International Journal of Scientific Research and Engineering Development-– Volume 3 Issue 3, May – June 2020

Available at www.ijsred.com

RESEARCH ARTICLE OPEN ACCESS

Effect of Copper based Fungicides on the properties of Red Soils

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Abstract:

Soils may become contaminated by the accumulation of heavy metals through emissions from the rapidly expanding industrial areas, disposal of high metal wastes, land application of fertilizers, animal manures, sewage sludge, pesticides, wastewater irrigation etc. The need of the modern industrial societies to increase agricultural production and to maintain the good characteristics of fresh foods for longer periods of time, has led to an increase in the use of pesticides and fertilizers. Several common pesticides used fairly extensively in agriculture and horticulture contain substantial concentrations of metals like copper-containing fungicidal sprays such as Bordeaux mixture (copper sulphate) and copper oxychloride. The paper aims at the comparative study to determine the effects of these copper based fungicides on the Atterberg limits and specific gravity of red soils which is found ideal for gardening and agricultural uses due to its texture, ability to retain nutrients and water. In the present study red soil collected from two sites were artificially contaminated using Bordeaux mixture (copper sulphate) and copper oxychloride separately at different percentages and the variations in geotechnical properties were analysed. It was observed that increased concentration of fungicides affects the geotechnical properties of soil adversely.

Keywords **— Heavy metals, red soil, fungicides, Bordeaux mixture, copper oxychloride**

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I. INTRODUCTION

Soils may become contaminated by the accumulation of heavy metals and metalloids through emissions from the rapidly expanding industrial areas, mine tailings, disposal of high metal wastes, leaded gasoline and paints, land application of fertilizers, animal manures, sewage sludge, pesticides, waste water irrigation, coal combustion residues, spillage of petrochemicals, and atmospheric deposition. Heavy metals constitute an ill-defined group of inorganic chemical hazards, and those most commonly found at contaminated sites are lead (Pb), chromium (Cr), arsenic (As), zinc (Zn), cadmium (Cd), copper (Cu), mercury (Hg), and nickel (Ni). Soils are the major sink for heavy metals released into the environment by aforementioned anthropogenic activities and unlike organic contaminants which are oxidized to carbon oxide by microbial action, most metals do not undergo microbial or chemical degradation, and their total concentration in soils persists for a long time after their introduction. Changes in their chemical forms (speciation) and bioavailability are, however, possible. The presence of toxic metals in soil can severely inhibit the biodegradation of organic contaminants. Heavy metal contamination of soil may pose risks and hazards to humans and the ecosystem through: direct ingestion or contact with contaminated soil, the food chain (soil-plant-human or soil-plant-animal human), drinking of contaminated ground water, reduction in food quality (safety and marketability) via phytotoxicity, reduction in land usability for agricultural production causing food insecurity, and land tenure problems.

II. PAGE LAYOUT

Jasmine B.S et al (2018) studied the effect of fertilizers on soil and its remediation using activated carbon reactive barrier. In this study, low plastic and high plastic commercial clays were artificially contaminated using NPK fertilizer separately at different percentages and the variations in geotechnical properties were analyzed. Granular activated carbon was used as a reactive material and is having high adsorption capacity. The efficiency of activated carbon in removing the contaminant concentration was estimated by conducting the soil leachate column test with and without activated carbon reactive barrier. It was found that fertilizers have a negative effect on the properties of soils.

Markus Flury (2001) gave an experimental evidence of transport of pesticides through field soils. In loamy soils, even strongly adsorbing chemicals can move along preferential flow pathways and that the travel times of pesticides are comparable to those of conservative solute. The amounts of pesticides leached below the root zone by worst case rainfall events depend on the chemical properties and can reach up to 5% of the applied mass.

LIU Yong et al (2015) studied the heavy metal contamination of agricultural soils in Taiyuan, China. The concentrations of 8 heavy metals in soils were investigated by means of extensive sampling in farmlands, forestlands, and grasslands in the city. Farming practices, especially sewage irrigation, might play the most important role in Cd, Cu, Hg, Pb, Zn, and Cr accumulation in the soils of the study area.

III. EXPERIMENTAL STUDIES

A. Materials and Methodology

Red soil is a type of soil that develops in a warm, temperate, moist climate, under deciduous or mixed forest, having thin organic and organic-mineral layers overlying a yellowish-brown leached layer resting on an illuvium red layer. Red soils are generally derived from crystalline rock. The texture of red soil varies from, sand to clay,the majority being loam. Theircharacteristicsinclude porous and friable struc ture,absenceof lime, kankar and free carbonates, and small quantity of soluble salts. In general these soils are deficient in lime, magnesia, phosphates, nitrogen, humus an d potash. Intense leaching is a menace to these soils. On the uplands, they are thin, poor and gravelly, sandy, or stony and porous, light-colored soils on which food crops like bajra can be grown. But on the lower plains and valleys they are rich, deep, dark colored fertile loam on which, under irrigation, they can produce excellent crops like cotton, wheat, pulses, tobacco, jowar, inseed, millet, potatoes a nd fruits. These are also characterized by stunted forest growth and are suited to dry farming. The soils obtained from the sites were air dried for testing purposes. Properties of the soils collected from Kazhakuttam and Neyyatinkara are shown in Table I and Table II respectively.

