Status of Available Calcium And Magnesium In Soils Treated With Industrial Wastes of Wazirpur, Delhi

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In partial fulfillment of requirements for the degree
of
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Submitted by

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CERTIFICATE

The research work embodied in this dissertation entitled **"STATUS OF AVAILABLE CALCIUM AND MAGNESIUM IN SOILS TREATED WITH INDUSTRIAL WASTES OF WAZIRPUR, DELHI"** is done by me under the supervision of Prof. A.K Bhattacharyya in partial fulfillment of the requirements for the degree of Master of Philosophy. The work has been carried out in the School of Environmental Sciences, Jawaharlal Nehru University, New Delhi. The work is original and has not been submitted in part or full for any other degree or diploma to any university.

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To

My grand mother
(DIDI MAA)

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ABBRIVIATIONS AND NOTATIONS

ANOVA	analysis of variance
CEC	cations exchange capacity
Chh	Chhattarpur
cont	control
CPCB	Central Pollution Control Board
DMC	Delhi Municipal Corporation
DPCC	Delhi Pollution Control Corporation
DW	distilled water
E(P)Act	Environment Protection Act
EBT	eriochrome black T
EC	electrical conductivity
EDTA	ethylene diamine tetracetate
JNU	Jawaharlal Nehru University
L	lime
lime t	lime treatment
Moist cont	moisture content
mon	monsoon
MW	monsoon waste
NBSS	National Board of Soil Sciences
NCAER	National Council For Applied Economic Research
NCT	National Capital Territory
OC	organic carbon
Org.C	organic carbon
sum	summer
SW	summer waste
TEA	triethylamine
USDA	United States Department of Agriculture
WHC	water holding capacity
win	winter
WW	winter waste

NOTATIONS WITH EXPLANATIONS

C-0-0	100%	Chhattarpur soil,	0%waste,	0%lime
C-0-0	100%	Chhattarpur soil,	0%waste,	0.5%lime
C-0-1.0	100%	Chhattarpur soil,	0%waste,	1%limes
C-M10-0	90%	Chhattarpur soil,	10% Monsoon waste	0%lime
C-M10-0.5	90%	Chhattarpur soil,	10% Monsoon waste	0.5%lime
C-M 10-1.0	90%	Chhattarpur soil,	10% Monsoon waste	1%lime
C-M20-0	80%	Chhattarpur soil,	20% Monsoon waste	0%lime
C-M20-0.5	80%	Chhattarpur soil,	20% Monsoon waste	0.5%lime
C-M20-1.0	80%	Chhattarpur soil,	20% Monsoon waste	1%limes
C-M30-0	70%	Chhattarpur soil,	30% Monsoon waste	0%limes
C-M30-0.5	70%	Chhattarpur soil,	30% Monsoon waste	0.5%lime

C-M30-1.0	70% Chhattarpur soil,	30% Monsoon waste	1%limes

C-W10-0	90% Chhattarpur soil,	10% Monsoon waste	0%limes
C-W10-0.5	90% Chhattarpur soil,	10% Monsoon waste	0.5%limes
C-W10-1.0	90% Chhattarpur soil,	10% Monsoon waste	1%limes
C-W20-0	80% Chhattarpur soil,	20% Monsoon waste	0%limes
C-W20-0.5	80% Chhattarpur soil,	20% Monsoon waste	0.5%limes
C-W20-1.0	80% Chhattarpur soil,	20% Monsoon waste	1%limes
C-W30-0	70% Chhattarpur soil,	30% Monsoon waste	0%limes
C-W30-0.5	70% Chhattarpur soil,	30% Monsoon waste	0.5%limes
C-W30-1.0	70% Chhattarpur soil,	30% Monsoon waste	1%limes

C-S10-1.0	90% Chhattarpur soil,	10% Monsoon waste	0%limes
C-S10-1.0	90% Chhattarpur soil,	10% Monsoon waste	0.5%limes
C-S10-1.0	90% Chhattarpur soil,	10% Monsoon waste	1%limes
C-S20-1.0	80% Chhattarpur soil,	20% Monsoon waste	0%limes
C-S20-1.0	80% Chhattarpur soil,	20% Monsoon waste	0.5%limes

C-S20-1.0	870% Chhattarpur soil,	20% Monsoon waste	1%limes
C-S30-1.0	70% Chhattarpur soil,	30% Monsoon waste	0%limes
C-S30-1.0	70% Chhattarpur soil,	30% Monsoon waste	0.5%limes
C-S30-1.0	70% Chhattarpur soil,	30% Monsoon waste	1%limes

J-0-0	100% JNUsoil,	0%waste,	0%lime
J-0-0	100% JNUsoil,	0%waste,	0.5%lime
J-0-1.0	100% JNUsoil,	0%waste,	1%limes
J-M10-0	90% JNUsoil,	10% Monsoon waste	0%lime
J-M10-0.5	90% JNUsoil,	10% Monsoon waste	0.5%lime
J-M 10-1.0	90% JNUsoil,	10% Monsoon waste	1%lime
J-M20-0	80% JNUsoil,	20% Monsoon waste	0%lime
J-M20-0.5	80% JNUsoil,	20% Monsoon waste	0.5%lime
J-M20-1.0	80% JNUsoil,	20% Monsoon waste	1%limes
J-M30-0	70% JNUsoil,	30% Monsoon waste	0%limes
J-M30-0.5	70% JNUsoil,	30% Monsoon waste	0.5%lime
J-M30-1.0	70% JNUsoil,	30% Monsoon waste	1%limes

J-W10-0	90% JNUsoil,	10% Monsoon waste	0%limes
J-W10-0.5	90% JNUsoil,	10% Monsoon waste	0.5%limes
J-W10-1.0	90% JNUsoil,	10% Monsoon waste	1%limes
J-W20-0	80% JNUsoil,	20% Monsoon waste	0%limes
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INTRODUCTION

INTRODUCTION

Not so long ago, man was convinced that science and technology would create a paradise on earth. We have learned that progress in some areas can often cause distress in other. So scientists always try to focus on the role and the use of the sciences in supporting the prudent management of the environment and development for the daily survival and future development of humanity. Scientists are improving their understanding in areas such as climate change, growth in rates of resource consumption, demographic trends and environmental degradation. Environmental degradation is more closely related with population growth, urban-sprawling, industrialization and rising standards of living, which lead to increase in both the amount and variety of waste generation. The waste which arises from virtually all man's activities, can be classified in major categories, among them industrial process wastes encompass a very wide range of materials and may include general factory rubbish, packaging materials, organic wastes, acids, alkalis and metalliferous sludge. All the solid wastes are dumped or disposed on the soil, which lead to soil pollution. So, gradually we are loosing our valuable resource.

Solid wastes (refuse) may be categorized by source into mining, agriculture, industrial municipal wastes and sewage sludge. The US Environmental Protection Agency (US EPA) estimates that 344,000,000 metric tones (weight basis) of industrial processing residues is generated annually (EPA report, August 1978) in the united states. This represents approximately 3% of the total solid waste load in the nation and it is increasing at about 4.5% yearly. EPA also estimates that 10-15% of the 344,000,000 MT of industrial processing wastes is hazardous.

Solid wastes can be defined as unwanted or discarded materials in solid forms resulting from industrial, commercial domestic and various other anthropological activities. The term waste is of no concern and is of no use to any one. It creates problems because it is unwanted. Per capita waste generation varies between 2.75-4.0 kg per day in high-income countries, but is as low as 0.5 kg per day in these countries with lowest income (Santra, 2001).

INTRODUCTION

Solid wastes may be hazardous or non-hazardous. 'Hazardous wastes' could be defined as "The wastes other than radio active wastes which by reasons of their chemical reactivity or toxicity, explosive, corrosive or other characteristics causing danger or like to cause danger to health or the environment, whether alone or coming into contact with other wastes, are legally defined as hazardous in the state in which they are generated or in which they are disposed of or through which they are transported"[UNEP, 1989].

Solid wastes can be classified according to their sources. Major categories including household and consumer wastes (i.e. municipal waste), industrial wastes, agricultural wastes, extraction wastes, energy production wastes and sewage sludge waste can be classified by nature and by composition.

Industrial waste is more troublesome than other wastes. It consists of toxic inorganic, organic and high concentration of heavy metals (Table 1.1) which are causing harmful health effect to the living organisms and ecosystem (Subrahmanyam, 1991).

The national capital of Delhi, with a population approximately of 12 million, covering an area of 1483 sq km. is highly polluted due to a large number of existing industries. It has a cluster of small-scale industries with a spectacular growth during the period of 1968-1996, which is shown in the table no.1.2. (Office of the Commissioner of Industries, Delhi, 1996). The Industrial progress in Delhi is reflected not only in increased productivity and income, but also in a large amount of pollutants being added to the environment. Indiscriminate industrial location and lack of urban planning have resulted in a high concentration. of pollutants in the city. A large number of industries including hazardous ones are located in non-confirming areas especially in the vicinity of residential areas. Prime examples are the Wazirpur Industrial Area situated near Shalimarbagh and Najafgarh Industrial Area between

Waste Category	Type of wastes	Regulatory Quantity(kg/Year)
No.1	Cyanide Wastes	1(as cyanide)
No.2	Metal finishing Wastes	10(the sum of the specified substance calculated as pure metal).
No.3	Waste containing water soluble chemical compounds of Pb, Cu, Zn, Cr, Ni, Se, Ba Sb	10(specified substance as pure metal)
No.4	Mercury, Arsenic, Thallium, and Cadmium bearing wastes	5(specified substance as pure metal)
No.5	Non-halogenated hydrocarbons including solvents.	200(as non-halogenated hydrocarbon.
No.6	Halogenated hydrocarbon including solvents.	50(as halogenated hydrocarbons)
No.7	Wastes from paints, pigments glues, varnish, printing ink.	250(as oil or oil emulsions)
No.8	Wastes form dyes and dye intermediates containing inorganic chemical compounds	50(as inorganic chemicals)
No.9	Wastes from dyes and dye intermediates containing inorganic chemical compounds.	200(as inorganic chemical)
No.10	Waste oil and emulsion	1000(as oil, oil emulsion)
No.11	Tarry wastes from refining and tar residues from distillation or pyrolytic treatment.	200(as tar)
No.12	Sludge arising from treatment of waste waters containing heavy metals, toxic, organics, oil emulsions and spent chemicals and incineration ash.	Irrespective of any quantity.
No.13	Phenols	5(as phenols)
No.14	Asbestos	200 (as asbestos)
No.15	Wastes from manufacturing of pesticides and residues from pesticides and herbicides formulation units.	200 (as pesticide and their intermediate products)
No.16	Acidic/alkaline/slurry waste	200 (as acid/alkali)
No.17	Off-speciation and discarded products	Irrespective of any quantity.
No.18	Discarded containers and container liners of hazardous and toxic wastes.	Irrespective of any quantity.

Table no: 1.1. Categories of hazardous waste (Source: Freeman H.W. (1988). ***Standard Handbook of Hazardous Waste Treatment and Disposal*)**

Year	*No. of units*
1951	8,160
1961	17,000
1965	19,038
1968	23,496
1978	40,000
1985	65,000
1990	81,000
1992	89,000

Table no: 1.2. - Growth of Industries in Delhi

Source 1. ***Surveys conducted by Industries Dept.*** (1951, 1965, 1968)
2. ***PHDCCI*** (1961, 1978, 1985, 1990)
3. ***Pioneer, Industrial Pollution in the capital***, April 4, 1993.

Patel agar and Motinagar, where although big industrial units are largely responsible for the pollution problem, the small-scale industries cumulatively contribute significantly more to the pollution levels. Dirty, hazardous waste affects the ground water quality, biota and even health of the people of the near by area According to a recent report by DPCC there are about 80,000 registered industries located in 28 well defined industrial areas in Delhi *(Table No: 1.3.)*

Total number of industrial units of Wazirpur Industrial Area is 1665, among these 1379 have responded to the study done NCAER and 189 units are not responding at all to either any correspondence from any agency or to the survey team. Another 97 industrial units have been reported to be either closed or shifted (NPC, 2002 unpublished). Similarly, Wazirpur, an authorized industrial area, was set up in the early sixties to accommodate the hosiery industry. But today 75% of the industrial units are process steel industries. Hundreds of industries in Wazirpur release sludge with acid in open drains. The untreated acid goes into the sewer system and eventually finds its way into the Yamuna.

Sr. No	Industrial area/estates
1.	Wazirpur industrial area
2.	G.T.Karnal Road Industrial Area
3.	Lawrence Road Industrial Area
4.	Udyog Nagar
5.	Rajasthani Udyog Nagar Industrial Estate
6.	S.M.A. Industrial Area
7.	S.S.I. Industrial Area.
8.	D.S.I.D.C.Nangloi Industrial Area
9.	Mangolpuri Industrial Area
10.	Okhla Industrial Area
11.	Okhla Industrial Estate
12.	Okhla Flatted Factory Complex For Electronics
13.	Naraina Industrial Area
14.	Mayapuri Industrial Area
15.	Badii Industrial Area
16.	Jhilmil Industrial Area
17.	Friends Colony Industrial Area
18.	Patpargang Industrial Area
19.	Mohan Co-operative Industrial Area
20.	Tilak Nagar Industrial Area
21.	Kiti Nagar Industrial Area
22.	Najafgarh Road Industrial Area
23.	Moti Nagar D.L.F. Industrial Area
24.	Birla Mill Site on G.T.Karnal Road Area
25.	Flatted Factories Complex Jhandenwalan Industrial Area
26.	Anand Parbat Industrial Area
27.	Shahadra Industrial Area
28.	Narela D.S.I.D.C. Industrial Area

Table No: 1.3 Legends of Industrial Areas/ Estates

Source: NCAER, 2002 Unpublished Data.

Total number of responding units	13,785
Total number of polluting units	3,680
Total hazardous waste generating units	2613
Total quantity of hazardous waste generated from these units	151588 kg/day
Total quantity of sludge from proposed CETPs.	57 M^3/day

Table no. 1.4. Status of polluting unit in approved industrial areas in NCT of Delhi.

Source: ***NCAER, 2002 UNPUBLISHED DATA***

Reportedly all these units operate without registration and all that they buy and sell is in black, without receipts. Further any department does not recognize this industrial area. The Central Board for the Prevention and Control camped in that area in Feb 1982. They identified three types of industries namely textile, electroplating and rolling and pickling as the major polluting industries.

Units	% of total units
Machining without cutting	43
Trading	13
Plastic products	10.5
Textile dye processing	6

Table No. 1.5. Sectoral Distribution of Industrial Units
Source: ***NPC, 2002*** **(UNPUBLISHED)**

As the industrial areas are classified based on the products, it is not sufficient to identify the polluting industrial units, all the industrial units have been classified into various industrial sectors and sub sectors based on the production process. Many of these units are located in congested localities where they are operating as family business

The present study has been undertaken to characterize the road side dumps of solid wastes generated from these industries, especially pickling and rolling industries, and find a way for their safe disposal on land.

Whatever wastes are generated from these units are highly acidic (pH 2.3-3.8) in nature and high concentration of heavy metals like Fe, Zn, Cu, Mn, Cd, Pb are present in this waste making it highly hazardous (Unpublished M.Phil dissertation of Jagdish Chandra 1998 SES/JNU); A.K.Bhattacharyya and A.K Giri 1999. Besides, Ca^{++}, Mg^{++}, K^{+}, Na^{+}, available phosphates, organic carbon and nitrogen are also present, therefore, it can be used as organic manure also after treatment. In this study this waste was mixed with two different soils (JNU/Chhattarpur), with and without lime, in different percentages and then the samples were studied to see the minimization of hazardous effects (rising pH towards neutral value and low availability of heavy metals and the nutrients like Ca^{++} and Mg^{++}). My senior colleagues in this laboratory have done various physico-chemical and microbial aspects but my main concern is to study the availability of calcium and magnesium in the soils (JNU/Chhattarpur) treated with different wastes.

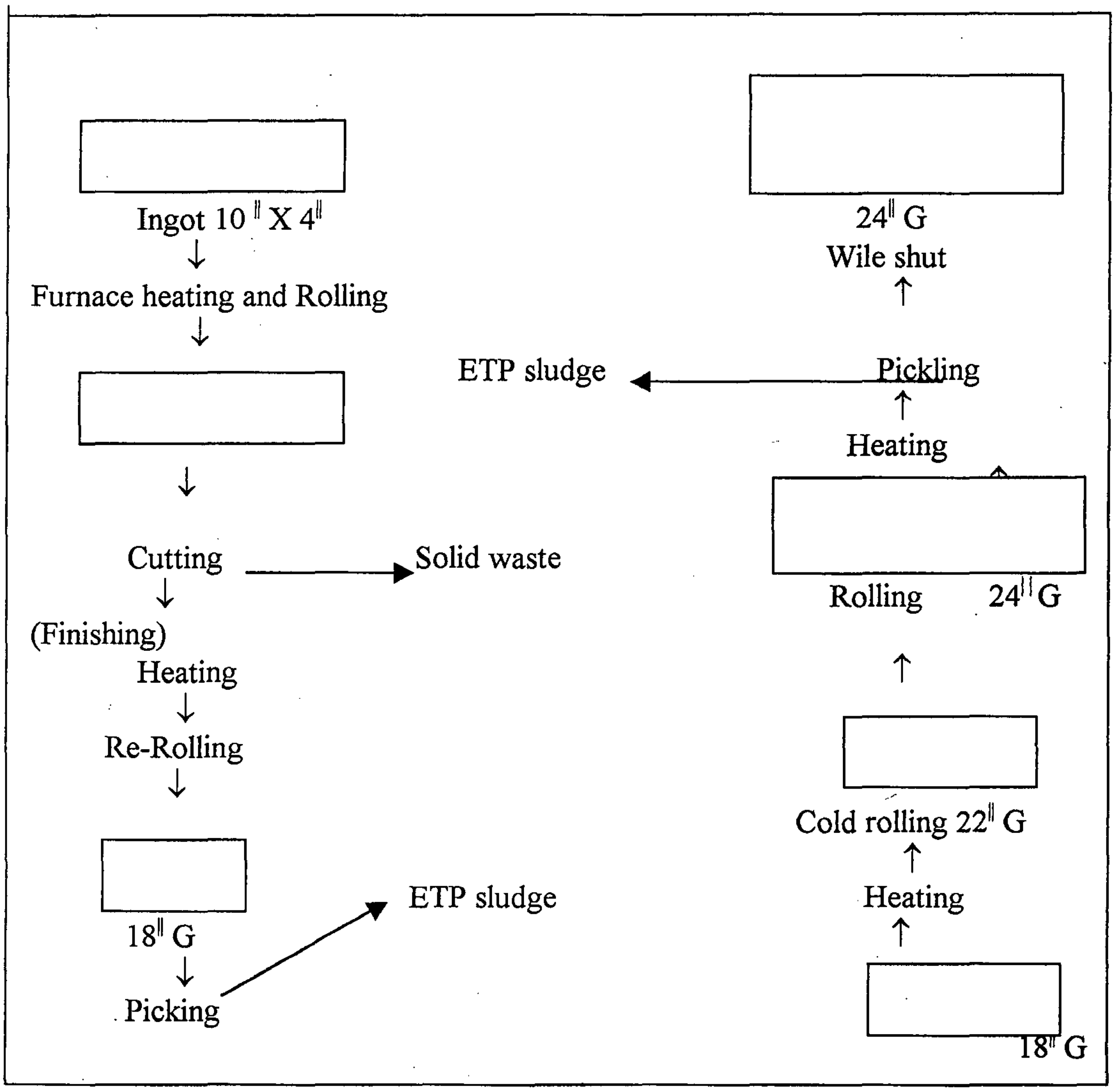


Fig. No. 1.1. Flow diagram of the process of Pickling and Rolling industry and generation of waste in different steps

In plants, calcium is essential for growth of meristem and root tips and tends to accumulate in leaves as calcium pectate. Magnesium is an essential constituent of chlorophyll and is also involved in enzyme reactions. A deficiency of Mg typically causes chlorosis (D. Mitra J. Guha, S.K. Chowdhuri, 2000). In soil Ca^{++}, Mg^{++}, are the macronutrients that help to maintain a pH balance. Lime treatment of acidic soil increases the availability of Ca^{++} and Mg^{++} in soil. The main sources of Ca in soil are Calcitic limestone and Dolomite stone **[($CaCO_3$) CaCO3, CaMg (CO_3)]**

If the percentage Calcium saturation of a soil is high the displacement of cations is comparatively easy and rapid, thus-6cmol/kg of each Ca^{++} in soil whose exchange capacity is 8 c mol/kg (75%calcium saturation) probability would be mean ready availability, but cmol/kg of exchangeable $Ca^{2+}$when the total exchangeable capacity of soil is 30cmol/kg (20% calcium saturation produces quite opposite condition. (Brady, 2000).

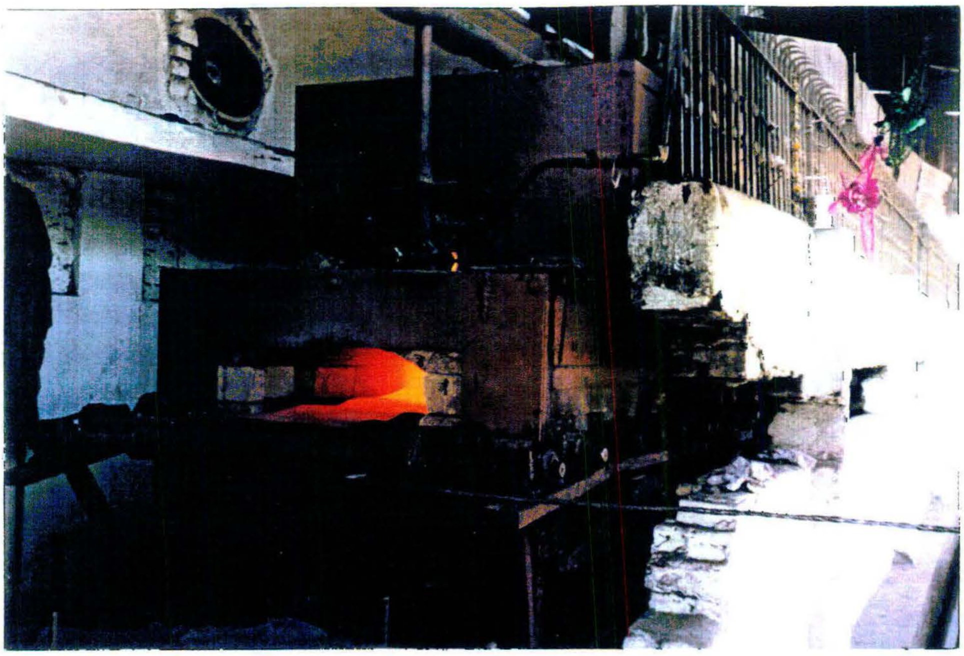
The wastes generated in Wazirpur Industrial Area, contains moderate level of calcium and magnesium from the metal manufacturing industries, soap manufacturing industries, textiles and dying industries. But when it is mixed with soil it gives better results. The availability of Ca^{++} and Mg^{++} also has increased and so that plants will utilize the macronutrients.

OBJECTIVES

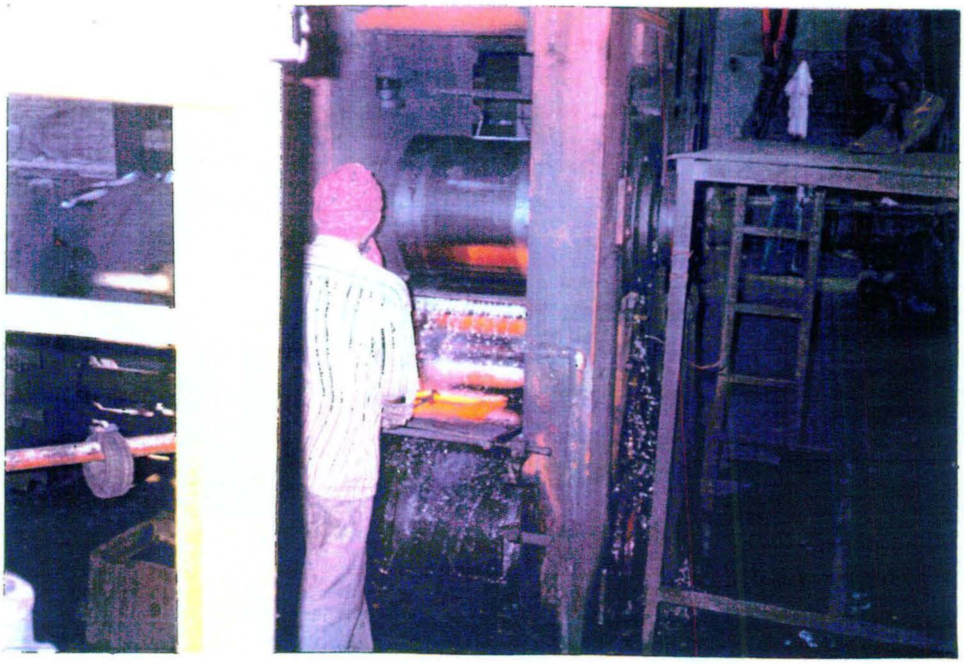
- To analyze the physico-chemical parameters of the industrial wastes collected from Wazirpur Industrial Area
- To analyze changes in physico-chemical properties of soils (collected from Chhattarpur and JNU) treated with different properties of solid waste and lime; with an intention to evolve a safe disposal method.

Agricultural soil in a farmhouse, Chattarpur

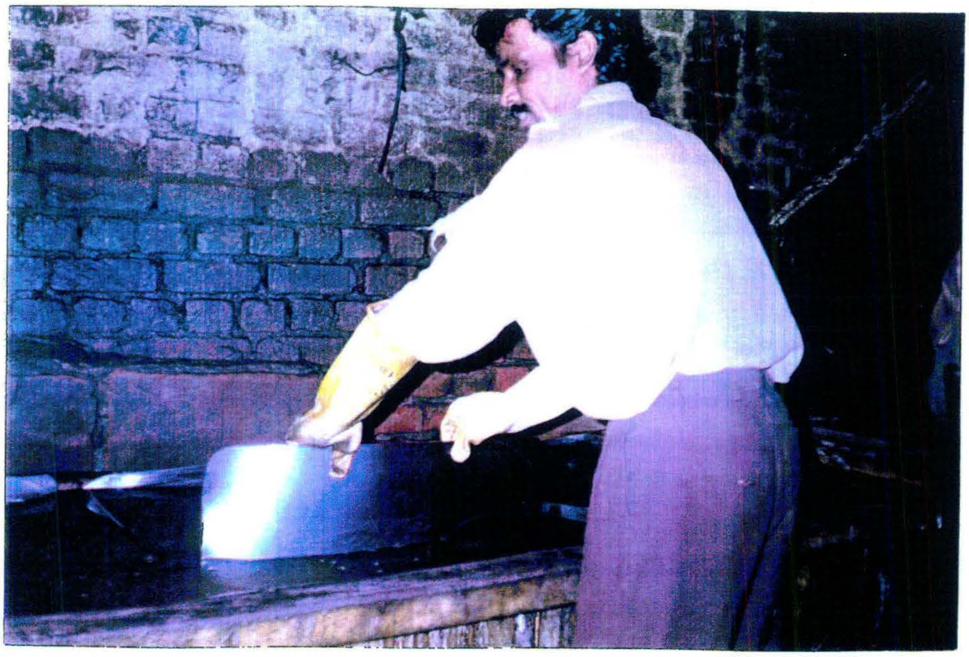
Nursery soil with vegetation, JNU



Inside an industrial unit, hot rolling of iron sheets



Inside the unit, cold rolling of the iron sheets



Inside the unit, pickling of the iron sheets

Inside the unit, washing of the iron sheets

Outside the unit, 26 Gauge finished iron sheets

Roadside dumping of industrial waste, Wazirpur

Common dumping land near railway line in Block A, Wazirpur

Roadside dumping of sludge in Block B, Wazirpur

LITERATURE REVIEW

Soil is the complex mixture of the decomposed organic material and eroded rock textures on of earth's surface that support plants they underlie the foundation of houses and factories and determine whether the foundations are adequate. Having miscellaneous properties with the integrated effects of climate and living matter acting upon parent material, as conditioned by relief, over period of time (USDA, 1951). People are dependent on soil, and conversely, good soils are dependent on people and the use they make of the land soil also have other meaning of human kind. Soil is used to absorb wastes from sewage systems, wastes from other municipal, industrial, and animal sources. Unfortunately misused and unprotected soil can be deposited in municipal reservoirs, impairing water quality and shortening the usefulness of the reservoir (Brady, 2000). Modern society discharges many waste products and chemicals in the water, which enter the soil, and affects all forms of life.

