Effect of H.E.C. effluent on morphological development of *Vicia faba*

Arshia Naaz, Saloni Swaroopa and A. K. Choudhary

Laboratory of Plant Physiology and Biotechnology, University Department of Botany,
Ranchi University, Ranchi-834008, Jharkhand, India

Abstract- Wastewater commonly use in irrigation for several crop plants growth. The reason is because it contains various important micro and macro-nutrients which are useful for crop development. However the content of nutrients in wastewater completely depends on their origin of source. Moreover such variations in nutrients availability greatly influence the particular crop growth. In the present study we addressed the effect of heavy metal industry, Heavy Engineering Corporation (H.E.C.) wastewater on growth of *Vicia faba* (Broad bean). Different concentrations of H.E.C. effluent (0% - 100%) were used to examine their effect on development of *Vicia faba* morphologies. We found that 20% effluent concentration is most suitable for development of different morphologies of *Vicia faba*, indeed support the maximum growth. At higher concentrations (40% - 100%) development of crop is significantly compromised suggesting certain constituents in effluent are present excess than their tolerance limit. Nonetheless, 20% effluent concentration contains optimum micro and macro-nutrients as well as other components which are useful for better growth of *Vicia faba*.

Index Terms- Development, Effluent, Heavy Engineering Corporation (H.E.C.), Morphology, *Vicia faba*, Wastewater.

I. INTRODUCTION

Commonly synthetic fertilizers are being used to provide the requirement of various nutrients to get the best productivity of crop (Liu et al., 2014; Liu et al., 2011). Excess utilization of synthetic fertilizers often leads to deteriorate the soil which ultimately decrease the crop growth (Savci, 2012a, b).Moreover, their production and utilization in irrigation is often associated with high cost (Hussain et al., 2002; Khaleel et al., 2013). Nowadays wastewater is frequently use in irrigation to overcome the cost associated problem as well as their recycling (Hussain et al., 2002; Khaleel et al., 2013). One of the most advantageous factor behind the use of wastewater in irrigation is the presence of desirable nutrients (Hussain et al., 2002). However, types of nutrients and their requirement substantially differ for specific crop developmental growth. One of the major source of wastewater is industry which almost prevalent around world (Hanchang, 2009; Rana et al., 2014). Industrial wastewater contains important micro- and macro-nutrients, though their concentration varies with characteristic of industry (Gatta et al., 2015; Hussain et al., 2002; Rana Ibrahim Al-Dulaimi, 2012). Moreover, type of effluent which depends on the strategies used while treatment of wastewater such as untreated or partially treated, also affect the concentration of nutrients (Chauhan, 2016). Despite important nutrients, wastewater also contains several undesirable components which often toxic for plant growth. It has been reported that certain micro and macro-nutrients at lower concentration is beneficial however their higher concentration is lethal for crop growth (Barakat, 2011; Chibuike and Obiora, 2014; Yadav, 2010; Yu et al., 2014). Thus, it is worthwhile to examine the systematic analysis of suitable concentration of effluent which can be use in irrigation for better growth of specific crop. H.E.C effluent is commonly using in irrigation for several crop plants growth. In this study we have investigated the effect of heavy metal industry (H.E.C.) effluent on different morphological development of *Vicia faba*. We examined their different concentrations (0% - 100%) effect on various developmental stages of *Vicia faba*. We found that development of different morphologies of *Vicia faba* was higher at 20% concentration effluent and gradually decreased at higher tested concentrations (40% - 100%).

II. MATERIALS AND METHODS

Wastewater was collected at regular interval of six months from the H.E.C. plant Ranchi, Jharkhand, India. Different concentrations of effluent were prepared with distilled water. The prepared effluent concentrations were 0%, 20%, 40%, 60%, 80% and 100%. The control was 0% (distilled water) and the crude was 100% effluent concentration. Pot study experiment was performed to examine the effect of H.E.C. effluent concentrations on development of different morphologies of *Vicia faba*. After post flowering stage different morphologies such as length of root, shoot, leaf and total number of nodule, stem, branch, leaf and flower were analyzed. Length and width of respective morphologies were measured by meter scale and the number was scored. All the experiments were performed in quadruplicate. All data were expressed as mean values with the corresponding standard deviations (SD).

