

EFFECT OF DIFFERENT CONCENTRATIONS OF PYRETHROID AND ORGANOPHOSPHORUS PESTICIDES ON SEEDLING GROWTH OF *Cicer arietinum*

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ABSTRACT

Seed treatment with pesticides is one of the components of IPM. Pesticides, the chemical ingredients are generally used to assassinate biological entities that cause damage to cultivated crops. To maintain the quantity and quality of the plant produce, a large number of chemicals in the form of pesticides and/or fungicides are sprayed on them. Although these compounds affect the growth of seedlings and also negatively influence the growth of symbiotic bacteria and their interaction with crop plants resulting in a reduction in nitrogen fixation by plants and ultimately yield. A study on the consequences of chemical pesticides on seed germination and seedling growth of *Cicer arietinum* was carried out at Chhatrapati Shahu Ji Maharaj University, Kanpur, Uttar Pradesh, India in 2016. The present study was done to assess the effect of pesticides on root length, shoot length, leaf area, fresh weight, and dry weight of seedlings. The experiment was conducted by using different concentrations viz., 0% (control), 0.5%, 1%, 1.5%, 2%, 2.5%, 5%, 7.5%, and 10% of organophosphorus monocrotophos and pyrethroid pesticide deltamethrin. Observations were done on the 7th, 14th, and 21st days of radicle emergence. The study showed that both types of pesticides such as pyrethroid deltamethrin and organophosphorus monocrotophos were found to be toxic to plants in high concentrations and can be preferred in low concentrations such as 0.5%, which is less harmful to crop plants.

Keywords: *Cicer arietinum*, Growth parameters, IPM, Organophosphorus, Pyrethroid and Radicle.

INTRODUCTION

Cicer arietinum, chickpea, or black gram is a major cultivated pulse crop worldwide, especially in India. The crop is commercially grown for its nutritious

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seeds, which are a rich source of protein, carbohydrates, fiber, vitamins, and minerals. Chickpea along with pigeon pea play a substantial role in the food and nutrition security of the underprivileged in developing countries of Asia (Rao et al., 2010), though significant yield losses have been estimated in chickpea caused by insect pests. Pre-sowing treatment of seeds with pesticides can be the most efficient and economical way of getting disease-free crops and higher yields.

The use of chemical pesticides on plants can no doubt solve the problem of pests to great extent. However, the practice of using pesticides may advance many complications in the germination of seeds, growth, and developmental processes of crop plants. Seeds are considered suitable hosts to maintain the seed-borne fungi/microbes even in the absence of the host. In such cases, seeds before sowing are treated with some pesticides to protect them against the attack of fungi, nematodes, or insect pests (Busse et al., 2001). Tiyyagi et al. (2004) watched the impact of different pesticides such as aldicarb, carbofuran, phorate fensulfothion, and fenamiphos on chickpea plants. They utilized distinctive concentrations, viz. 5, 10, and 25 ppm of pesticides, and watched the impact on plant development and advancement parameters, root nodulations, and chlorophyll substance. Essential enhancement in plant development was found in lower concentrations such as 5 and 10 ppm of distinctive pesticides but the 5-ppm concentration was outlined to be altogether compelling in terms of plant development and non-phytotoxic and the phytotoxic impact was eminent in those plants treated with 25 ppm concentration of all the pesticides (Tiyagi et al., 2004).

Dhanamajuri et al. (2013) studied the behavior of the seeds chickpea (*Cicer arietinum*) and maize (*Zea mays*) with various concentrations of fungicides. The effect of 1 ppm, 10 ppm, 50 ppm, and 1000 ppm concentrations of concerned fungicide Captain, Bavistain and Domarc was analyzed on germination of seed, growth, and biomass production of *Cicer arietinum* and *Zea mays*. Best seed germination and plant growth were seen at 1 ppm to 10 ppm beyond that the parameters declined (Dhanamajuri et al., 2013). Pre-sowing treatments of seeds with appropriate fungicide and or/ pesticide have augmented amazingly over the past few years. Thube et al. (2018) investigated to examine the appropriateness of some insecticides such as imidacloprid (600 FS), fipronil (5FS), and chlorpyrifos (20 EC) for pre-sowing treatments in seeds of *Cicer arietinum* and to uphold the compatibility of identified doses of insecticides along with biofertilizers (*Mesorhizobium ciceri* @ 25 g/kg seed), and bio fungicide (*Trichoderma harzianum* @ 4 g/kg seed). They advocated suitable seed pretreatments viz., (1) Imidacloprid 5 ml/kg + *Mesorhizobium* (dose please), (2) Imidacloprid 5 ml/kg + *Mesorhizobium* @ 25 g/kg seed + *Trichoderma harzianum* @ 4 g/kg seed, (3) Fipronil @ 5 ml/kg + *Mesorhizobium* @ 25 g/kg seed, (4) Fipronil @ 5 ml/kg + *Mesorhizobium* @ 25 g/kg seed + *Trichoderma harzianum* @ 4 g/kg seed.