REVIEWS OF ABROAD

Progress in agriculture and industry is taken a general criterion of development of any country; this craze resulted into ultimate exploitation of every parts of natural environment. Industry manufacturers food, petroleum, steel, chemicals, fertilizer, etc. and releasing toxic pesticides, detergent, plastics organic and inorganic solvents, dyes, food additives, heavy metals etc. and so many of toxicants. These toxicants are ultimately leaching in to the soil and are transferred to organism through proper food chain causing a number of unavoidable incidents.

Heavy metals in the soil are one of the big concern now- a -days. Large scale application or dumping of industrial sludge and solid wastes in soil, cause the high concentration of heavy metals like Zn, Cu, Ni, Cd, Cr, Pb. Lake et al (1984) have shown that elements are generally bounded by soil constituents, that they don't easily leach from the soil and that they are not readily available to the plants of monitoring of soil acidity and judicious lime application can prevent the leaching of these elements into ground water. Soil salinity is another problem due to salts accumulation are much more. Some parts of western. United states have major salinity problem [EI Ashry et al (1985)]. The use of gypsum ($CaSO_4,2H_2O$) on saline soil are commonly recommended for the purposes of exchanging Ca^{++} for Na^+.

To maintain satisfactory soil fertility, apply needed quantity of lime, which not only maintain the level of exchangeable calcium and magnesium, but encourages the growth of most common crops balancing the neutral pH (Barber 1984).

Sewage sludge is the solid byproduct of domestic and / industrial waste water/ treatment plant. Philadelphia has developed a system of composting and of land application of sewage sludge on a basis for its sewage disposal. Levels of heavy metals, such a s zinc, lead, copper, iron, manganese, and cadmium, are determined largely by the degree of which industrial wastes have been mixed with domestic wastes (Lochar,1979). Heavy annual application of sludge on land can increase the organic matter and nitrogen content of the soil (Sheaffer, 1979). UK has been interested towards the use of mechanical use of dewatering and directly applying liquid sludge direct to form filled land (Standridge, 1971). Industrial wastes are major contributor to the U.S. solid-waste management problem. For the sound disposal of industrial solid waste it is necessary to know rate of generation of waste and properties of wastes (Niessen, 1977). Sufficient information of industrial waste generation is usually either unavailable or most difficult to obtain.

Land disposal of liquid sludge effects on soil pH (King and Morris, 1972). The Ca-sludge increased soil pH, availability of P from Ca, Fe, and Al sludge in soil (Soon, et al 1978). Changes in soil temperature, moisture content and biological activity can give rise to seasonal changes in soil pH (Weaver and Foralla 1979). Cattle manure can increase soil pH and supply considerable quantities of available nutrients (P.K) in Japan (Whalen, et al., 2000). Most of the sludge about lime requirement and pH buffering capacity of soil have either calibrated buffer solution to soil-$CaCO_3$ reaction or have co-related pH buffering with soil properties such as clay and organic matter content (Conyers et.al. 2000).

Soil acidity limits land availability crop production and yields. Soil acidity raises the cost of production due to regular apply of lime. Recent experiment have shown that increase in sol acidity can decrease of soil CEC and addition of lime causes reverse effects (Brauer David K 1999) CEC is important to soil quality because higher levels are associated with greater retentions of plant nutrients and water. Liming usually decreased the conc. of basic cations (i.e. Mg, K, and Na) other than the Ca. But as incubation progressed the solution concentration of Ca, Mg, K, and Na increased in both lime and unlimed soils (Curling 1995). The potential, impacts of limed sludge on nutrient and heavy metal bioavailability has been studied for the safe use on acidic soil of eastern Canada. Hare raw sewage sludge stabilized with CaO (CaO+S) or cement kilns dust (CKD+S) where pH reached up to 6.5 and after different days of increasing period the availability of P, K, Zn, Cu also increased but Al content decreased. So a combination of CaO+CKD to stabilize sewage sludge would be more suitable to provide appropriate level of P and K without resulting in large increase in extractable heavy metal content (Simard et. al. 1999). Soil cations exchange capacity (CEC) is important in plant nutrient uptake and ion movement and is highly correlated with organic carbon content and clay content of soil. There is no quantitative information about change in CEC caused by change in soil organic matter content as result of long-term mannuring practices. The increase in CEC caused by increase in TOC through mannuring (Gao Chang1996). Organic matter was found to contribute significantly to the CEC of fractionated materials in soil of Hardin, Country Jawa, where the contribution of organic matter to the specific surface area (SSA) of fractionated materials probably was less important than the inorganic contribution. Organic colloids may coat inorganic surfaces however and hold together particles, making net CEC and SSA lower than what might be predicted. The net effect of organic matter is usually to increase the CEC and SSA of soil material beyond the expected form inorganic constituents alone (Thompson et al., 1989). Another study we performed in the soil of Canadian Prairies where they showed that organic matter as a major source of Ca preferring sites. The proportions of organic sites have also increased as the pH increased (Curtin et al., 1998).

The distribution of completely absorbed cations between solution and sorbed phases strongly influences the mobility of ion species in soil. Selectivity co-efficient used to describe this distribution typically vary from soil to soil (Gaston, 1993). The effects of the organic matter addition of soil in relation to soil pH changes is not well understood because organic matter additions to soil have been reported to both increase and decrease of soil pH. Decomposition of Ca-containing organic molecules was shown to have an effect on pH analogous to that of mineral lime (Pocknee & Sumner, 1997). Liming has been used extensively to overcome soil acidity problems. Liming can also affect soil structural stability, and both beneficial (Gardner and Gardner, 1953; Muneer and Oades, 1989; Baldock *et.al*, 1994) and deleterious (Ghani *et. al*, 1955; Roth, 1991;Roth and Pavan, 1991) effects have been reported. Another report, increase in soil structural stability was detectable 3 years after lime application in the limed soil that also had lost soil organic carbon. A gradual increase in soil aggregate stability after an initial decline as a result of liming an Australian Oxic Paleustalf (Chan & Heenan) investigated the decline in soil organic carbon on same area (red earth) as a result of lime application.

Fly ash can supply the alkaline micronutrients like B, Cu, Fe, Mo, Zn. Sewage sludge on the other hand is acidic in nature and containing macronutrients like Ca, S, Mg, P, K etc. Land disposal of these wastes separately will cause problems like

(i) Potential phytotoxicity from micronutrients excess (especially B)

(ii) Shortage of essential major nutrient

(iii) Nutrient deficiency caused by unfavorable fly ash pH and slow nutrient release.

Most of these problems can be overcome by exploiting the complementary nature of fly ash, sewage sludge and poultry manure; and additional nutritional benefits (especially N, P, K balancing) are possible by mixing these three waste materials together (Schumann, Arnold, Sumner and Maleolm, 2000). It has been reported that most of the on farm composting and industrial plants in the humid cold region of Canada are prone to important leaching loss that is environmentally non-sustainable. Complete protection of materials from barn to finish products should be considered to increase the nutrient content of compost and to reduce the potential for soil and water pollution through leaching by precipitation (Gagnon *et al* 1999).

Calcium and Magnesium are classified as secondary nutrients. They are secondary only in the probability of deficiencies and are taken up by plants in quantities similar to phosphorus. These two elements along with potassium and hydrogen (H, which causes soil to become acidic) are adsorbed to the surface of the clay and organic matter in soil by electrostatic charge. They are called exchangeable cations. The capacity of the soil to hold these cations against leaching with water is called Cation Exchange Capacity (CEC). In plants calcium is essential for growth, it is typically deficient in acidic soil and in sodium rich alkali soil. Albert and Smith (1952) considered that calcium deficiency is a prominent feature of the adverse effects on soil acidity upon plant growth. Colwel and Brady (1945) found that a deficiency of Ca^{2+} was the principal cause of pool yield of groundnuts grown in an acidic soil. Magnesium and Potassium uptake is impaired by excess calcium and Jacoby (1961) showed that reduced Magnesium uptake from soil with low Mg^{2+}/Ca^{2+} ratio is due to excess Ca^{2+} and not low Mg^{2+}.

Deficiency of Mg^{++} in an alkaline soil may be due to precipitation and partly due to complementary ion effect. Sometimes high calcium magnesium ratio impairs the uptake of Mg^{2+} but the most commonly encountered and antagonistic ion is potassium. Hovland and Caldwell (1960) consider that potassium interference with magnesium up take in at level 3 general ways:

I) Addition of potassium to soils may decrease the case of displacement of Mg^{2+}.

II) Increased soil K^+ may compete with Mg^{2+} for exchangeable sites on plants roots

III) High conc. of K^+ in plants may prevent magnesium form function properly.

Welte and Werner (1963) investigated the uptake of Mg^{2+} by plants as influenced by H^+, K^+, NH_4^+ and Ca^{2+} ions. They found that H^+ ions suppressed Mg^{2+} uptake most and with a strongly acid substrate. Applying Mg^{2+} and raising the pH could remove Mg^{2+} deficiency. Raising the soil pH without adding Mg^{2+} increased Mg^{2+} availability more than by adding Mg^{2+} without raising the pH. An excess of lime however, is to be avoided as causing calcium antagonism (Myern et al., 1988). The depressive effects upon magnesium uptake by the ions tested were additive and thus the effect of potassium antagonism and thus the effect of potassium antagonism was increased with decreasing pH. Bould (1963) reported that the ratio of K^+ and Mg^{2+} in soil solution will be higher in wet season than in drier one (by the Donnan rule) and hence Mg^{2+} deficiency will be more pronounced during wet season. Deficiency of Magnesium was reduced by organic mannuring. (Soalbach and Judel, 1961). The common ions for hardness i.e. Ca^{++} and Mg^{++} are atleast partially capable of alleviating the toxic Copper ions. They can afford physiological protection against Copper (Praker et al., 1998) and Nickel (Gabrielli & Pandolfini, 1984). Ca^{2+} and Mg^{2+} could interact more subtly with plasma membrane (i.e. by altering conformation or fluidity) in such a way as to diminish the sensitivity of root growth to excess Copper. The specific effect caused by a higher exchangeable Mg^{2+} content will further increase the sodicity hazard of Mg^{2+}-rich waters (Rahma & Rowel, 1979). Kinraide and Parker (1987) have shown that cations (Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}) can ameliorate the Aluminum toxicity in wheat.

Soil acidity is a major problem of South Africa (Bornman, 1985, 1993). Over-liming should be managed by providing clarity through research. Many explanations are given for the negative aspects associated with over liming (Folseher et al., 1986), among them, the constraint of availability of phosphorus. Most researchers are of the opinion that the precipitation of phosphorus as calcium phosphates is the primary reason for phosphorus deficiency during over liming (Bronman et al., 1998). Furthermore availability of high Ca^{2+} concentration with high pH values to reduce Boron uptake by nearly 50% in cotton, further supports a role for Boron deficiency during Calcium hydroxide over liming (Lucas and Knezek, 1972). Calcium also reduces the potential maximum quantity of NH_4^+ absorbed by the soil as well as the soil buffer capacity for NH_4^+. Combining Ca^{2+} with NH_4^+ fertilizer increased NH_4^+ concentration in the NH_4^+ soil solution. The influence of the Ca^+ on soil solution NH_4^+ concentration is attributed to preferential adsorption of Ca^+ and displacement of NH_4^+ from soil exchange site. So, application of Ca^{2+} increases the adsorption and availability of NH_4^+ by plants (Koenig & Pan, 1996).

The mechanistic nutrient uptake model described by Barber and Cushmn (1981) and Barber (1984), has been used to predict the uptake of monovalent cations, as K^+ by soybeans (Silberbush and Barber, 1983) and NH_4 by corn (Anghinoni and Barber, 1990) and rice (Teo et al., 19902). This model was used as the basis for evaluating the influence of Ca^{2+} on NH^+_4 uptake by plants (Koenig & Pan, 1992).

Calcium also stimulates NH_4^+ absorption by horticultural crops in solution (Fenn et al., 1987) and soil (Fenn & Taylor, 1990; fenn et al., 1994) media. This effect has previously been attributed to a physiological stimulation of NH_4^+ absorption by Ca^{2+} (Fenn & Taylor, 1990). In an another study, the addition of urea fertilizers might increase potassium availability where as in others the opposite can be true as NH_4^+ was more capable of displacing K^+ from the solid surface than K^+ was of displacing NH_4^+ (Barbayinnis et al., 1996). In this study, it was clear that as the concentration of third cation has increased the potential buffering capacity of cations under question decreased in contrast to other studies (Lumbanraja and Evangelou, 1990) that the concentration of third cation (K^+) increased PBC of second cation (NH_4^+) also increased. In general, at low exchangeable fractional loads, NH_4^+ is more capable of displacing K^+ from the exchange phase than K^+ is cable of displacing NH_4^+.

The heavy sewage sludge application has some favourable effects on the physical properties of soil. Sludge can serve as organic mulch, there by protecting the soil and conserving soil moisture. The direct application of industrial sewage sludge some times shows harmful (toxic, harmful and some times lethal) effect on dumping site biota. So for application of sewage sludge first it has to neutralize to some extent. For that composting is a good treatment process where the wastes are converted into stable, humus like product (Xin- Taoltes et al., 1992).

The environmentally sound management of solid wastes within Agenda-21 is in response to General assembly resolution 44/228, section-I, in which the assembly affirmed that the conference should elaborate the strategies and measures to half and reverse the effects of environmental degradation in the context of increased national and international efforts to promote sustainable and environmentally sound development in all countries. The programme has covered the following areas-

a) Protection of the quality and supply of fresh water resource
b) Promoting sustainable human settlement development.
c) Protecting and promoting human health conditions.
d) Change consumption pattern.

Environmentally sound waste management go beyond the mere safe disposal or recovery of wastes that are generated and seek to address the root cause of the problem by attempting to change unsustainable pattern of production & consumption.

According to the framework, the objective focus on 4 major waste related programme area which are interrelated and mutually supportive to manage the municipal solid wastes-

a) Minimization of waste.
b) Maximizing environmentally sound waste reuse and recycle.
c) Promoting environmentally sound waste disposal & treatment.
d) Extending waste service cover.

("Earth Summit 1992")

REVIEWS IN INDIA

Dumping of the wastes is the most convenient way of getting rid of wastes from the system. But sound disposal of wastes is not free of disadvantages.

Land filling of the solid wastes is one of the good options to dispose the wastes. Besides, this garbage farming, organic composting, biogas production and recycling of certain wastes material are also applicable for solid waste management (Santra, 2000). Government of India has been increasingly concerning about the control of environmental pollution specifically due to industrial activities. These programmes involve three different approaches namely

i) Tackling of the pollutants.
ii) Tackling of the polluted area.
iii) Tackling of the polluting sources.

(DMC act 1985),

The Central Pollution Control Board (CPCB) has been actively involved in developing the sector wise standards at national level for treatment of effluent and emissions from different polluting industrial sector. State pollution Control Board is also active to do such kind of work. (Parivesh-polluting Industry, 1999-2000).

The hazardous wastes generations by the industries are required to be disposed in secure landfill. The following listed wastes should not be disposed off directly into the land filled facility.

- Waste, which is a fluid, slurry or paste.
- Waste, which is delivered under pressure or under vacuum.
- Waste which has obnoxious odor
- Waste, which reacts with moisture to produce considerable amount of heat.
- Waste which is highly inflammable
- Waste which contains shock sensitive substance
- Waste which contains oxidizing reagents
- Waste, which falls below a pH, value 4 and exceeds 13
- Wastes, which possess calorific, value more than 3200 Kcal/ Kg.

(CPCB Annual report 2001)

In Delhi, 6000 ton/day of solid waste is generated, this puts a garbage pressure of 4.042 ton/Km. The wastes generated in this way have a pressure on land fill is 5000 ton/Kg.(CPCB Annual report 1999-2000).

The implementation of the action of plan for pollution control in 1551 medium and large seals units identified under 17 highly polluting industrial reactors was continued under section of E (P) Act 1986,the defaulting industries are identified as a result the no. of defaulting industries have been reduced (CPCB Annual report 2000)

The solid waste generating industries discharge their waste directly in river and lakes also. CPCB ran a program called Industrial pollution control along the rivers and lakes. There were 851 industries release their waste directly into the river in 1997 but by March 2000 they are only 93 (Annual Report 2000 CPCB).

Among solid waste many wastes are hazardous mainly the wastes generated form industrial area (like Wazirpur) are hazardous in nature. They have created a serious problem in that area. This wastes contain Pb, Cr, Ni, Cu, Rd and Zn, Mn, and highly acidic. So proper disposal of that waste is need. (Giri and Bhattacharyya, 1999) for that first find out the sources of wastes are generated. Then action should be taken for proper disposal of that kind of waste for the search of healthy environment- both economically and ecologically reliable.

STUDY AREA

Fig.: 3.1 Delhi Map Showing Wazirpur Industrial Area and Soil Sampling Sites.

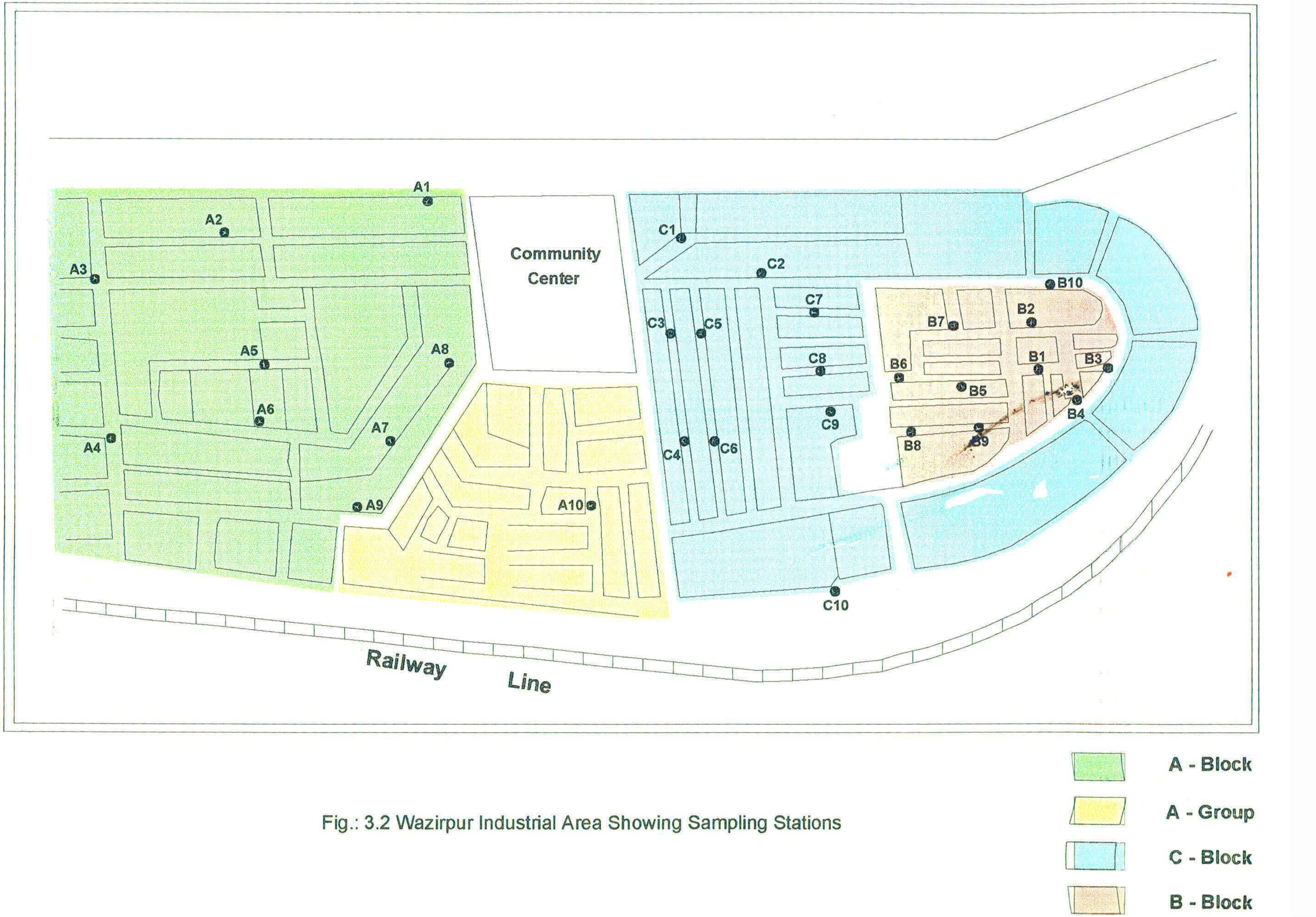


Fig.: 3.2 Wazirpur Industrial Area Showing Sampling Stations

Wazirpur Industrial Area, which is situated in Northwest part of Delhi covers an area of 210 acres, (*figure 3.1*). Northwestern ring road system surrounds this highly polluted area.

Initially this area had approximately 1000 industries among which only 424 were registered. But after 1998, as per strong recommendation of CPCB and DPCC a lot of unregistered industries are now closed. The main polluting industries, which are still in working conditions, are electroplating, rolling-pickling and textiles. The others are rubber, plastic, soap, electronic goods etc. Due to its large number of small-scale industries and their unmonitored level of pollution, now Wazirpur has emerged as one of the major polluted industrial zones of Delhi.

The entire area is divided into three industrial parts A, B and C (*figure 3.2*). Due to its industrial units, every day a huge amount of toxic wastes are spewing out of those units.

The hazardous effluents are governed by strong acids like HNO_3, H_2SO_4, HF, HCl and coating materials like chromium, zinc blend, bleaching powder, and iron pieces, used as raw material in the electroplating, rolling & pickling and textiles industries.

Though some of these industries are closed by CPCB, this area does not have a sound and satisfactory waste disposal system. Major health problems occupying here are due to spraying of solid waste and effluents on the roadsides and in the dwelling places.

JNU soil is taken as a 'control'. JNU is educational cum residential institution. Here no industrial, agricultural or such other activities are taking place. Moreover JNU is covered by thick greenery with rich flora and fauna. The soil here is shallow, loamy and rich in nutrients, (N.B.S.S.Report 2002). The soil collected from Chhattarpur is a firm land. So the soil has already exposed to fertilizer, pesticides and many other pollutants. But the productivity of the soil is higher than JNU soil.

MATERIAL AND METHODS

4.1 SAMPLE COLLECTION

4.1.1 ***Collection of solid waste:*** Wazirpur industrial area is devided into three blocks A, B, and C. Samples were collected from ten different spots from each block (Fig no. 3.2). So we had thirty samples for each season. Samples were collected from an open dumping ground and roadside dump. The solid wastes were collected from the surface to 30 cm below. Then the samples were mixed and kept in airtight polythene bags.

4.1.2 ***Collection of soil:*** Soil has been collected from 5 different spots of JNU and Chhattarpur (Fig.no.3.1) and homogenized separately.

4.2 FREQUENCY OF SAMPLING:

The solid wastes from Wazirpur industrial area were collected once a season. Soil sample from JNU and Chhattarpur were collected only once in the study.

Samples	Date of sampling
Monsoon waste	Aug 2000
Winter waste	Dec 2000
Summer waste	May2001
Chhattarpur	Oct 2001
Jnu soil	September 2001

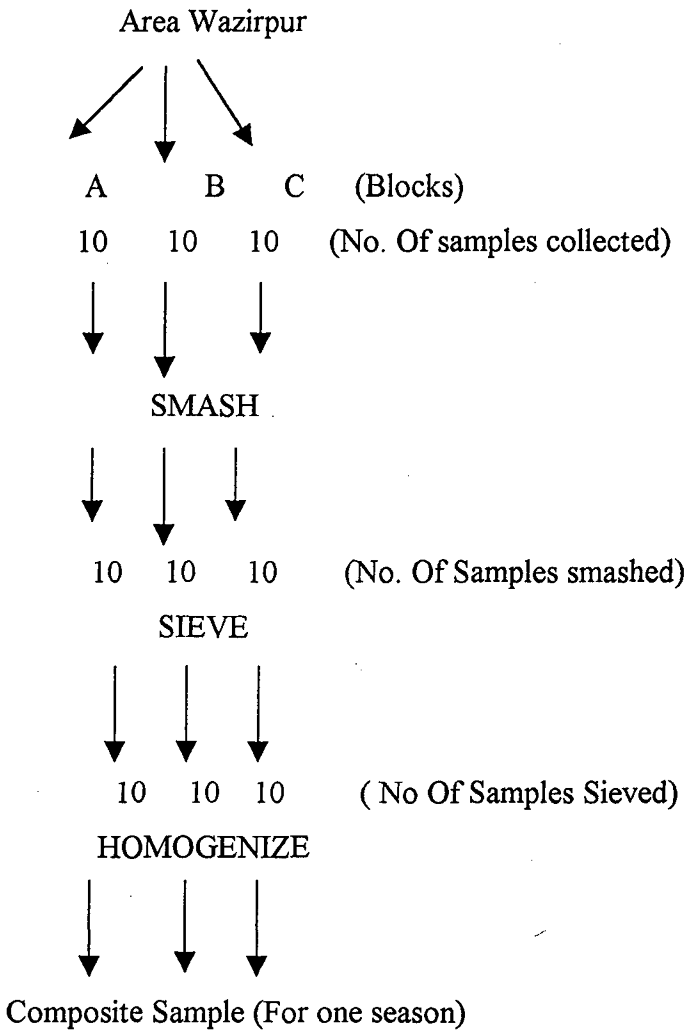
4.3 PRESERVATION OF SAMPLES:

The collected samples both the soil and solid wastes were first air-dried and then kept in airtight polythene bags in dark cold room (4^0C). But for pH, EC & % moisture content of the samples were determined just after collection.

4.4. SAMPLE PROCESSING:

Both the solid wastes and soil samples were air-dried and then grinded by mortar & pestle and sieved using 2mm sieve. Solid wastes of each season (10 samples from each block) are taken and homogenized to make respective composite samples by quadrate system. The collected soils also first air-dried and then smashed by using grinder and then homogenized after sieving and kept in airtight polythene bag.

FLOW DIAGRAM OF SOLID WASTE PROCESSING



4.5 EXPERIMENTAL BOTTLE PREPARATION

Different percent (10%, 20% and 30%) of composite solid waste of each season (summer/winter/monsoon) were mixed by quadrat system with composite JNU & Chhattarpur soil to prepare experiment bottles. Different percentage of lime (0%, 0.5%, & 1.0%) by weight was then applied followed by distilled water in accordance with moisture content (%) of soil and solid wastes. Known volume of samples (500g) filled in small polythene bags were incubated in BOD incubator.

4.5.1 Incubation of the experimental bottles: The polythene bags were kept in BOD incubator at 28^{0}C. The moisture of the experimental bottles was maintained by adding distilled water everyday. For analysis of pH, EC, CEC, Organic Carbon, Calcium, Magnesium the incubated samples were taken from the bottles after 0, 10, 20, 30, 45, 60, 90 & 120 days of incubation.

4.5.2 ***Preservation of incubated samples:***

The incubated samples were taken from the experimental bottles and filling in small airtight polythene bags then kept in the dark cold room at 4 ^{0}C.

4.6 ANALYSIS OF PHYSICO-CHEMICAL PARAMETERS

4.6.1 MOISTURE CONTENT

Solid wastes generally get moisture from the infiltration of precipitated water when dumped in the open space. Through evaporation and run-off major portion of rainwater is lost. Incase of winter and summer season, the wastes get water in the process of its origin.

The moisture content of the soil/ samples at any time more or less depends on its water holding capacity and environmental condition with time. The moisture content is normally expressed in percentage on weight basis (g of water/100 g oven dry soil).

% of moisture in dry wt basis = WmX100/Ws
Where, *Wm= Wi-Ws*
Wi= Initial wt. of soil.
Ws= Dry wt. of soil (NCERT-1985).

Procedure: 10g of fresh solid wastes and soils (JNU and Chhattarpur) were kept in hot-air oven at 105 ^{0}C in clean-dry petridishes separately. Weights were taken after 24 and 48 hrs. Five replicas have been taken.

4.6.2. THE WATER HOLDING CAPACITY (WHC)

Water holding capacity is defined as the maximum amount of water a freely obtained sample can hold. The water is held in the soil pores with varying degrees of tenacity depending on the amount of water present in the size of pores. (Brady, 2000) Both the WHC and moisture contents have an intimate relationship with nutrient availability (Ca^{++}, K^{+}, N, P). The WHC also indicates the texture of the soil and solid wastes (Tennifer W.Harden, 1988) but here we followed the weight % of WHC.

$$\text{Weight \% of WHC} = \frac{(\text{Water saturated soil} - \text{Oven dried soil}) \times 100}{\text{Oven dried soil}}$$

Procedure: About 20g of processed soil sample each of JNU & Chhattarpur and solid wastes (summer, monsoon, winter) were flooded for 2 hrs in 100 ml beakers separately. Filtered for the last drop of water using filter paper (whatman-1), 10g of these saturated soils in previously weighed petridishes were kept in a hot air oven at 105°C and weighed after 24 and 48 hrs.

