

ORIGINAL ARTICLE

Phytoextraction of soil cadmium and zinc by microbes-inoculated Indian mustard (*Brassica juncea*)

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A pot experiment was carried out to evaluate the effect of *Pseudomonas fluorescens* and *Trichoderma harzianum* inoculation on the uptake of zinc (Zn) and cadmium (Cd) by Indian mustard (*Brassica juncea*) from the soil having three different concentrations of Zn (300, 600, 900 mg/kg) and Cd (5, 10, 15 mg/kg) separately. Microbial inoculation resulted in significantly better plant growth, available metal content and their uptake than control (without microbes). Available Zn was enhanced, ca. 1.6- and 1.4-fold and Cd ca. 2.5- and 1.8-fold, by *P. fluorescens* and *T. harzianum* respectively. *P. fluorescens* resulted in an increase in Zn uptake by 113.9, 51.9 and 58.4% and *T. harzianum* by 42.6, 32.1 and 33.9% over control from soils having 300, 600 and 900 mg Zn, respectively, while of the corresponding results for Cd were 110.2, 48.9 and 58.1% with *P. fluorescens* and 42.6, 30.9 and 33.4% with *T. harzianum* from soil having 5, 10 and 15 mg Cd, respectively, after 90 days of treatment. In general the rate of metal uptake was higher during the initial 30 days and declined later.

Keywords: contamination; heavy metal; hyperaccumulator; microbes; phytoextraction

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Research Article

Monitoring of Impact of Ferti-irrigation by Post-methanated Distillery Effluent on Groundwater Quality

The impact assessment of molasses-based distillery-effluent irrigation on groundwater quality around village Gajraula in the district of Jyotiba Phule Nagar, Uttar Pradesh, India was studied by sampling groundwater on monthly intervals consecutively for summer, winter and monsoon seasons during 2006–2007 and water quality parameters, viz. pH, electrical conductivity (EC), chloride (Cl^-), sulphate (SO_4^{2-}), nitrate (NO_3^-), chemical oxygen demand (COD), total solids (TS), total dissolved solids (TDS), sodium (Na^+), potassium (K^+), calcium (Ca^{2+}), magnesium (Mg^{2+}), zinc (Zn^{2+}), iron (Fe^{3+}), and total coliforms (TC) were monitored. Results depicted that the values of all parameters decreased with increasing depth of water table. Sulphate, nitrate and potassium contents were maximal in agricultural site during monsoon while EC, Cl^- , TS, TDS, Na^+ , Ca^{2+} , Mg^{2+} , Zn, and Fe were maximal in industrial sites during summer. Groundwater samples of residential site harboured maximum coliforms especially during monsoon, highlighting threat to groundwater. Significant positive correlation matrix between coliforms with nitrate, sulphate and potassium ions explained their survival on these nutrients. To overcome this, important measures emphasizing improvement in effluent treatment technology matching site-specific characteristics are recommended for eco-friendly ferti-irrigation.

Keywords: Bioremediation; Groundwater; Irrigation; Wastewater

A construction of water quality index considering physicochemical properties for drinking purposes in a rural settlement: a case study of Gajraula region, Ganga River Basin (North India)

Bineet Singh, Jaspal Singh Chauhan and Anuraag Mohan

ABSTRACT

A simple methodology based on several key variables of groundwater chemistry is used to create a water quality index (WQI), with the aim of monitoring the influence of industrial and rapid urbanization on a typical rural settlement. The applicability of the constructed indices as an assessment and communication tool is evaluated in a case study of Gajraula and its suburb of JP Nagar district in northern India. The water quality data from 2007 to 2009 were analysed for 12 different locations surrounding Gajraula for two seasons, i.e. wet and dry. Five point rating scale was used to classify water quality for each of the study locations. Rating curves were drawn based on the tolerance limits of drinking waters. In the present study, the WQI demonstrated a modest increase in wet seasons (August to November) than dry seasons (February to June) for all locations with a few exceptions. Hardness, total dissolved solids, NO_3^- , biochemical oxygen demand, and Fe in most cases were found to be responsible for the decline in seasonal WQI for various locations. However, the WQI around Gajraula varied from 50.6 to 87.7 and was found to be satisfactory except for some locations.