Anderson et al. (2003) examined the effect of sulfonylurea residues in some legume crops and meadows and found that it can inhibit the growth of legume crops and meadows by inhibiting the symbiotic nitrogen fixation by legume crops and meadows. Reductions in nitrogen fixation might result from the herbicidal effect on rhizobial growth and/or indirect growth of the plant. The soil contaminated with chlorsulfuron may reduce the modulation, which can affect the nitrogen fixation of chickpea plants.

MATERIALS AND METHODS

Deltamethrin is a chemical pesticide of class pyrethroids compounds. Unlike other pyrethroids, deltamethrin consists of one pure compound. Monocrotophos is an organophosphate insecticide and a relatively cheap pesticide. Monocrotophos, commonly known as Azodrin or Nuvacron is an organophosphate insecticide that despite its ban is preferred due to its high efficacy against insect pests. Being readily soluble in water, it is grouped under class 1: highly toxic compounds. Microbes such as *Bacillus*, *Pseudomonas*, *Aspergillus*, *Anabaena*, and *Nostoc* at 25-37°C and pH 5.5-8.5 can utilize monocrotophos as a nutrient source and can tolerate up to 500-1200 mg L⁻¹ of monocrotophos (Kaur et al., 2019). Monocrotophos and deltamethrin were prepared in different concentration with distilled water, viz., 0.5%, 1%, 1.5%, 2%, 2.5%, 5%, 7.5% and 10%. The control concentration was distilled water alone. These different pesticides were prepared in different concentrations along with control. Distilled water sprayed on seeds in the Petri dishes on alternative days.

The study was carried out at Chhatrapati Shahu Ji Maharaj University, Kanpur, Uttar Pradesh, India in 2016. Healthy seeds of *Cicer arietinum* were selected and surface sterilized by using mercuric chloride (HgCl₂) and then washed with distilled water. The sterilized Petri dishes were taken and spread with wet filter paper and the seeds were transferred in these Petri dishes. 10 seeds were taken in each Petri dish. The Petri dishes with control seeds were sprayed with distilled water alone and other Petri dishes having seeds were treated with increasing concentrations of pesticides i.e., 0.5%, 1%, 1.5%, 2%, 2.5%, 5%, 7.5%, and 10%. The seeds were germinated and the emergence of radicle and plumule was taken as confirmation of seed germination. Readings were taken on the 7th, 14th and 21st day of radicle emergence including, root, shoot length, fresh and dry weight of samples by getting plants dry in the oven for two days at 100°C.

RESULTS AND DISCUSSION

Effect of different concentrations of organophosphorus monocrotophos on seedling growth of *Cicer arietinum* are shown in figure 1 (A, B and C). It has been observed that increasing the concentration of monocrotophos (0.5%, 1%, 1.5%, 2%, 2.5%, 5%, 7.5%, and 10%) results in a decrease in the growth of seedlings at all sampling days (7th, 14th and 21st). At 10% pesticide concentration no growth was observed. The