4.6.3. ELECTRICAL CONDUCTIVITY (EC)

Electrical conductivity of a solution is the conductance of the solution at 25°C temperature between electrodes 1 cm sq. and 1 cm apart. Conductance is the reciprocal of resistance and is measured in 'Siemens' (mhos). For soil solution it is more usual to express results of conductivity as millisiemens per cm (Hesse, 1972). The salinity is commonly expressed in terms of electrical conductivity (EC) i.e. the electrical conductivity is the measurement of dissolved salts in a soil solution (Holden, 1970).

Properties of Normal Soil compared to Acidic, Saline, Sodic and Saline sodic Soils (After, Brady, 2000).

Sr. No.	Soil	Common pH	Common EC (mS/cm)
1	Normal	6.5-7.2	<4
2	Acidic	<6.5	<4
3	Saline	<8.5	>4
4	Saline sodic	<8.5	>4
5	Sodic	>8.5	<4

The conductivity is related to the total concentration of the ions in solution, their valency (charge) mobility and the temperature. Soluble salts also affect the plant uptake of P, Na^+ & K^+ and especially, Ca^{++} depress the solubility of phosphate in soil (Van Wesemeal and Lehr, 1954). A very broad generalization of plant susceptibility to soluble salts is given in the USDA Saline handbook; it is based upon the conductivity of soil saturation extracts. The book recommended that at 0-2δ X 10^3, Millisiemens/ cm the salinity effects are negligible.

Principle: Conductivity depends on dilution of the sample. However sample/water ratio is 1:5, 1:10 are most common for conductivity study to reduce microbial influence, Conductivity measurement should be done within few hours of preparation of sample solution the conductivity. The conductivity is related to total concentration of ions in solution, their valency (charge) mobility and temperature of measurement.

EC is expressed as **C= 1/R** Where **C**= Electrical conductance in mS/cm. R is resistance

Procedure: A solution of soil and double distilled water is made in the ratio of 1:10 in a 100 ml beaker by stirring it with a magnetic stirrer for 10 minutes. EC values were measured after half an hour using an Electrical-conductivity meter after standardization.

4.6.4. pH

Principle: Soil pH is one of the most indicative measurements of the chemical properties of the soil whether a soil is acidic, neutral or basic has much to do with the solubility of various compounds, the relative bonding of ions to exchange sites and the activity of various micro-organisms. Thomas (1967) noted that three soil pH ranges are particularly informative : a pH<4 indicates the presence of free acids generally from oxidation of sulfides ; a pH < 5.5 suggest the likely occurrence of exchangeable Al and a pH 7.8 to 8.2 indicates the presence of $CaCO_3$. Sorenson's (1909) defined the pH as the negative logarithm of the hydrogen ion concentration – that is, $\mathbf{pH = \log 1/ a^{H+} = -\log a^{H+}}$

Where a^{H+} represents the activity of hydrogen ions refers strictly to a true solution in which the ions are completely dissociated and where there exists a large volume compared to molecular dimensions.

Measurement of pH: The measurement of pH is normally done by either a colorimetric or an electrometric method. In present study case electrometric methods have been followed. This involves a glass H^+ sensing (indicator) electrode (Calomel electrode) paired with a reference electrode attached to a suitable meter for measurement of electro motive force, which is shown below to be proportional to pH. The calomel electrode contains a saturated KCl bridge that contacts the soil suspension and has a characteristic potential (voltage) relatively independent of H^+ activity.

Procedure: A solution of soil and double distilled water is prepared in the ratio of 1:10 in a 100 ml beaker by stirring it with a magnetic stirrer for 10 minutes and pH values were measured after half an hour using a pH meter after standardization.

4.6.5. ORGANIC CARBON

Organic matter influences physical and chemical properties of soils far out of proportion to the small quantities present (Balestent et al., 1988). Organic matter is an index of productivity of soil. Since it is a storehouse of essential nutrients for plant growth. It also influences many other properties including the infiltration and retention of water, degree of aggregation and overall structure that affects the air and water relationships, cation exchange capacity, soil color, which in-turn affects temperature relationship and adsorption and deactivation (or both) of agricultural chemicals. In poorly drained soil, because of their moisture content and relatively poor aeration, are generally much higher in organic matter (Nichols, 1984).

Principle: As per procedure given by Walkley and Black (1934) the soil or solid waste were digested with chromic and sulphoric acid to oxidize the humus. The excess of chromic acid not reduced by sol, soil organic matter, is determined by titration with standard $Fe(NH_4)_2SO_4$ solution in presence of phosphoric acid sodium fluoride and diphenylamine solution as an indicator. At the end point, color change is blue to scarlet green H_3PO_4 and NaF make the color change distinct because of thin suppression of the Fe^{3+} (ferric) ion activity which is generated during the titration with ferrous salt.

Procedure: One gm of each sample was taken and shaken well with 10 ml 1N $K_2Cr_2O_7$ in 500 ml conical flask. Then with stirring added 20 ml of conc. H_2SO_4 in each sample & kept for 30 minute to complete the reaction. Then added 200 ml distilled water in each conical flask. Next 2 gram NaF and 10 ml orthophosphoric acid were mixed and stirred vigorously. Titration was done against 0.1 N ferrous ammonium sulphate in presence of diphenylamine as indicator. A blank in exactly similar way but without any soil (sample) was run.

Calculation:

Organic Carbon (%) = (3.951/ dry wt. Of soil) X 1- (ml of $Fe(NH_4)_2SO_4$ used for sample) / (ml of $Fe(NH_4)_2SO_4$ used for blank).

Organic matter (%) = Organic carbon (%) X 1.724.

4.6.6. CATION EXCHANGE CAPACITY

Cation exchange capacity (CEC) is "the sum total of the exchangeable cations that a soil can absorb" (Brady, 2000). The CEC has been recognized by soil scientists for allover a century (Thompson, 1850; Way, 1850, 1852). A soil leached with salt solution has the power to absorb the cations of the percolating solution and liberate equivalent amount of other cations. The exchangeable form is the most important source of instantly available plant nutrient; in general 'available cation' can be considered as 'exchangeable' cation (Hesse, 1971). Recent research results indicate that increase in soil acidity can decrease soil CEC and thus soil quality (Brauer, 1999). CEC is highly dependent upon soil texture and organic matter. In general, the more clay and more organic matter in soil, the higher the CEC.

Two factors determine the relative proportions of the different cation absorbed by clay are:

Cations are not held equally tight by the soil colloids. When cations are present in equivalent amount, the order of strength of absorption is $Al^{3+} > Ca^{2+} > Mg^{2+} > K^+ = NH_4^+ > Na^+$. And very acidic soils have high concentration. of H^+ and Al^{3+}. In moderately alkaline soils, Ca^{2+} and Mg^{2+} dominate, and poorly dry soil may absorb Na^+ in very high quantities (Brady, 2000).

Principle: A soil leached with a salt solution (1M) has the power to absorb the cations of the percolating solution and to liberate an equivalent amount of other cations. Thus the soil leached with 1N ammonium acetate (pH- 7) solution will absorb some ammonium ions and liberate calcium, magnesium, and other ions, which will appear in leachate. When the sample (ammonium saturated soil) is distilled in Kjeldahl flask and the distilled sample is titrated with 0.1 N HCl, gives the cation exchange capacity.

Procedure: Five gram of soil sample was shaken well in ammonium acetate solution and kept overnight, covered with a watch glass. Next day it was filtered with excess NH_4OAc and then washed with 95% ethanol till the filtrate shows the presence of NH_4 with Nesseler's reagent and left for half an hour to drop out ethanol.

Now the sample along with the filter paper in 400 ml double distilled water and 25 ml 45% NaOH was digested in Kjeldahl flask in presence of glass bids and liquid paraffin. About 200 ml distillate was collected in 20 ml 2% boric acid mixed indicator solution in a 250 ml conical flask and titrated against 0.1N HCl.

Calculation:

CEC= 10 T/ D.

Where, T= the volume in ml of standard acid after correction for blank. And

D = dry weight (oven dry) of the soil sample.

4.6.7. EXCHANGEABLE CALCIUM

Ca occurs widely and abundantly in soils as carbonate, phosphate silicate, fluoride and sulphate. The carbonate is the most important source of sol calcium although phosphate and sulphate becomes predominant in certain types of soil.

Calcium is typically deficient in very acid soils, but can be deficient also in sodium-rich alkali soils where it may precipitate as the carbonate and where it can also become involved in complementary ion effect, exchangeable calcium being displaced least by sodium compounds. In neutral soils calcium can be fixed by phosphorus but otherwise, until such time as it is leached away, it remains readily available to plants, although the presence of montmorillonitic clays reduces the availability of exchangeable calcium (Allaway, 1945).

Reagents: Ammonium Acetate [$CH_3COONH_4^+$], 1M, standard Calcium solution, hydroxyl amine, hydrochloric acid, potassium ferrocynide, triethyl amine, 10% sodium hydroxide, Calcon indicator, EDTA-disodium, TEA.

Procedure: Disodium-EDTA was standardized using Calcon as indicator following Internationally recognized standard method. (Jackson,1958).

Then placed 10 ml of aliquot of soil extract (with ammonium acetate solution) and volume was made to 50 ml with distilled water and 10 drops each of $NH_2OH \cdot HCL$, $K_4Fe(CN)_6$ and TEA and add enough 10% NaOH to raise the pH to 12 or slightly higher. PH was checked with a pH hydride paper. Adding 5 drops of Calcon indicator for end point marked color change from red to blue.

N.B. If endpoint is difficult because of the presence of phosphate add the masking reagent as before and known excess EDTA disodium to a new sample. Slowly bring the pH up to 12 with 10% NaOH. Then heat the solution to near boiling for several minutes, cool it and add 5 drops of Calcon indicator and titrated solution from blue to red color with standard calcium solution.

Calculation

Milimoles of calcium in bulk solution = (conc. of standard EDTA in milimoles per mol) X (ml EDTA sample –ml EDTA blank) X (dilution factor)

$$\text{Ca2+ in milliequv/100g soil} = \frac{\text{milimoles of cations in bulk solution X 100}}{\text{Dry wt of the soil in gm}}$$

4.6.8 EXCHANGEABLE MAGNESIUM

In soils magnesium occurs principally in the clay minerals, being common in micas, vermiculites and chlorites; it sometimes occurs as the carbonate. Smaller quantities are present as exchangeable ions, water-soluable forms and in organic combinations.

Magnesium can be lost from soils by leaching and this will be influenced by soils physical conditions as well as by rainfall. Many years ago Voelcker (1871) reported that applications of super phosphate or of potash would increase the amount of magnesium lost in drainage water.

Magnesium is an essential constituent of chlorophyll and also is involved in enzyme reactions. The element affects the translocation of phosphorus (Troug et. al, 1947) and has been reported (Semenove, 1962) to increase sugars, vitamins, starch and insulin in root crops. A deficiency of magnesium typically typically causes chlorosis and has been associated recent years with certain animals disorders (Reith, 1963). The appearance of magnesium deficiency has become more frequent of late in agricultural land due to greater removal by high-yielding crops, leaching form acid coarse-textured soils and with less magnesium being applied in fertilizers.

Reagents: Buffer solution TEA, $NH_2OH{\cdot}HCL$ Ammonium Acetate $[CH_3COONH_4]^+$, 1M, Standard Magnesium solution, hydroxylamine, hydrochloric acid, potassium ferrocynide, triethyl amine, 10% sodium tungstate, EDTA-disodium.EBT indicator.

Procedure: After standardization of EDTA 10 ml of ammonium acetate extract of soil was taken and the volume was made to 50 ml with distilled water. 20 ml tungstate solution was added. Heated and filtered the content through whatman-1 filter paper. Washed the paper and precipitated with a solution containing 50 ml of buffer solution per liter. To the filtrate added 10 drops of $NH_2OH{\cdot}HCL$, $K_4Fe(CN)_6$ and TEA and allowed a few minutes for the reactions to take place. Titrated the solution using 10 drops of EBT indicator with a color change from red to permanent blue. Heating the solution speeds up the endpoint (A.L. Page 1982).

Calculation:

Milimoles of calcium in bulk solution = (conc. of standard EDTA in milimoles per mol) X (ml EDTA sample –ml EDTA blank) X (dilution factor)

$$Mg^{2+} \text{ in milliequv/100g soil} = \frac{\text{milimoles of cations in bulk solution X 100}}{\text{Dry wt of the soil in gm}}$$

4.7. DATA ANALYSIS

In the present study, five different physico-chemical parameters for the soil (treated with different proportion of lime and waste) were monitored on different days after incubation of samples. To facilitate interpretation, data were arranged to execute two sets of 2-factor ANOVA as follows;

A) Keeping waste treatment constant, days of incubation and lime treatment were taken as two factors.

B) Keeping lime treatment constant, days of incubation and waste treatment were taken as two factors.

Since only one observation was made for each sample type, the ANOVA is without replication. The exercise was executed separately for different seasons; hence for each parameter, the study yields 10 ANOVA inferences in case of first set (waste treatment kept constant); and 9 ANOVA inferences in case of second set (lime treatment kept constant). One additional ANOVA in the first case represent the control; (apart form nine permutations of seasons and lime/waste treatments). Above exercises were performed for Chhattarpur soil and JNU soil, exclusive of each other.

Infact ANOVA is executed in order to determine whether, either of the two factors in each set of exercise would make significant different in the values of monitored parameters.

Each of the ANOVA inference itself carries F and P values for each of the two factors. F value depicts the significance of difference due to particular factor; and it yields inference in terms of *significant* or *insignificant*. Here we use 95% level of significance. Critical F-value, at this level, and at a particular degree of freedom, has been used as criteria of decision in each exercise.

P-value, on the other hand, indicates the exact level of significance. The lesser the P value, the higher significance that statistic will show.

RESULTS AND DISCUSSION

5.1. pH

Measurements of pH show variations across the samples (Table 5.3 and 5.4). Moreover its (pH) comparison with corresponding values of moisture content makes an impression that former depends upon latter to certain extent.

Among, the pure solid waste samples, monsoon waste are found less acidic (pH-4.4) than summer waste (pH-3.9) followed by winter waste (pH 2.7). Resembling to this trend, the moisture content of monsoon waste is the highest (6.5%), followed by winter waste (2.0%) and summer waste (1.5%) respectively.
For pure soil, the value of pH for Chhattarpur (pH-8.9) is higher than that for JNU; against which the moisture content of Chhattarpur soil is found higher (1.5%) than that of JNU soil (1.0%).

For different combinations of soil and solid waste {with or without lime treatment}, pH values show miscellaneous pattern. Up to 45 days of incubation period, the pH values have increased with the increasing percentage of lime {in contrast to control} in both the type of soils and solid waste combinations. After the 45 days, however, values of pH show stability.

pH of Chhattarpur soil

Chhattarpur soil is basic in nature (pH 8.9) while solid wastes are highly acidic. When the Chhattarpur soil is mixed with solid wastes in different proportions (i.e. 10%, 20% and 30% of waste), pH occupies a range of 6.64-7.91 in different period of incubation (Fig 5.1, 5.2,5.3). This mixture, when treated with lime, the pH varies in range (7 - 7.86) as shown in Table No. 5.3.

Chhattarpur soil, when mixed with different proportion of monsoon wastes (10%, 20% and 30%), showed the pH values of 7.84, 7.39 and 6.98 respectively. By the application of lime there is increase in pH.

Again pH has always increased with the increase in degree of lime treatment in case of winter waste as well as summer wastes. Besides it, when incubation is considered, the effectiveness of lime treatment continued to show basic pH up to 30 days of incubation studies; and after that it decreased and got stabilized between pH 7.5-7.6. This trend appears for monsoon waste (10%) with Chhattarpur soil. (Table No. 5.3).

Parameters	Different types of wastes		
	Monsoon Waste	Winter Waste	Summer Waste
Moist.cont.(%)	6.5	2.0	1.5
WHC (%)	44.5	35.5	38.0
PH	4.4	2.7	3.9
EC	1.921	1.700	1.100
Org.C (%)	3.874	3.185	3.161
CEC	11.814	12.193	12.675
Ca^{2+}	5.139	5.317	5.424
Mg^{2+}	2.506	3.125	2.895

Table : 5.1. Physico-chemical characteristics of pure wastes

Parameters	Soils	
	Chhattarpur	JNU
Moist cont (%)	1.5	1
WHC (%)	36.5	31.5
PH	8.9	8.33
EC	0.070	0.127
Org-C (%)	0.607	0.367
CEC	11.869	10.781
Ca^{2+}	5.34	4.125
Mg^{2+}	3.135	2.691

Table : 5.2 Physico-chemical characteristics of pure soils

When Chhattarpur soil is mixed with winter solid wastes, pH decreased with incubation period; but it never reached beyond the pH value of 6.82. Without lime treatment the pH value fell up to 6.4 with an average value around 7.3. After 20 days of incubation, the pH values showed stability (Table No. 5.3).

Since we are seeking an effective treatment option for waste management, the results of the study suggests that 0.5% lime treatment is more suitable than 1.0%.

lime treatment. Though neutral pH is achieved quickly by 1% lime treatment; both the treatments ultimately give same pH after 30 days of incubation and onwards. As 1% lime treatment incurs double amount of lime than 0.5% lime treatment, the latter is more economically viable option.

% of w	Sample	Period Incubated (days)							
		0	10	20	30	45	60	90	120
0	C-0-0	8.9	8.4	8.39	8.32	8.16	8.3	8.2	8.18
	C-0-0.5	10.34	8.55	8.58	8.51	8.35	8.44	8.41	8.4
	C-0-1.0	11.522	9.14	9.11	8.78	8.55	8.49	8.4	8.32
10M	C-M10-0	7.84	7.73	7.73	7.63	7.45	7.71	7.76	7.66
	C-M10-0.5	7.85	7.72	7.8	7.67	7.5	7.78	7.78	7.65
	C-M10-1.0	8.01	7.82	7.83	7.71	7.52	7.79	7.79	7.69
20M	C-M20-0	7.39	7.45	7.45	7.38	7.24	7.43	7.49	7.27
	C-M20-0.5	7.44	7.51	7.54	7.52	7.21	7.52	7.52	7.45
	C-M20-1.0	7.65	7.6	7.63	7.6	7.37	7.56	7.6	7.48
30M	C-M30-0	6.98	7.17	7.02	6.93	6.68	6.75	6.86	6.7
	C-M30-0.5	7.18	7.36	7.26	7.24	7.08	7.19	7.23	7.16
	C-M30-1.0	7.47	7.45	7.45	7.47	7.36	7.44	7.56	7.39
10W	C-W10-0	7.86	7.66	7.73	7.71	7.64	7.82	7.7	7.54
	C-W10-0.5	7.9	7.77	7.78	7.74	7.66	7.78	7.73	7.59
	C-W10-1.0	7.69	7.78	7.85	7.77	7.7	7.8	7.8	7.65
20W	C-W20-0	7.49	7.35	7.41	7.38	7.3	7.4	7.4	7.2
	C-W20-0.5	7.6	7.45	7.53	7.49	7.4	7.52	7.6	7.46
	C-W20-1.0	7.3	7.56	7.6	7.58	7.47	7.63	7.56	7.5
30W	C-W30-0	7.04	7.04	6.96	6.96	6.92	6.7	6.7	6.48
	C-W30-0.5	7.25	7.26	7.3	7.28	7.03	711	7	6.82
	C-W30-1.0	7.58	7.4	7.48	7.34	7.22	7.37	7.4	7.16
10S	C-S10-0	7.91	7.71	7.75	7.75	7.6	7.71	7.8	7.65
	C-S10-0.5	7.9	7.7	7.78	7.76	7.54	7.77	7.81	7.66
	C-S10-1.0	8.18	7.85	7.84	7.82	7.63	7.75	7.86	7.66
20S	C-S20-0	7.45	7.37	7.49	7.45	7.12	7.43	7.5	7.34
	C-S20-0.5	7.62	7.44	7.57	7.59	7.41	7.56	7.61	7.46
	C-S20-1.0	7.91	7.51	7.69	7.72	7.63	7.68	7.67	7.59
30S	C-S30-0	7.16	6.94	7.26	7.23	6.55	7.07	7.05	6.8
	C-S30-0.5	7.38	7.13	7.41	7.37	7.04	7.34	7.36	7.25
	C-S30-1.0	7.74	7.44	7.51	7.5	7.24	7.52	7.63	7.42

Table No. 5.3 pH of Chhattarpur Soil after different interval of Incubation.

RESULTS AND DISCUSSION

pH of JNU soil:

JNU soil is also basic in nature (pH 8.33). When it is mixed with solid wastes (acidic), pH values decrease, ranging between 7.3-7.72 (Fig. No 5.4 5.5, 5.6) at the initial stage. The pH changed with different lime treatments and different days of incubation. When the solid waste was mixed with JNU soil and treated with lime, the resultant pH range was between 7.32 and 8.1. (Table No. 5.4). Since solid wastes are highly acidic in nature (pH 4.4-2.7 mentioned in table no. 5.1) and JNU soil is basic (pH 8.33 mentioned in table no. 5.4), they neutralized each other, when mixed. After lime treatment the pH has increased. But, with increasing incubation period, pH gradually decreased up to 30 days of incubation, then it increased and got stabilized.

In the case of monsoon solid waste, pH values have decreased with increasing incubation period. For 10% solid waste mixed soil, the pH ranges between 7.44-7.82 after increasing days of incubation (Fig. No. 5. 4). In case of winter waste the pH increased till 45th day of incubation; after that it decreased; ranging between 7.95-7.97. On the first day pH was 7.75 (0.5% lime and 10% winter solid waste) and after 20 days of incubation it was 7.86.

In case of 20% winter waste treated with 0.5% lime, the pH ranges between 7.95 (0 day of incubation) to 7.84 (120 days of incubation). But when treated with by 1% lime the pH value first increased (pH-7.85) then it decreased up to 7.65(after 20 day of incubation). For the soil with 30% winter waste, the pH decreased up to a range of 7.55 -7.74 with the increase in days of incubation. (Fig. No 5.5)

The results are quite different in case of 10% summer waste mixed with JNU soil i.e. pH of JNU soil increased from 7.64 to 7.86 after 10 days of incubation; afterwards it decreased (pH-7.7) up to 60 days of incubation and then again it increased up to 7.9. But, when treated 0.5% limes, pH first increased till 20 days of incubation, after which it got stabilized and pH ranges between 7.89 and 7.98. By the application of 1% lime, pH value followed the same trend (Table No. 5.4).In case of 20% solid waste mixed soil, the pH was observed between 7.66 and 7.75 till 30 days; after that it increased with time. By the application of 0.5% lime in 30% summer waste mixed soil, pH got stabilized after 20 days of incubation. From the above discussion it is clear that 0.5% lime treatment of solid wastes gives better results. It is also economically viable for larger scale application.

	Sample	Incubation Period (days)							
% of w		0	10	20	30	45	60	90	120
0	J-0-0	8.33	8.37	8.26	8.14	8.2	8.29	8.16	8.21
	J-0-0.5	9.92	8.79	8.56	8.5	8.43	8.48	8.35	8.48
	J-0-1.0	10.56	9.61	8.57	8.57	8.52	8.48	8.37	8.44
10M	J-M10-0	7.39	7.82	7.71	7.72	7.8	7.81	7.81	7.83
	J-M10-0.5	7.44	7.8	7.74	7.76	7.85	7.85	7.82	7.82
	J-M10-1.0	7.6	7.79	7.75	7.79	7.81	7.87	7.89	7.82
20M	J-M20-0	7.39	7.62	7.59	7.55	7.72	7.74	7.67	7.69
	J-M20-0.5	7.44	7.65	7.6	7.58	7.72	7.71	7.69	7.73
	J-M20-1.0	7.6	7.7	7.65	7.62	7.71	7.74	7.7	7.74
30M	J-M30-0	7.32	7.46	7.47	7.5	7.6	7.63	7.54	7.65
	J-M30-0.5	7.32	7.53	7.52	7.55	7.63	7.61	7.59	7.68
	J-M30-1.0	7.63	7.62	7.61	7.58	7.68	7.65	7.61	7.7
10W	J-W10-0	7.72	7.83	7.79	7.69	7.9	7.9	7.83	7.95
	J-W10-0.5	7.75	7.88	7.86	7.77	7.97	7.9	7.83	7.93
	J-W10-1.0	7.87	7.89	7.81	7.78	8	7.9	7.86	7.96
20W	J-W20-0	7.52	7.71	7.68	7.53	7.7	7.68	7.7	7.8
	J-W20-0.5	7.59	7.73	7.76	7.61	7.72	7.72	7.69	7.84
	J-W20-1.0	7.85	7.81	7.65	7.66	7.76	7.74	7.72	7.84
30W	J-W30-0	7.4	7.56	7.59	7.51	7.66	7.58	7.55	7.73
	J-W30-0.5	7.47	7.62	7.6	7.55	7.67	7.6	7.57	7.74
	J-W30-1.0	7.79	7.72	7.67	7.57	7.67	7.61	7.62	7.4
10S	J-S10-0	7.64	7.86	7.75	7.75	7.9	7.9	7.87	7.9
	J-S10-0.5	7.76	7.88	7.8	7.8	7.98	7.91	7.89	7.95
	J-S10-1.0	8	7.97	7.82	7.81	7.93	7.92	7.78	7.97
20S	J-S20-0	7.52	7.74	7.61	7.63	7.79	7.69	7.72	7.87
	J-S20-0.5	7.66	7.75	7.66	7.65	7.77	7.74	7.75	7.87
	J-S20-1.0	8.05	7.96	7.79	7.76	7.81	7.76	7.72	7.87
30S	J-S30-0	7.41	7.53	7.55	7.54	7.62	7.66	7.62	7.77
	J-S30-0.5	7.58	7.64	7.57	7.57	7.63	7.62	7.59	7.77
	J-S30-1.0	8.1	7.95	7.76	7.66	7.64	7.62	7.64	7.82

Table No. 5.4. pH of JNU soil (mixed with solid wastes of different seasons) after different days of incubation.

5.2. ELECTRICAL CONDUCTIVITY (E C)

Value of EC in different samples (both Chhattarpur and JNU soil, mixed with solid wastes) is below 2 ms/cm

In pure Chhattarpur soil the EC ranges from 0.070 ms/cm to 0.164 ms/cm in different days of incubation (Fig. No 5.7).

After 0.5% lime treatment, EC varied between 0.085– 0.182 mS/cm (Fig. No. 5.8) and for 1% lime treatment the range is 0.128 –0.195. In case of JNU pure soil the range is approximately the same i.e. 0.127 –0.195 mS/cm (Fig. No 5.7 and table no. 5.6).

For 10% monsoon waste mixed soil of Chhattarpur, the electrical conductivity (0.612 mS/cm) of soil showed more variations, compared to pure soils (0.070 mS/cm).

An increase in EC was observed with increase in days of incubation, till 30 days and afterwards it decreased. The same trend was observed in case of 20% and 30% monsoon waste mixed soil of Chhattarpur. After 30 days of incubation the EC values decreased with increase in days of incubation (Table 5.5). The same trend was found for JNU soil, mixed with monsoon waste. Maximum values of EC were observed after 20 days of incubation and after that EC decreased with time. Similar trends were found in the case of both winter and summer waste mixed JNU soil (Table No. 5.6). But in case of Chhattarpur soil, mixed with 3 different types of solid wastes showed the maximum value after 30 days of incubation and after that it decreased (Table No. 5.5).

