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Response of plants to pollution emitted from oil and gas plant with special reference to heavy metals accumulation

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Introduction: It was hypothesized that different plant species vary in response to the oil and gas pollution in terms of composition and distribution pattern as well. Some of the plants have more tolerance to heavy metals accumulation in polluted ecosystem than others. Quantitative ecological techniques using quadrat methods were applied in a stratified random design around the Nashpa Oil and Gas Plant District Karak to check specific plant indicators that can grow, survive and show more tolerance against Oil and Gas pollution. In four directions from Gas Plant 10 stations were established at a distance of one Km from each other. Different size of quadrats i.e. 1×1 m2, 5×5 m2 and 10×10 m2 for herbs, shrubs and trees were used respectively. The phyto-sociological attributes of each species (density, relative density, frequency, relative frequency, cover, relative cover and Importance Values Index) were measured at each station. *Calotropis procera* plant was further investigated for Pb, Cr and Cu heavy metals accumulation using atomic absorption spectrophotometer. Data matrices were analyzed via Cluster analysis and Canonical Correspondence Analysis (CCA) using PC-ORD version 5 and CANOCO software. A total of 113 plant species were recorded belonging to 44 families from the Nashpa Oil and Gas Plant. Dominant and rare plants of heavy, moderate and less-polluted regions were identified and assessed. *Calotropis procera* has more tolerant against pollution. It was concluded that the Oil & Gas Plant has significant effect on surrounding habitat plants for heavy metal accumulation. Higher concentration of K, pH and organic matter has significant effects ($p \leq 0.002$) on plant species diversity and its distribution pattern. Result of Pb and Cu accumulation in C. procera showed heavy metals accumulation increased from less polluted sites towards moderate and more polluted regions gradually. It is recommended that further study needed to examine other dominant species as well.

The purpose of the study is to determine the Response of Plants to Pollution Emitted From Oil and Gas Plant With Special Reference to Heavy Metals Accumulation

Methods: Study area: The Nashpa Oil and Gas Plant covers an area of 500 kanals, located at 32° 48' to 33° 23' North latitudes, 70° 40' to 71° 30' East longitudes, having an area of 3372 sq. Km with Semi-arid climate in the District Karak, Pakistan. It shares border with Lakki Marwat on its South, Minawali at South East, Bannu District at South West, Kohat at North Waziristan Agency at West side (Tabassum, 2012). This Plant was the joint adventure of three companies including Government Holding Private Limited, Pakistan Petroleum Limited and Oil and Gas Development Company limited with mutual share of 15, 28.55 and 56.45% respectively. Oil and Gas production was started in May 2010 and presently from six wells i.e. Nashpa-1, Nashpa-2, Nashpa-3, Nashpa-4, Nashpa-X5 and Nashpa-7 oil and gas are extracting. The production of the Plant is 25270 Barrels of oil per day and storage capacity is 120000 Bbls. Gas production is 90.3860 Million standard cubic feet per day and is sold to Sui northern Gas Pipeline limited is 89.4860 Million standard cubic feet per day (Oil and Gas Development Company limited Nashpa Oil and Gas field Karak, KPK). Vegetation sampling: Quadrat quantitative ecological techniques were used to measure the effect of air pollution and other environmental variables on plant species composition, abundance and distribution pattern. Nashpa Gas Plant was taken as central point and quadrats were laid in all four directions i.e., North, South, East and West up to a distance of 10 Km. At each direction from central point 10 stations were established at one Km interval up to the distance of 10 Km (A total of 120 quadrats). The size of quadrats were kept 1×1 m2, 5×5 m2 and 10×10 m2 for herbs, shrubs and trees respectively (Ahmad et al., 2016; Khan et al., 2013; Khan et al., 2016a). The phyto-sociological attributes i.e., Frequency (F), Density (D), Cover (C), Relative Frequency (RF), Relative Cover (RC). Relative Density (RD) and Importance Value Index (IVI) were calculated at station level. The plant specimens were collected, labeled with tags, placed in blotting papers and

