International Journal of Advance and Applied Research
Peer Reviewed | International Open Access Journal
ISSN: 2347-7075 | Impact Factor – 8.141 | *Website:* https://ijaar.co.in/
Volume-13, Issue-3 | January – February 2026

Original Article

Impact of Sugar Mill Effluent on Germination, Growth and Protein Content of Zea mays L.

Dr. Sachin Dadaji Kuvar

Associate Professor, Department of Botany,

Siddharth College of Arts, Science & Commerce, Fort, Mumbai, Maharashtra

Manuscript ID:
IJAAR-130366
ISSN: 2347-7075
Impact Factor – 8.141

Volume - 13
Issue - 3
January – February 2026
Pp. 353 - 359

Submitted: 14 Jan.2026
Revised: 20 Jan. 2026
Accepted: 30 Jan. 2026
Published: 10 Feb. 2026

Corresponding Author:
Dr. Sachin Dadaji Kuvar

Quick Response Code:

Website: https://ijaar.co.in/

DOI:10.5281/zenodo.20473101

DOI Link:
https://doi.org/10.5281/zenodo.20473101

Abstract:

The disposal of untreated industrial effluents into the environment has become a major ecological concern due to their adverse effects on soil, water and plant health. The present study was undertaken to evaluate the impact of sugar mill effluent on seed germination, seedling growth and protein content of Zea mays L. Different concentrations of sugar mill effluent were used to assess their toxicological as well as beneficial effects on maize under laboratory conditions. Physico-chemical characteristics of the effluent such as pH, electrical conductivity, total dissolved solids and nutrient content were analysed prior to treatment. Healthy seeds of maize were treated with varying concentrations of sugar mill effluent along with a control using distilled water. Parameters including percentage of seed germination, root length, shoot length, fresh weight, dry weight and protein content were recorded after a specified growth period. The results indicated that lower concentrations of sugar mill effluent promoted seed germination and seedling growth due to the presence of essential nutrients and organic matter. However, higher concentrations showed inhibitory effects on germination percentage, growth parameters and protein content, indicating phytotoxicity caused by excessive salts and organic load. The study concludes that diluted sugar mill effluent can be utilized as a potential biofertilizer or irrigation supplement for agricultural crops, whereas untreated or highly concentrated effluent may adversely affect plant growth and metabolism. Proper treatment and controlled application of sugar mill effluent are therefore essential for sustainable agricultural and environmental management.

Keywords: Sugar Mill Effluents, Maize Seed, Growth Parameter, Protein Contents, Seed Germination.

How to cite this article:

Dr. Sachin Dadaji Kuvar. (2026). Impact of Sugar Mill Effluent on Germination, Growth and Protein Content of Zea mays L. International Journal of Advance and Applied Research, 13(3), 353 - 359. https://doi.org/10.5281/zenodo.20473101

International Journal of Advance and Applied Research
Peer Reviewed | International Open Access Journal
ISSN: 2347-7075 | Impact Factor – 8.141 | *Website:* https://ijaar.co.in/
Volume-13, Issue-3 | January – February 2026

Introduction:

Rapid industrialization and urbanization have led to the generation of large quantities of industrial effluents, which pose serious threats to environmental sustainability and agricultural productivity. Among various agro-based industries, sugar mills are one of the major contributors of liquid waste containing high amounts of organic matter, dissolved solids, nutrients and toxic substances. Disposal of untreated sugar mill effluent into nearby water bodies and agricultural lands adversely affects soil fertility, groundwater quality and plant growth. However, when properly diluted and managed, such effluents may also serve as a source of nutrients beneficial for crop development.

Sugar mill effluent is rich in organic compounds, nitrogen, phosphorus, potassium and other micronutrients generated during sugar processing operations. These constituents can influence seed germination and plant growth either positively or negatively depending on their concentration and chemical composition. Excessive application of industrial effluents may lead to osmotic stress, toxicity and metabolic disturbances in plants, whereas lower concentrations may improve nutrient availability and enhance growth parameters. Therefore, evaluation of the toxicological and beneficial effects of sugar mill effluent on crop plants is essential for determining its suitability for agricultural reuse.

Zea mays L., commonly known as maize, is one of the most important cereal crops cultivated worldwide for food, fodder and industrial purposes. Due to its economic importance and sensitivity to environmental changes, maize is widely used in studies related to plant growth and environmental stress. Seed germination and seedling growth are critical stages in the life cycle of plants and are highly affected by the quality of irrigation water and soil conditions. Protein content is another important biochemical parameter that reflects the physiological and metabolic status of plants under stress conditions. Several researchers have reported that industrial effluents exert varying effects on germination, growth and biochemical constituents of crop plants. The response largely depends on the concentration of effluent, duration of exposure and plant species involved. Therefore, scientific assessment of sugar mill effluent is necessary before recommending its use for irrigation purposes.

