Impact Of Brick Kiln Emission on Soil Fertility

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***Abstract*—Three brick kilns of Mithai villages, district Madhepura were selected. To assess the impact of brick kiln emission on soil fertility. Physico-chemical parameters are the important factors for soil fertility. In the present study, physico-chemical parameters such as pH, E.C., OC, Nitrogen, phosphorus, potash and heavy metals were determined. The value of pH was lowest in production season and highest in pre-production season while E.C. was highest in production season. Near all three brick kilns, organic carbon, nitrogen, phosphorus and potash were lowest during production season. Further, the value of these parameters was lowest at a distance of 100m. Heavy metals Pb, Cr, Cd and as were recorded from the soil samples near all brick kilns. Maximum value of all heavy metals was highest during production season.**

***Index Terms*—Brick kiln, Heavy metals, physico-chemical parameters, soil fertility.**

I. INTRODUCTION

Rapid growth in population, industrialization and urbanization led to a rise in construction activities resulting in high demand of brick. This high demand of bricks resulted in mushroom growth of Brick kiln in developing countries. Brick kiln's emission contains heavy metals like lead, cobalt, chromium, nickel which adversely affect biodiversity (Day and Day-2017). Accumulation of heavy metals in soil negatively affect soil fertility. Elevated level of lead, nickel and cobalt reduces soil organic matter and decrease the availability of nutrients like heavy metals from bottom ash and fly ash from Brick kiln spread to nearby agriculture fields and alter soil structure (Sikdar et. al. 2016). Brick kiln's emission contains gaseous pollutants like CO, CO_2, SO_2, NO which disrupts nitrogen cycle and nutrient depletion in the soil (Krishna and Govil-2007). Skinder et. al. (2014) reported that emission range of carbon monoxide, sulfur dioxide and particular matter in 6.35-12.3kg, 0.52-5.9kg, 0.64-1.4kg respectively by brick kiln for the production of 1000 bricks. Brick kilns are significant source of black carbon causing air pollution. Thygerson and Thygerson (2016) reported that Brick kiln produces approximately 31% suspended particulate matter in air. Hossain et. al. (2019) reported that acidic deposition of sulfur and nitrogen oxides emitted by brick kiln adversely affect crop productivity. Heavy metal deposition in soil decreases soil enzyme activity. Electrical conductivity of soil increases and pH decreases. High electrical conductivity and low pH negatively affect soil enzyme activity. Soil enzymes are biologically active components closely related to physicochemical parameters and biological properties (Sukla and Verma-2011). Soil enzyme activity serves as a sensitive biological indicator for assessing soil contamination. Brick Kiln's emission is the major source of environmental pollution, land degradation and have direct impact on soil fertility by affecting soil enzyme activity, physicochemical parameters of soil, soil microflora and microfauna.

II. MATERIAL AND METHODS

The study was carried out in 5 Brick kiln industries of Mathai village of Madhepura district. 5 agriculture fields were randomly selected near each brick kiln at a distance of 100m, 200m, 300m, 400m and 500m. Soil samples were collected from each field during pre-production season (Sept-Dec), Production season (Jan-April) and post-production season (May-Aug). The study was carried out from Sept-2023 to Aug-2025. Soil samples were collected at a depth of 0-15cm. Each sample was kept separately and brought to laboratory in polythene bags. Brick kilns were assigned codes as Brick kiln of Mithai- BM_1, BM_2, BM_3.

Physicochemical analysis was carried out for pH, E.C., OC, N_2, P and K. Moisture was measured by Gravimetric method, pH and E.C. were measured by

Jackson's method (1973) using cystronic pH meter and conductivity meter. OC (organic carbon) was measured by the method of Walkley and Black (1934). Nitrogen was estimated by Kjeldhal method, phosphorus was measured by Olsen et. al. (1982) method and potassium were estimated by Flame photometer. Heavy metals such as Pb, Cr, Cd, As were estimated using atomic absorption photometer (AAS).

