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Morphological Study of *Cicer arietinum* crop Irrigated with Industrial waste water of Kota, Rajasthan, India

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Abstract
Water pollutants are a major environmental concern. The study was aimed to investigate the effect of industrial waste water pollution on the morphological parameters of *Cicer arietinum* crop. Industrial waste water samples were collected from a common outlet of different industries from Kota. Various morphological parameters were analysed comparatively in *Cicer* plants irrigated with tap water (control) and industrial waste water. This study showed that industrial waste water irrigated crop has significantly decreased seed germination, vigour index, stem length, internodal length and petiole length. Whereas, slight decrease in seedling length, seed size, number of leaves in leaflet, seedling fresh and dry weight was found in industrial waste water irrigated crop than control crop.

Key words- *Cicer arietinum*, Industrial waste water, Morphological parameters

Introduction

Water Pollution is the major issue now days. Waste water from cities is causing most environmental issues, mainly in the developing countries (Mage *et al*., 1996). Polluted water directly affects the crop by entering into the root, shoot, leaf and individual cells, which manipulates the plants metabolic activities. The effects of industrial waste water can easily be detected on plant's morphology. Many researchers (Bhatti and Iqbal, 1988; Gupta and Ghouse, 1988) had reported that the pollution effects on the morphology and anatomy of different plant species, grown in different regions. Pollutants are substances that can harm the environment like pesticides, insecticides, dyes, harmful chemicals containing heavy metals that do not naturally occur in the environment. It has been found that the plant growth, development, yield and soil health gets affected when polluted water or industrial waste water is used for long term for irrigation purpose. (Nandy and Kaul, 1994) (Reig-Armiñana *et al*., 2004; Silva *et al*., 2005).

The present study was conducted to investigate the effect of industrial waste water on the morphological characteristics of *Cicer arietinum* crop grown commonly in Kota region. Irrigation of crops with industrial waste water is a very common practice in India.

Study Area

The district Kota lies between 24°25' and 25°51' North latitudes and 75°31' and 77°26' East longitudes with total area of 5767.97 Sq Km. " Kota is a prime industrial town of Rajasthan with historical importance of its own. In last decade, Kota city has emerged as "educational city" of India mainly because of its excellence in coaching for entrance examinations (Gupta *et al.*,
2011) . Few large scale industries including DCM Shriram Consolidated Limited (DSCL), Multimetals Limited, Samtel Glass Limited, Chambal Fertilizers and Chemicals Limited (CFCL), Shriram Fertilizers and Metal India, Shriram Rayons and a number of Kota stone cutting and polishing units further enhance the heavy metal burden in the Atmosphere. Many large and small scale industries are present due to availability of river water and power. (Meena *et al.*, 2014)

Industrial waste water outlet site

Table:1 Comparative studies of morphological characters in *Cicer arietinum* L. plant irrigated with control and industrial waste water

(1-7: At the age of 7days; 8-12: At the age of 7 weeks)

S.No.	Morphological characters	*Cicer* (Control)	*Cicer* (Industrial waste water)
1.	Germination percentage	80 %	73.33 %
2.	Seedling length (cm.)	13.12± 0.55	13.04 ±0.832
3.	Seedling shoot length (cm.)	4.04 ±0.2	3.7 ±0.404
4.	Seedling root length (cm.)	9.08 ±0.964	9.34 ±0.472
5.	Seedling fresh weight (gm.)	0.653 ±0.033	0.596 ±0.0184
6.	Seedling dry weight (gm.)	0.0584± 0.003	0.0342 ±0.001
7.	Vigour index (cm.)	1049.6	956.22
8.	Petiole length (cm.)	2 ±0.5	1.33 ±0.152
9.	Inter-nodal length (cm.)	3.2 ±0.360	1.73 ±0.208
10.	Stem length (cm.)	25.33 ±1.414	21.5 ±1.32
11.	Leaflet length (cm.)	5.98 ±0.427	5.36 ±0.461
12.	Average number of leaflets in leaf	11	12
13.	Average seed size (mm.)	7.18x5.60	6.18x4.60

Discussion

Results showed that industrial waste water irrigated crop has significantly decreased seed germination, vigour index, stem length, internodal length and petiole length. Whereas, slight decrease in seedling length, seed size, number of leaves in leaflet, seedling fresh and dry weight was found in industrial waste water irrigated crop than control crop (Table: 1).

In *Cicer* industrial waste water irrigated crop value of all morphological characters were observed to be reduced. Various morphological characteristics observed in *Cicer* crop were germination percentage, vigour index, seedling length, seedling shoot and root length, seedling fresh and dry weight, petiole length, internodal length, stem length, leaflet length, number of leaflet, seed and hilum size.