The present study was undertaken to investigate the impact of sugar mill effluent on seed germination, seedling growth and protein content of Zea mays L. The study aims to evaluate both the beneficial and toxic effects of different concentrations of sugar mill effluent and to determine its potential applicability in sustainable agricultural practices and environmental management.

Material And Methods:

Seed Materials:

The seeds of Maize were purchased from "Pathare Nursery", Kalyan (West), Maharashtra**.** The seeds with uniform size, colour and weight were chosen for the experimental purpose.

Collection of Sugar Mill Effluents:

Three type of effluent sample were collected in plastic container from the point of disposal from a sugar factory named "Dwarkadish Sugar Factory" located at Sheware, taluka Satana in Nasik District, Maharashtra and the collected samples are stored in cool place until physic-chemical parameters such as Colour, Temperature, Conductivity, BOD, COD, total solids (TS), total dissolved solids (TDS), total suspended solids (TSS), alkalinity, hardness, salt

International Journal of Advance and Applied Research
Peer Reviewed | International Open Access Journal
ISSN: 2347-7075 | Impact Factor – 8.141 | *Website:* https://ijaar.co.in/
Volume-13, Issue-3 | January – February 2026

(NaCl), pH, odour were measured using standard method.

The three types of effluent samples are collected:

1. RO Feed (Sample - A) – Main process west
2. RO Permeate (Sample - B) – After filtration of control water
3. RO Reject (Sample - C) – After filtration of raw water

The different concentrations of the each sample effluent (20%, 40%, and 60%) were prepared and used for the pot culture experiment.

Pot Culture Experiment:

The experiment was conducted at normal environmental condition. The impact of sugar factory effluent on the growth and biochemical characteristics of the maize was investigated using soil pots (15 cm height & 15 cm width). About 3 kg of air-dried soil taken into separated pot.

Three different concentration (viz, 20%, 40%, 60%) and two sets of each sugar mill effluent were prepared and poured into each pot. The control was also maintained and irrigated with tap water. Ten seeds pre-sterilized with 0.1% Mercuric chloride, were sown in each pot. All pots were irrigated with 100ml of respective concentration of test solution daily

Growth Analysis:

The plant samples were collected on 30th days after sowing. The plant from each replicates of pot was analyzed for various growth parameters such as length of root and shoot.

Observation And Discussion:

Observation of The Seed Germination Test:

SET – A

Conc. Of the Effluent	No. of seed germinated	% of germination
Sample-A		
0% (Control)	10	100%
20%	8	80%
40%	5	50%
60%	5	50%
Sample- B		
20%	4	40%
40%	3	30%
60%	2	20%
Sample – C		
20%	9	90%
40%	8	80%
60%	7	70%

International Journal of Advance and Applied Research
Peer Reviewed | International Open Access Journal
ISSN: 2347-7075 | Impact Factor – 8.141 | *Website: https://ijaar.co.in/*
Volume-13, Issue-3 | January – February 2026

SET – B

Conc. Of the Effluent	No. of seed germinated	% of germination
Sample-A		
0% (Control)	10	100%
20%	6	60%
40%	3	30%
60%	4	40%
Sample- B		
20%	4	40%
40%	2	20%
60%	2	20%
Sample – C		
20%	8	80%
40%	6	60%
60%	7	70%

Observation of Root and Shoot Growth:

SET – A

Conc. of the Effluent	Height of Root (cm)	Height of Shoot (cm)
Sample A		
0% (Control)	45	52
20%	40	44
40%	37	40
60%	33	36
Sample B		
20%	30	40
40%	--	--
60%	--	--
Sample C		
20%	50	62
40%	49	57
60%	43	51

SET – B

Conc. of the Effluent	Height of Root(cm)	Height of Shoot(cm)
Sample A		
0% (Control)	45	52
20%	41	47
40%	40	49
60%	38	43
Sample B		
20%	31	43
40%	--	--
60%	--	--

International Journal of Advance and Applied Research
Peer Reviewed | International Open Access Journal
ISSN: 2347-7075 | Impact Factor – 8.141 | *Website:* https://ijaar.co.in/
Volume-13, Issue-3 | January – February 2026

Sample C		
20%	50	64
40%	43	61
60%	40	53

Result:

The observed values of Root & Shoot length of maize plant irrigated with Sample – C (20% & 40%) were higher in comparison to the control plant. which may be taken as an indication of beneficial range, while for higher concentrations of effluents (60%) a decreasing trend was observed, which confirms the toxic effect of these effluents to maize plants. The physico-chemical parameters of the effluent were found to be above permissible limit of Indian Standards. The analysis of sugar mill effluent showed that sample A and sample B are acidic in nature, brown in colour and having decaying smell. And sample – C was observed to be almost neutral in pH also colorless and odorless. The sample – B (RETENET) contained high amount of dissolved solids. High value of BOD & COD more observed compared to sample A and sample C.