		Period Incubated (days)							
% of W	Sample	0	10	20	30	45	60	90	120
0	C-0-0	0.070	0.127	0.155	0.164	0.123	0.117	0.117	0.122
	C-0-0.5	0.085	0.166	0.164	0.182	0.116	0.134	0.111	0.112
	C-0-1.0	0.128	0.188	0.184	0.195	0.138	0.128	0.135	0.136
10M	C-M10-0	0.612	0.529	0.591	0.629	0.372	0.361	0.365	0.355
	C-M10-0.5	0.565	0.507	0.570	0.607	0.343	0.355	0.378	0.356
	C-M10-1.0	0.546	0.501	0.540	0.600	0.342	0.342	0.381	0.382
20M	C-M20-0	0.936	0.713	0.801	0.887	0.546	0.502	0.536	0.489
	C-M20-0.5	0.916	0.767	0.790	0.868	0.581	0.514	0.532	0.530
	C-M20-1.0	0.987	0.748	0.801	0.870	0.510	0.492	0.518	0.557
30M	C-M30-0	1.256	0.985	1.029	1.162	0.687	0.652	0.619	0.602
	C-M30-0.5	1.266	0.940	0.994	1.137	0.699	0.599	0.629	0.611
	C-M30-1.0	1.242	0.991	1.092	1.423	0.686	0.585	0.648	0.621
10W	C-W10-0	0.412	0.609	0.518	0.815	0.300	0.258	0.342	0.406
	C-W10-0.5	0.477	0.564	0.517	0.775	0.252	0.314	0.320	0.368
	C-W10-1.0	0.382	0.553	0.499	0.755	0.249	0.292	0.285	0.339
20W	C-W20-0	0.601	0.818	0.755	1.177	0.474	0.404	0.436	0.490
	C-W20-0.5	0.615	0.827	0.760	1.270	0.441	0.490	0.468	0.339
	C-W20-1.0	0.702	0.812	0.795	1.205	0.491	0.430	0.453	0.480
30W	C-W30-0	0.920	1.036	0.930	1.589	0.608	0.533	0.552	0.578
	C-W30-0.5	0.937	1.031	0.980	1.585	0.624	0.579	0.595	0.572
	C-W30-1.0	0.895	1.156	0.990	1.631	0.618	0.601	0.585	0.650
10S	C-S10-0	0.364	0.471	0.515	0.728	0.264	0.352	0.311	0.286
	C-S10-0.5	0.430	0.490	0.518	0.828	0.350	0.354	0.321	0.306
	C-S10-1.0	0.388	0.485	0.497	0.765	0.261	0.386	0.300	0.327
20S	C-S20-0	0.738	0.708	0.775	1.230	0.588	0.428	0.429	0.439
	C-S20-0.5	0.743	0.787	0.769	1.242	0.540	0.435	0.462	0.453
	C-S20-1.0	0.775	0.798	0.751	1.247	0.511	0.456	0.442	0.426
30S	C-S30-0	1.066	0.866	0.989	1.639	0.645	0.559	0.578	0.547
	C-S30-0.5	0.916	0.948	0.975	1.666	0.597	0.575	0.568	0.516
	C-S30-1.0	1.012	1.041	1.022	1.725	0.567	0.593	0.588	0.566

Table No. 5.5 Electrical Conductivity waste amended Chhattarpur Soil (mS/cm) after different days of incubation

		Period Incubated (days)							
% of W	Samples	0	10	20	30	45	60	90	120
0	J-0-0	0.127	0.137	0.164	0.161	0.129	0.195	0.179	0.131
	J-0-0.5	0.156	0.150	0.167	0.159	0.156	0.116	0.205	0.132
	J-0-1.0	0.288	0.276	0.288	0.189	0.157	0.135	0.212	0.168
10M	J-M10-0	0.813	0.847	0.854	0.661	0.614	0.526	0.506	0.535
	J-M10-0.5	0.845	0.816	0.829	0.681	0.633	0.495	0.493	0.567
	J-M10-1.0	0.841	0.868	0.882	0.668	0.595	0.502	0.575	0.612
20M	J-M20-0	1.325	1.325	1.339	0.887	0.873	0.751	7.060	0.689
	J-M20-0.5	1.317	1.289	1.299	0.868	0.882	0.823	0.740	0.721
	J-M20-1.0	1.275	1.350	1.361	0.870	0.877	0.776	0.838	0.820
30M	J-M30-0	1.692	1.685	1.692	1.162	1.059	0.953	0.838	0.812
	J-M30-0.5	1.628	1.705	1.711	1.137	1.080	0.904	0.790	0.771
	J-M30-1.0	1.705	1.729	1.738	1.111	1.066	0.971	0.959	0.929
10W	J-W10-0	0.626	0.704	0.719	0.709	0.525	0.436	0.644	0.626
	J-W10-0.5	0.629	0.677	0.693	0.682	0.378	0.430	0.567	0.592
	J-W10-1.0	0.634	0.685	0.699	0.648	0.430	0.433	0.580	0.599
20W	J-W20-0	1.010	1.075	1.088	0.831	0.766	0.722	0.776	0.752
	J-W20-0.5	1.007	1.017	1.031	0.817	0.760	0.630	0.610	0.602
	J-W20-1.0	0.975	1.054	1.069	0.859	0.754	0.671	0.680	0.633
30W	J-W30-0	1.356	1.340	1.347	1.032	0.935	0.870	0.826	0.813
	J-W30-0.5	1.285	1.415	1.422	1.107	0.955	0.845	0.871	0.841
	J-W30-1.0	1.345	1.444	1.451	1.142	0.930	0.985	0.898	0.877
10S	J-S10-0	0.703	0.726	0.738	0.671	0.535	0.440	0.449	0.429
	J-S10-0.5	0.700	0.762	0.779	0.662	0.389	0.420	0.401	0.411
	J-S10-1.0	0.713	0.746	0.762	0.652	0.470	0.418	0.422	0.430
20S	J-S20-0	1.149	1.095	1.102	0.710	0.649	0.664	0.660	0.654
	J-S20-0.5	1.133	1.125	1.132	0.711	0.687	0.651	0.633	0.631
	J-S20-1.0	1.143	1.189	1.196	0.717	0.693	0.693	0.629	0.611
30S	J-S30-0	1.536	1.495	1.501	1.192	0.932	0.820	0.901	0.903
	J-S30-0.5	1.545	1.598	1.600	1.121	0.943	0.842	0.873	0.889
	J-S30-1.0	1.537	1.607	1.611	1.105	0.965	0.892	0.889	0.899

Table No. 5.6 Electrical Conductivity Waste amended JNU Soil (mS/cm) after different days of incubation

4.3. ORGANIC CARBON:

Carbon is the chief element present in soil organic matter, comprising 48% to 58% of the total weight. Therefore organic carbon determination is often used as the basis for organic matter estimation (through multiplying the organic carbon value by a factor). For many years the Van Bemmelen Factor of 1.724 was used, based on the assumption that the organic matter contains 58% organic carbon.

	INCUBATION PERIOD (DAYS)							
Samples	0	10	20	30	45	60	90	120
C-0-O								
C-0-0.5	0.6065	0.7266	0.5884	0.6508	0.5596	0.6029	0.5762	0.6523
C-0-1.O								
C-M10-0								
C-M10-0.5	1.0586	1.0646	0.9328	0.8809	0.7777	0.9271	0.8464	0.9923
C-M10-1.0								
C-M20-0								
C-M20-0.5	1.5369	1.5443	1.1643	1.5294	1.3591	1.2414	1.2328	1.3814
C-M20-1.0								
C-M30-0								
C-M30-0.5	1.7154	1.9378	1.7069	1.7636	1.65	1.5937	1.4747	1.6065
C-M30-1.0								
C-W10-0								
C-W10-0.5	1.1328	1.1328	0.8795	0.9355	0.8663	0.8555	0.8602	1.0377
C-W10-1.0								
C-W20-0								
C-W20-0.5	1.2502	1.2453	1.1826	1.1604	1.1612	1.0832	1.0779	1.2182
C-W20-1.0								
C-W30-0								
C-W30-O.5	1.7381	1.5681	1.5065	1.5101	1.4702	1.2699	1.346	1.5372
C-W30-1.0								
C-S10-0								
C-S10-0.5	1.0357	0.9981	0.9046	0.8327	0.9708	0.9687	0.8369	0.9638
C-S10-1.0								
C-S20-0								
C-S20-0.5	1.3548	1.1611	1.1429	1.0545	1.1039	0.9989	0.9699	1.135
C-S20-1.0								
C-S30-0								
C-S30-0.5	1.714	1.5563	1.4823	1.5686	1.4584	1.7572	1.3024	1.3499
C-S30-1.0								

Table No. 5.7 Organic Carbon in Chhattarpur soil treated with wastes in different days of incubation

Although even the organic content of the soil is only 1% by volume, it will have tremendous influence on soil properties and plant growth. It is a major source of nitrogen, phosphorous and sulphur and in addition to other major and minor nutrients in soil. Finally the organic matter is the main source of energy for soil microorganisms. In the formation of the fertile soil, organic substance play a diverse role, as they are the source of plant nutrients, which are released in available forms during mineralization. Humus can be considered to be a storehouse of various nutrients essential for the plant growth.

The values of organic carbon of JNU soil and Chhattarpur soil (pure) are the 0.367 and 0.6065 respectively (Table No. 5.2). Among the solid waste the organic carbon is the highest in monsoon solid waste (pure) followed by winter and summer waste. (Fig. No. 5.10).

But when both the JNU and Chhattarpur soil separately mixed with different percentage of solid waste, the percentage of organic carbon also changed. From the results, it is clear that lime treatment did not make any significant difference in organic carbon of the same sample. But with different waste treatments, difference is significance (Table No 5.7,5.8)

In case of Chhattarpur soil the organic carbon is not significantly varying with time, till 60 days of incubation, form the Fig. No. 5.11 it is clear that the value of organic carbon was almost same after 120 days of incubation as it was at 0^{th} day. However after 10 days, organic carbon was slightly high and afterwards it slowly went down. in case of JNU pure soil, the same trends are found. (Fig No. 5.12)

When Chhattarpur soil is mixed with monsoon waste, it showed decreasing value of organic carbon in between 45-60 days of incubation but after that it increased and after 120 days ultimately it attained almost the same value as it was on the initial day.

In case of summer solid waste mixed with both JNU and Chhattarpur soil (separately) the organic carbon has decreased till 45 days of incubation and after that it increased and reached in a stable from The winter waste mixed with Chhattarpur soil showed different trend i.e. in case of 10% solid waste the organic carbon got stabilized after 30 days of incubation (Fig. No.5.16). But 20% and 30% winter solid waste showed the trend similar to monsoon solid waste (Fig No. 5.15).

DAYS OF INCUBATION								
Samples	0	10	20	30	45	60	90	120
J-0-O J-0-0.5 J-0-1.O	0.367	0.376	0.376	0.412	0.403	0.411	0.366	0.360
J-M10-0 J-M10-0.5 J-M10-1.0	0.476	0.466	0.412	0.437	0.444	0.429	0.427	0.429
J-M20-0 J-M20-0.5 J-M20-1.0	0.772	0.776	0.663	0.637	0.6065	0.6065	0.701	0.701
J-M30-0 J-M30-0.5 J-M30-1.0	1.0586	0.9355	0.9046	0.8327	0.8327	0.8808	0.8980	0.9046
J-W10-0 J-W10-0.5 J-W10-1.0	0.552	0.536	0.506	0.476	0.566	0.582	0.590	0.6065
J-W20-0 J-W20-0.5 J-W20-1.0	0.777	0.706	0.712	0.637	0.701	0.772	0.767	0.772
J-W30-0 J-W30-O.5 J-W30-1.0	1.1328	1.1161	1.0586	1.0546	0.9981	0.9923	1.0586	1.1112
J-S10-0 J-S10-0.5 J-S10-1.0	0.559	0.541	0.5031	0.5010	0.5229	0.5572	0.5824	0.5925
J-S20-0 J-S20-0.5 J-S20-1.0	0.8327	0.8211	0.8025	0.8025	0.8112	0.8101	0.8229	0.8231
J-S30-0 J-S30-0.5 J-S30-1.0	1.2453	1.2328	1.1612	1.1039	1.1039	1.1121	1.1611	1.1611

Table No. 5. 8 Organic Carbon of JNU soil treated with wastes in different days of incubation

In case of JNU soil, the organic carbon first decreased up to 30 days of incubation; afterwards it increased and then decreased and finally got stabilized (Fig No. 5.14).

From the study it is clear that, for 30% winter waste mixed with JNU soil organic carbon has decreased compared to summer solid waste. (Table No.5.8) But in Chhattarpur soil, mixed with waste, the trend was different. Here organic carbon showed lesser value in case of 30% monsoon waste mixed soil, followed by winter and summer waste mixed soil (Table No 5.7)

5.4. CATION-EXCHANGE CAPACITY (CEC)

Soil scientists have well recognized the phenomenon now known as Cation Exchange over a century (Thompson, 1850, Way 1850, 1852). A soil leached with a salt solution has the power to absorb the cations of the percolating solution and to liberate an equivalent amount of others cations. Thus a soul leached with ammonium acetate solution will absorb some ammonium ions and liberate calcium, magnesium and other ions, which will, appeared in the leached (Hasse, 1972). The predominant cations involved in exchange are hydrogen, calcium, magnesium, potassium, sodium and ammonium. The exchangeable form is the most important source of immediately available plant nutrient. In general, available cations can be considered as exchangeable cations. The exchangeable cations are generally available to both higher plants and microorganisms. By cations exchange, hydrogen ions from the root hairs and microorganisms replace nutrients cations from the exchangeable complex (Brady, 2000). The total amount of exchangeable cations that can be hold by a soil is known its cations exchange capacity.

The determination of CEC and individual exchangeable cations not only helps to evaluate the fertility of soil but also to classify it.

Cations Exchange capacity is defined as the degree to which a soil can absorb and exchange cations. CEC is highly dependent upon soil texture and organic matter

			Incubation Period (Days).							
Season	% of W	% Lime	0	10	20	30	45	60	90	120
	0	0	11.896	10.445	9.258	10.919	11.157	9.103	9.001	9.131
		0.5	12.106	10.207	9.723	11.394	9.971	9.871	9.471	9.269
		1.0	14.955	13.056	9.907	12.581	10.919	10.569	10.141	9.907
Summer	10	0	12.153	12.392	11.433	11.915	11.191	10.191	10.020	9.909
		0.5	12.630	13.345	13.338	13.583	12.153	11.372	10.238	10.103
		1.0	10.732	12.392	12.868	14.060	12.630	11.923	10.723	10.239
	20	0	13.157	12.200	11.722	12.200	13.875	12.371	11.878	11.589
		0.5	13.636	12.440	12.679	14.114	14.354	13.123	11.702	11.321
		1.0	12.679	12.200	12.918	15.311	14.593	12.532	11.021	10.837
	30	0	14.410	13.402	12.728	12.008	12.008	12.90	10.020	9.320
		0.5	15.370	14.377	14.169	13.209	13.929	11.732	10.132	9.707
		1.0	13.689	14.377	14.410	13.929	15.370	13.829	11.958	10.283
Monsoon	10	0	10.287	13.397	12.679	11.110	10.908	9.091	9.110	9.089
		0.5	10.047	11.483	11.961	13.875	10.851	9.910	9.587	9.411
		1.0	10.047	11.483	12.440	13.875	11.084	10.179	9.891	9.582
	20	0	11.091	10.367	10.367	11.031.	10.849	10.010	9.683	9.373
		0.5	11.572	10.608	11.814	15.672	11.091	10.783	10.102	9.919
		1.0	12.778	10.608	11.814	13.019	11.573	11.010	10.011	9.973
	30	0	10.449	12.636	12.150	11.580	10.206	9.837	9.189	8.929
		0.5	10.692	11.664	13.122	12.636	11.907	11.121	10.523	10.011
		1.0	11.412	11.664	13.365	12.879	14.337	12.371	11.608	11.217
Winter	10	0	9.994	10.232	10.469	11.183	7.614	8.021	8.000	8.090
		0.5	10.469	10.232	10.469	13.325	8.804	8.171	7.925	7.989
		1.0	10.707	10.232	10.464	13.801	9.994	9.231	9.101	9.032
	20	0	10.494	9.779	11.687	11.449	13.357	11.597	10.327	10.172
		0.5	10.494	10.256	12.880	13.118	12.880	11.231	10.927	10.589
		1.0	10.733	10.971	13.357	13.595	15.265	12.932	12.157	11.998
	30	0	13.389	12.193	11.943	11.943	13.628	11.783	11.232	10.997
		0.5	13.150	13.150	12.657	13.893	12.910	11.321	10.757	10.231
		1.0	13.867	12.671	12.675	12.918	11.954	10.854	10.328	10.171

Table No. 5.9 CEC of Waste amended and limed Chhattarpur soil after different days of incubation

	PERIOD OF INCUBATION (DAYS)							
SAMPLE	0	10	20	30	45	60	90	120
J-0-0	10.781	9.921	8.711	9.723	10.282	9.32	9.26	9.131
J-0-0.5	11.292	10.207	9.021	10.102	10.723	9.723	9.779	9.779
J-0-1	13.211	12.153	9.257	10.824	10.824	9.921	9.921	9.909
J-M10-0	9.211	11.488	11.608	11.943	11.608	11.01	10.429	10.367
J-M10-0.5	8.724	9.91	11.101	11.943	11.573	11.449	10.919	10.469
J-M10-1.0	8.724	9.91	10.206	11.101	10.997	10.287	10.919	10.707
J-M20-0	10.725	10.367	11.608	11.608	11.01	10.283	9.521	9.521
J-M20-0.5	10.725	10.483	11.998	11.449	11.687	10.851	10.283	9.878
J-M20-1.0	10.725	11.664	12.15	11.664	11.943	10.992	10.851	9.878
J-M30-0	9.449	11.629	11.449	11.217	11.687	11.01	10.851	10.191
J-M30-0.5	9.655	11.664	12.157	12.371	11.943	11.614	10.971	10.723
J-M30-1.0	10.725	11.907	12.636	12.879	12.88	11.814	11.01	10.971
J-W10-0	8.877	9.101	10.608	11.597	11.814	11.814	11.183	11.183
J-W10-0.5	9.269	10.011	11.217	11.943	12.44	11.943	11.449	11.687
J-W10-1.0	9.707	10.589	11.449	11.943	12.193	11.943	11.449	11.157
J-W20-0	9.556	10.172	11.573	11.573	12.15	12.157	11.943	11.449
J-W20-0.5	9.559	10.283	11.217	11.943	12.392	12.392	11.943	11.449
J-W20-1.0	9.811	11.217	12.2	11.449	11.687	11.943	11.943	11.664
J-W30-0	12.101	11.084	11.483	12.636	12.679	11.943	11.597	11.01
J-W30-0.5	12.389	11.687	11.687	12.88	12.88	12.193	11.814	11.217
J-W30-1.0	12.885	11.998	13.343	13.628	12.675	12.44	11.814	11.814
J-S10-0	11.252	11.121	10.289	11.121	11.608	11.01	10.837	10.783
J-S10-0.5	11.811	12.531	12.782	12.778	12.728	12.636	12.636	11.608
J-S10-1.0	10.723	11.921	12.862	12.862	12.862	12.636	12.153	11.954
J-S20-0	11.127	11.119	10.422	11.573	11.907	11.421	11.121	10.723
J-S20-0.5	12.428	11.872	11.769	12.636	12.88	12.44	12.224	11.814
J-S20-1.0	12.79	11.98	12.112	13.656	13.357	12.88	12.44	11.814
J-S30-0	12.51	11.556	11.002	12.879	12.879	12.15	11.572	11.01
J-S30-0.5	13.357	12.877	13.249	13.636	13.801	13.397	12.778	11.907
J-S30-1.0	13.861	13.299	13.808	11.573	11.449	10.723	10.179	11.01

Table No. 5.10 CEC of Waste amended and limed JNU soil after different days of incubation.

After treatment with monsoon wastes, CEC values have not increased. But with increasing incubation period, it increased compared to pure JNU soil. It is clear that lime treatment did not differ significantly compared to unlimed soil with respect to CEC. But waste treatment caused variation in CEC values with different days of incubation and lime treatment (Table 5.10).

The same trend was found in case of winter and summer waste mixed JNU soil, i.e. CEC did not increase with waste treatment. But after treatment with waste, if soil is treated with lime, the CEC increased with time. Almost in each case, CEC attained the peak value after 45 days of incubation and then it slightly decreased with time.

5.5 CALCIUM

Calcium occurs very abundantly in soil in the form of carbonate, phosphate, silted fluorides and sulphate. Calcium is typically deficient in acidic soil but can also be deficient in sodium rich alkali soil (Brady, 2000), where it may be precipitated as carbonate; or may be displaced by sodium compounds. In natural soil calcium can be fixed by phosphorous, and remains readily available to plants until it leached away (Hesse, 1971).

CALCIUM IN CHHATTARPUR SOIL

In Chhattarpur pure soil the available calcium is moderately high i.e. 5.34 meqv /100g soil and up to 30 days of incubation it increased, but after 120 days of incubation it decreased up to 4.023 mequv/100 g soil. After lime treatment (1% lime) the concentration available calcium in soil increased, while application of 0.5% lime did not make as much as difference. The values of calcium are almost same in different days of incubation (Table No. 5.11)

When Chhattarpur soil was mixed with different types of wastes, available calcium increased; moreover lime application has enhanced the availability of exchangeable calcium in the soil.

In case of treatment with monsoon waste, the available calcium status has increased with time. Figure showing that after mixing different proportions of the monsoon wastes with Chhattarpur soil, the availability of Calcium did not increase in the initial days of incubation. The values increased with increasing days of incubation up to 30 days, and after 45^{th} day it got stabilized. The retention of available calcium was much higher in monsoon waste mixed soil than in pure soil (Fig No. 5.17). Available calcium is always higher in the soil mixed with solid waste than in control by the application of 0.5% lime except 10% of monsoon solid wastes mixed waste treatment soil When treated with lime, pH and Calcium of both the pure soil and wastes mixed soil increased (Fig No. 5.18,5.19). 30% monsoon waste mixed soil, on 30[th] day, showed a neutral pH (7.24) and higher value of available Ca^{++} compared to control. After that pH got stabilized but available calcium slowly decreased with incubation days.

	Incubation Period (Days)							
Samples	0	10	20	30	45	60	90	120
C-0-O	5.34	5.083	5.575	5.665	5.77	4.125	4.023	4.023
C-0-0.5	5.23	5.476	4.575	5.977	5.977	4.575	4.184	4.125
C-0-1.O	6.3	6.3	5.125	5.977	5.556	4.575	4.184	4.184
C-M10-0	4.575	5.476	5.775	6.665	5.445	4.995	4.445	4.445
C-M10-0.5	5.043	5.963	5.997	6.125	5.977	5.476	4.95	4.995
C-M10-1.0	5.382	5.977	6.056	6.56	5.775	5.476	5.125	5.125
C-M20-0	5.726	5.075	5.775	5.775	5.225	4.995	4.222	4.125
C-M20-0.5	5.726	5.799	5.975	6.05	5.77	5.075	4.575	4.656
C-M20-1.0	6.329	6.329	5.56	6.665	5.975	5.382	5.125	5.205
C-M30-0	5.168	5.445	5.725	6.329	5.665	5.075	4.323	4.115
C-M30-0.5	5.476	5.775	5.977	6.665	5.728	5.164	4.72	4.565
C-M30-1.0	6.075	6.015	5.056	6.125	5.995	5.575	4.925	4.925
C-W10-0	5.056	5.056	5.575	6.125	4.575	4.123	4.123	4.153
C-W10-0.5	5.275	5.275	5.775	5.775	4.12	4.445	4.403	4.403
C-W10-1.0	5.775	5.775	6.025	6.665	4.234	4.235	4.235	4.445
C-W20-0	5.068	5.068	5.205	5.565	4.885	4.885	4.623	4.445
C-W20-0.5	5.725	5.725	5.997	6.665	5.125	4.995	4.575	4.625
C-W20-1.0	5.977	5.977	6.125	6.665	5.375	5.083	4.995	4.755
C-W30-0	5.977	5.977	6.125	6.665	5.565	5.445	4.995	4.565
C-W30-O.5	6.205	6.205	6.56	5.977	5.565	4.995	4.665	4.665
C-W30-1.0	6.575	6.575	6.575	6.575	5.975	4.995	4.995	4.95
C-S10-0	5.361	5.726	5.975	6.125	6.225	5.995	5.075	5.075
C-S10-0.5	5.659	5.977	5.977	6.326	6.775	5.995	5.265	5.075
C-S10-1.0	6.255	6.3	6.205	6.326	6.775	5.995	5.265	5.125
C-S20-0	5.98	6.231	6.575	6.575	6.575	6.125	5.755	5.565
C-S20-0.5	6.877	6.775	6.302	6.575	6.775	6.125	5.785	5.785
C-S20-1.0	7.476	7.531	6.918	7.431	6.989	6.575	5.997	5.565
C-S30-0	7.205	7.205	6.918	6.575	6.989	6.775	5.995	5.775
C-S30-0.5	7.505	7.625	7.431	6.918	7.205	7.205	5.565	5.625
C-S30-1.0	7.505	7.625	7.625	6.918	7.625	7.205	5.565	5.565

Table No. 5.11 Available Calcium in Chhattarpur soil mixed with wastes in different days of incubation

For Chhattarpur soil mixed with Monsoon waste and lime, application of 1% lime did not make any difference in the availability of calcium between different proportions of wastes and pure soil in the initial days of incubation. Moreover all the pH, CEC, and exchangeable calcium were very high in pure Chhattarpur soil with 1% lime treatment. With the increasing days of incubation all the pH, Ca^{++} and CEC values of the pure Chhattarpur soil have decreased, though for the soil treated with monsoon waste these parameters increased up to 30 days of incubation and after that their values deceased with time but not less that of pure soil with 1% lime.

The winter waste mixed Chhattarpur soil, without lime treatment, did not show any significant difference in available Ca^{++} compared to pure soil. The values of both CEC and pH are almost same in both cases. Except pH, other two parameter have increased after 20 days of incubation with respect to pure soil, without lime treatment. The values of available calcium were the highest in 30% winter waste mixed soil (6.125 mequv/100g) on the 30 days of incubation and pH was found neutral (Fig No. 5.20).

Only in case of Chhattarpur soil mixed with 10% of winter waste, available calcium showed a lower value than in pure soil, treated with 0.5% lime .On other hand, soil mixed with 20% and 30% winter waste, showed higher values compared to pure soil treated with 0.5% lime. But after 10 days all winter waste mixed Chhattarpur soil, showed higher values of calcium than pure soil, treated with 0.5% lime up to 30 days of incubation and after that Ca^{++} of waste mixed soil decreased up to 60 days of incubation compared to pure soil, treated with 0.5% lime and after 90 days of incubation and onwards the available calcium increased a little compared to pure soil treated with 0.5% lime (Fig No. 5.21).

For Chhattarpur soil treated with different proportions of winter waste and 1 % lime, the pattern of availability of calcium is quite different. At the 1st day of incubation, the available calcium was higher than other samples. After 10 days of incubation, the available calcium was higher than pure soil. However after 30 days of incubation, the trend reversed except for 30 % winter waste mixed soil. In subsequent period the values of available calcium were almost the same as for pure soil (Fig No. 5.22).

For summer waste mixed soil treated with 0% lime, available calcium was always high than pure one. The values were the highest after 10 days of incubation. The CEC on the other hand was always high for pure soil (Fig No. 5.23).

For summer waste mixed soil treated with 0.5% lime, both the exchangeable calcium and CEC were always high with respect to pure soil, treated with 0.5% lime. Till 60 days of incubation the available calcium in 10%, 20% and 30% summer waste mixed with soil showed the values ranging from 6.326-5.326: 6.877-5.324 and 7.625-5.997 mequv/100g soil respectively (Fig No. 5.24).

For summer waste mixed soil treated with 1% lime, Ca^{++} values are always higher compared to pure soil treated with 1% lime except 10% summer waste mixed soil. In this case CEC is always much higher in compared to 1% limed pure soil. Here available calcium was the highest (7.625) among all samples. Up to 45 days, the available calcium was found almost stable and after that it decreased with incubation days (Fig No. 5.25).

CALCIUM IN JNU SOIL

Calcium in JNU soil is 4.125 meqv/100g of soils and it did not change remarkably with increasing incubation days (range is 4.49 – 4.023 meqv/100g). But lime treatment made a large difference in calcium in different days of incubation The maximum value was 5.725 meqv/100 g of soil after 10 days of incubation in case of 1% lime treatment and after that it decreased and got stabilized after 45 days of incubation (Fig No. 5.26).

It is surprising that application of acidic waste (of three different seasons) in JNU soil have enhanced the availability of calcium with respect to the pure soil without any lime treatment The available Ca^{++} has increased up to 30 days of incubation, then got stabilized. Ultimately the values decreased up to the 1^{st} day of incubation (Fig No. 5.28).

For each case the available calcium increased with the treatment of wastes and lime. Besides the treatment of 1% lime, the pH values can also increased by the treatment of 0.5% lime in waste mixed soils (Fig No. 5.29, 5.30).