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pressed using plant presser. Mercuric Chloride and Ethyl Alcohol solution were used to poison the plant specimens. Specimens were then mounted on standard herbarium sheets having size of 17.5 × 11.5 inches. All the plant specimens were identified using the Flora of Pakistan and other available literature (Nasir & Ali, 1972; Ali & Qaiser, 2004). The Voucher plant specimens were deposited in the Herbarium of Quaid-i-Azam University, Islamabad, Pakistan. Soil collection: The soil samples at a depth of 30 cm were collected from each quadrat by using soil sampling instrument. The collected samples were put in polythene bags, dried at room temperature and sieved for further analysis. The physiochemical analyses of soil i.e., pH, Electrical Conductivity (E.C), Soil Texture (ST), Organic Matter (OM), Magnesium (Mg), Calcium (Ca), Potassium (K) and Phosphorus (P) concentrations were analyzed in the Agriculture Research DepartmentRawalpindi, Government of the Punjab. In addition to, root samples were also collected and preserved in order to check the ability of selected dominant plant species for heavy metal accumulation. Heavy metal analysis: The acid digestion method was used for samples preparation of Atomic absorption according to protocol given by (Zasoski & Burau, 1977; Filgueiras et al., 2000). One gm of oven dried Calotropis procera root and soil were taken and grounded with help of pestle and mortar. Ten ml of Nitric acid and Perchloric acid in 3:1 were added in 50 ml conical flask and kept for 24 hours. For initial digestion, sample was placed in fume hood and a temperature up to 150˚C was given for one hour. The temperature was raised up to 235˚C till white fumes appear. After cooling mixture was filtered, 40 ml of distilled water was added. At last the sample was analyzed through atomic absorption spectrophotometer for heavy metals accumulation.

Results: Preliminary a total of 113 plant species were recorded from 120 quadrats belonging to 44 families and 96 genera around Naspha Oil and Gas Plant. It contains 76 (67.26%) herbs, 21 (18.59%) shrubs and 16 (14.16%) tree species. The family Poaceae was the topmost dominant family having 17 plant species covering up 15% of the total plant species in the region followed by Solanaceae with 8 plant species. The remaining plant families have less than 8 species and encompass about 77% of the total plants in the studied region.

Conclusion: It was concluded that the Nashpa Oil and Gas plant has significant effect on plant species distribution pattern, composition and abundance. Minimum numbers of individual plants were recorded in heavily polluted region as compared to moderate-polluted and less-polluted regions. Heavily-polluted region contain higher pH and saturated soil condition, dominated by Prosopisjuliflora, Capparis decidua, Ziziphus nummularia, Calotropis procera, Withania coagulans, Rhazya stricta, Poa annua, Parthenium hysterophorus and Dichanthium annulatum plant species. The most abundant plant species of moderate polluted regions included Acacia modesta, Ziziphus jujuba, Monotheca buxifolia, Justiciaa dhatoda, Otostegia limbata, Cynodon dactylon and Tragus roxburghii with phosphorus, EC, organic matter and Potassium edaphic variables. While the less-polluted regions showed higher concentration of Mg, Ca and texture class environmental variables dominated by plant species like Acacia nilotica, Dalbergia sissoo, Dodonaea viscosa, Parkinsonia aculeata, Euphorbia prostrata, Brachiaria reptans and Conyza canadensis. Heavy metal accumulation by Calotropis procera increases gradually from less polluted sites towards moderately and heavilypolluted regions. Introduction of such species will result to clean oil and gas pollution in order to sustain the natural environment. Further studies can be help to investigate is needed to investigate the tolerance level of heavy metal accumulation in these dominant plants and application of indicator species in search for underground natural gas and oil fields.

Keywords: *Air pollution, Calotropis procera, Heavy metals, Dominant plant.*

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