III. RESULT AND DISCUSSION

In the present study, three brick kilns of Mathai village, dist- Madhepura was selected to assess the impact of brick kiln emission on soil fertility. Physicochemical parameters like pH, E.C., OC, Nitrogen, Phosphorus, Potash and heavy metals were determined.

pH: Soil pH is an important parameter which influence several soil factors such as Nutrient availability, nutrient leaching, soil microorganisms and plant growth. The pH of soil near brick kiln (BM_1) varied from 6.5 to 7 during pre-production season, 6.2 to 6.5 during production season and 6.5 to 6.9 during post-production season. pH of soil near brick kiln (BM_2) varied from 6.3 to 7 during pre-production season, 6.1 to 6.5 in production season and 6.5 to 6.9 in post-production season. pH of soil near brick kiln (BM_3) varied from 6.3 to 6.8 in pre-production season, 6.2 to 6.8 in production season and 6.5 to 7.1 in post-production season. The sulfur dioxide and nitrogen oxides released in brick kiln emission decreases pH of the soil (Greentech-2012). Yaseen et. al. (2015) reported that low pH effect adversely to normal growth of water.

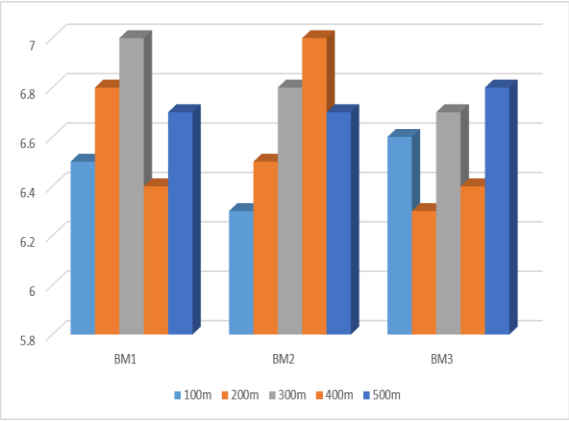

Fig 01: pH value of soil samples near brick kilns during pre-production season

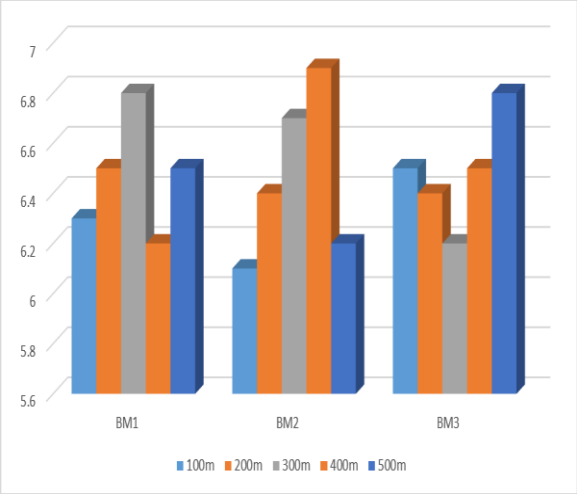

Fig 02: pH value of soil samples near brick kilns during production season

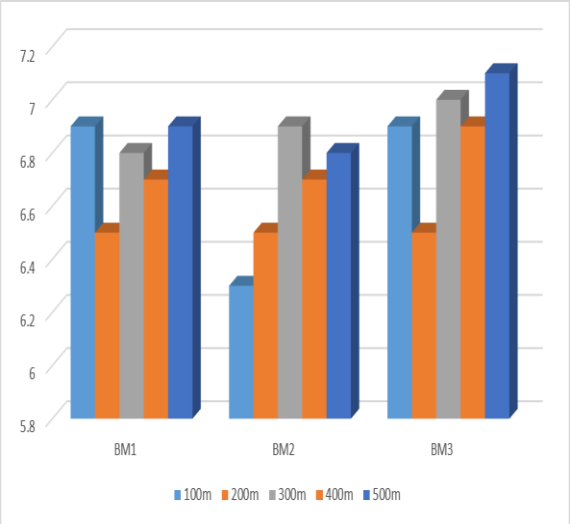

Fig 03: pH value of soil samples near brick kilns during post-production season

Electrical conductivity (E.C.): E.C. is also one of the important parameters of soil which indicate the number of soluble ions in soil. It effects crop yield and nutrient availability. The electrical conductivity of soil near brick kiln (BM_1) varied in between0.42-0.47ms/cm during pre-production season, 0.40-0.49ms/cm during production season and 0.41to 0.47ms/cm during post production season. E.C. of soil near brick kiln (BM_2) varied in between 0.36-0.48ms/cm during pre-production season, 0.37-0.48ms/cm during production season and 0.41-0.47ms/cm during post-production season.