Period of Incubation (DAYS)								
SAMPLES	0	10	20	30	45	60	90	120
J-0-O	4.125	4.125	4.125	4.445	4.125	4.075	4.108	4.023
J-0-0.5	4.125	4.575	4.075	4.425	4.125	4.125	4.125	4.184
J-0-1.O	4.556	5.725	4.445	4.854	4.425	4.372	4.375	4.375
J-M10-0	5.125	5.665	5.707	5.775	5.665	5.056	4.775	4.775
J-M10-0.5	5.125	5.665	5.775	5.855	5.665	5.125	4.209	4.9
J-M10-1.0	5.235	5.975	5.858	5.977	5.702	5.125	4.775	4.775
J-M20-0	5.665	4.725	5.056	5.125	5.056	4.408	4.225	4.125
J-M20-0.5	5.775	4.445	5.125	5.448	5.125	4.57	4.225	4.44
J-M20-1.0	5.997	4.725	5.445	5.665	5.324	4.997	4.655	4.44
J-M30-0	5.056	4.925	5.235	5.235	5.26	4.975	4.225	4.125
J-M30-0.5	5.325	4.997	5.656	5.775	5.324	4.975	4.445	4.225
J-M30-1.0	5.775	5.056	5.854	5.977	5.775	5.056	4.625	4.445
J-W10-0	5.056	4.125	4.448	4.99	4.875	4.444	4.44	4.123
J-W10-0.5	5.43	4.435	4.898	5.056	5.056	4.749	4.325	4.403
J-W10-1.0	5.665	4.456	4.997	5.125	5.225	4.997	4.775	4.744
J-W20-0	4.445	4.925	4.925	5.125	5.125	4.775	4.125	4.125
J-W20-0.5	4.995	4.925	5.056	5.345	5.205	4.775	4.125	4.445
J-W20-1.0	5.265	5.056	5.325	5.656	5.324	4.997	4.125	4.125
J-W30-0	5.375	5.445	5.656	5.655	5.205	4.448	4.44	4.44
J-W30-O.5	5.775	5.775	5.875	5.975	5.375	4.975	4.567	4.445
J-W30-1.0	5.995	6.125	6.125	5.975	5.778	4.995	4.775	4.225
J-S10-0	5.125	5.235	5.125	5.225	5.125	4.438	4.125	4.475
J-S10-0.5	5.408	5.656	5.656	5.326	5.324	4.875	4.475	4.625
J-S10-1.0	5.475	5.775	5.565	5.775	5.895	4.975	4.555	4.772
J-S20-0	5.125	5.325	5.238	5.445	5.125	5.125	4.875	4.772
J-S20-0.5	5.775	5.655	5.428	5.556	5.324	4.975	4.875	4.995
J-S20-1.0	5.656	5.975	5.556	5.775	5.556	5.125	4.995	4.62
J-S30-0	5.776	5.776	5.775	5.775	5.556	5.056	4.775	4.565
J-S30-0.5	6.231	5.656	5.855	6.025	5.975	5.125	4.565	4.775
J-S30-1.0	6.575	5.995	5.977	6.125	5.775	5.325	4.775	4.775

Table No. 5.12 Available Calcium In JNU Soil mixed with wastes in different days of incubation.

From the above discussion it is clear that, available calcium and magnesium in Chhattarpur soil are higher than those for JNU soil (Table No. 5.11, 5.12). By the treatment of lime, Ca^{++} increased while Mg^{++} decreased. With different days of incubation the available calcium increased up to 30 days, after that it got stabilized. In case of magnesium in both soils, the values are in decreasing order with increasing days incubation. These results were similar to the work of Bould (1963) that monsoon wastes have low Mg^{++} level than summer and winter wastes. The highest values of magnesium were found in summer waste followed by winter waste mixed soil (Fig No. 5.32 ,5.33, 5.35, 5.36). It is important to mention that, pure JNU soil and Chhattarpur soil could not maintain the values of available calcium, but if solid wastes are mixed, they can maintain the availability of calcium up to 120 days of incubation compared to pure soil.

To sum up the wastes from Wazirpur Industrial area contains moderately high percentage of both calcium and magnesium.

6.5 MAGNESIUM

In soil, magnesium occurs principally in the clay minerals, being common in micas, vermicultures and chlorites; it sometimes occurs as carbonates. Smaller quantities are present in exchangeable ions, water-soluble forms and in organic combination. In chlorites, magnesium occurs in a layer alternating with silicate layers, and it is common inter layer contained in vermicutiles (salmon 1963). Magnesium can be lost from soil by leaching and it will be influenced by soil physical conditions as well as by rainfall. Bould (1963) reported that the ratio of potassium and magnesium in soil solution will be higher in wet then in dry soil and hence magnesium deficiency will be more pronounced during wet season. Saalbach and Judel (1961) has investigated that organic mannuring can be used to control magnesium deficiency. Apart form Magnesium added in the manure, it was concluded that microorganisms were stimulated whose metabolic products mobilized unavailable magnesium.

Magnesium is an essential constituent of chlorophyll and also involved in enzymatic reactions. This element affects the translocation of phosphorous (Truog et al 1947) and has been reported (Semenova, 1962) to increase sugar, vitamins starches and insulin in root crops. A deficiency of magnesium typically causes chlorosis (Reith 1963). The appearance in magnesium deficiency has become more frequent of late agricultural land due to greater removal by high yielding crops, leaching from acid, course-textured soil and with less magnesium being applied in fertilizer (Hesse, 1972). Sometimes high calcium magnesium ratios impair the uptake of magnesium but the most commonly encountered antagonistic ion is potassium. Wette and Werner (1963) investigated the uptake of magnesium by plants are influenced by H^+, K^+, $NH4^+$ and Ca^+ ions.They found that H^+ ions suppressed magnesium uptake most and with a strongly acidic substrate, magnesium deficiency could be remained by applying magnesium and raising pH. Raising the soil pH without adding magnesium increase magnesium

	Period of Incubation (DAYS)							
Samples	0	10	20	30	45	60	90	120
C-0-O	3.135	3.135	2.973	2.876	2.691	2.691	2.222	2.115
C-0-0.5	3.135	3.023	2.691	2.691	2.691	2.556	2.474	2.11
C-0-1.O	3.023	3.315	2.229	2.221	2.221	2.222	2.11	2.01
C-M10-0	3.289	3.023	2.973	2.973	2.878	2.776	2.776	2.668
C-M10-0.5	2.69	2.876	2.774	2.69	2.69	2.448	2.376	2.376
C-M10-1.0	2.691	2.691	2.321	2.221	2.229	2.21	2.11	1.901
C-M20-0	3.315	3.472	3.115	3.135	3.023	3.115	3.023	2.978
C-M20-0.5	3.315	3.135	3.135	3.023	3.023	3.115	3.023	2.876
C-M20-1.0	3.013	3.023	2.876	2.667	2.44	2.221	2.01	1.89
C-M30-0	3.289	3.315	3.023	2.975	2.876	2.975	2.878	2.676
C-M30-0.5	3.289	3.279	3.023	2.824	2.824	2.659	2.448	2.448
C-M30-1.0	3.135	2.974	2.679	2.659	2.448	2.324	2.11	1.99
C-W10-0	2.974	2.974	2.674	2.777	2.674	2.776	2.668	2.668
C-W10-0.5	2.676	2.526	2.576	2.321	2.328	2.328	2.115	2.01
C-W10-1.0	2.974	2.679	2.442	2.223	2.202	2.11	1.92	1.9
C-W20-0	3.279	3.279	3.123	3.023	2.974	2.779	2.778	2.676
C-W20-0.5	3.279	3.315	3.115	3.023	2.888	2.668	2.668	2.668
C-W20-1.0	3.279	2.974	2.961	2.771	2.11	2.11	2.221	2.11
C-W30-0	4.476	3.626	3.434	3.279	3.115	2.998	2.878	2.674
C-W30-O.5	4.781	3.88	3.279	3.115	3.023	2.023	2.222	2.202
C-W30-1.0	4.17	3.434	3.279	3.115	2.778	2.448	2.222	2.202
C-S10-0	3.315	3.025	3.023	3.315	3.339	3.115	3.115	3.023
C-S10-0.5	3.135	3.135	3.434	3.023	3.023	3.115	2.978	2.776
C-S10-1.0	3.289	3.023	3.023	2.691	2.691	2.663	2.663	2.448
C-S20-0	4.766	4.115	3.973	3.888	3.668	3.441	3.378	3.315
C-S20-0.5	4.781	4.405	3.872	3.872	3.626	3.626	3.626	3.315
C-S20-1.0	4.17	4.005	3.663	3.279	3.115	2.974	2.879	2.448
C-S30-0	4.275	4.115	3.889	3.889	3.889	3.889	3.778	3.448
C-S30-0.5	4.376	4.115	3.626	3.434	3.626	3.558	3.448	3.023
C-S30-1.0	4.376	3.973	3.115	3.023	2.976	2.674	2.572	2.328

Table No. 5.13 Available Magnesium in Chhattarpur soil mixed with wastes in different days of incubation.

Incubation Period (Days)								
Samples	0	10	20	30	45	60	90	120
J-0-0	2.691	2.448	2.110	2.023	2.023	1.920	1.990	2.000
J-0-0.5	2.891	2.676	2.448	2.448	2.211	2.010	2.010	2.010
J-0-1.0	2.668	2.448	2.110	2.003	2.023	2.010	2.023	2.023
J-M10-0	2.884	2.884	2.879	2.756	2.577	2.444	2.231	2.201
J-M10-0.5	2.448	2.998	2.888	2.776	2.575	2.378	2.336	2.301
J-M10-1.0	2.448	2.115	2.105	2.003	2.211	2.210	2.210	2.321
J-M20-0	3.115	2.978	2.978	2.888	2.577	2.324	2.222	2.121
J-M20-0.5	3.023	3.115	3.373	2.897	2.878	2.727	2.571	2.449
J-M20-1.0	3.023	2.878	2.679	2.444	2.221	2.111	2.010	2.110
J-M30-0	2.884	2.678	2.478	2.778	2.662	2.502	2.502	2.448
J-M30-0.5	2.998	2.888	2.668	2.778	2.558	2.502	2.511	2.458
J-M30-1.0	2.676	2.448	2.442	2.373	2.273	2.222	2.201	2.101
J-W10-0	2.868	2.979	2.888	2.575	2.431	2.207	2.121	2.023
J-W10-0.5	2.572	2.678	2.575	2.345	2.271	2.271	2.270	2.111
J-W10-1.0	2.442	2.222	2.115	2.101	2.243	2.336	2.101	2.023
J-W20-0	2.988	2.878	2.778	2.529	2.442	2.248	2.236	2.136
J-W20-0.5	2.776	2.575	2.444	2.448	2.242	2.228	2.241	2.224
J-W20-1.0	2.668	2.448	2.316	2.261	2.162	2.162	2.111	2.011
J-W30-0	3.315	3.023	2.723	2.668	2.412	2.316	2.256	2.260
J-W30-O.5	3.434	3.115	3.046	2.998	2.722	2.575	2.448	2.221
J-W30-1.0	3.115	3.023	2.888	2.777	2.511	2.321	2.310	2.321
J-S10-0	2.974	2.878	2.678	2.778	2.588	2.338	2.228	2.221
J-S10-0.5	3.023	2.878	2.878	2.778	2.432	2.227	2.227	2.171
J-S10-1.0	3.115	2.464	2.222	2.151	2.023	2.023	2.001	2.001
J-S20-0	3.115	3.023	2.998	2.668	2.448	2.222	2.220	2.221
J-S20-0.5	3.448	3.211	2.998	2.998	2.878	2.578	2.448	2.228
J-S20-1.0	3.023	2.778	2.575	2.444	2.221	2.023	2.103	2.023
J-S30-0	3.663	3.442	3.211	3.023	3.023	2.998	2.888	2.778
J-S30-0.5	3.889	3.662	3.448	3.221	3.123	3.023	2.997	2.929
J-S30-1.0	3.448	3.404	2.978	2.779	2.579	2.507	2.448	2.273

Table No. 5.14 Available Magnesium in waste amended JNU soil after different days of incubation.

availability more than by adding magnesium without raising pH. An excess of lime, however, is to be avoided as causing calcium antagonism.

In Chhattarpur soil the available magnesium is 3.135 meqv/100 g soil and the soil maintained its values up to 2.876 meqv/100 g soil up to 30 days of incubation, but after that the values decreased up to 2.115 meqv/100g soil (after 120 days of incubation). But treatments of lime (0.5% and 1%) could not enhance the availability of magnesium; moreover 1% lime treatment decreased the availability of magnesium (Table No. 5.14).

For Chhattarpur soil mixed with Monsoon waste, the results show that availability of calcium has decreased with increasing days of incubation and degree of lime treatment (Fig No. 5.39, 5.40, 5.41)

For Chhattarpur soil mixed with 20% Monsoon waste and 0.5% lime. There is some negative relation between available magnesium and lime treatment.

In each case same results have been found but by the application of 30 % winter waste in 20% of summer wastes really enhanced the available magnesium in Chhattarpur soil (Fig No. 5.43, 5.44, 5.45). From the above table (No. 5.13), it is obvious that available magnesium decreased with days of incubation in each case. But the treatment of 30% winter waste and summer wastes have increased the availability of magnesium in soil. After 120 days of incubation, the availability of magnesium was quite higher in comparison to pure soil. Although, the available magnesium did not increase with the days of incubation, it remained almost same or slightly above the normal soil magnesium level.

The same trend was found in each case of JNU soil. (Fig No. 5.45, 5,46, 5.47, 5.48, 5.49, 5.50, 5.51, 5.52, 5.53)

But it is clear that, Chhattarpur soil shows higher availability of magnesium (3.135 mequv/100 g soil) than JNU soil (2.691 mequv/100 g soil).

5.7. INTERPRETATION OF ANOVA EXERCISES

For each of the studied parameters, two factor ANOVA (Analysis of Variance) was performed to confirm the significance of difference due to different (common) factor, the exercise was executed separately against two factors and
F-values viz. lime treatment and waste treatment.

Following the decision rule as described earlier in Materials and Methods, the interpretation of various ANOVA exercises can be made.

We have following (total) number of ANOVA inferences for interpretation:

2 (sites of soil collection) X 5 (physico-chemical parameters) X **19** (ten units in the first set and nine units in the second set of treatments) = **190**

RESULTS AND DISCUSSION

To avoid complexicity of detailed account, each set of 9/10 ANOVA has been treated as aggregate inference. Based upon the numbers of individual inferences of each type, [i.e. significant (S) and insignificant (I)]; aggregate inference would be expressed in terms of either mostly significant, **MS** ($S>6$), or equally significant/insignificant, **ES** ($S \approx 1 \approx 5$), or mostly insignificant, **IS** ($S<4$).

The results are interpreted in following sequence:

1. pH

A. Keeping waste treatment constant;

a. For Chhattarpur soil;

i. Days of incubation:	MS
ii. Lime treatment:	MS

b. For JNU soil;

i. Days of incubation:	MS
ii. Lime treatment:	MS

B. Keeping lime treatment constant;

a. For Chhattarpur soil;

i. Days of incubation:	IS
ii. Waste treatment:	MS

b. For JNU soil;

i. Days of incubation:	IS
ii. Waste treatment:	MS

2. EC

A. Keeping waste treatment constant;

a. For Chhattarpur soil;

i. Days of incubation:	MS
ii. Lime treatment:	ES

b. For JNU soil;

i. Days of incubation:	MS
ii. Lime treatment:	ES

B. Keeping lime treatment constant;

a. For Chhattarpur soil;

i. Days of incubation: MS

ii. Waste treatment: MS

b. For JNU soil;

i. Days of incubation: MS

ii. Waste treatment: MS

3. CEC

A. Keeping waste treatment constant;

a. For Chhattarpur soil;

i. Days of incubation: MS

ii. Lime treatment: ES

b. For JNU soil;

i. Days of incubation: MS

ii. Lime treatment: MS

B. Keeping lime treatment constant;

a. For Chhattarpur soil;

i. Days of incubation: MS

ii. Waste treatment: MS

b. For JNU soil;

i. Days of incubation: IS

ii. Waste treatment: MS

4. Ca^{++} concentration;

A. Keeping waste treatment constant;

a. For Chhattarpur soil;

i. Days of incubation: MS

ii. Lime treatment: ES

b. For JNU soil;

i. Days of incubation: MS

ii. Lime treatment: MS

B. Keeping lime treatment constant;
   a. For Chhattarpur soil;
      i. Days of incubation: MS
      ii. Waste treatment: MS
   b. For JNU soil;
      i. Days of incubation: MS
      ii. Waste treatment: MS

5. **Mg^{++}concentration;**

A. Keeping waste treatment constant;
   a. For Chhattarpur soil;
      i. Days of incubation: MS
      ii. Lime treatment: MS
   b. For JNU soil;
      i. Days of incubation: MS
      ii. Lime treatment: MS

B. Keeping lime treatment constant;
   a. For Chhattarpur soil;
      i. Days of incubation: MS
      ii. Waste treatment: MS
   b. For JNU soil;
      i. Days of incubation: MS
      ii. Waste treatment: MS

The study comes out with miscellaneous series of inferences. In most of the cases the treatments (both factors) make significant differences in the studied parameters. However in certain cases treatments are either insignificant or equally significant/insignificant.

Table 5.15. Two-factor ANOVA to test significance of difference in pH in Chhattarpur soil due to days vs waste-treatment (0.05 level of significance)								
Sl.	Sample type		Diff.due to rows(days)			Diff.due to columns(w.t.)		
No.	lime	season	F-value	S/I	P-value	F-value	S/I	P-value
			2.4876			3.0725		
1	0.0%	mon	4.3943	S	3.83E-03	208.0182	S	9.00E-16
2	0.5%	mon	1.3394	I	2.81E-01	30.7147	S	7.21E-08
3	1.0%	mon	1.5042	I	2.20E-01	17.1711	S	7.25E-06
4	0.0%	win	5.1068	S	1.65E-03	225.3762	S	3.99E-16
5	0.5%	win	0.9991	I	4.59E-01	0.9807	I	4.21E-01
6	1.0%	win	1.0264	I	4.42E-01	16.4481	S	9.92E-06
7	0.0%	sum	5.4869	S	1.08E-03	161.1591	S	1.18E-14
8	0.5%	sum	1.8939	I	1.22E-01	30.9323	S	6.79E-08
9	1.0%	sum	2.1740	I	7.97E-02	17.3518	S	6.71E-06

Table 5.16. Two-factor ANOVA to test significance of difference pH in JNU soil due to days vs waste-treatment (0.05 level of significance)								
Sl.	Sample type		Diff.due to rows(days)			Diff.due to columns(w.t.)		
No.	lime	season	F-value	S/I	P-value	F-value	S/I	P-value
			2.4876			3.0725		
1	0.0%	mon	5.1068	S	1.65E-03	225.3762	S	3.99E-16
2	0.5%	mon	1.3394	I	2.81E-01	30.7147	S	7.21E-08
3	1.0%	mon	1.5042	I	2.20E-01	17.1711	S	7.25E-06
4	0.0%	win	5.1068	S	1.65E-03	225.3762	S	3.99E-16
5	0.5%	win	0.9991	I	4.59E-01	0.9807	I	4.21E-01
6	1.0%	win	0.9983	I	4.60E-01	0.9778	I	4.22E-01
7	0.0%	sum	5.4869	S	1.08E-03	161.1591	S	1.18E-14
8	0.5%	sum	1.8939	I	1.22E-01	30.9323	S	6.79E-08
9	1.0%	sum	2.1740	I	7.97E-02	17.3518	S	6.71E-06

Table 5.17. Two-factor ANOVA to test significance of difference in pH in Chhattarpur soil due to days vs lime-treatment (0.05 level of significance)

Sl.	Sample type		Diff.due to rows(days)			Diff.due to columns(lime t.)		
No.	waste	season	F-value	S/I	P-value	F-value	S/I	P-value
			2.7642			**3.7389**		
1	0%	con	7.2730	**S**	8.72E-04	5.3853	**S**	1.84E-02
2	10%	mon	45.0155	**S**	1.55E-08	14.0477	**S**	4.50E-04
3	20%	mon	14.0776	**S**	2.34E-05	34.3815	**S**	3.96E-06
4	30%	mon	3.8134	**S**	1.59E-02	93.6826	**S**	7.85E-09
5	10%	win	4.9080	**S**	5.58E-03	1.4701	**I**	2.63E-01
6	20%	win	1.1827	**I**	3.72E-01	8.1997	**S**	4.39E-03
7	30%	win	0.9993	**I**	4.71E-01	1.0004	**I**	3.93E-01
8	10%	sum	15.1087	**S**	1.54E-05	6.9563	**S**	7.99E-03
9	20%	sum	5.4664	**S**	3.44E-03	33.2704	**S**	4.79E-06
10	30%	sum	9.2956	**S**	2.43E-04	56.9161	**S**	1.89E-07

Table 5.18. Two-factor ANOVA to test significance of difference in pH in JNU soil due to days vs lime-treatment (0.05 level of significance)

Sl.	Sample type		Diff.due to rows(days)			Diff.due to columns(lime t.)		
No.	waste	season	F-value	S/I	P-value	F-value	S/I	P-value
			2.7642			**3.7389**		
1	0%	con	7.2730	**S**	8.72E-04	5.3853	**S**	1.84E-02
2	10%	mon	45.0155	**S**	1.55E-08	14.0477	**S**	4.50E-04
3	20%	mon	14.0776	**S**	2.34E-05	34.3815	**S**	3.96E-06
4	30%	mon	3.8134	**S**	1.59E-02	93.6826	**S**	7.85E-09
5	10%	win	4.9080	**S**	5.58E-03	1.4701	**I**	2.63E-01
6	20%	win	1.1827	**I**	3.72E-01	8.1997	**S**	4.39E-03
7	30%	win	0.9993	**I**	4.71E-01	1.0004	**I**	3.93E-01
8	10%	sum	15.1087	**S**	1.54E-05	6.9563	**S**	7.99E-03
9	20%	sum	5.4664	**S**	3.44E-03	33.2704	**S**	4.79E-06
10	30%	sum	9.2956	**S**	2.43E-04	56.9161	**S**	1.89E-07

Table 5.19. Two-factor ANOVA to test significance of difference in EC in Chhattarpur soil due to days vs waste-treatment (0.05 level of significance)

Sl.	Sample type		Diff.due to rows(days)			Diff.due to columns(w.t.)		
No.	lime	season	F-value	S/I	P-value	F-value	S/I	P-value
			2.4876			**3.0725**		
1	0.0%	mon	6.4308	S	4.01E-04	64.7803	S	8.78E-11
2	0.5%	mon	7.4416	S	1.51E-04	33.3567	S	3.56E-08
3	1.0%	mon	5.4766	S	1.09E-03	47.0964	S	1.68E-09
4	0.0%	win	7.4416	S	1.51E-04	33.3567	S	3.56E-08
5	0.5%	win	7.8204	S	1.07E-04	34.2567	S	2.83E-08
6	1.0%	win	7.9302	S	9.75E-05	37.5906	S	1.26E-08
7	0.0%	sum	6.1680	S	5.23E-04	31.5471	S	5.75E-08
8	0.5%	sum	7.5180	S	1.41E-04	31.8203	S	5.34E-08
9	1.0%	sum	6.6568	S	3.20E-04	29.0530	S	1.15E-07

Table 5.19. Two-factor ANOVA to test significance of difference in EC in Chhattarpur soil due to days vs waste-treatment (0.05 level of significance)

Sl.	Sample type		Diff.due to rows(days)			Diff.due to columns(w.t.)		
No.	lime	season	F-value	S/I	P-value	F-value	S/I	P-value
			2.4876			**3.0725**		
1	0.0%	mon	6.4308	S	4.01E-04	64.7803	S	8.78E-11
2	0.5%	mon	7.4416	S	1.51E-04	33.3567	S	3.56E-08
3	1.0%	mon	5.4766	S	1.09E-03	47.0964	S	1.68E-09
4	0.0%	win	7.4416	S	1.51E-04	33.3567	S	3.56E-08
5	0.5%	win	7.8204	S	1.07E-04	34.2567	S	2.83E-08
6	1.0%	win	7.9302	S	9.75E-05	37.5906	S	1.26E-08
7	0.0%	sum	6.1680	S	5.23E-04	31.5471	S	5.75E-08
8	0.5%	sum	7.5180	S	1.41E-04	31.8203	S	5.34E-08
9	1.0%	sum	6.6568	S	3.20E-04	29.0530	S	1.15E-07

Table 5.21. Two-factor ANOVA to test significance of difference in EC in Chhattarpur soil due to days vs lime-treatment (0.05 level of significance)								
Sl.	Sample type		Diff.due to rows(days)			Diff.due to columns(lime t.)		
No.	waste	season	F-value	S/I	P-value	F-value	S/I	P-value
			2.7642			**3.7389**		
1	0%	con	17.7571	**S**	5.85E-06	12.9528	**S**	6.54E-04
2	10%	mon	144.8814	**S**	5.70E-12	4.1016	**S**	3.96E-02
3	20%	mon	145.1702	**S**	5.62E-12	0.4210	**I**	6.64E-01
4	30%	mon	66.9838	**S**	1.09E-09	1.6234	**I**	2.32E-01
5	10%	win	137.4196	**S**	8.20E-12	4.7921	**S**	2.60E-02
6	20%	win	110.6832	**S**	3.61E-11	0.7506	**I**	4.90E-01
7	30%	win	433.0668	**S**	2.91E-15	5.1137	**S**	2.15E-02
8	10%	sum	124.6122	**S**	1.60E-11	4.7687	**S**	2.63E-02
9	20%	sum	318.0733	**S**	2.48E-14	0.4412	**I**	6.52E-01
10	30%	sum	214.4967	**S**	3.81E-13	1.9222	**I**	1.83E-01

Table 5.22. Two-factor ANOVA to test significance of difference in EC in JNU soil due to days vs lime-treatment (0.05 level of significance)								
Sl.	Sample type		Diff.due to rows(days)			Diff.due to columns(lime t.)		
No.	waste	season	F-value	S/I	P-value	F-value	S/I	P-value
			2.7642			**3.7389**		
1	0%	con	17.7571	**S**	5.85E-06	12.9528	**S**	6.54E-04
2	10%	mon	144.8814	**S**	5.70E-12	4.1016	**S**	3.96E-02
3	20%	mon	145.1702	**S**	5.62E-12	0.4210	**I**	6.64E-01
4	30%	mon	66.9838	**S**	1.09E-09	1.6234	**I**	2.32E-01
5	10%	win	137.4196	**S**	8.20E-12	4.7921	**S**	2.60E-02
6	20%	win	110.6832	**S**	3.61E-11	0.7506	**I**	4.90E-01
7	30%	win	433.0668	**S**	2.91E-15	5.1137	**S**	2.15E-02
8	10%	sum	124.6122	**S**	1.60E-11	4.7687	**S**	2.63E-02
9	20%	sum	318.0733	**S**	2.48E-14	0.4412	**I**	6.52E-01
10	30%	sum	214.4967	**S**	3.81E-13	1.9222	**I**	1.83E-01

Table 5.23. Two-factor ANOVA to test significance of difference in CEC in Chhattarpur soil due to days vs waste-treatment (0.05 level of significance)								
Sl.	Sample type		Diff.due to rows(days)			Diff.due to columns(w.t.)		
No.	lime	season	F-value	S/I	P-value	F-value	S/I	P-value
			2.4876			**3.0725**		
1	0.0%	mon	7.5763	**S**	1.34E-04	1.5711	**I**	2.26E-01
2	0.5%	mon	6.9769	**S**	2.34E-04	3.3659	**S**	3.79E-02
3	1.0%	mon	2.6757	**S**	3.80E-02	1.7123	**I**	1.95E-01
4	0.0%	win	2.3584	**I**	6.05E-02	12.5756	**S**	6.35E-05
5	0.5%	win	5.6512	**S**	9.03E-04	12.7717	**S**	5.73E-05
6	1.0%	win	2.2736	**I**	6.86E-02	4.0354	**S**	2.06E-02
7	0.0%	sum	3.3680	**S**	1.44E-02	3.3659	**S**	3.79E-02
8	0.5%	sum	7.6635	**S**	1.24E-04	15.5224	**S**	1.50E-05
9	1.0%	sum	1.0003	**I**	4.58E-01	1.0015	**I**	4.12E-01

Table 5.24. Two-factor ANOVA to test significance of difference in CEC in JNU soil due to days vs waste-treatment (0.05 level of significance)								
Sl.	Sample type		Diff.due to rows(days)			Diff.due to columns(w.t.)		
No.	lime	season	F-value	S/I	P-value	F-value	S/I	P-value
			2.4876			**3.0725**		
1	0.0%	mon	2.0817	**I**	9.15E-02	11.3009	**S**	1.27E-04
2	0.5%	mon	1.9156	**I**	1.18E-01	3.9761	**S**	2.17E-02
3	1.0%	mon	0.9412	**I**	4.97E-01	3.5111	**S**	3.31E-02
4	0.0%	win	2.0817	**I**	9.15E-02	11.3009	**S**	1.27E-04
5	0.5%	win	2.1080	**I**	8.80E-02	9.4604	**S**	3.73E-04
6	1.0%	win	0.2820	**I**	9.54E-01	4.4136	**S**	1.48E-02
7	0.0%	sum	10.8974	**S**	9.29E-06	72.1961	**S**	3.14E-11
8	0.5%	sum	2.9769	**S**	2.47E-02	68.2916	**S**	5.33E-11
9	1.0%	sum	0.9867	**I**	4.67E-01	4.3175	**S**	1.61E-02