III. RESULTS

Vicia faba was grown in the presence of different concentrations of H.E.C. effluent. To understand the specific response of different concentrations of effluent we systematically examined the several morphological development of plant. We investigated the influence of different effluent concentrations (0%, 20%, 40%, 60%, 80% and 100%) on the length of root, shoot, leaf and total number of nodule, stem, branch, leaf and flower. All the above mentioned morphologies were analyzed after post flowering stage.

Root length: Results show that length of root varies with respect to different concentrations of effluent. The maximum length of

Table 1. Effect of different concentrations of H.E.C. effluent on morphological development of *Vicia faba*.

H.E.C. effluent concentration	Root length (cm)	Shoot length (cm)	Leaf length (cm)	Leaf width (cm)
0%	17.5 ± 1.29	84.25 ± 1.26	5.5 ± 0.43	4.3 ± 0.32
20%	22.25 ± 1.26	91.25 ± 1.5	6.1 ± 0.52	5.2 ± 0.29
40%	20.25 ± 1.5	87.75 ± 0.96	6.0± 0.34	5.1 ± 0.31
60%	18.25 ± 1.71	85.0 ± 0.82	5.8 ± 0.45	5.1 ± 0.28
80%	17.0 ± 1.63	82.75 ± 0.5	5.5 ± 0. 39	4.5 ± 0.41
100%	14.25 ± 0.96	80.5 ± 1.0	5.4 ± 0.41	5.1 ± 0.35

root (22.25 cm) was found to be at 20% concentration of effluent (table 1). Moreover, the length of root was decreased at higher tested concentrations as compared to 20% effluent concentration. The length of root was 20.25, 18.25, 17.0 and 14.25 cm at 40%, 60%, 80% and 100% effluent concentrations respectively. Root length was found to be 17.5 cm in control (0% effluent concentration) which was used to prepare the different dilution of effluent concentrations. These results indicate that 20% - 60% effluent concentrations are suitable for root development as compared to control. However higher concentrations (80% - 100%) of effluent decreased the root development as compared to control.

Shoot length: Similar to root length the shoot length was found maximum at 20% effluent concentration as compared to control and the other tested effluent concentrations (table 1). Shoot length was found to be 91.25 cm at 20% concentration however it was 84.25 cm at control. Moreover, shoot length was higher at 40% - 60% and decreased at 80% - 100% effluent concentrations as compared to control. The length of shoot was 87.75, 85.0, 82.75 and 80.5 cm at 40%, 60%, 80% and 100% effluent concentrations respectively. The pattern of shoot development at various effluent concentrations suggesting that 20% to 60% effluent concentrations are optimum, however 80% to 100% concentrations can decrease the shoot development.

Leaf length and width: Effect of effluent on leaf elongation (length and width) was minor as compared to root and shoot development. Nevertheless, maximum length and width of leaves were found to be at 20% as compared to control and other tested effluent concentrations (table 1). The length and width of leaves at 20% effluent concentration were 6.1 cm and 5.2 cm respectively. However, the length and width of leaves were 5.5 cm and 4.3 cm at control. Though the development of leaves was increased at 20%, it almost remains or comparable to the control at higher tested effluent concentrations (40% - 100%). The length at 40%, 60%, 80% and 100% effluent concentrations were 6.0, 5.8, 5.5, and 5.4 respectively. Likewise the width was 5.1, 5.1, 4.5 and 5.1 cm respectively.

Total number of nodules: Results show that nodules number increased at 20% effluent concentration as compared to the control (table 2). The total number of nodules was 43 at 20% effluent concentration and 36 at control. However nodule number decreased with increased in effluent concentration, nevertheless it remain higher up to 60% as compared to control. Total number of nodules was 40 and 38 at 40% and 60% effluent concentrations respectively. At 80% effluent concentration number of nodules was same as control however it was decreased to 35 at 100% effluent concentration.