Key words | drinking water, effluent irrigation, industrial pollution, rating curve, water quality index (WQI)

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Research Article

Reuse of Distillery Wastewater with Designed Dose and Pattern for Sugarcane Irrigation

The present investigation aims to optimize dose and pattern of distillery effluent for sugarcane irrigation. The postmethanated distillery effluent (PMDE) was recorded to have significant amount of micro- (Na, Zn, Fe) and macro- (Ca, Mg, N-NO_3^- , P, K, S-SO_4^{2-}) nutrients and so was utilized for sugarcane irrigation. Lysimetric studies were conducted to assess the impact of PMDE on sugarcane productivity with different concentrations (50 and 75%) and irrigation patterns (intermittent and pre-sowing). The intermittent pattern of ferti-irrigation with 50 and 75% effluent dose for sugarcane crop was found to enhance the growth and quality parameters of crop without impairing the groundwater quality. Results were more pronounced with 75% intermittent irrigation as the percent increase with respect to control for plant length, cane girth, cane weight, number of internodes per cane, dry matter accumulation, juice extraction, sucrose content, and available sugar were 28.0, 42.5, 14.6, 40.2, 54.4, 18.9, 44.9, 57.9, and 50.0%, respectively. It is suggested that PMDE can be used as an alternative of fresh water irrigation and also as a fertilizer for sugarcane, provided that the effluent quality and sugarcane quality is continuously monitored to avoid any contamination.

Keywords: Ferti-irrigation; Groundwater; Land treatment; Pollution; Water quality



Hydro-Chemical Assessment of Groundwater Considering Distillery Effluent Irrigation

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Key Words:

Distillery effluent irrigation
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ABSTRACT

The objective of this study is to evaluate contamination of groundwater due to distillery effluent irrigation. The groundwater chemistry was studied in a series of eight multi-level depth locations of Gajraula and its suburb of JP Nagar district in Uttar Pradesh. The treated distillery effluent was used twice @ 225-50 m³/ha as a pre-sown irrigation. The study was conducted in pre-irrigation and post-irrigation phase for the year 2008-2009. The comparative analysis showed that private wells (shallower hand pumps) have high NO₃⁻, BOD and Fe concentrations as compared to the public supply wells (deep boreholes) during the post irrigation. The TDS, Cl⁻ and Ca²⁺ values were found near to IS:10500 permissible limit values i.e., 500 mg/L, 250 mg/L and 75 mg/L respectively. However, negative effect of the effluent irrigation on groundwater quality was reported at R-1, R-2, R-3 and R-4 sites, which may have been influenced by industrial, local agricultural practices, distillery lagoon and effluent irrigation as mixed sources.



ASSESSMENT OF POTABILITY OF GROUNDWATER AROUND FERTI-IRRIGATED AREA OF INDUSTRIAL REGION

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Abstract: An experiment was conducted to evaluate the impact of ferti-irrigation with distillery effluents on groundwater quality around village Gajraula, UP, India. Groundwater sampling was carried out around ferti-irrigated field from an openwell (15m depth), tubewell (22m depth) and borewell (22m depth) on bimonthly intervals consecutively for two years. A tubewell, depth 22m located 5Km away from the experimental site was selected for control. Samples were analyzed for relevant water quality parameters viz. pH, EC, Cl⁻, SO₄²⁻, NO₃⁻, TDS, Na⁺, K⁺, Ca²⁺ and Mg²⁺ and were recorded significantly ($p < 0.05$) higher than control following the trend: openwell > tubewell > borewell > control. Ground water quality index (GWQI) was also calculated to categorize the water samples on the basis of pollutant load and the results revealed that only openwell samples were severely polluted (GWQI 79.19). Statistical analysis showed that the common ionic pairs showing significant correlation ($p < 0.05$) between openwell and tubewell were Na⁺/Cl⁻; Na⁺/NO₃⁻; Mg²⁺/Cl⁻, while that between tubewell and borewell were Na⁺/Cl⁻; Na⁺/NO₃⁻; K⁺/TDS; Mg²⁺/Cl⁻, suggesting that these ions are added in groundwater from a common source.