results show shoot lengths (Fig. 1A) for sampling days (7th, 14th and 21st) to be 5.22, 7.41, 9.21 cm, and 5.41, 7.54, 9.56 cm, and 3.56, 5.32, 6.62 cm, and 3.35, 4.71, 5.23 cm, and 2.61, 3.59, 4.19 cm, and 2.48, 3.19, 3.75 cm, and 2.09, 2.84, 3.12 cm, and 1.2, 1.91, 2.32 cm, respectively for 0%, 0.5%, 1%, 1.5%, 2%, 2.5%, 5%, 7.5% concentrations. The root length (Fig. 1A) for sampling days 7th, 14th and 21st are 2.75, 3.4, 5.33 cm, and 2.13, 2.82, 4.72 cm, and 2.12, 2.47, 4.11 cm, and 1.64, 2.13, 3.65 cm, and 1.56, 2.13, 3.12 cm, and 1.22, 1.72, 2.92 cm, and 0.75, 1.51, 2.12 cm, and 0.41 cm, 1.21 cm, 1.41 cm respectively for control, 0.5, 1, 1.5, 2, 2.5, 5, 7.5% of pesticide concentrations.

The leaf area in cm² (Fig. 1B) for the sampling days 7th, 14th and 21st at monocrotophos concentrations 0.5%, 1%, 1.5%, 2%, 2.5%, 5%, 7.5% were recorded as 4.83, 5.41, 5.68 cm², and 3.12, 3.31, 4.12 cm², and 2.16, 2.95, 3.35 cm², and 1.97, 2.25, 2.82 cm², and 1.34, 1.95, 2.15 cm², and 0.96, 1.26, 1.54 cm², and 0.54, 0.99, 1.13 cm², respectively. No results were obtained for 10% concentration. The leaf areas of control plants are 4.12, 5.14, and 5.31 cm² at respective sampling days.

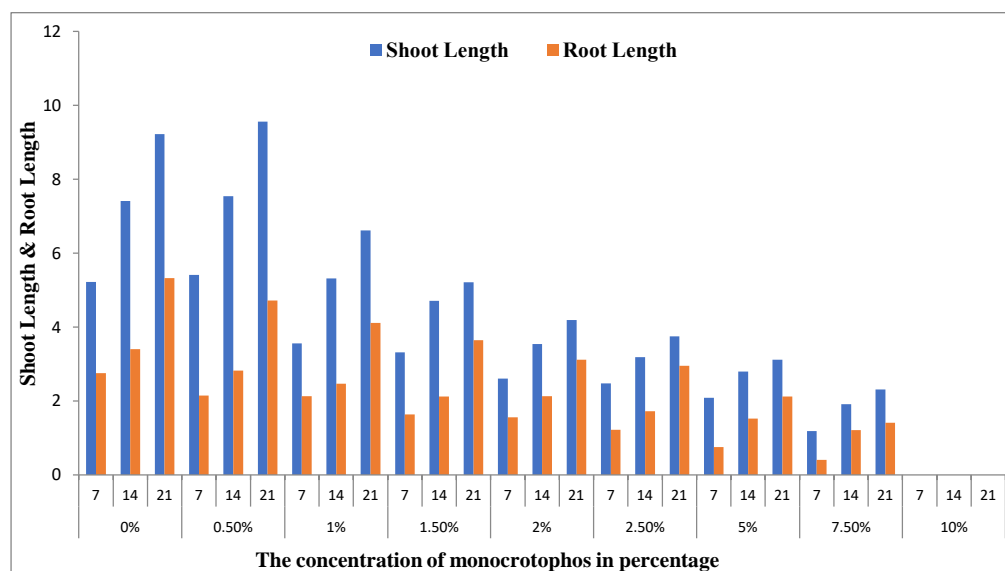


Figure 1A. Effect of various concentrations of monocrotophos on seedling length of *Cicer arietinum*