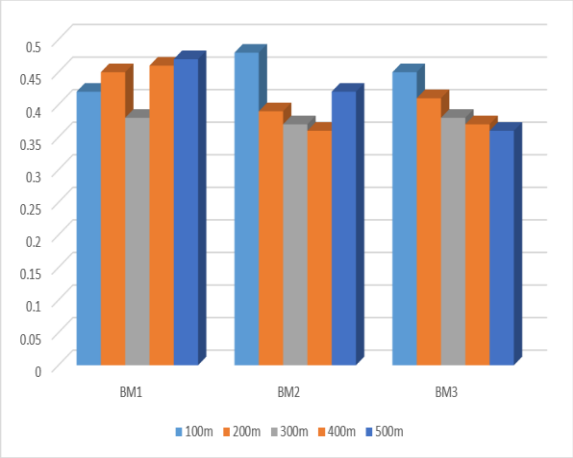

Fig 04: E.C. value of soil samples near brick kilns during pre-production season

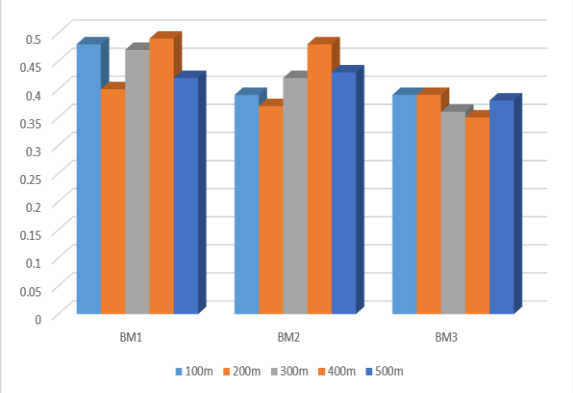

Fig 05: E.C. value of soil samples near brick kilns during production season

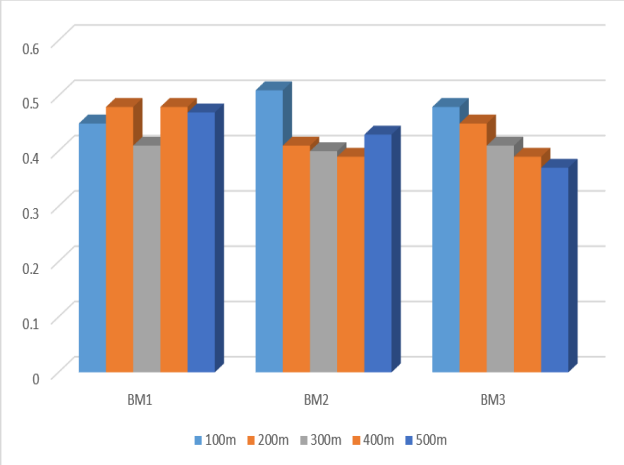

Fig 06: E.C. value of soil samples near brick kilns during post-production season

Organic carbon (OC): Organic carbon improves soil structure, enhance water holding capacity and supply nutrients for growing crops. Yaseen et. al. (2025) reported that organic carbon greater than 0.8% indicate good quality of soil. In pre-production season, organic carbon near brick kiln (BM_1) varied in between1.49% to 1.78%, near brick kiln (BM_2) varied in between 1.79% to 2.46% and near brick kiln (BM_3) varied in between 1.32% to 1.76%.

During production season, OC varied from 1.23% to 1.74%, 1.83% to 2.36% and 1.32% to 1.72% in soil near BM_1, BM_2 and BM_3 brick kilns respectively.

During post-production season, OC in soil varied from 1.26%-1.78%, 1.82%-2.43% and 1.30%-1.76% near brick kiln BM_1, BM_2 and BM_3 respectively.

Nitrogen, phosphorus and potash are macronutrient for plants. Deficiency of these nutrients inhibit the growth of plants. Near brick kiln (BM_1), nitrogen in soil varied in between 203.8kg/ha to 230.4kg/ha, near brick kiln (BM_2) nitrogen in soil samples varied in between 198.5kg/ha to 218.3kg/ha, near brick kiln (BM_3), nitrogen in soil varied in between 203.5kg/ha to 215.6kg/ha.