RESEARCH PAPER

Monitoring the self-purification capacity of the River Alaknanda stretch at Srinagar, Uttarakhand, India

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ABSTRACT

After six months from Uttarakhand's biggest flood tragedy that took place at Kedamath, a rapid investigation was conducted to assess the water quality and purification capacity of flooded River Alaknanda. Representative water samples were collected from eight different sites selected along the river stretch and relevant physico-chemical parameters along with biological indicators (coliform and periphyton) were analysed to get effective results. The results indicated that all the studied parameters were under the permissible limits prescribed by World Health Organization (WHO) and Bureau of Indian Standards (BIS) except the coliform count, which ranged between 65 and 270/100 ml. The biochemical tests and staining tests marked the species of *Lactobacillus*, *Bacillus*, *Clostridium*, *Streptococcus*, *Staphylococcus*, *Escherichia coli*, *Shigella*, *Salmonella* and *Pseudomonas* in the studied stretch of the Alaknanda. A high range of dissolved oxygen (DO, 8–9.8 mg/l) and a low range of biochemical oxygen demand (BOD, 1.2–2.8 mg/l) for the studied river stretch showed its good purification potential. Moreover, algae like *Oscillatoria*, *Euglena*, *Chlamydomonas*, *Navicula*, *Nitzschia*, *Fragillaria*, *Amphora* and *Synedra* which are considered as good self-purification agents of water bodies, were dominant in organically polluted sites. The periphyton density was recorded as a maximum of $19.9 \times 10^{10}/m^2$ in the month of February at the S4 site and the periphyton biofilm thickness was recorded as a maximum of 3.8 mm at the S4 site in April. Mostly, the sites having high BOD, that is, S4 and S6, harboured a high level of bacterial and algal species representing them as a good indicator of organic pollution. The study suggests that the water of the studied stretch of the River Alaknanda is not compatible for drinking purposes without treatment as the presence of various pathogenic agents has been observed that may enhance the chances of various diseases and infections to local people of the region.

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Bio-indicator; periphyton;
self-purification; Alaknanda

CASE REPORT

Natural and Anthropogenic Impacts on Forest Structure: A Case Study of Uttarakhand State

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Abstract: Forests are among the most important natural resources in Uttarakhand as they occupy 71% of the geographic area and contribute a good share in state economy. They are rich repositories of biodiversity and are providers of ecosystem goods and services to both regional and global community. People are dependent on forests for fuel wood, grass and other biomass. But unfortunately recent trend of data shows a huge degradation of forestland due to natural and anthropogenic activities. Variations in climatic condition and natural disasters are triggering rate of degradation of forests in Uttarakhand. The present paper reviews the status of forest in Uttarakhand and discusses the major natural and anthropogenic factors responsible for its degradation.



Assessment of the Efficiency of Fly Ash Amended Soil for Distillery Effluent Treatment

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Key Words:

Fly ash amended soil
Lysimeter
Distillery effluent
Land treatment

ABSTRACT

A lysimetric experiment was conducted to assess the effectiveness of soil amended with fly ash, to remove different contaminants of distillery effluent. Four lysimeters containing amended soil mixtures were prepared by mixing top layer of normal soil and fly ash in different ratios, i.e. S_{95} (pure soil:fly ash, 95:5), S_{90} (pure soil:fly ash, 90:10), S_{85} (pure soil:fly ash, 85:15) and S_{100} (pure soil). Secondly treated distillery effluent was used for irrigating the prepared lysimeter and leachate was collected to analyse the various relevant parameters, viz. pH, BOD, COD, TDS, N, P, K, Ca, Na, Mg, NO_3^- , SO_4^{2-} , Zn and Fe. The results depicted that fly ash amended soil was effective to enhance the potential of normal soil to remove the pollutants from effluent. Soil with lowest fly ash content, i.e. S_{95} was recorded to be the best for land disposal of the effluent. With an increase in the amount of fly ash, i.e. soil S_{90} and S_{85} , leaching of pollutants was observed indicating the possibility of contamination of groundwater.

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ORIGINAL ARTICLE



Assessment of potability of spring water and its health implication in a hilly village of Uttarakhand, India

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Abstract

Water quality assessment of different sources of water in a village was carried out by taking selected significant parameters, namely temperature, pH, conductivity, total dissolved solids (TDS), dissolved oxygen (DO), free carbon dioxide (free CO_2), alkalinity, hardness, calcium, phosphate, nitrate, chloride and coliform count. All these parameters were analyzed as per the standard protocol of American Public Health Association. Further, seven parameters (pH, TDS, alkalinity, hardness, calcium, nitrates and chloride) were used to calculate water quality index for assessing overall drinking water status of sampling sites. A survey of health status of population of the village was also conducted with the help of questionnaire and interview method to draw the relationship of water quality and health. All selected physicochemical parameters were found under prescribed limits as stated by Indian Standard 10500 and Central Pollution Control Board guidelines. The values for most probable number count were found above the permissible limit of drinking water indicating contamination of coliform at all sites. Further, water quality index for SN1, SN2, SN3, SN4 and SN5 was 17.61, 30.11, 69.73, 25.60 and 47.15, respectively. As per the water quality index, the water samples of natural springs which were away from village were classified under 'excellent' category as compared to supply water samples. The result of survey recorded 38% population suffered from dysentery, 23% from diarrhea and 17% from typhoid. The report of the survey and the presence of coliform suggest that drinking water contamination is leading to waterborne diseases like cholera, dysentery and typhoid. It is also suggested that water quality of all sites except SN3 was suitable for drinking purpose, but disinfection of coliform before use is warranted.