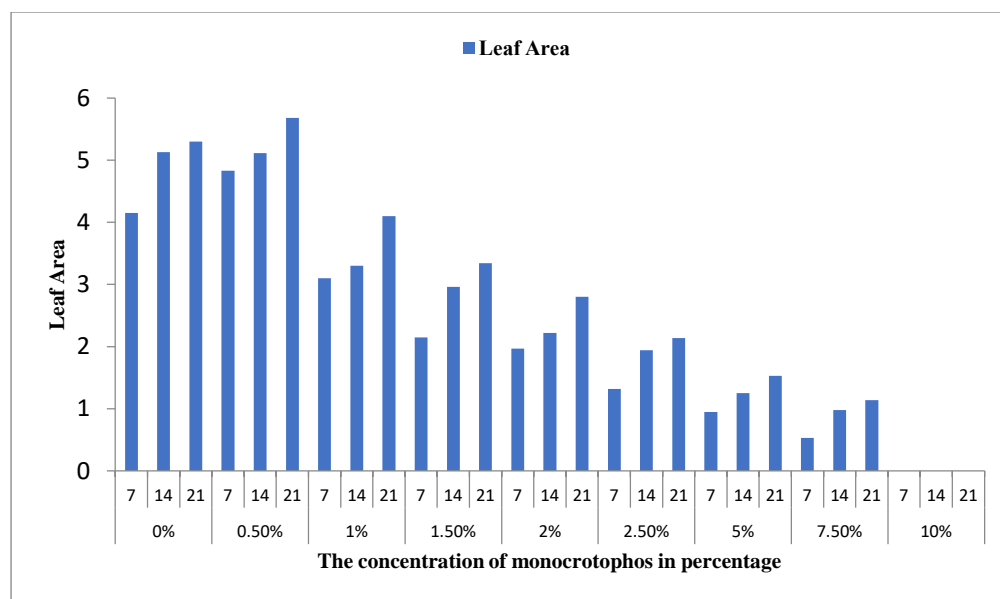


Figure 1B. Effect of various concentrations of monocrotophos on seedling leaf area of *Cicer arietinum*

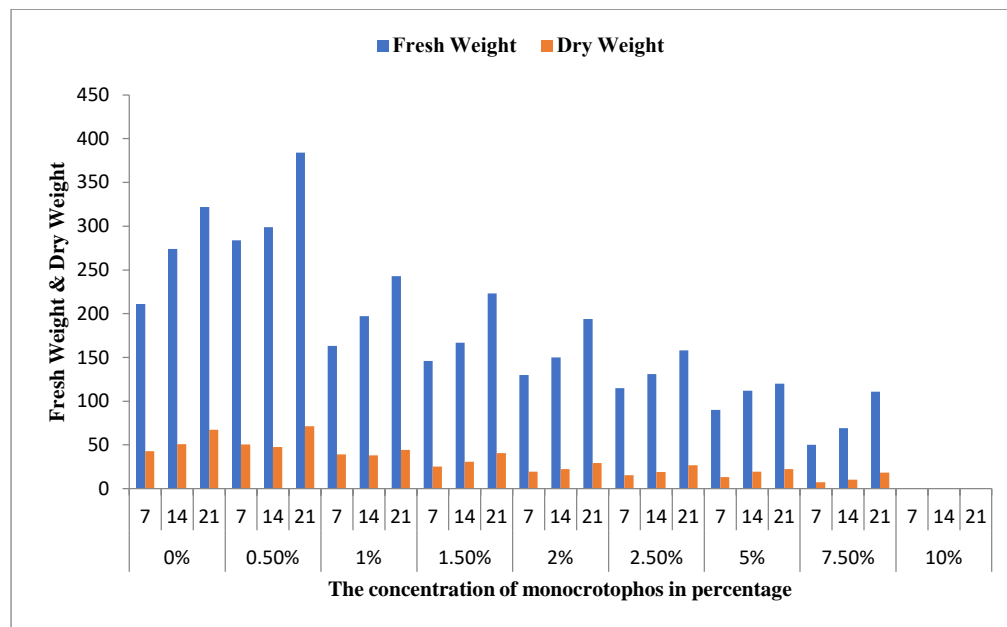


Figure 1C. Effect of various concentrations of monocrotophos on fresh weight and dry weight of *Cicer arietinum*

The data of fresh weight (Fig. 1C) for the above values are 284, 299, 384 mg, and 162, 198, 243 mg, and 146, 168, 223 mg, and 132, 150, 195 mg, and 115, 132, 158 mg, and 92, 112, 120 mg, and 50, 68, 111 mg, respectively. No results were obtained for 10% concentration. The data for control values of fresh weight were 210, 274 and 322 mg. The data for the dry weight (Fig. 1C) of plants for above parameter are 43.9, 52.9, 68.2 mg for control plant, 40.4, 47.6, 55.4 mg, and 32.2, 40.2, 45.3 mg, and 26.4, 35.6, 42.6 mg, and 21.3, 27.5, 31.4 mg, and 19.25, 24.2, 27.8 mg, and 14.23, 19.3, 22.5 mg, and 8.23, 14.4, 19.2 mg respectively. No results were obtained for 10% concentration.