Table 5.25. Two-factor ANOVA to test significance of difference in CEC in Chhattarpur soil due to days vs lime-treatment (0.05 level of significance)								
Sl.	Sample type		Diff.due to rows(days)			Diff.due to columns(lime t.)		
No.	waste	season	F-value	S/I	P-value	F-value	S/I	P-value
			2.7642			3.7389		
1	0%	con	11.1650	S	8.85E-05	10.9693	S	1.36E-03
2	10%	mon	30.8823	S	1.82E-07	0.3558	I	7.07E-01
3	20%	mon	13.7511	S	2.68E-05	4.5696	S	2.97E-02
4	30%	mon	4.1938	S	1.08E-02	3.8385	S	4.69E-02
5	10%	win	23.1296	S	1.14E-06	8.1812	S	4.43E-03
6	20%	win	18.7910	S	4.14E-06	20.2792	S	7.33E-05
7	30%	win	9.8514	S	1.77E-04	0.5957	I	5.65E-01
8	10%	sum	8.9927	S	2.90E-04	4.9045	S	2.43E-02
9	20%	sum	7.4806	S	7.56E-04	1.4214	I	2.74E-01
10	30%	sum	1.0009	I	4.70E-01	1.0019	I	3.92E-01

Table 5.26. Two-factor ANOVA to test significance of difference in CEC in JNU soil due to days vs lime-treatment (0.05 level of significance)								
Sl.	Sample type		Diff.due to rows(days)			Diff.due to columns(lime t.)		
No.	waste	season	F-value	S/I	P-value	F-value	S/I	P-value
			2.7642			3.7389		
1	0%	con	10.8352	S	1.05E-04	11.9565	S	9.36E-04
2	10%	mon	10.0508	S	1.59E-04	3.5860	S	5.53E-02
3	20%	mon	18.3181	S	4.84E-06	9.7345	S	2.24E-03
4	30%	mon	22.3747	S	1.41E-06	18.8165	S	1.08E-04
5	10%	win	42.6156	S	2.23E-08	9.4731	S	2.50E-03
6	20%	win	19.7610	S	3.04E-06	0.4918	I	6.22E-01
7	30%	win	9.2861	S	2.44E-04	10.7076	S	1.51E-03
8	10%	sum	1.9076	I	1.44E-01	20.9843	S	6.13E-05
9	20%	sum	16.1524	S	1.04E-05	100.1886	S	5.07E-09
10	30%	sum	1.4950	I	2.47E-01	4.0769	S	4.02E-02

Table 5.27. Two-factor ANOVA to test significance of difference in Ca conc.in Chhattarpur soil due to days vs waste-treatment (0.05 level of significance)								
Sl.	Sample type		Diff.due to rows(days)			Diff.due to columns(w.t.)		
No.	lime	season	F-value	S/I	P-value	F-value	S/I	P-value
			2.4876			**3.0725**		
1	0.0%	mon	18.7411	**S**	1.05E-07	1.3953	**I**	2.72E-01
2	0.5%	mon	16.0841	**S**	3.91E-07	5.8378	**S**	4.60E-03
3	1.0%	mon	11.8427	**S**	4.84E-06	3.8133	**S**	2.51E-02
4	0.0%	win	15.0168	**S**	6.97E-07	11.8462	**S**	9.37E-05
5	0.5%	win	9.1489	**S**	3.49E-05	4.8325	**S**	1.04E-02
6	1.0%	win	19.8371	**S**	6.35E-08	7.1332	**S**	1.75E-03
7	0.0%	sum	8.7439	**S**	4.85E-05	40.7024	**S**	6.25E-09
8	0.5%	sum	9.7158	**S**	2.23E-05	36.9199	**S**	1.48E-08
9	1.0%	sum	18.2131	**S**	1.34E-07	42.0762	**S**	4.65E-09

Table 5.28. Two-factor ANOVA to test significance of difference in Ca conc.in JNU soil due to days vs waste-treatment (0.05 level of significance)								
Sl.	Sample type		Diff.due to rows (days)			Diff.due to columns (w.t.)		
No.	lime	season	F-value	S/I	P-value	F-value	S/I	P-value
			2.4876			**3.0725**		
1	0.0%	mon	6.0680	**S**	5.80E-04	24.9478	**S**	4.04E-07
2	0.5%	mon	4.7696	**S**	2.44E-03	14.0837	**S**	2.96E-05
3	1.0%	mon	4.4508	**S**	3.58E-03	6.3870	**S**	3.02E-03
4	0.0%	win	4.0202	**S**	6.11E-03	13.4850	**S**	3.98E-05
5	0.5%	win	4.8815	**S**	2.14E-03	18.6827	**S**	3.87E-06
6	1.0%	win	3.6498	**S**	9.87E-03	5.5188	**S**	5.91E-03
7	0.0%	sum	7.0198	**S**	2.25E-04	44.4968	**S**	2.81E-09
8	0.5%	sum	6.6417	**S**	3.25E-04	34.7309	**S**	2.52E-08
9	1.0%	sum	8.9689	**S**	4.03E-05	14.4673	**S**	2.46E-05

Table 5.29. Two-factor ANOVA to test significance of difference in Ca conc.in Chhattarpur soil due to days vs lime-treatment (0.05 level of significance)								
Sl.	Sample type		Diff.due to rows(days)			Diff.due to columns(lime t.)		
No.	waste	season	F-value	S/I	P-value	F-value	S/I	P-value
			2.7642			**3.7389**		
1	0%	con	13.1056	**S**	3.55E-05	1.8256	**I**	1.97E-01
2	10%	mon	23.4806	**S**	1.04E-06	10.3452	**S**	1.74E-03
3	20%	mon	15.1715	**S**	1.50E-05	15.1986	**S**	3.10E-04
4	30%	mon	11.5033	**S**	7.48E-05	2.8993	**I**	8.84E-02
5	10%	win	30.6232	**S**	1.92E-07	3.7617	**S**	4.93E-02
6	20%	win	20.2164	**S**	2.64E-06	18.3214	**S**	1.23E-04
7	30%	win	27.2975	**S**	4.01E-07	3.5579	**I**	5.63E-02
8	10%	sum	26.0321	**S**	5.42E-07	7.6426	**S**	5.71E-03
9	20%	sum	7.7370	**S**	6.37E-04	9.4794	**S**	2.50E-03
10	30%	sum	34.5546	**S**	8.78E-08	3.3765	**I**	6.36E-02

Table 5.30. Two-factor ANOVA to test significance of difference in Ca conc.in JNU soil due to days vs lime-treatment (0.05 level of significance)								
Sl.	Sample type		Diff.due to rows(days)			Diff.due to columns(lime t.)		
No.	waste	season	F-value	S/I	P-value	F-value	S/I	P-value
			2.7642			**3.7389**		
1	0%	con	2.9492	**S**	4.04E-02	10.6464	**S**	1.55E-03
2	10%	mon	41.2547	**S**	2.76E-08	2.4047	**I**	1.27E-01
3	20%	mon	57.0795	**S**	3.20E-09	18.5085	**S**	1.17E-04
4	30%	mon	40.4645	**S**	3.13E-08	19.1371	**S**	9.88E-05
5	10%	win	27.8761	**S**	3.51E-07	27.1170	**S**	1.53E-05
6	20%	win	22.4480	**S**	1.38E-06	6.2380	**S**	1.16E-02
7	30%	win	45.8395	**S**	1.38E-08	14.0302	**S**	4.53E-04
8	10%	sum	41.0939	**S**	2.83E-08	31.9657	**S**	6.04E-06
9	20%	sum	10.2805	**S**	1.40E-04	5.4267	**S**	1.80E-02
10	30%	sum	43.2493	**S**	2.02E-08	6.8158	**S**	8.57E-03

Table 5.31. Two-factor ANOVA to test significance of difference in Mg conc.in Chhattarpur soil due to days vs waste-treatment (0.05 level of significance)								
Sl.	Sample type		Diff.due to rows(days)			Diff.due to columns(w.t.)		
No.	lime	season	F-value	S/I	P-value	F-value	S/I	P-value
			2.4876			**3.0725**		
1	0.0%	mon	11.3444	S	6.79E-06	13.3494	S	4.26E-05
2	0.5%	mon	11.2157	S	7.43E-06	19.0075	S	3.40E-06
3	1.0%	mon	21.8783	S	2.66E-08	3.7097	S	2.76E-02
4	0.0%	win	7.4922	S	1.45E-04	11.0252	S	1.48E-04
5	0.5%	win	5.4741	S	1.10E-03	6.0658	S	3.85E-03
6	1.0%	win	17.5716	S	1.83E-07	12.5104	S	6.57E-05
7	0.0%	sum	6.3026	S	4.56E-04	50.0639	S	9.64E-10
8	0.5%	sum	10.7337	S	1.04E-05	61.9749	S	1.33E-10
9	1.0%	sum	17.3445	S	2.05E-07	22.0483	S	1.08E-06

Table 5.32. Two-factor ANOVA to test significance of difference in Mg conc.in JNU soil due to days vs waste-treatment (0.05 level of significance)								
Sl.	Sample type		Diff.due to rows(days)			Diff.due to columns(w.t.)		
No.	lime	season	F-value	S/I	P-value	F-value	S/I	P-value
			2.4876			**3.0725**		
1	0.0%	mon	9.7289	S	2.21E-05	17.2187	S	7.10E-06
2	0.5%	mon	9.7867	S	2.11E-05	16.3904	S	1.02E-05
3	1.0%	mon	9.7867	S	2.11E-05	16.3904	S	1.02E-05
4	0.0%	win	5.7131	S	8.45E-04	4.1460	S	1.87E-02
5	0.5%	win	29.3177	S	1.83E-09	23.7806	S	5.94E-07
6	1.0%	win	18.3808	S	1.24E-07	24.5536	S	4.60E-07
7	0.0%	sum	9.3214	S	3.04E-05	21.5480	S	1.30E-06
8	0.5%	sum	23.9737	S	1.16E-08	86.5787	S	5.48E-12
9	1.0%	sum	61.7949	S	1.38E-12	165.4086	S	9.11E-15

Table 5.33. Two-factor ANOVA to test significance of difference in Mg conc.in *Chhattarpur soil due to days vs lime-treatment (0.05 level of significance)*

Sl.	Sample type		Diff.due to rows(days)			Diff.due to columns(lime t.)		
No.	waste	season	F-value	S/I	P-value	F-value	S/I	P-value
			2.7642			**3.7389**		
1	0%	con	12.3429	*S*	5.01E-05	6.5681	*S*	9.73E-03
2	10%	mon	10.6278	S	1.17E-04	66.4254	S	7.16E-08
3	20%	mon	3.8582	S	1.51E-02	22.9997	S	3.77E-05
4	30%	mon	20.8487	S	2.18E-06	32.0215	S	5.98E-06
5	10%	win	7.1918	S	9.23E-04	23.0628	S	3.71E-05
6	20%	win	12.3772	S	4.93E-05	17.5758	S	1.52E-04
7	30%	win	28.2406	S	3.23E-07	4.7817	S	2.61E-02
8	10%	sum	2.2402	I	9.43E-02	8.6654	S	3.56E-03
9	20%	sum	40.9806	S	2.88E-08	41.5621	S	1.29E-06
10	30%	sum	9.3492	S	2.35E-04	19.1058	S	9.97E-05

Table 5.34. Two-factor ANOVA to test significance of difference in Mg conc. in *JNU soil due to days vs lime-treatment (0.05 level of significance)*

Sl.	Sample type		Diff.due to rows(days)			Diff.due to columns(lime t.)		
No.	waste	season	F-value	S/I	P-value	F-value	S/I	P-value
			2.7642			**3.7389**		
1	0%	con	26.6830	*S*	4.63E-07	10.0755	*S*	1.95E-03
2	10%	mon	1.5573	I	2.27E-01	8.4952	S	3.84E-03
3	20%	mon	18.4703	S	4.60E-06	20.7970	S	6.42E-05
4	30%	mon	17.1572	S	7.20E-06	48.4561	S	5.11E-07
5	10%	win	4.1483	S	1.13E-02	6.1661	S	1.20E-02
6	20%	win	22.5963	S	1.32E-06	17.9591	S	1.36E-04
7	30%	win	53.1219	S	5.17E-09	11.6492	S	1.05E-03
8	10%	sum	14.0466	S	2.37E-05	13.2069	S	5.99E-04
9	20%	sum	47.2408	S	1.13E-08	43.8141	S	9.41E-07
10	30%	sum	49.0268	S	8.81E-09	62.1561	S	1.09E-07

Fig No. 5.1 pH of Chhattarpur soil with MW, without lime treatment

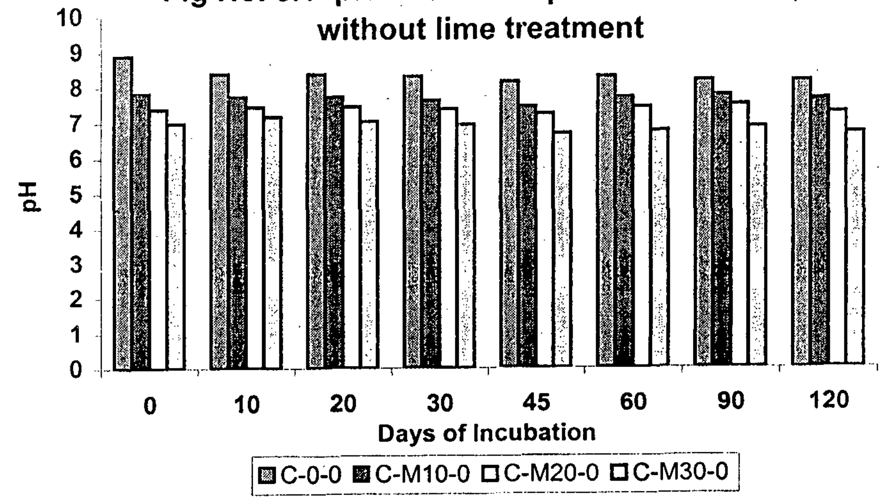


Fig No. 5.2 pH of Chhattarpur soil with WW, without lime treatment

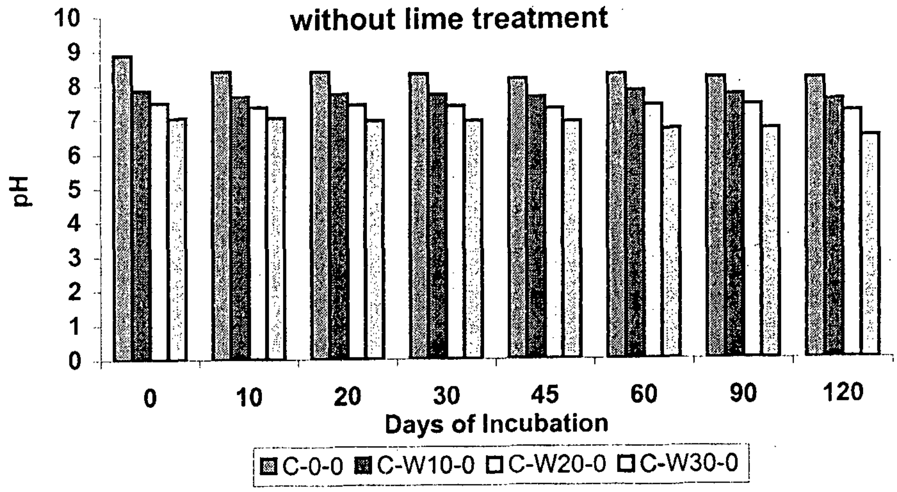


Fig No. 5.3 pH of Chhattarpur soil with MW without lime

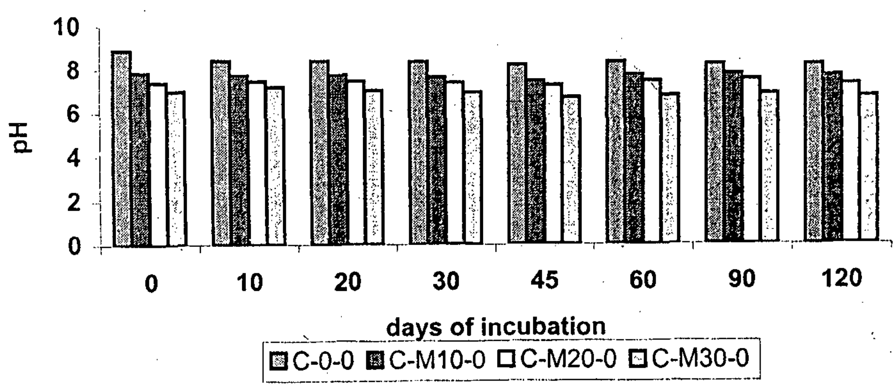


Fig No. 5.4 pH of JNU soil with MW(without lime)

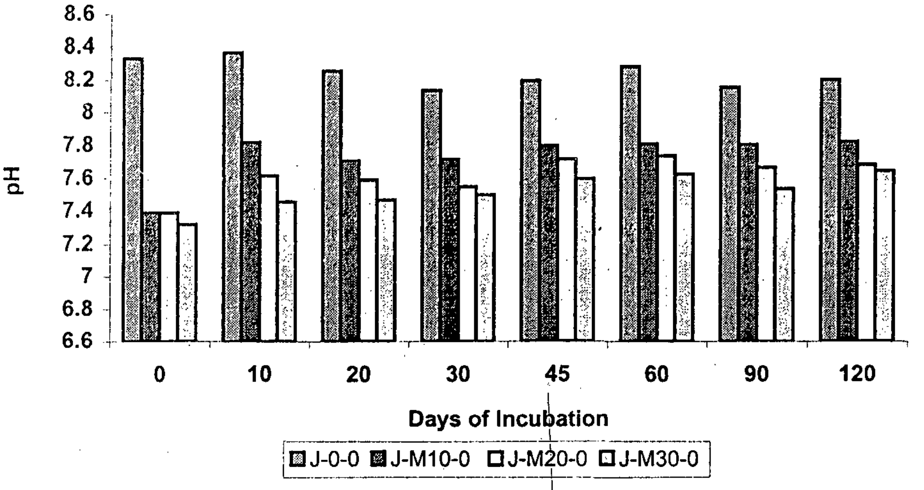


Fig No. 5.5 pH of JNU soil with WW Without lime

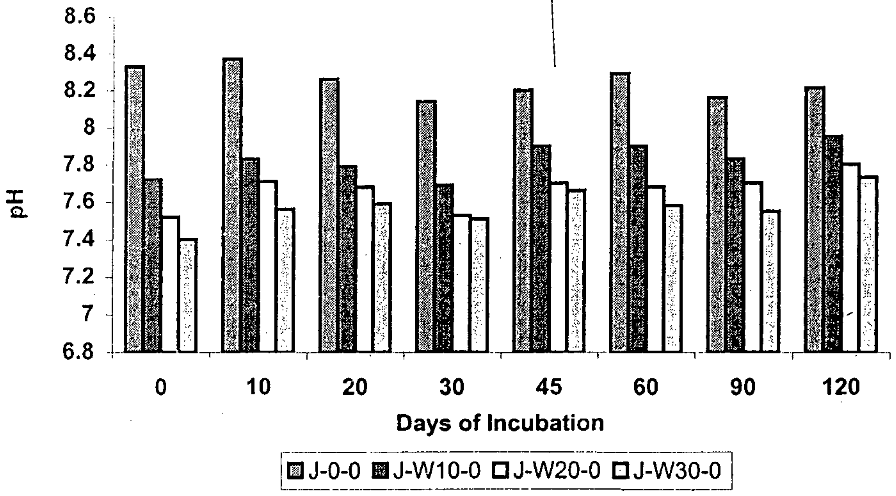


Fig No. 5.6 pH of JNU soil with SW Without lime

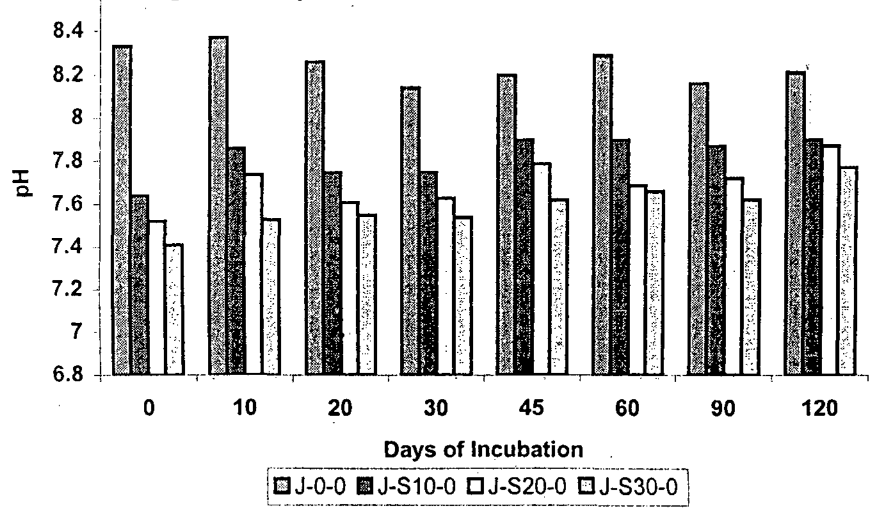


Fig No. 5.7 EC of Chhattarpur and JNU soi l(pure)

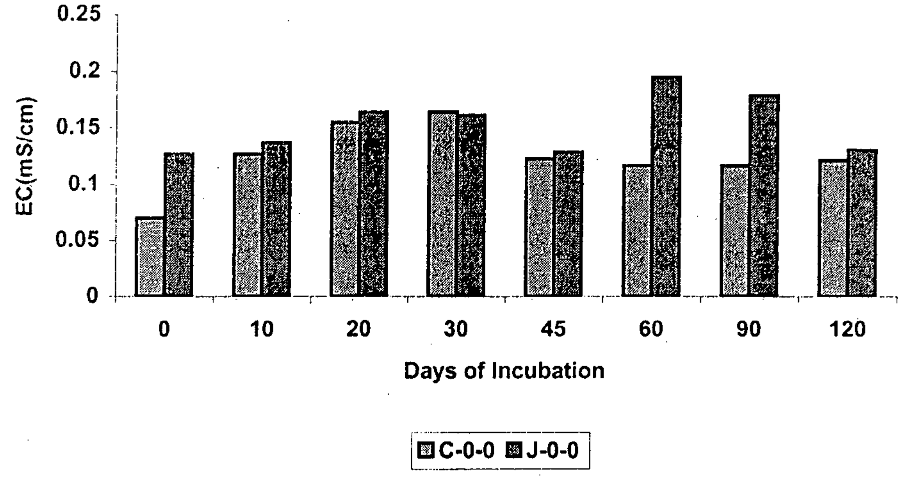


Fig No. 5.8 EC of Chhattarpur and JNU soil treated with 0.5% lime

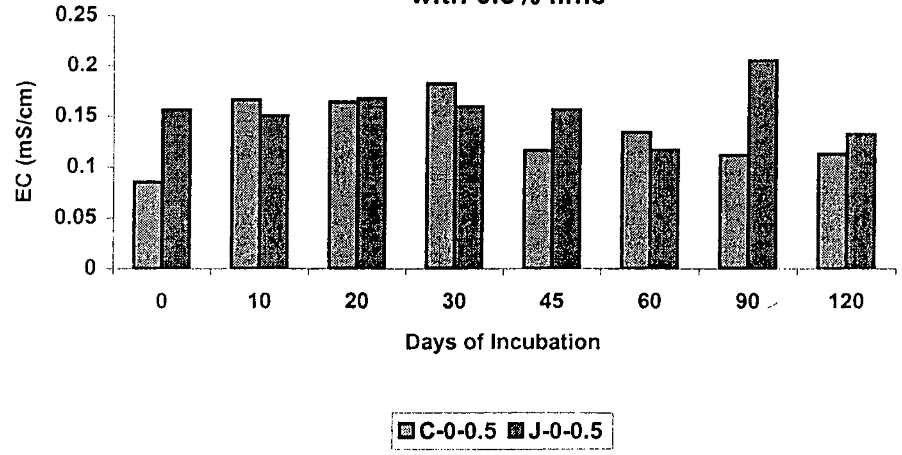


Fig No. 5.9 EC of Chhattarpur and JNU soil treated with 1% lime

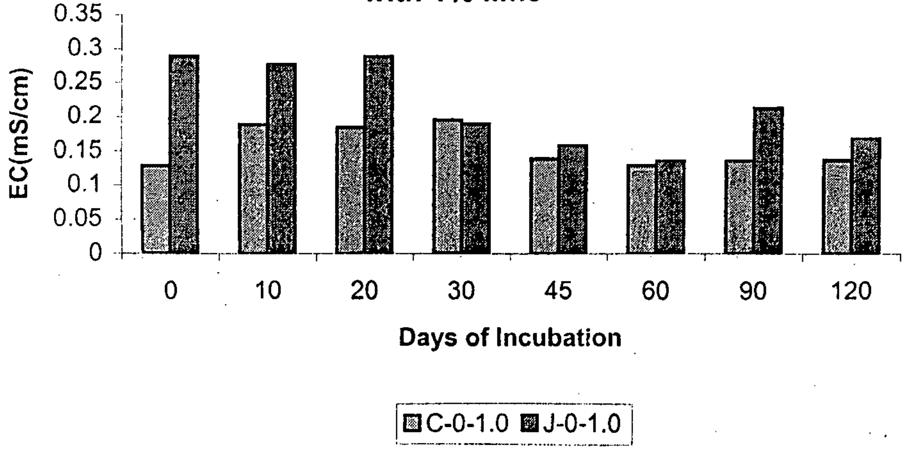


Fig No. 5.10 Organic carbon in different types of wastes and soils

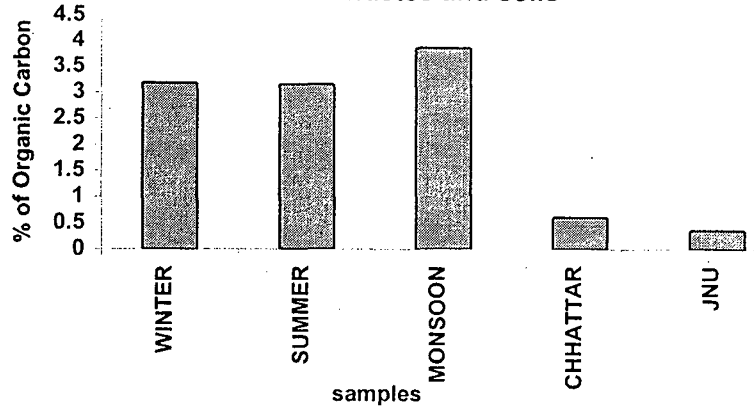


Fig No. 5.11 Organic Carbon in Chhattarpur pure soil in different days of incubation