TABLE I
PROPERTIES OF RED SOIL 1

Sl.no	Properties	Values
1	Specific gravity	2.62
2	Optimum Moisture Content (%)	17
3	Maximum Dry Density (g/cc)	1.7
4	Liquid Limit (%)	48
5	Plastic Limit (%)	24.47
6	Plasticity Index (%)	23.53
7	IS Classification	CI
8	Unconfined Compressive Strength, UCC (kN/m^2)	33.23
9	Permeability, k (cm/s)	5.35×10^{-3}

TABLE II
PROPERTIES OF RED SOIL 2

Sl.no	Properties	Values
1	Specific gravity	2.61
2	Optimum Moisture Content (%)	24
3	Maximum Dry Density (g/cc)	1.65
4	Liquid Limit (%)	45.5
5	Plastic Limit (%)	31
6	Plasticity Index (%)	14.5
7	IS Classification	MI
8	Unconfined Compressive Strength, UCC (kN/m^2)	29.56
9	Permeability, k (cm/s)	4.2×10^{-3}

Bordeaux mixture (also called Bordo Mix) is a mixture of copper sulphate ($CuSO_4$) and slaked lime ($Ca(OH)_2$) used as a fungicide. It is used in vineyards, fruit-farms and gardens to prevent infestations of downy mildew, powdery mildew and other fungi. If it is applied in large quantities annually for many years, the copper in the mixture eventually becomes a pollutant. In addition to its use to control fungal infection on grape vines, the mixture is also widely used to control potato blight, peach leaf curl and apple scab. Copper oxychloride ($3Cu(OH)_2.CuCl_2$) is a fungicide used at 2.50 g L^{-1} against early and late blight in potato crops. Although copper is essential for metabolic processes in all organisms when in trace amounts, the use of copper-based fungicides has been ecologically harmful. Hence, a reduction or replacement of copper compounds in disease control is desirable. Copper oxychloride can affect plant productivity and yield.

Studies are conducted to determine the effects of fungicides like Bordeaux mixture and copper oxychloride on both soils. For this, contaminants are mixed in various proportions and the variations in geotechnical properties like liquid limit, plastic limit, specific gravity and unconfined compressive strength are analyzed. The tests were conducted as per IS 2720.

B. Results and Discussions

Variations in liquid limit and plastic limit with the addition of pesticides Bordeaux mixture and copper oxychloride in red soil 1 & 2 are shown in Fig 1 and Fig 2. Here the fertilizers are added in 0.05 M, 0.06 M, 0.07 M, 0.08 M, 0.09 M and 0.1 M.

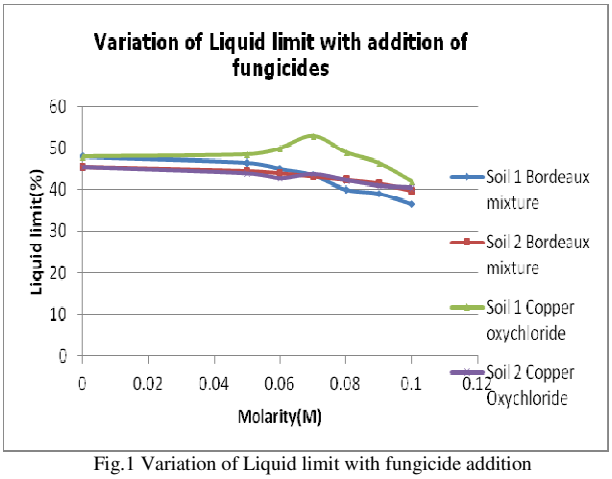

Fig.1 Variation of Liquid limit with fungicide addition

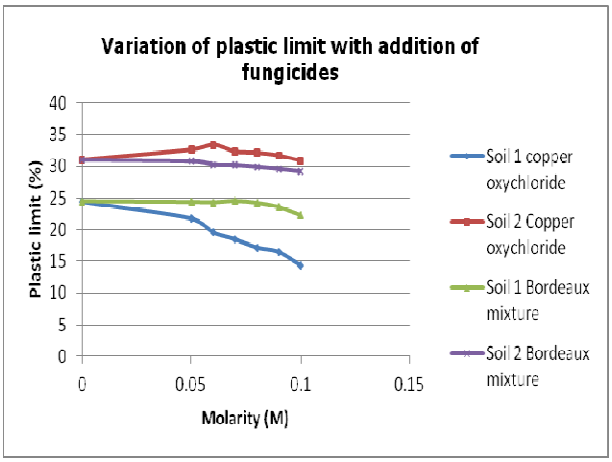

Fig.2 Variation of Plastic limit with fungicide addition

Here (Figure 1 and Figure 2) with the addition of copper oxychloride, the liquid limit increases upto 0.07 M and then decreases for soil 1 and plastic limit shows decreasing trend in both soils. Copper remains in the soil more than others

and it forms oxides and attaches on the soil particles. So this reduces the water absorption of the soil. With addition of Bordeaux mixture, the liquid limit and plastic limit shows decreasing trend in both soils. The reason for this can also be inferred to be the same.