The results for *Cicer arietinum* treated with the pyrethroid pesticide deltamethrin are depicted in figure 2 (A, B and C), and here also the same trends of the responses of various concentrations of the pesticide deltamethrin are shown by seedling growth parameters. The shoot length (Fig. 2A) at sampling days 7th, 14th and 21st and pesticide concentrations 0.5%, 1%, 1.5%, 2%, 2.5%, 5%, 7.5% and 10% show following trends. As compared to control plant shoot length, i.e., 4.9, 7.35, 9.57 cm at respective days, the length of shoot to different increasing concentrations were 4.35, 6.19, 7.29 cm, and 3.45, 3.91, 6.95 cm, and 3.25, 4.69, 5.4 cm, and 3.1, 3.49, 4.2 cm, and 2.49, 2.95, 3.1 cm, and 2.12, 2.85, 3.22 cm, and 1.21, 1.96, 2.3 cm respectively. At 10% concentration, no results were observed. The results of root growth parameters (Fig. 2A) show parallelism with shoot parameters. As compared to control plants, i.e., 2.69, 3.39, 5.3 cm at respective sampling days, the values for increasing concentrations of pesticide were 2.13, 2.83, 4.65 cm, and 2.14, 2.46, 4.91 cm, and 1.63, 2.1, 3.69 cm, and 1.57, 2.13, 3.14 cm, and 1.21, 1.7, 2.91 cm, and 0.74, 2.53, 2.14 cm, and 0.42, 1.23, 1.43 cm respectively with increasing concentrations. At 10% concentration, no results were observed.

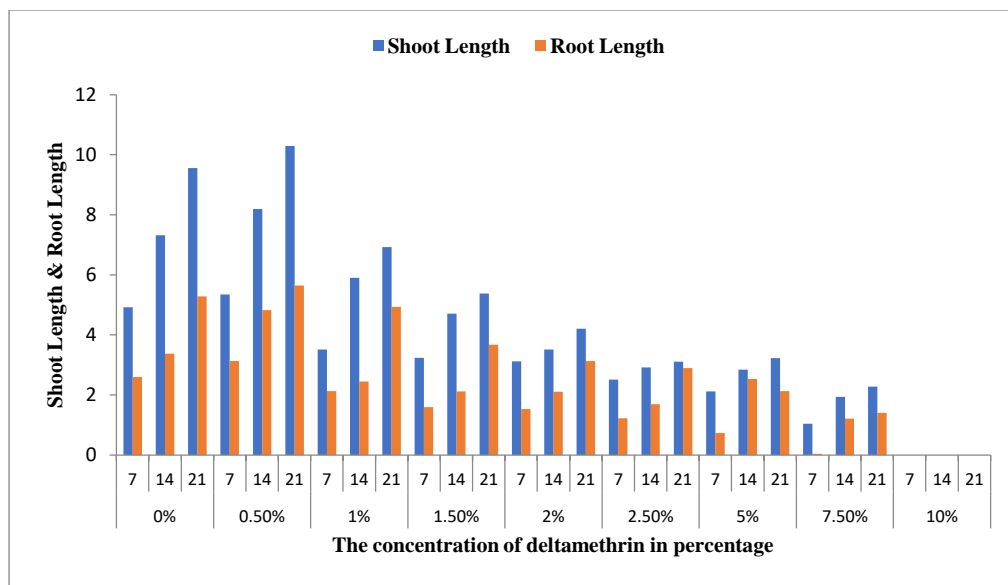


Fig. 2A. Effect of various concentrations of deltamethrin on seedling length of *Cicer arietinum*