The physico-chemical parameters of sugar factory effluent from Dwarkadish Sugar Factory located at Sheware, Taluka Satana, District Nasik, Maharashtra

Parameters	**Value**		
	Sample – A (FEED)	**Sample – B (RETENET)**	**Sample – C (REJECT)**
Colour	Brown	Dark Brown	Colorless
Temperature (°C)	30.10	30.9	32
Conductivity (µS/cm)	21900	53900	-
BOD	13150	25704	50
COD	10250	19609	20
Alkalinity	6150	8750	250
Hardness	3300	7700	5
Salt (Nacl)	0.58	1.7	0.02
T.S.	19780	46780	240
T.D.S	18930	46110	240
T.S.S	850	670	0
pH	605	607	7.2
Odour	Decaying smell	Decaying smell	Odorless

Root And Shoot Growth:

Root and shoot length of maize plants differed with different Concentrations of sugar mill effluents in the soil. The observed values Root & Shoot length of maize plant irrigated with Sample – C (20% & 40%) were higher in comparison to the control plant. which may be taken as an indication of beneficial range, while for higher concentrations of effluents (60%) a decreasing trend was observed, which confirms the toxic effect of this effluents to maize plants. Protein content of maize (*Zea mays* L.) was maximum at low (20 % and 40 %) concentration of sugar mill effluent in the soil than in the control plants.

Further, the values decreased with a gradual increase in effluent (60%) concentration. Plant treated with higher effluent concentration (60%) showed lower amount of protein content due to presence of alkalinity, total solid, total dissolve solid and the acidic pH of the effluent. 100% seed germination was observed in the control. Seedling growth (Length of Root and Shoot) were maximum at low concentration (20% & 40%) in sample C than in the control plant.

Conclusion:

This study concluded that the physio-chemical parameters, such as COD, BOD, Alkalinity, Hardness and pH were relatively higher in the sugar factory effluent and severely affected the plant growth. There was a gradual decrease in the root and shoot length, protein content in maize (*Zea mays* L.) plant, when irrigated with 60% effluent concentration compared to the control. Effluent at 20% and 40% concentration favored the plant growth and increased the root and shoot length. This may be attributed to the optimum levels of inorganic nutrients and reduction in toxicity level due to dilution. Thus, the effluent diluting up to 40% can be used for the irrigation as soil fertilizers for the better growth, biochemical, and yield of maize. In the beneficial effluent concentration, 20% was better than 40% in sample C.

The lower concentration of sugar mill effluent contained required amount of nutrients which helped the growth of seedlings as well as fresh and dry weight of the seedlings. The required amount of various chemicals present in the lower concentration of sugar mill effluent promoted the plant growth. The higher concentrations of sugar mill effluent minimized the fresh weight and dry weight of seedlings. The decrease of seedlings weight may be due to the poor growth of seedlings under the higher concentrations of effluent irrigation. The presence of various chemicals in wastewater often detrimentally affect early plant development. Research demonstrates that the impact varies significantly both by effluent type and crop species. This study concluded that untreated wastewaters should not be discharged into agricultural systems and advocated for industrial treatment plants. Thus the present study collectively affirm that the effects on germination and early growth are critically dependent on effluent source, concentration and crop tolerance.

References:

1. Borole, D.V. and Patil, P.R. (2004). "Pollution Status Due to Sugar Mill Effluent." *Nature Environment and Pollution Technology*, 3 (1): 43–45.
2. Doke, K.M., Khan, E.M., Rapolu, J. and Shaikh, A. (2011). "Physico-Chemical Analysis of Sugar Industry Effluent and Its Effect on Seed Germination of *Vigna angularis*, *Vigna cylindrical* and *Sorghum cernum*." *Annals of Environmental Science*, 5: 45–51.
3. Ezhilvannan, D., Sharavanan,P.S. and Vijayaragavan M. (2011). Effect of Sugar mill effluent on changes of growth and amino acid & protein content of maize (*Zea mays* L.) plants Journal of Ecobiotechnology, 3(7): 26-29.
4. Indira S. and Mohanty, B. K. 2006. Effect of sugar mill effluent on ragi (*Eleusine coracana*. L) and growth behaviour of its seedlings, Ad Plant Sci .19(II): 463-467.
5. Ijaz, M., Sarfraz, M., Nawaz, A., Yasir, T.A., Sher, A., Sattar, A. and Wasaya, A. (2018). "Diluted Sugar Mill Effluent Application with PGPR Improves the Performance of Maize (*Zea mays* L.) under an Arid Climate." *Agronomy*, 8(5): 67.