Variations in specific gravity with the addition of pesticides Bordeaux mixture and copper oxychloride in red soils are shown in Fig 3. Here the pesticides are added in 2%, 4%, 6%, 8%, 10% and 12%.

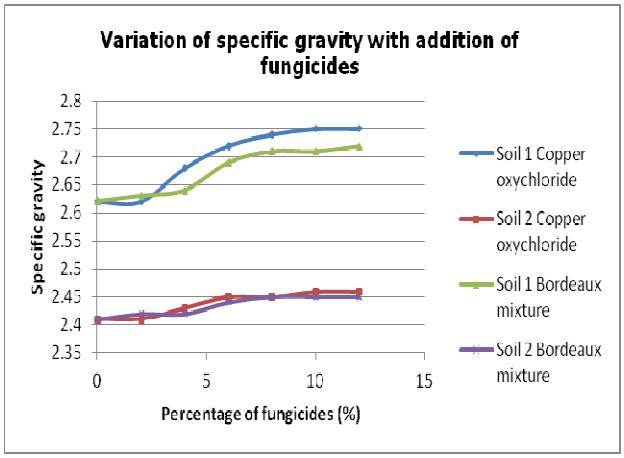

Fig.3 Variation of Specific gravity with fungicide addition

From the results it was observed that the specific gravity shows an increasing trend for both Bordeaux mixture and copper oxychloride. The presence of heavy metals in soils can cause an increase in the specific gravity of the soil. This may be because the addition of the chemical fungicide will cause an increase in the fine particles. The fine grained particles have less void space or pore space so its specific gravity increases.

Variations in unconfined compressive strength with the addition of pesticides Bordeaux mixture and copper oxychloride in red soil 1 & 2 are shown in Fig 4. Here the fertilizers are added in 0.05 M, 0.06 M, 0.07 M, 0.08 M, 0.09 M and 0.1 M.

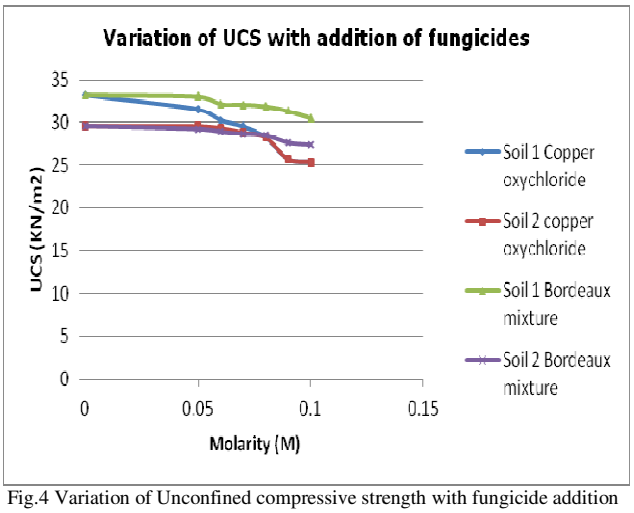

Fig.4 Variation of Unconfined compressive strength with fungicide addition

With the addition of fungicides on both soils, the UCS shows a decreasing trend. This shows the weakening of soil under the usage of pesticides. Plants do not absorb much copper from the soil. So it will remain in the soil and when it comes in contact with water it gets oxidised and attaches on the soil particles and forms an outer layer on the soil particles. This reduces the water absorption of the soil and also reduces cohesion between soil particles. This results in reduction of soil strength (Jasmine B.S et al., 2018).

IV. CONCLUSIONS

Variations in the properties of red soils with fungicides like copper oxychloride and Bordeaux mixture were studied. Based on the experimental observations and investigations of the test results the following conclusions were drawn.

- Liquid limit and plastic limit shows a decreasing trend for both soils contaminated with Bordeaux mixture.
- With the addition of copper oxychloride, the liquid limit increases upto 0.07 M in soil 1 and then decreases and plastic limit shows decreasing trend for both soils.
- Specific gravity of soils contaminated with copper oxychloride and Bordeaux mixture shows an increasing trend.

- The UCC strength of contaminated soils shows decreasing trend with the increase in fungicide addition.

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