Gobbrielli (1999). Response to Cd in higher plants. Environ. Exp. Bot., 41: 105-130.
8. Cottoine A., A. Dhaese and R. Camerlynck (1976). Plant quality response to uptake of polluting elements. Qualitas Plantarum Plant food for Human Nutrition 26(1/3): 293-319.
9. Kazhai H., Katayoon H. and Mohen Z. (2014). A review of Plantogo plant Indian J. of Traditional Knowledge, 13(4): 681-685.
10. Corradi MG, Blanchi A. Albasini A. (1993). Chromium toxicity in Salvia sclareo (L) affect of hexavalent chromium on seed germination and seedling development. Environ. Exp. Bot., 33(3): 405-413.
11. Gill S.S., Khan N.A, Anjum N.A., Tuteja N. (2011). Amelioration of Cadmium stress in crop plants by nutrient management. Morphological Physiological and Biochemical aspects. Special Issues. Plant stress. 5: 1-23.
12. Reeves R.D. Bake AJM (2000). Metal accumulating plants in Raskin I, Ery B.D. Ed^{n} Photoremediation of toxic metals using plants to clean up the environment. New York John Wiley and Sons Inc. 193-229.
13. Lakra N., Pushpa C. Tomar and S.M. Mishra (2016). Growth response modulation by putrescine in Indian mustard Brassica juncea L under multiple stress. Indian J. Exp- Biol. 54: 262-70.
14. Ghassemi-Golezanik, Jabbar pour S., Zehtab-Salmas S. Muhammad. A. (2010). Response of winter rapeseed (Brassica napusa L) cultivars to salt priming of seeds Afr. J. Agric ROS, 5: 1089-1094.
15. Kaazem G.G., Afsaneh C.J. and Parisa Z. M. (2011). Influenced of salt priming on mucilage yield of Isabgol (Plantago ovata Forsk) under salinity stress, J. of Med. Plants Res. 5(4): 3236-3241.