Total number stem: Effect of effluent on the number of stem followed the same trends like number of nodules. At 20% total number of stem was two-fold higher than the control and higher among other tested effluent concentrations (table 2). Total number of stem was 4 at 20% effluent concentration, however total number of stem was 2 at control. Further increased in effluent concentration decreased the number of nodule as compared to 20% concentration. Nevertheless number of nodule was higher at 40% to 60% as compared to control, however further decreased at 80% - 100%effluent concentrations.

Total number of branch: Results show that number of branch was higher at 20% and 40% effluent concentrations as compared to control (table 2). Total number of branch was 5 at both 20% and 40% however it was 4 at control. However the number of branch was similar to control at 60% effluent concentration. Moreover, their number further decreased with increased in effluent concentration. The total number of branch was 3 and 2 at 80% and 100% effluent concentrations respectively.

Total number of leaf: Effect of effluent was most predominant on development of leaf among all examined morphologies of *Vicia faba*. Results show that the maximum number of leaves was at 20% effluent concentration (table 2). The total number of leaves was 99 at 20% effluent concentration however it was 75 at control. We found that number of leaf decreased gradually with increased in the effluent concentrations. The total number of leaf was98, 93, 62 and 52 at 40%, 60%, 80% and 100% effluent concentrations respectively. These results indicate that 20% to 60% effluent concentrations are suitable for leaf development as compared to control. However use of higher effluent concentrations such as 80%to 100% can inhibit the leaf development.

Total number of flower: Development of flower was found maximum at 20% effluent concentration (table 2). At 20%

Table 2. Effect of different concentrations of H.E.C. effluent on nodule, stem, branch, leaf and flower of *Vicia faba*.

H.E.C. effluent concentration	Total number of nodule	Total number of stem	Total number of branch	Total number of leaf	Total number of flower
0%	36	2	4	75	2
20%	43	4	5	99	5
40%	40	3	5	98	4
60%	38	3	4	93	3
80%	36	1	3	62	2
100%	35	1	2	52	1

effluent concentration total 5 flowers was developed however total number of flowers was 2 at control. We found that number 100% effluent concentration. The obtained result suggesting that 20% to 80% effluent concentrations are more beneficial for flower development as compared to control.

IV. DISCUSSION

H.E.C. effluent is utilizing in irrigation for several crops near their flow regions in Jharkhand, India. The reasons for their use in irrigation are to get nutrients for crop growth to overcome the cost associated with fertilizers. Though, this strategy is beneficial for certain crop it remains to investigate their optimum concentration which can be used in irrigation for specific plant such as *Vicia faba*. Moreover, analysis of suitable H.E.C. effluent concentration for better crop growth could economize the agriculture practice. In the present study we have examined the effect of H.E.C. effluent on different morphological development of *Vicia faba* growth as well as investigated the suitable concentration which can be used in irrigation for their growth. We tested the effect of different concentrations of effluent to better understand their response towards specific morphological development of *Vicia faba*. We grow the plant in the presence of different concentrations of effluent (0% - 100%) and examined their different morphologies after post flowering stage. We analyzed the effect of effluent on length of root, shoot, leaf and total number of nodule, stem, branch, leaf and flower. We found that development of all these morphologies were increased at 20% effluent concentration as compared to control. Moreover, we found that their development decreased with increased in effluent concentrations. Among all tested dilution the optimum concentrations of effluent were found to be 20% to 60% for root, shoot and leaf. For nodule and flower the optimum concentrations of effluent were 20% to 80%, for stem, branch and leaf the optimum concentrations were 20% to 60%. These results indicating that highest concentration contain excess nutrients or heavy metals which possibly affect the proper development of different morphologies of *Vica faba*. Several studies have reported the toxic effects of excess nutrients and heavy metals on plant growth (Barakat, 2011; Chibuike and Obiora, 2014; Yadav, 2010; Yu et al., 2014). Though, their lower concentrations are beneficial and important, higher concentrations can lead to abrogation in the plant growth. Thus, it will be insightful to analyze the physico-chemical properties to uncover the presence of specific nutrients and heavy metals in H.E.C. effluent. Moreover their quantitative analysis and investigation of individual response towards different morphological development will be useful to select the particular concentration of H.E.C. effluent in irrigation for specific plant growth.