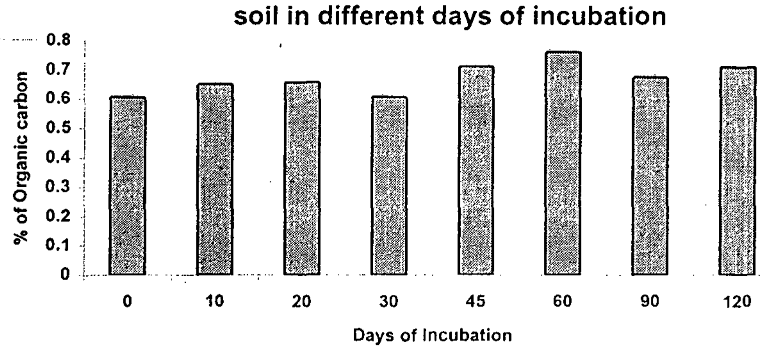


Fig No. 5.12 Organic Carbon in pure JNU soil in different days of incubation

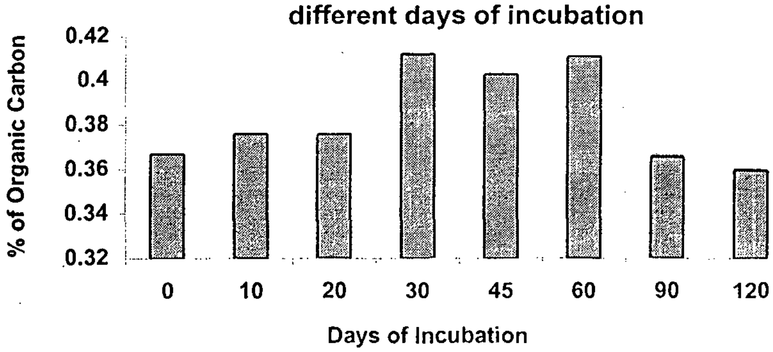


Fig No. 5.13 Organic Carbon in Chhattarpur soil mixed with MW

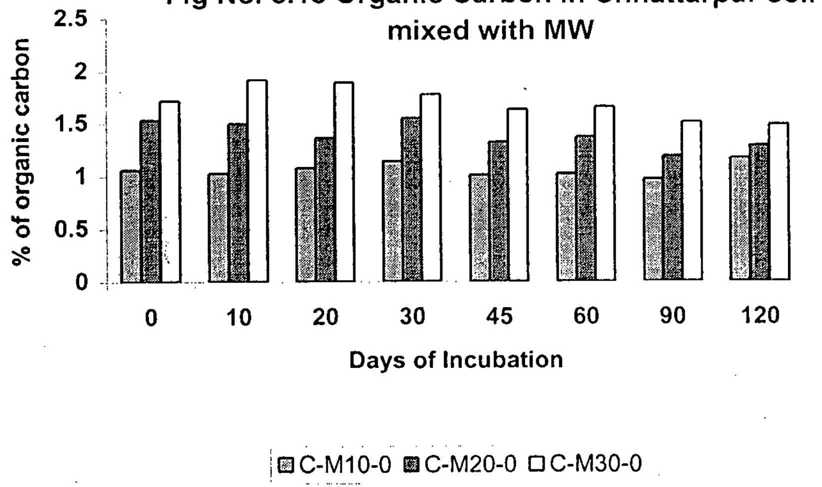


Fig no. 5.14 Organic carbon in JNU mixed with WW

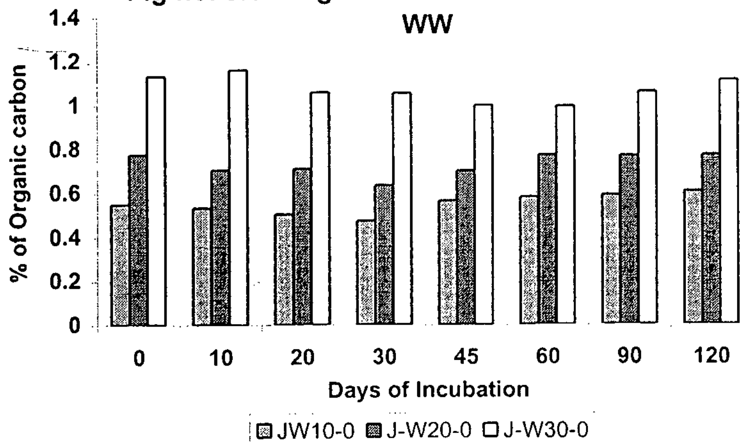


Fig No. 5.15 organic carbon in Chhattarpur soil mixed with WW

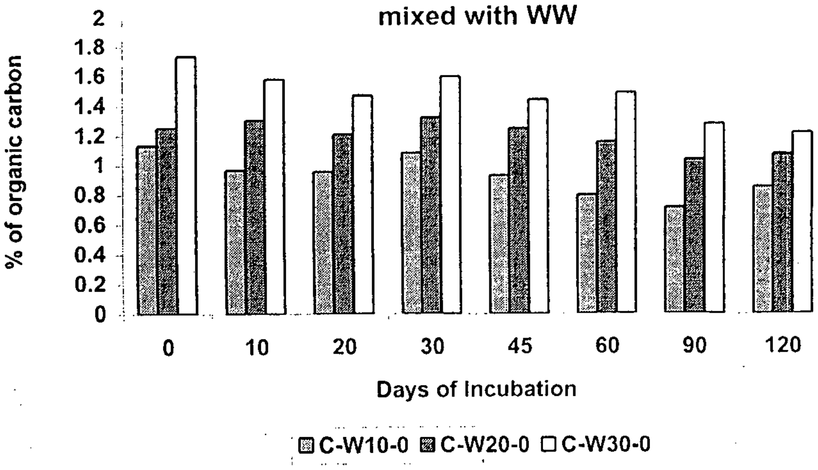
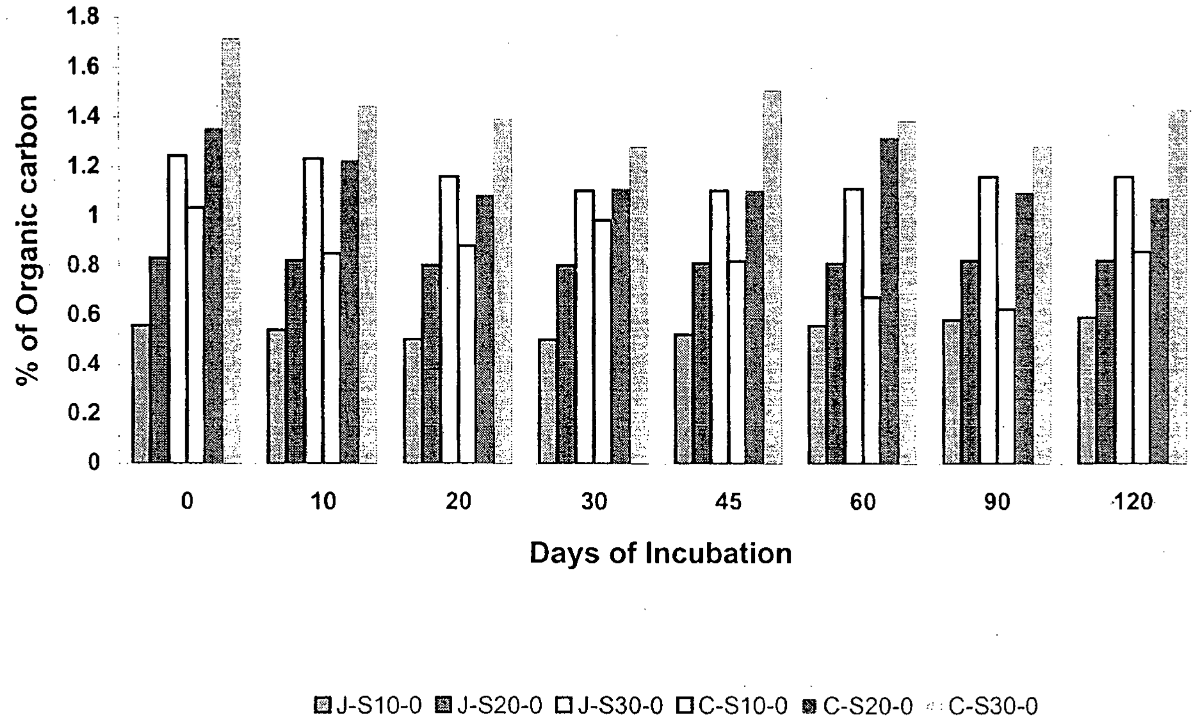


Fig No. 5.16 Organic carbon In soils mixed with SW



Monsoon

Fig No.5.17 Ca^{2+} in Chhattarpur soil mixed with MW without lime

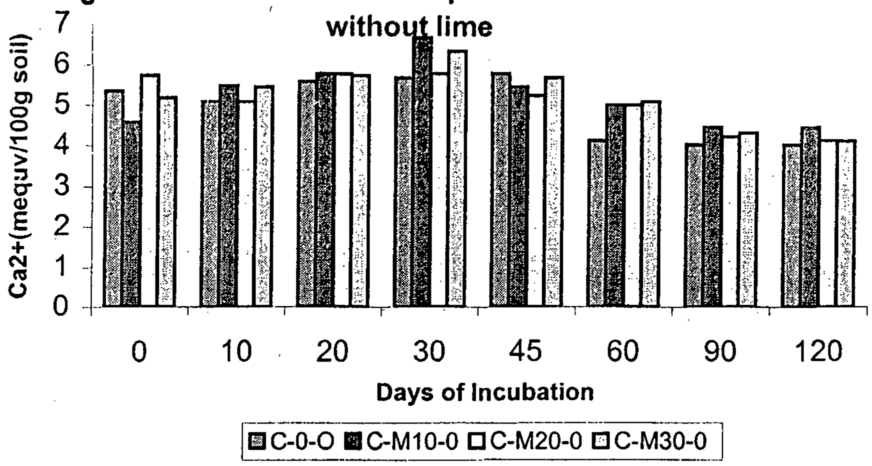


Fig No .5.18 Ca^{2+} in Chhattarpur soil mixed with MW with0.5%lime

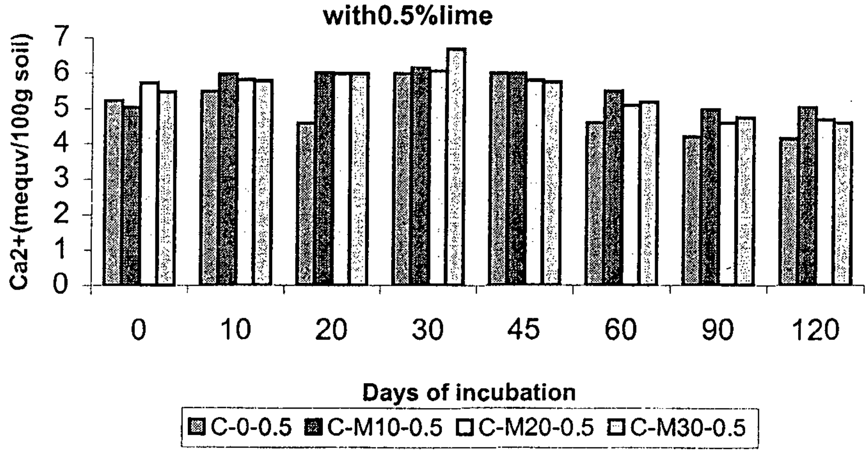
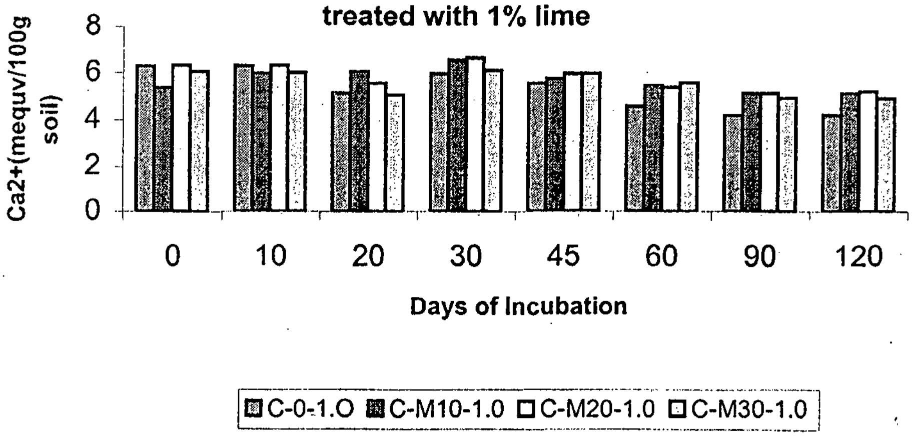


Fig No. 5.19 Ca^{2+}in Chhattarpur soil Mixed withMW treated with 1% lime



Winter

Fig No.5.20 Ca^{2+} in Chhattarpur soil Mixed with WW without lime

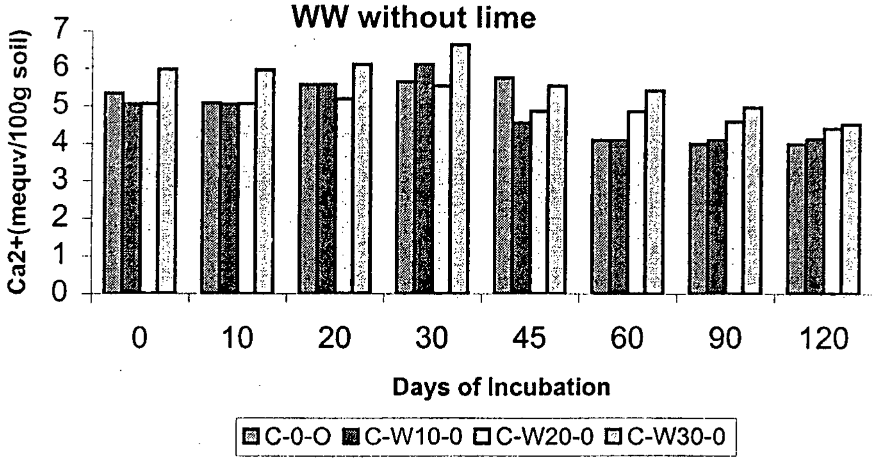


Fig No. 5.21 Ca^{2+} in Chhattarpur soil mixed with WW treated with 0.5% lime

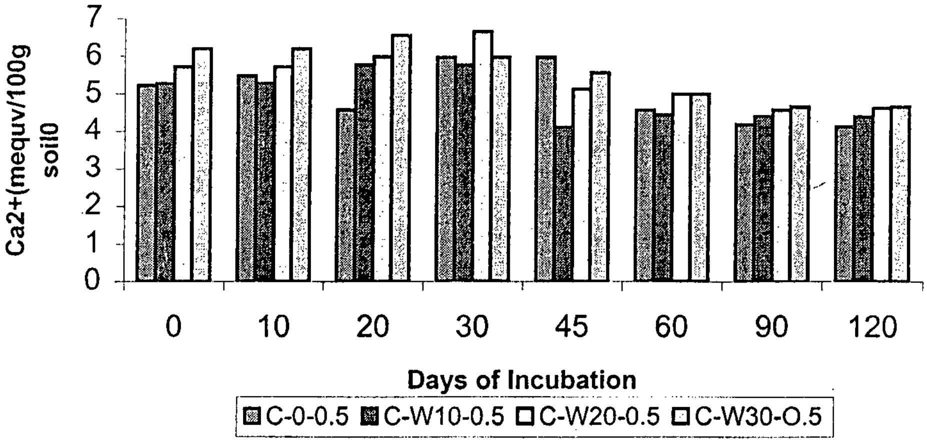
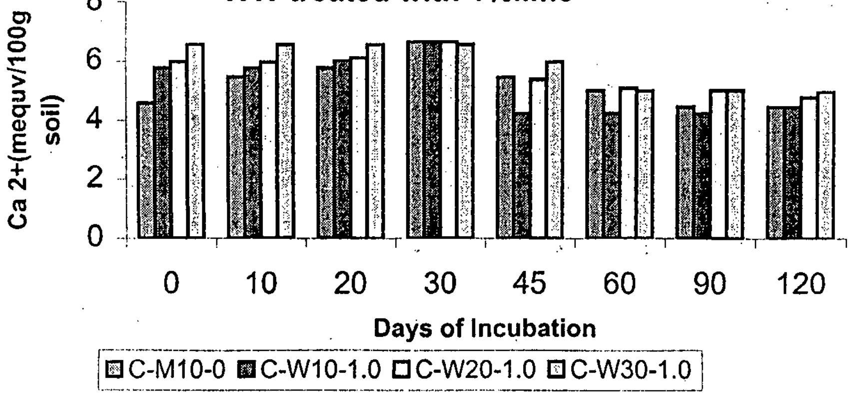


Fig No. 5.22 Ca^{2+} in Chhattarpur soil mixed with WW treated with 1%lime



Summer

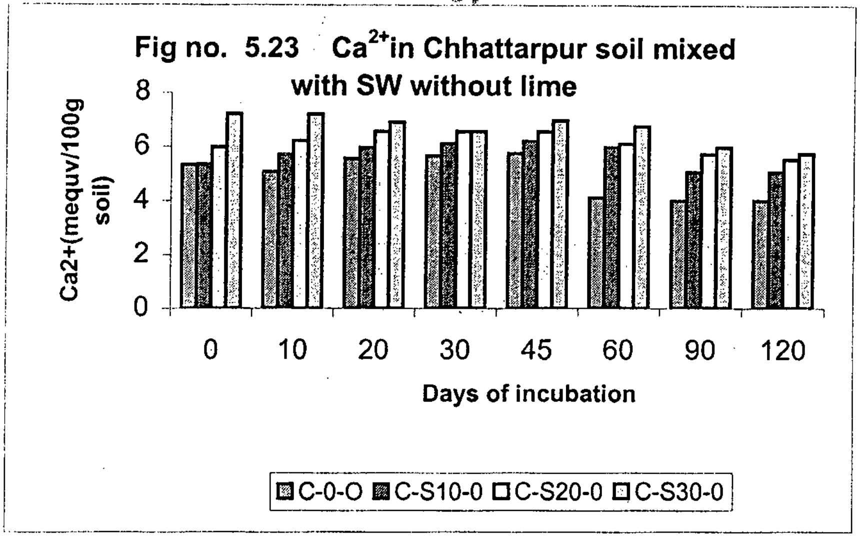


Fig no. 5.23 Ca^{2+}in Chhattarpur soil mixed with SW without lime

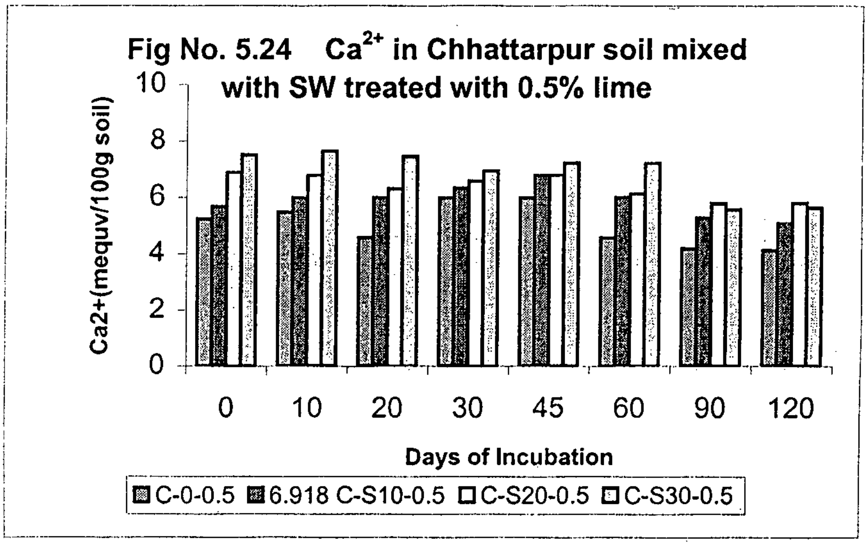


Fig No. 5.24 Ca^{2+} in Chhattarpur soil mixed with SW treated with 0.5% lime

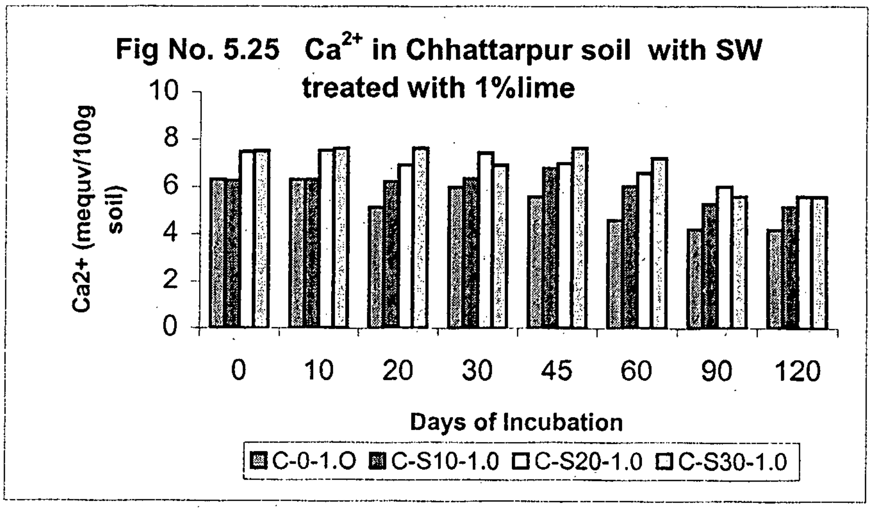


Fig No. 5.25 Ca^{2+} in Chhattarpur soil with SW treated with 1%lime

Monsoon

Fig No. 5. 28 Ca^{2+} in JNU soil with MW without lime

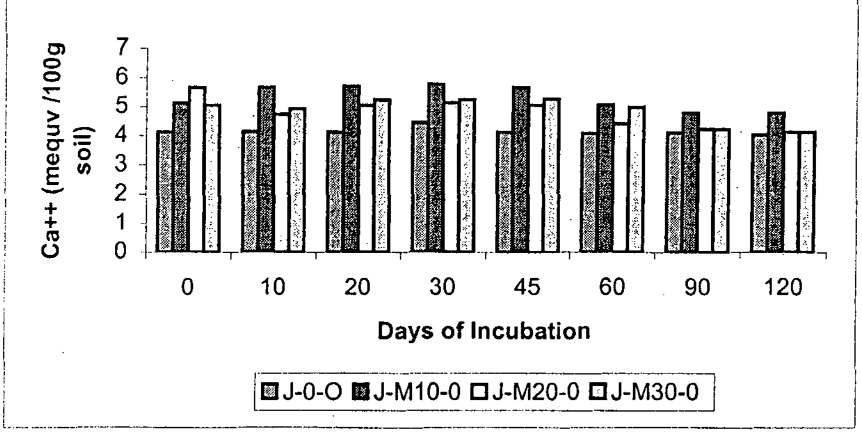


Fig No. 5.29 Ca^{2+} in JNU soil with MW with 0.5%Lime

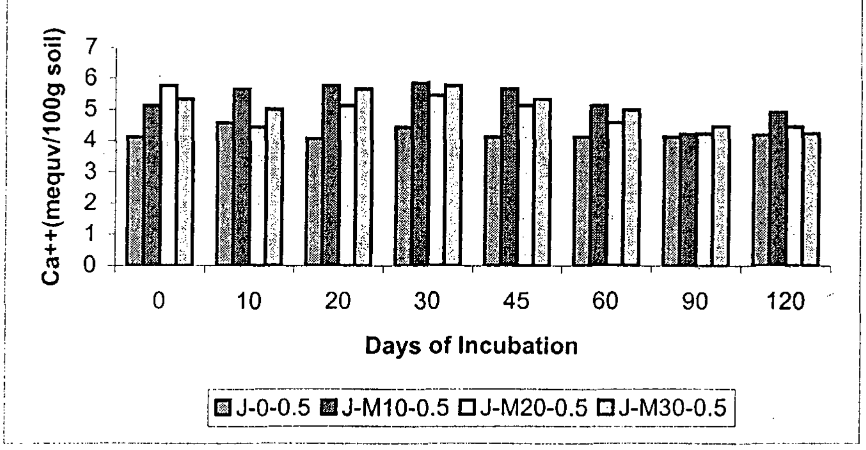
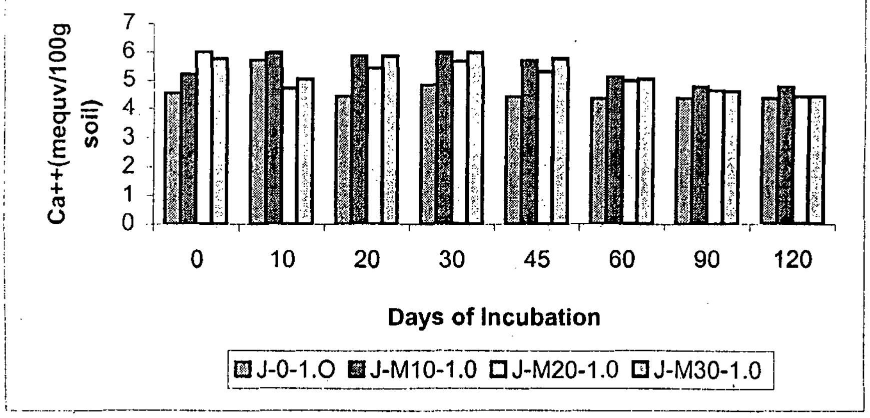


Fig No. 5.30 Ca^{2+} in JNU soil with MW with 1.0%Lime



winter

Fig No. 5.31 Ca^{2+} in JNU soil with WW treated without lime

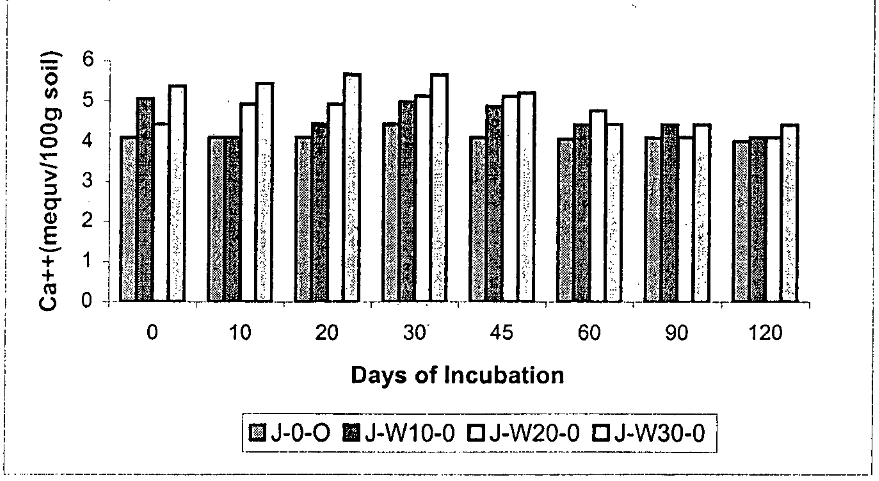


Fig No. 5.32 Ca^{2+} of JNU soil treated with WW with 0.5% lime

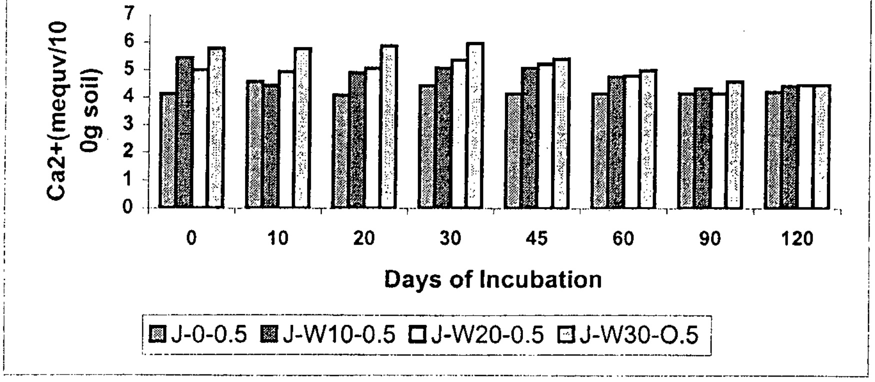
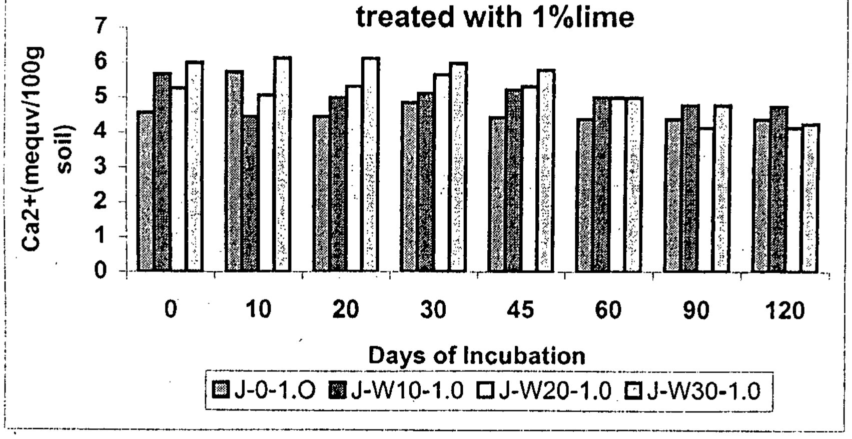


Fig No. 5.33 Ca^{2+} in JNU soil mixed with WW treated with 1%lime



Summer

Fig No. 5.34 Ca^{2+} in JNU soil with SW without liming

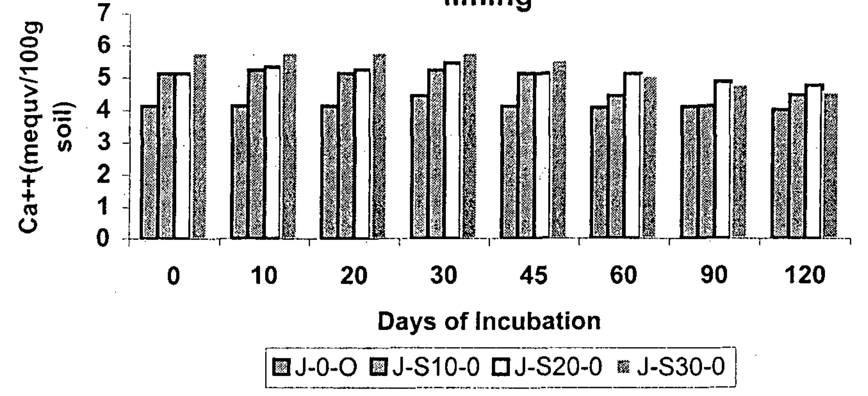


Fig No. 5.35 Ca $^{2+}$in JNU soil wixed with SW treated with 0.5% lime

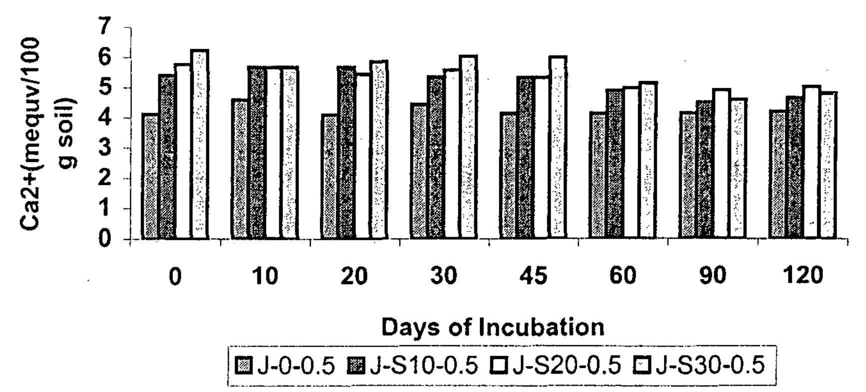
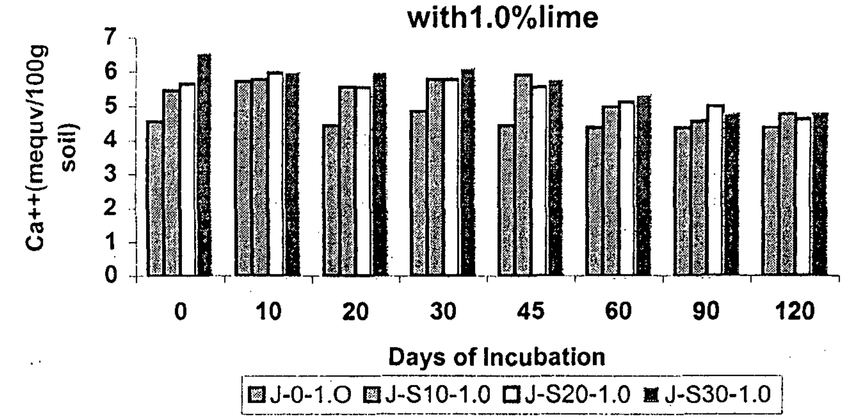