Phosphorus in soil was observed in between 9.3kg/ha to 10.8kg/ha, 8.9kg/ha to 10.7kg/ha and 9.3kg/ha to 12.5kg/ha near brick kiln BM_1, BM_2 and BM_3 respectively.

Potash was estimated in soil in between 162.3kg/ha to 171.5kg/ha, 148.7kg/ha to 165.3kg/ha 152.5kg/ha to 165.7kg/ha near brick kiln BM_1, BM_2 and BM_3 respectively.

N, K, P- production season: During production season nitrogen in soil varied from 201.3kg/ha-225.5kg/ha, near BM_1, BM_2 and BM_3 brick kilns respectively. Phosphorus in soil varied from 8.3 to 10.5kg/ha, 8.6kg/ha to 10.5kg/ha and 9.3kg/ha to 12.5kg/ha near brick kiln BM_1, BM_2 and BM_3 respectively. Potash in soil varied from 160.5kg/ha to 170.3kg/ha, 150.3kg/ha to 156.2kg/ha and 142.3kg/ha to 165.4kg/ha near brick kilns BM_1, BM_2 and BM_3 respectively.

N, K, P- post-production season: During post-production season nitrogen in soil varied from 202.8kg/ha to 228.7kg/ha, 196.5kg/ha to 218kg/ha, 201.8kg/ha to 215kg/ha near brick kiln BM_1, BM_2 and BM_3 respectively. Phosphorus in soil varied from 9.1kg/ha to 10.3kg/ha, 8.8kg/ha to 10.2kg/ha, 9.1kg/ha to 11.5kg/ha near brick kiln BM_1, BM_2 and BM_3 respectively. Potash in soil varied from 160.5kg/ha to 170.3kg/ha, 150.3kg/ha to 156.2kg/ha, 142.3kg/ha to 165.4kg/ha near brick kiln BM_1, BM_2 and BM_3 respectively.

Impact of heavy metals in soil released by brick kilns: The heavy metals concentration showed diverse variation in their distribution. Maximum amount of heavy metals was recorded during production season. Further at a distance of 100m from brick kilns amount of heavy metals was highest in comparison to a distance of 500m from brick kiln. The concentration of Pb was recorded as 8.6mg/kg to 18.9mg/kg, 2.8mg/kg to 14.4mg/kg and 0.5mg/kg to 16.3mg/kg during pre-production season in soil near brick kilns BM_1, BM_2 and BM_3.

As per US EPA standard limit for concentration of lead is 200mg/kg (Mclean et. al.-1992, C.J. Rosen-2002). During production season concentration of lead in soil varied from 8.7mg/kg to 20.3mg/kg, 7.6mg/kg to 16.5mg/kg and 0.5mg/kg to 18.5mg/kg near brick kiln BM_1, BM_2 and BM_3 respectively. In post-production season, lead concentration in soil was recorded as 8.7mg/kg to 19.2mg/kg, 5.4mg/kg to 15.8mg/kg and 0.7mg/kg to 8.3mg/kg near brick kiln BM_1, BM_2 and BM_3 respectively.

Chromium concentration in soil ranged from 7.4mg/kg to 8.4mg/kg, 7.3mg/kg to 9.3mg/kg and 0.8mg/kg to 7.6mg/kg in pre-production season, 7.4mg/kg to 9.1mg/kg, 7.4mg/kg to 10.5mg/kg, 0.8mg/kg to 8.3mg/kg in production season and 7.9mg/kg to 9.5mg/kg, 7.8mg/kg to 11.3mg/kg, 1.2mg/kg to 8.1mg/kg in post-production season near BM_1, BM_2 and BM_3 brick kilns respectively.

Concentration of Cadmium during pre-production season ranged from 3.8-5.3mg/kg, 2.2-6.5mg/kg and 0.3-6.3mg/kg in soil samples near brick kiln BM_1, BM_2 and BM_3 respectively. During production period cadmium concentration increased and ranged from 3.9-5.8mg/kg, 2.2-7.3mg/kg and 0.8-7.4mg/kg in soils near brick kiln BM_1, BM_2 and BM_3 respectively. During post-production season, cadmium concentration ranged from 3.3-6.2mg/kg, 2.8-6.2mg/kg and 0.4-7.2mg/kg in soil near brick kiln BM_1, BM_2 and BM_3 respectively.