ACKNOWLEDGMENT

Authors acknowledge the Dean and Head of department, university department of Botany, Ranchi University, Jharkhand, India. Arshia Naaz also acknowledge the UGC - MANF for fellowship.

REFERENCES

[1] Barakat, M. (2011). New trends in removing heavy metals from industrial wastewater. Arabian Journal of Chemistry *4*, 361-377.

[2] Chauhan, C.P.D.S.S. (2016). Study of the Impact on Morphological Features of *Abelmoschusesculentus* var. Ankur 41, irrigated by the Waste Water from AmanishahNallah, Sanganer Town, Jaipur, Rajasthan, Vol 6 (International Journal of Scientific and Research Publications).

[3] Chibuike, G., and Obiora, S. (2014). Heavy metal polluted soils: effect on plants and bioremediation methods. Applied and Environmental Soil Science *2014*.

[4] Gatta, G., Libutti, A., Gagliardi, A., Beneduce, L., Brusetti, L., Borruso, L., Disciglio, G., and Tarantino, E. (2015). Treated agro-industrial wastewater irrigation of tomato crop: effects on qualitative/quantitative characteristics of production and microbiological properties of the soil. Agricultural Water Management *149*, 33-43.

[5] Hanchang, S. (2009). Industrial wastewater-types, amounts and effects. Point Sources of Pollution: Local Effects and their Control-Volume II, 191.

[6] Hussain, I., Raschid, L., Hanjra, M.A., Marikar, F., and Van Der Hoek, W. (2002). Wastewater Use in Agriculture: Review of Impacts and Methodological Issues in Valuing Impacts: with an Extended List of Bibliographical References, Vol 37 (Iwmi).

[7] Khaleel, R.I., Ismail, N., and Ibrahim, M.H. (2013). The impact of waste water treatments on seed germination and biochemical parameter of Abelmoschus esculentus L. Procedia-Social and Behavioral Sciences *91*, 453-460.

[8] Liu, C.W., Sung, Y., Chen, B.C., and Lai, H.Y. (2014). Effects of nitrogen fertilizers on the growth and nitrate content of lettuce (Lactuca sativa L.). Int J Environ Res Public Health *11*, 4427-4440.

[9] Liu, X., Ren, G., and Shi, Y. (2011). The effect of organic manure and chemical fertilizer on growth and development of *Stevia rebaudiana Bertoni*. Energy Procedia *5*, 1200-1204.

[10] Rana Ibrahim Al-Dulaimi, N.B.I., Mahamad Hakimi Ibrahim (2012). The effect of industrial wastewater in seed Growth rate: A Review, Vol 2 (International Journal of Scientific and Research Publications).

[11] Rana, R.S., Singh, P., Kandari, V., Singh, R., Dobhal, R., and Gupta, S. (2014). A review on characterization and bioremediation of pharmaceutical industries' wastewater: an Indian perspective. Applied Water Science, 1-12.

[12] Savci, S. (2012a). An agricultural pollutant: chemical fertilizer. International Journal of Environmental Science and Development *3*, 73.

[13] Savci, S. (2012b). Investigation of effect of chemical fertilizers on environment. APCBEE Procedia *1*, 287-292.

[14] Yadav, S. (2010). Heavy metals toxicity in plants: an overview on the role of glutathione and phytochelatins in heavy metal stress tolerance of plants. South African Journal of Botany *76*, 167-179.

[15] Yu, X., Li, Y., Zhang, C., Liu, H., Liu, J., Zheng, W., Kang, X., Leng, X., Zhao, K., and Gu, Y. (2014). Culturable heavy metal-resistant and plant growth promoting bacteria in V-Ti magnetite mine tailing soil from Panzhihua, China. PloS one *9*, e106618.

Correspondence Author – Arshia Naaz
Email: arshianz96@gmail.com