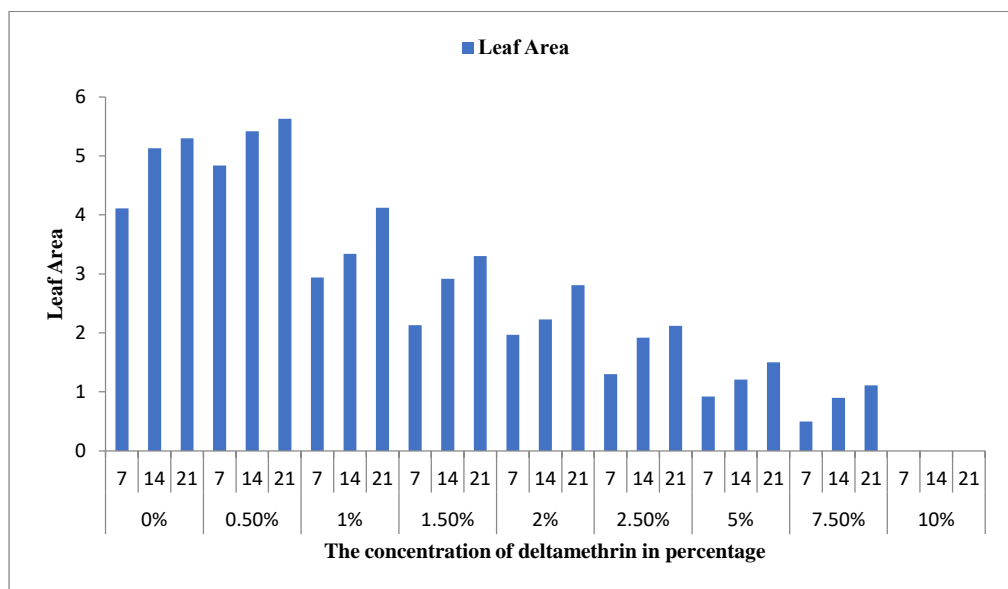


Figure 2B. Effect of various concentrations of deltamethrin on seedling leaf area of *Cicer arietinum*

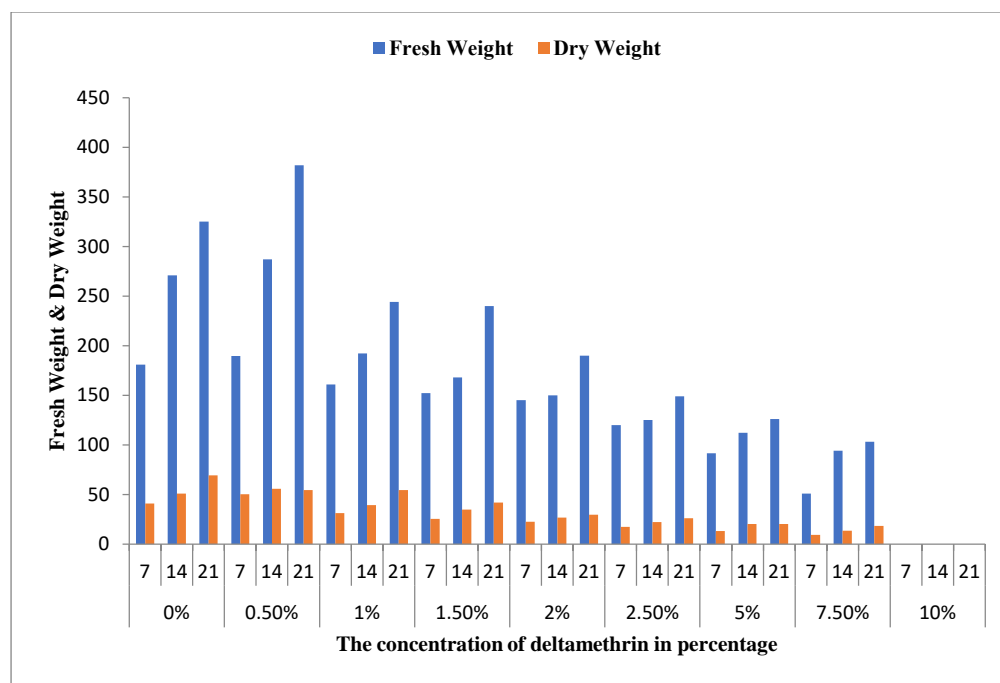


Figure 2C. Effect of various concentrations of deltamethrin on fresh weight and dry weight of *Cicer arietinum*

The leaf area (Fig. 2B) as compared to the control values, i.e., 4.13, 5.1, 5.32 cm² at 7th, 14th and 21st days respectively were 3.84, 4.42, 4.63 cm², and 2.99, 3.35, 4.15 cm², and 2.15, 2.94, 3.32 cm², and 1.98, 2.24, 2.83 cm², and 1.32, 1.9, 2.13 cm², and 0.95, 1.23, 1.51 cm², and 0.52, 0.91, 1.12 cm² respectively with increasing concentrations of pesticide. No results were obtained at 10% concentration.