Concentration of Arsenic during pre-production period ranged from 3.8-6.5mg/kg, 2.6-5.4mg/kg and 0-7.8mg/kg in soil samples of brick kiln BM_1, BM_2 and BM_3 respectively. During production season Arsenic concentration ranged from 4.3-6.9mg/kg, 2.7-5.9mg/kg and 0.5-8.9mg/kg in soil samples of brick kiln BM_1, BM_2 and BM_3 respectively. During post-production season, Arsenic concentration ranged from 4.3-7.9mg/kg, 2.8-5.9mg/kg and 0.3-8.6mg/kg in soil samples of BM_1, BM_2 and BM_3 respectively.

IV. CONCLUSION

Brick Kiln's emission is the major source of environmental pollution, land degradation and have direct impact on soil fertility. Three brick kilns of Mithai villages, district Madhepura were selected. To assess the impact of brick kiln emission on soil fertility. Physico-chemical parameters are the important factors for soil fertility. In the present study, physico-chemical parameters such as pH, E.C., OC, Nitrogen, phosphorus, potash and heavy metals were determined. The selected brick kilns were BM_1, BM_2 and BM_3. Determination of physico-chemical parameters were performed during pre-production season, production season and post-production season. The pH of soil near brick kiln (BM_1) varied from 6.5 to 7 during pre-production season, 6.2 to 6.5 during production season and 6.5 to 6.9 during post-production season. pH of soil near brick kiln (BM_2) varied from 6.3 to 7 during pre-production season, 6.1 to 6.5 in production season and 6.5 to 6.9 in post-production season. pH of soil near brick kiln (BM_3) varied from 6.3 to 6.8 in pre-production season, 6.2 to 6.8 in production season and 6.5 to 7.1 in post-production season. The electrical conductivity of soil near brick kiln (BM_1) varied in between0.42-0.47ms/cm during pre-production season, 0.40-0.49ms/cm during production season and 0.41to 0.47ms/cm during post production season. E.C. of soil near brick kiln (BM_2) varied in between 0.36-0.48ms/cm during pre-production season, 0.37-0.48ms/cm during production season and 0.41-0.47ms/cm during post-production season. Organic carbon, nitrogen, phosphorus and potash were lowest during production season. All these parameters were low at a distance of 100m in comparison to at a distance of 500m. Heavy metals like Pb, Cr, Cd and As were determined. The heavy metals concentration showed diverse variation in their distribution. Maximum amount of heavy metals was recorded during production season. Further at a distance of 100m from brick kilns amount of heavy metals was highest in comparison to a distance of 500m from brick kiln. The concentration of Pb was recorded as 8.6mg/kg to 18.9mg/kg, 2.8mg/kg to 14.4mg/kg and 0.5mg/kg to 16.3mg/kg during pre-production season

in soil near brick kilns BM_1, BM_2 and BM_3. During production season concentration of lead in soil varied from 8.7mg/kg to 20.3mg/kg, 7.6mg/kg to 16.5mg/kg and 0.5mg/kg to 18.5mg/kg near brick kiln BM_1, BM_2 and BM_3 respectively. In post-production season, lead concentration in soil was recorded as 8.7mg/kg to 19.2mg/kg, 5.4mg/kg to 15.8mg/kg and 0.7mg/kg to 8.3mg/kg near brick kiln BM_1, BM_2 and BM_3 respectively. Chromium concentration in soil ranged from 7.4mg/kg to 8.4mg/kg, 7.3mg/kg to 9.3mg/kg and 0.8mg/kg to 7.6mg/kg in pre-production season, 7.4mg/kg to 9.1mg/kg, 7.4mg/kg to 10.5mg/kg, 0.8mg/kg to 8.3mg/kg in production season and 7.9mg/kg to 9.5mg/kg, 7.8mg/kg to 11.3mg/kg, 1.2mg/kg to 8.1mg/kg in post-production season near BM_1, BM_2 and BM_3 brick kilns respectively.