Wastewater ferti-irrigation: an eco-technology for sustainable agriculture

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Abstract

Water is essential for economic growth of a nation, sustained environmental development and for the survival of every living organism on earth. Due to rapid population growth the freshwater resources are receding at an alarming rate, creating a crucial condition of water shortage worldwide. Further, the unregulated industrial and agricultural expansion is also imparting the pressure on fresh water resulting in huge amount of wastewater. Disposal of this untreated wastewater in an aquatic ecosystem (like river, ponds, ocean, etc.) results in serious impairment of that system. However, with proper treatment it may be utilized for various fruitful activities like industrial processing, landscape irrigation, agricultural irrigation (Wastewater ferti-irrigation), etc., and can help in overcoming water shortage. Wastewater is a low expense option for irrigation in areas where water availability is very limited. The high nutrient content in wastewater can be utilized as nutrients for crops, reducing the extra cost of fertilizers. Moreover, the rivers and other aquatic ecosystems will also be spared from wastewater disposal. To reuse wastewater, proper treatment is essential which require a suitable, ecofriendly, cost-effective and efficient method usable by the small scale industries or by small towns/villages. Since there is lack of awareness among farmers, they don't accept the approach of utilizing wastewater for irrigation fearing to lose yield both quantitatively and qualitatively. This review paper will focus on the various aspects of wastewater reuse that may help government to formulate proper policies for the effective utilization of wastewater in agriculture.

Keywords Ferti-irrigation · Recycle · Wastewater reuse · Soil contamination



Past and future distribution pattern of *Myrica esculenta* in response to climate change scenario

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Abstract

The structure and functions of an ecosystem particularly species composition and their distribution are expected to be altered with changing climate, and sustainability can be understood by investigating some key stone species. *Myrica esculenta* is an important medicinal tree of northwestern Himalayas, naturally occurring in hilly regions of northern India, southern Bhutan and western Nepal. In the current study, the species was modeled to estimate its potential distribution pattern under past [late interglacial (LIG), paleoclimate, last glacial maximum (LGM)] and future climate change scenarios of the representative concentration pathways (RCP 2.5–8.0) for 2050 and 2070, using Maximum Entropy (MaxEnt) algorithm. Overall, out-of 1022 geo-tag locations, 450 well distributed species presence points were used to run the model, of which 70% was used for training and rest 30% for validation. The performance and accuracy of the model were checked through an area under curve (AUC) which ranged from 0.846 ± 0.053 (LGM) to 0.924 ± 0.057 (LIG). Among all 9 bioclimatic variables, only 4 viz. temperature seasonality (Bio 4), mean temperature of wettest quarter (Bio 8), precipitation of driest month (Bio 14) and precipitation of warmest quarter (Bio 18), were contributed significantly (75.85%) to all the models used for prediction mapping. The highest 37.73% gain was observed for RCP 4.5_70 from the predicted map, and the future distribution coincided mainly between the districts Almora, Pauri, Chamoli and Bageshwar. Although the current suitable climatic habitat is located in northwestern Almora, the centroid expressed a tendency to shift south-eastward under all the four scenarios of RCPs. Furthermore, the centroid of the climatic habitat suitability will shift maximally 4.39 km southeast under RCP 6.0_2050. By the 2070s, the centroid will shift 3.46 km south-eastward under RCP 2.6. Maxent results revealed an increase in the area of environmentally suitable habitats for *M. esculenta* in northwestern Himalayas, if there is no anthropogenic pressure and evolutionary change occurs in the natural zone of distribution. This research provided past existence of the species and future climatic indications for enhanced distribution, besides suggesting academically for the conservation, protection, management, and sustainable utilization of *M. esculenta* resources.

Keywords Geographical distribution · *Myrica esculenta* · Maxent model · Habitat suitability