The data for fresh weight (Fig. 2C) of seedlings were 183, 273, 329 mg for control value at respective sampling days while, 173.5, 237, 282 mg, and 163, 195, 249 mg, and 154.2, 169, 229 mg, and 148, 153, 194 mg, and 121, 126, 150 mg, and 92.4, 115, 121 mg, and 53, 97, 104 mg with respective concentrations of pesticide. At 10% no results were observed. The dry weight (Fig. 2C) shows parallel results with fresh weight as compared to control values, i.e., 42.9, 52.8, 69.1 mg at the 7th, 14th and 21st days respectively while the values for further increasing concentrations were 40.3, 46.6, 54.4 mg, and 32.1, 40.3, 45.4 mg, and 26.4, 35.6, 42.7 mg, and 21.34, 27.51, 31.42 mg, and 19.26, 24.21, 27.9 mg, and 14.24, 19.33, 22.29 mg, and 8.24, 14.5, 19.3 mg respectively with increasing concentrations of pesticide. At 10% concentration, no results were observed.

There can be many reasons for the inhibition of seed germination and seedling growth as the hydrolytic enzymes may be inhibited by pesticides or by blocking the

pathway of enzymes (Ganga et al., 1992). The cytological effects of deltamethrin, a synthetic pyrethroid used as an insecticide, have been studied using root meristems of *Allium cepa*. Deltamethrin treatment resulted in a dose-related reduction in a mitotic index. Both chromosomal and mitotic abnormalities were encountered at all concentrations ranging from 0.05 to 2 ppm. Most of the chromosomal and mitotic abnormalities were apparently due to disturbance in the mitotic spindle. Induction of chromosome and chromatid breaks with higher concentrations (0.5 to 2 ppm) suggested the clastogenic action of this compound (Chauhan et al., 1986).

Duran et al. (2015) observed the effect of deltamethrin pesticide on the biological properties of maize (*Zea mays* L. *saccharata* Sturt) by exposing the seeds to environmentally relevant dosages (0.01, 0.05, 0.1, and 0.5 ppm) of deltamethrin. On the 7th day of germination, morphological, anatomical, and physiological responses were determined. All seedling growth characters were decreased with increasing deltamethrin levels. The most negative effect on the radicle length of maize was observed by the highest deltamethrin concentration with a 61% decrease ($P < 0.05$). Both stomatal density and stomatal dimension reduction were caused by increasing concentrations of deltamethrin (Duran et al., 2015).

Various pre-sowing treatments were given to observe the impact on seed germination, seedling establishment, dry weight, and vigour in chickpea. The different pre-sowing seed treatments showed different responses against different parameters, and the control exhibited the lowliest performance for all seven seed quality attributes (Shahid et al., 2011).

The consequences of mancozeb and chlorpyrifos pesticides on *Allium cepa* were worked out by observing effects on germination %, survival %, root length, shoot length, and their ratio, seedling vigor index, tolerance index, and percentage of phytotoxicity. The work was supported by investigating the enzymatic activity of antioxidative enzymes along with morphological parameters and it was concluded that the growth of seedlings was badly affected by the two pesticides (Fatima et al., 2018).

Effect of different concentrations of deltamethrin and monocrotophos on different attributes of seedlings such as root length, shoot length, leaf area, fresh weight and dry weight exhibit the same pattern. The values of all the attributes were observed highest at 0.5% concentrations for both the pesticides.