6. Kumar, V. and Chopra, A.K. (2010). "Influence of Sugar Mill Effluent on Agricultural Soil and Crop Productivity." *Journal of Environmental Biology*, 31(5): 741–744.
7. Kumar, V. (2014). Sugar Mill Effluent Utilization in the Cultivation of Maize (*Zea mays* L.) in Two Seasons. Journal of Waste Management, Volume 2014, 1-12.
8. Kumar, V. and Chopra, A.K. (2014). "Pearl Millet (*Pennisetum glaucum* L.) Response after Ferti-irrigation with Sugar Mill Effluent in Two Seasons." *International Journal of Recycling of Organic Waste in Agriculture*, 3(6): 1–14.
9. Lowry, O. H. Rose-Brough, N. J., Fan, A. L. and Randal, R. J. (1951). Protein measurement with folin-phenol regent J. Biol chem. 193:265-275.
10. Maliwal, G.L., K.P. Patel, K.C. Patel and M.N. Patel. (2004). Pollution studies on sugar mill effluent, physico-chemical properties and toxic metals, Pollution Research, 14: 231-238.
11. Mishra, R.N., Panigrahy, G. N. and Patra, K.S. (1989). Studies on physiotoxicity of paper mill effluent on Eleusine coracana Var. AKP-2. Bullen. Pure and Appl. Sci., 8 B (1-2):6-10.
12. Muthumari, M.1, Mariappan, V.2, Kamalraj, P. (2026). Impact of Sugar Mill Effluent on Growth and Biochemical Characters of *Acacia ferruginea* DC. International Journal on Science and Technology (IJSAT), 17 (1) 1-16.
13. Nath, K. and Sharma Y.K. (2002). Effect of sugar factory effluent on seed germination and seedling growth in pulses. Current Botany, 28: 73-78.
14. Patro S., Sudhakar P., Sahu U.K. and Mohanty B.K. (2007). Study on the Impact of Sugar Mill Effluent on Germination Behaviour and Some Biochemical Parameters of a Crop Plant, *Cajanas cajan* (L.) Millsp. (Red Gram), Journal of Research & Development, Vol. 7, 11-18.
15. Rajesh, K. 1995. Effect of sugar mill effluent on the seed germination and seedling growth of *Cicer arietinum* CV. Adv. Plant Sci. 8 (1):52-56.
16. Rathore, N.S., Khangarot, B.S. and Singh, P. (2000). "Sugar Mill Effluent Pollution and its Impact on Plant Growth." *Environmental Ecology*, 18 (3): 615–619.
17. Saini, S. and Pant, S. (2014). "Physico-chemical Analysis of Sugar Mill Effluent and their Impact on Changes of Growth of Wheat (*Triticum aestivum*) and Maize (*Zea mays* L.)." *IOSR Journal of Environmental Science, Toxicology and Food Technology*, 8 (4): 57–61.
18. Samuel, S. (2011). "Physico-Chemical Analysis of Sugar Mill Effluent, Contaminated Soil and its Effect on Seed Germination of Paddy (*Oryza sativa* L.)." *International Journal of Pharmaceutical and Biological Archive*, 2(5): 1469–1473.
19. Sundaramoorthy, P., Chidambaram, A.L.A., Ganesh, K.S. and Rajesh, M. (2006). "Growth Response of Paddy (*Oryza sativa* L.) to Sugar Mill Effluent Irrigation." *Pollution Research*, 25(4): 749–752.
20. Thamizhiniyan, P., Sivakumar, P.V., Lenin, M. and Sivaraman, M. (2009). "Sugar Mill Effluent Toxicity in Crop Plants." *Journal of Phytology*, 1(2): 68–74.
21. Vaithiyanathan, T. and Sundaramoorthy, P. (2017). "Analysis of Sugar Mill Effluent and its Influence on Germination and Growth of African Marigold (*Tagetes erecta* L.)." *Applied Water Science*, 7: 4715–4723.