Decreased germination percentage and vigour index is also reported by Khan and Sheikh (1976). They observed significant reduction and delay in the germination of *Capsicum annum* seeds. They explained that osmotic pressure of the effluent water increases at higher concentrations as total salts concentration in waste water is high which makes imbibition more difficult and retard germination efficiencies. The ability of seeds to germinate varies in various varieties as well as species under high osmotic pressure (Ungar, 1987). Slightly reduced Seedling length was also observed in *Cicer*, which was explained in previous studies that this may be probably due to accumulation of heavy metals and salts around seed that reduced water suction by the seed, therefore result in reduced seedling growth (Rahimi *et al.*, 2006). Previous study by Nath *et al.*, (2009) also reported that tannery effluents showed significant reduction in germination percentage and seedling growth with increase in concentrations of effluent.

Fresh and dry weights of seedlings, Stem length, inter nodal length were also found to be reduced. Zereen *et al.*, (2013) showed similar reduction at highest concentration of effluent treatments. They observed reduction in the fresh and dry weights of all the cultivars of sunflower as compared to control. They concluded from their study that waste water adversely affected the root and shoot development of all the cultivars of sunflower in higher treatment concentrations. Similar results were obtained by Jaja and Odoemena, 2004 on evaluating lead concentration in tomato and found root, shoot and leaf growth and fresh-dry biomass, were significantly reduced.

In some other studies on pea by Kevresan *et al.*, (2001), *Phaseolus vulgaris* and *Lens culinaris* (Haider *et al.*, 2006), similar results were obtained.

Parameters related to leaf such as leaflet length, average number of leaflets and petiole length were found slightly changed in industrial waste water irrigated crop. Similar results were observed by various workers in their studies, which showed similar reduction in different leaf variables in polluted environment (Jahan and Iqbal, 1992). All the metabolic changes such as decline of photosynthetic rate due to destroyed chloroplast ultrastructure, restrained chlorophyll synthesis, restricted electron transport and enzyme activities of Calvin cycle produced by presence of heavy metal such as Pb in irrigation water modifies plant growth and development. Therefore changes in parameters related to leaf, leaflets and petiole were results of it. (Yilmaz *et al.*, 2009)

Microscopic study of stomata of *Cicer* plants which were irrigated with tap water and industrial waste water was done. Modification in stomatal length, breadth, area and density was seen in plants when irrigated with industrial waste water.

In *Cicer* stomata length and breadth both decreases slightly whereas stomatal density was found increased. In previous studies researchers have reported increased stomatal density in leaves of plants which were grown under stress of heavy metals such as Cd (Baryla *et al.*, 2001; Chardonnens *et al.*, 1998). They reported that the increased stomatal density observed in these studies can be explained as compensatory measure to the reduced transpiration area so, this ensuring the maintenance of CO_2 flow without major harm to the photosynthesis. Abrams *et al.*, (1994) in their study correlates the stomatal cell length with stomatal conductance. Small stomata or area of stomata represent greater stomatal resistence, which would finally result in less water loss through transpiration. Modification in stomatal density and stomata sizes and area can be seen as a adaptative feature of plants in response to toxicity of heavy metals, as found on the adaxial epidermis. According to Melo *et al.*, (2007), the increased stomatal density, conjugated with the decrease in stomatal size and area, would be a

substitute to adequate supply of Carbon dioxide for photosynthesis, preventing on other hand excessive water loss due to stomata.

Table:2 Showing stomatal characters of leaves of plants irrigated with control and industrial waste water

S. No.	Parameters	*Cicer* (Control)	*Cicer* (Industrial waste water)
1	Length of stomata (µm)	12.89±0.972	11.51±1.152
2	Breadth of stomata (µm)	8.419±0.488	7.0566 ± 0.280
3	Area of stomata (µm²)	108.76±12.379	81.107 ±6.424
4	Stomatal density (mm²)	396.589±24.790	446.162±82.527

Result and Conclusion

It is clearly seen from morphological studies that the growth and development of crop was found to be affected by industrial waste water irrigation. But, industrial waste water evidently causes non substantial changes to most of *Cicer* plant parts.

The data collected from stomata study represent very slight decrease in length, breadth and area of stomata in *Cicer* industrial waste water irrigated plants. Stomatal density was found increased in *Cicer* plant leaves as compared to industrial waste water.

These changes are generally considered to be adaptations which increase the chances of the plant to withstand the stress imposed by salinity or alternatively these changes may be considered as signs of damage or disruption of the normal equilibrium of plant's life. So, it is suggested that to avoid lethal effects of pollutants waste water should be diluted properly before it is used for irrigation.

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