CONCLUSION

The result of the present studies indicates that seedling growth showed a similar pattern of growth when treated with either of the two pesticides. It is observed that a general decrease in seedling growth was observed at a higher concentration (7.5%) of both the pesticides. Although the best result was obtained at the concentration of 0.5% for both the pesticides. Seedling growth is not observed in 10% concentration, even seed is not germinated at such a high concentration of pesticides. The use of

seed treatments in Integrated Pest Management (IPM) of major field crops has considerably over the past few years. There are views in support of pesticides and against the use of pesticides. While pesticides increased the yield of crops and livestock, pesticides are also involved in damaging environmental health and cause a decrease in plant growth and germinating capability of seeds. Although pesticides are hazardous to the environment and health, they are used as a weapon to protect crop loss and provide more yield. Indeed, a safer use is needed. Hence, it is concluded that pesticides such as organophosphorus monocrotophos and pyrethroid deltamethrin are toxic to plants in higher concentrations and can be applied for agriculture crop protection in low concentrations only (0.5%).

REFERENCES

- Anderson, A., Baldock, J.A., Rogers, S.L., Bellotti, W. and Gill, G. (2004). Influence of chlorsulfuron on rhizobial growth, nodule formation and nitrogen fixation with chickpea. *Australian Journal of Agricultural Research*, 55(10): 1059-1070.
- Busse, M.D., Ratcliff, A.W., Shestak, C.J. and Powers, R.F. (2001). Glyphosate toxicity and the effects of long-term vegetation control on soil microbial communities. *Soil Biology and Biochemistry*, 33(12-13): 1777-1789.
- Chauhan, L.K.S., Dikshith, T.S.S. and Sundararaman, V. (1986). Effect of deltamethrin on plant cells I. Cytological effects on the root meristems of *Allium cepa*. *Mutation Research/Genetic Toxicology*, 171(1): 25-30.
- Dhanamanjuri, W., Thoudam, R. and Dutta, B.K. (2013). Effect of some pesticides (fungicides) on the germination and growth of seeds/seedlings of some crop plants (i.e., *Cicer arietinum* and *Zea mays*). *Middle East Journal of Scientific Research*, 17(5): 627-632.
- Duran, R.E., Kilic, S. and Coskun, Y. (2015). Response of maize (*Zea mays* L. *saccharata* Sturt) to different concentration treatments of deltamethrin. *Pesticide Biochemistry and Physiology*, 124: 15-20.
- Fatma, F., Verma, S., Kamal, A. and Srivastava, A. (2018). Phytotoxicity of pesticides mancozeb and chlorpyrifos: correlation with the antioxidative defence system in *Allium cepa*. *Physiology and Molecular Biology of Plants*, 24(1): 115-123.
- Gange, A.C., Brown, V.K. and Farmer, L.M. (1992). Effects of pesticides on the germination of weed seeds: implications for manipulative experiments. *Journal of Applied Ecology*, 29: 303-310.
- Kaur, R. and Goyal, D. (2019). Toxicity and degradation of the insecticide monocrotophos. *Environmental Chemistry Letters*, 17(3): 1299-1324.
- Rao, P.P., BIRTHAL, P.S., BHAGAVATULA, S. and BANTILAN, M.C.S. (2010). Chickpea and pigeonpea economies in Asia: facts, trends and outlook. International Crops Research Institute for the Semi-Arid Tropics, Patancheru, India.
- Shahid, M., Singh, A., Srivastava, M., Sachan, C.P. and Biswas, S.K. (2011). Effect of seed treatment on germination and vigour in chickpea. *Trends in Biosciences*, 4(2): 205-207.

- Shahid, M., Khan, M.S., Ahmed, B., Syed, A. and Bahkali, A.H. (2021). Physiological disruption, structural deformation and low grain yield induced by neonicotinoid insecticides in chickpea: A long term phytotoxicity investigation. *Chemosphere*, 262: 128-388.
- Thube, S.H., Mahapatro, G.K. and Kumar, A. (2018). In vitro evaluation of insecticides, bio-fungicide and bio-fertilizer for strategic and eco-friendly combinatorial seed treatments in chickpea. *Proceedings of the National Academy of Sciences, India Section B: Biological Sciences*, 88(2): 645-654.
- Tiyagi, S.A., Ajaz, S. and Azam, M.F. (2004). Effect of some pesticides on plant growth, root nodulation and chlorophyll content of chickpea. *Archives of Agronomy and Soil Science*, 50(6): 529-533.