Fig No. 5.36 Ca^{2+} in Jnu soil with SSW with1.0%lime



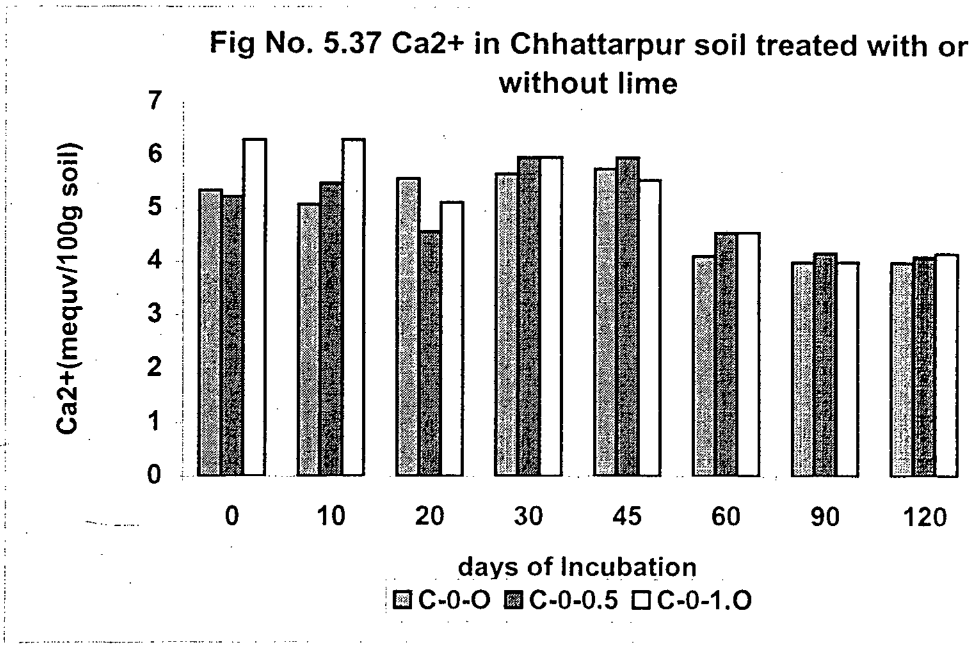


Fig No. 5.37 Ca2+ in Chhattarpur soil treated with or without lime
Ca2+(mequv/100g soil)
7
6
5
4
3
2
1
0
0
10
20
30
45
60
90
120
days of Incubation
C-0-O
C-0-0.5
C-0-1.O

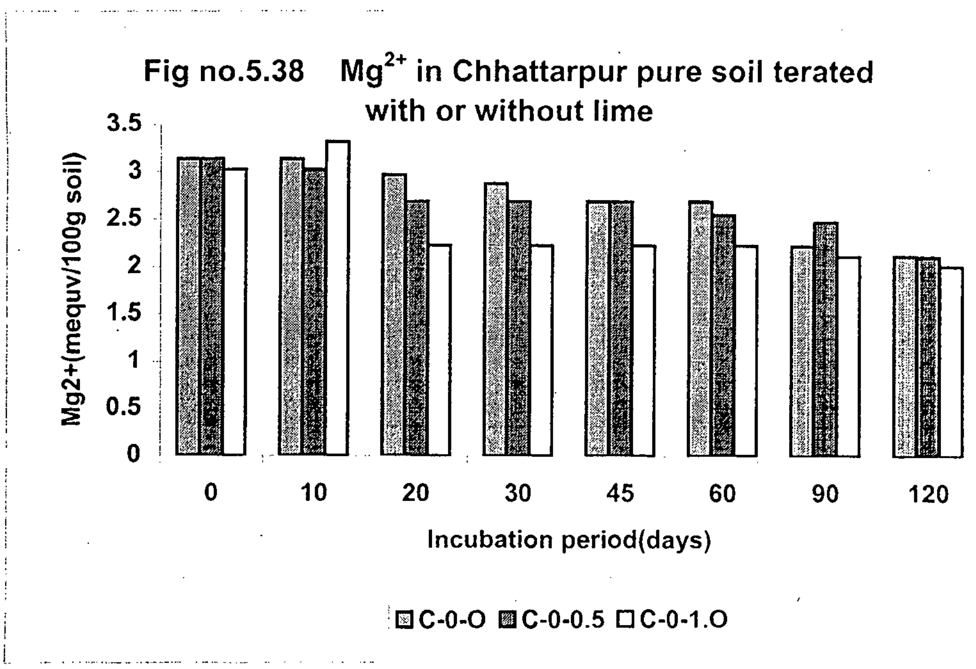


Fig no.5.38 Mg2+ in Chhattarpur pure soil terated with or without lime
Mg2+(mequv/100g soil)
3.5
3
2.5
2
1.5
1
0.5
0
0
10
20
30
45
60
90
120
Incubation period(days)
C-0-O
C-0-0.5
C-0-1.O

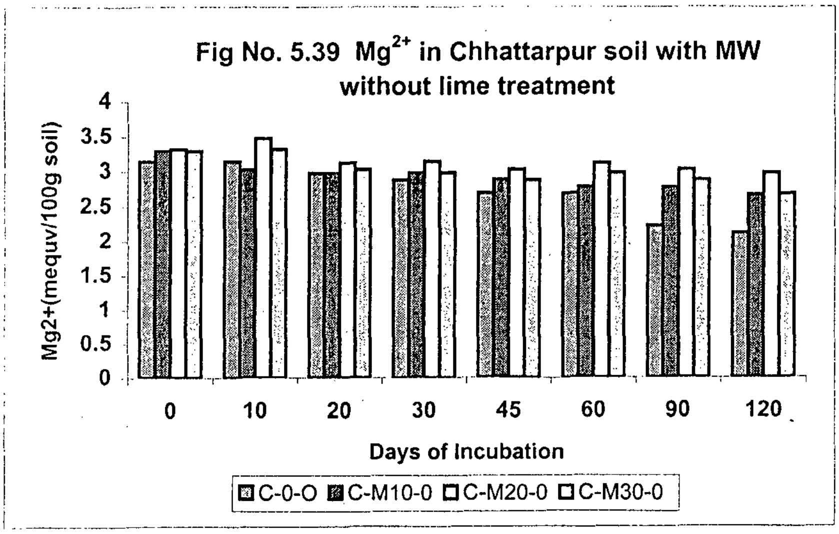


Fig No. 5.39 Mg2+ in Chhattarpur soil with MW without lime treatment
Mg2+(mequv/100g soil)
4
3.5
3
2.5
2
1.5
1
0.5
0
0
10
20
30
45
60
90
120
Days of Incubation
C-0-O
C-M10-0
C-M20-0
C-M30-0

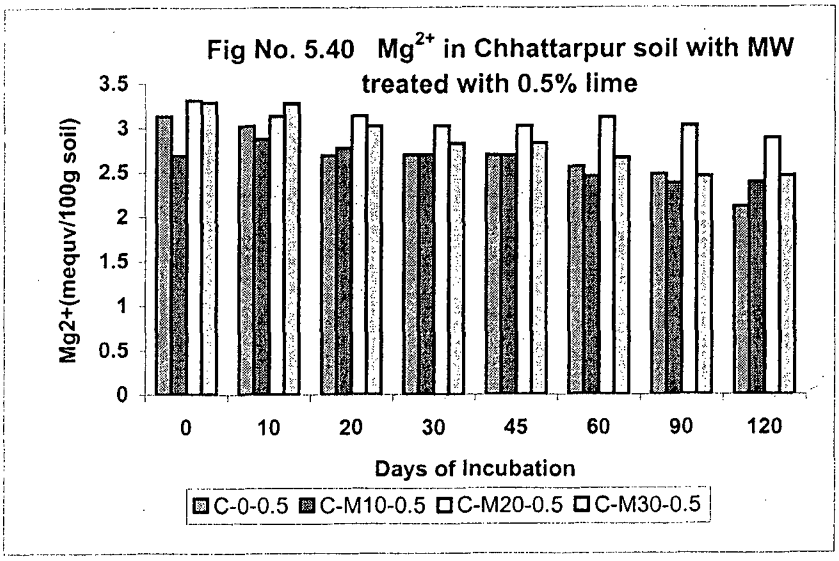


Fig No. 5.40 Mg2+ in Chhattarpur soil with MW treated with 0.5% lime
Mg2+(mequv/100g soil)
3.5
3
2.5
2
1.5
1
0.5
0
0
10
20
30
45
60
90
120
Days of Incubation
C-0-0.5
C-M10-0.5
C-M20-0.5
C-M30-0.5

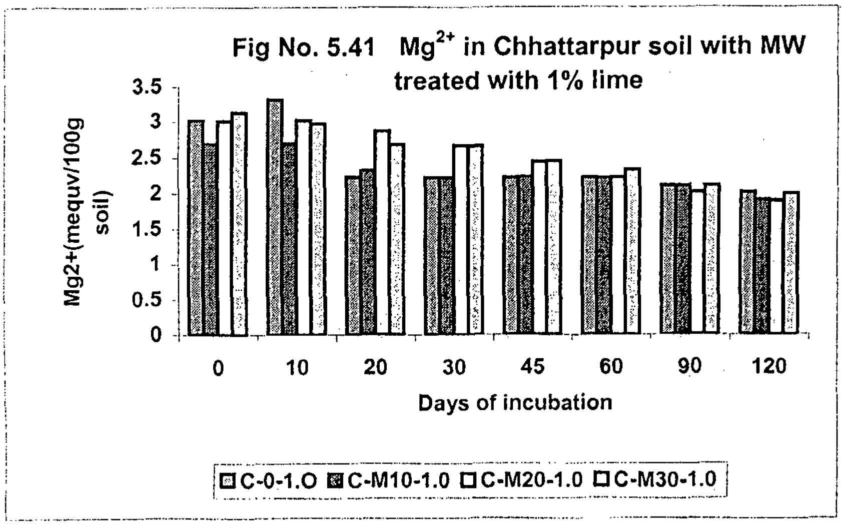


Fig No. 5.41 Mg2+ in Chhattarpur soil with MW treated with 1% lime
Mg2+(mequv/100g soil)
3.5
3
2.5
2
1.5
1
0.5
0
0
10
20
30
45
60
90
120
Days of incubation
C-0-1.O
C-M10-1.0
C-M20-1.0
C-M30-1.0

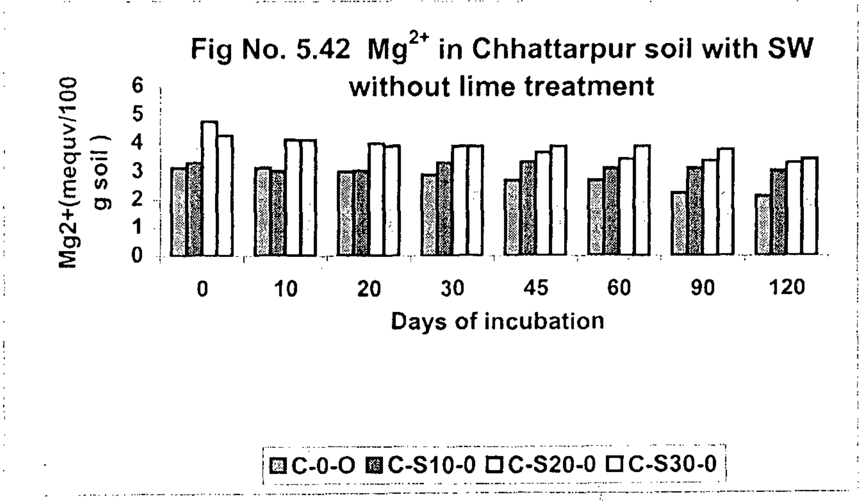


Fig No. 5.42 Mg2+ in Chhattarpur soil with SW without lime treatment
Mg2+(mequv/100 g soil)
0
1
2
3
4
5
6
0
10
20
30
45
60
90
120
Days of incubation
C-0-O
C-S10-0
C-S20-0
C-S30-0

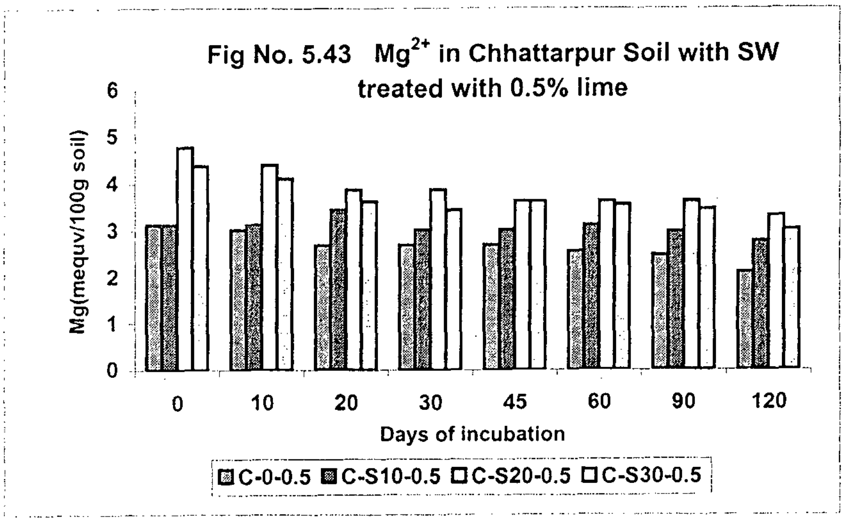


Fig No. 5.43 Mg2+ in Chhattarpur Soil with SW treated with 0.5% lime
Mg(mequv/100g soil)
0
1
2
3
4
5
6
0
10
20
30
45
60
90
120
Days of incubation
C-0-0.5
C-S10-0.5
C-S20-0.5
C-S30-0.5

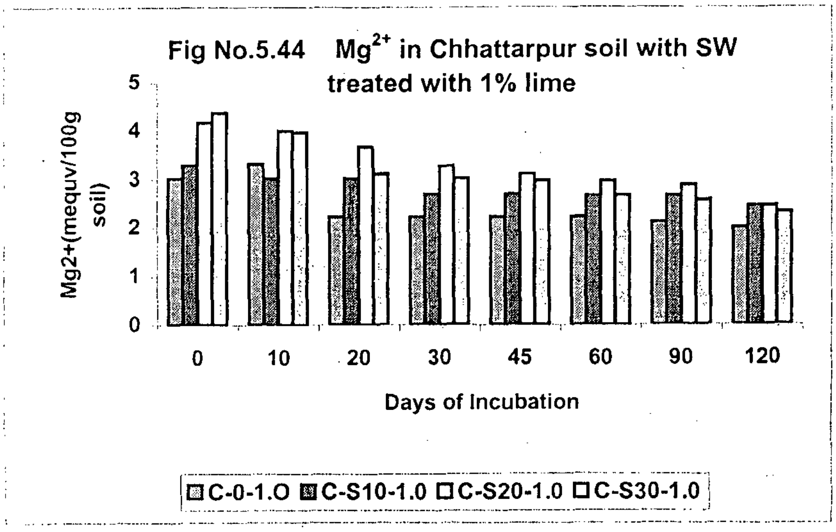


Fig No.5.44 Mg2+ in Chhattarpur soil with SW treated with 1% lime
Mg2+(mequv/100g soil)
0
1
2
3
4
5
0
10
20
30
45
60
90
120
Days of Incubation
C-0-1.O
C-S10-1.0
C-S20-1.0
C-S30-1.0

Fig No. 5.45 Mg^{2+}in JNU soil with MW without lime

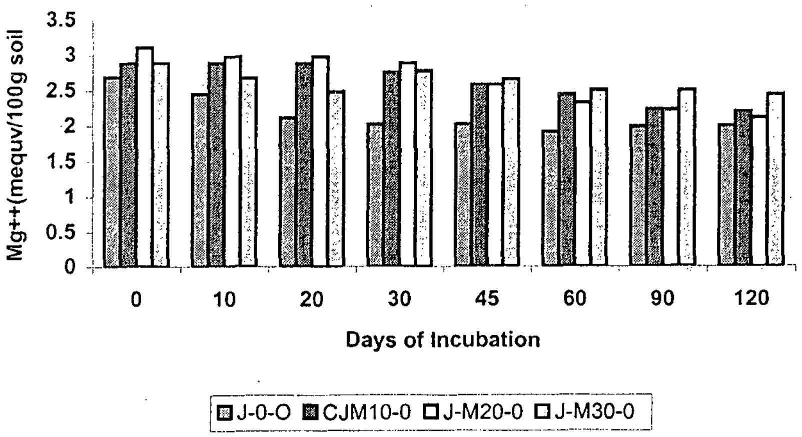


Fig No. 5.46 Mg^{2+}in JNU soil with MW treated with 0.5%lime

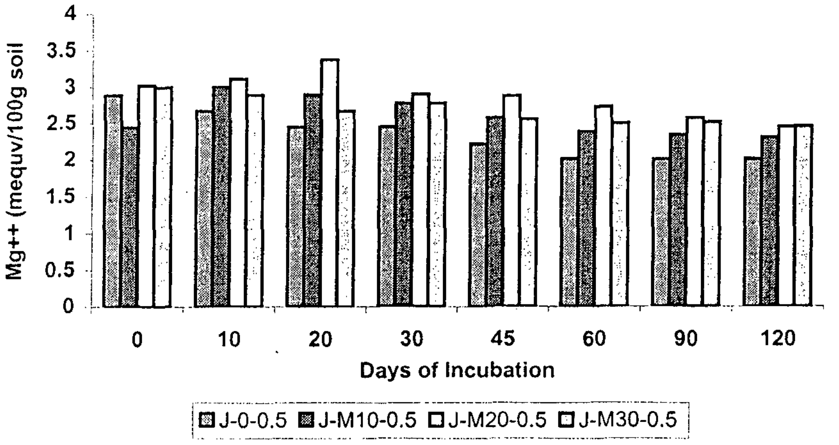
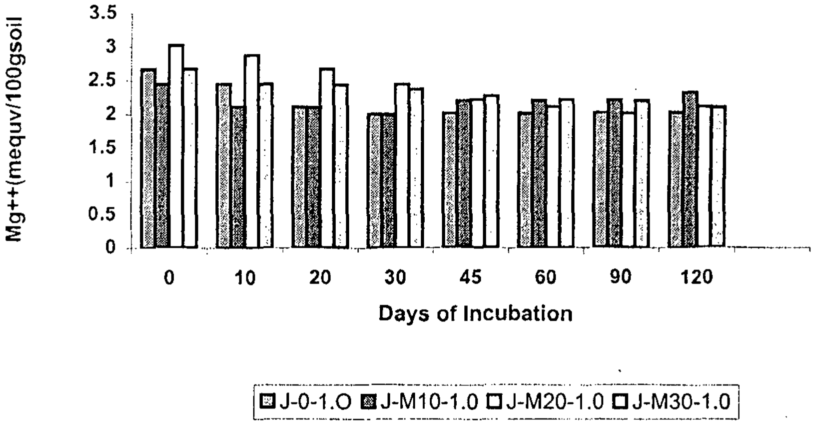


Fig No. 5.47 Mg^{2+} in JNU soil with MW with 1%Lime



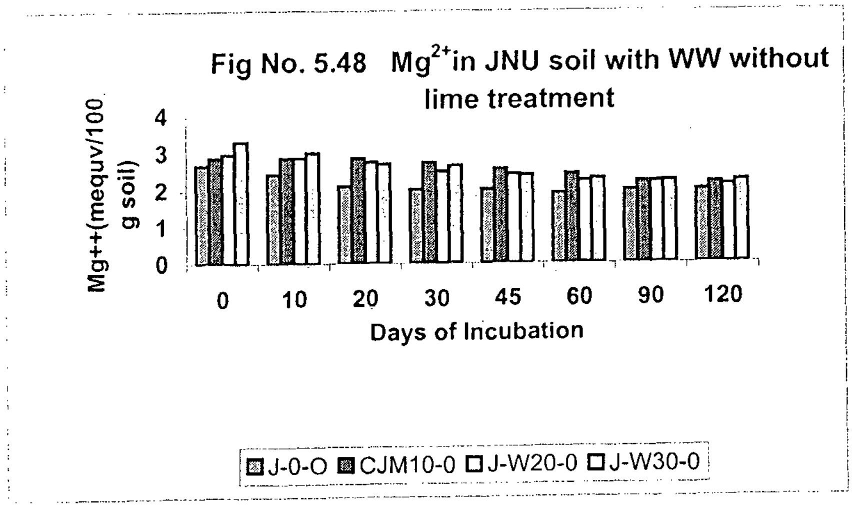


Fig No. 5.48 Mg2+in JNU soil with WW without lime treatment
Mg++(mequv/100 g soil)
4
3
2
1
0
0
10
20
30
45
60
90
120
Days of Incubation
J-0-O
CJM10-0
J-W20-0
J-W30-0

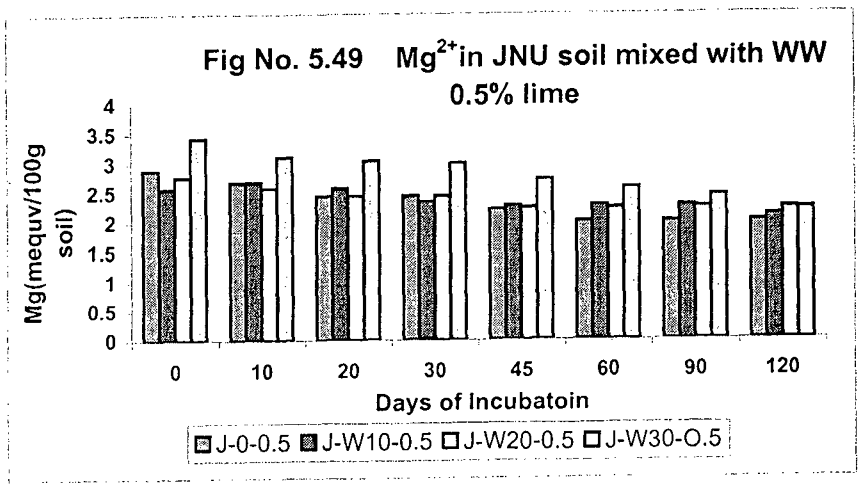


Fig No. 5.49 Mg2+in JNU soil mixed with WW 0.5% lime
Mg(mequv/100g soil)
4
3.5
3
2.5
2
1.5
1
0.5
0
0
10
20
30
45
60
90
120
Days of Incubatoin
J-0-0.5
J-W10-0.5
J-W20-0.5
J-W30-O.5

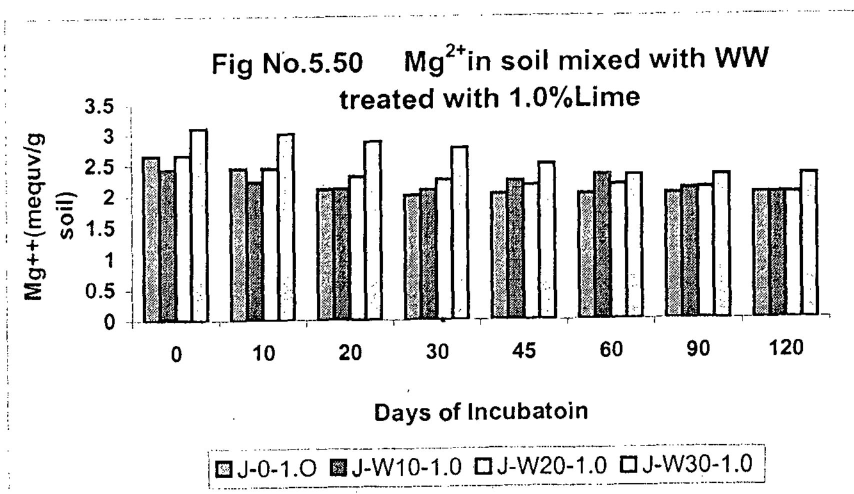


Fig No.5.50 Mg2+in soil mixed with WW treated with 1.0%Lime
Mg++(mequv/g soil)
3.5
3
2.5
2
1.5
1
0.5
0
0
10
20
30
45
60
90
120
Days of Incubatoin
J-0-1.O
J-W10-1.0
J-W20-1.0
J-W30-1.0

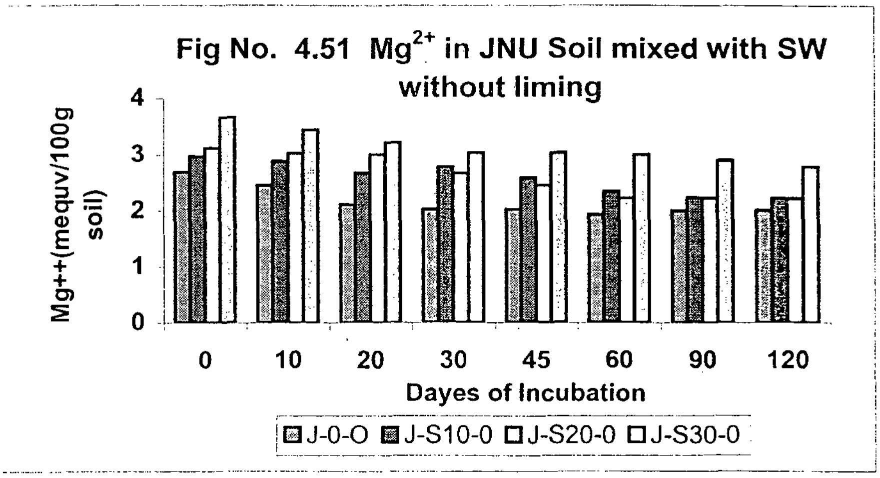


Fig No. 4.51 Mg2+ in JNU Soil mixed with SW without liming
Mg++(mequv/100g soil)
4
3
2
1
0
0 10 20 30 45 60 90 120
Dayes of Incubation
J-0-O
J-S10-0
J-S20-0
J-S30-0

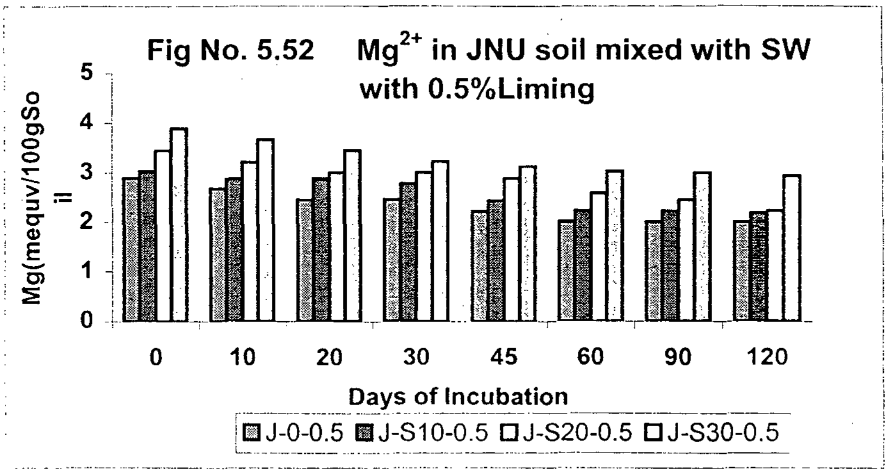


Fig No. 5.52 Mg2+ in JNU soil mixed with SW with 0.5%Liming
Mg(mequv/100gSoil
5
4
3
2
1
0
0 10 20 30 45 60 90 120
Days of Incubation
J-0-0.5
J-S10-0.5
J-S20-0.5
J-S30-0.5

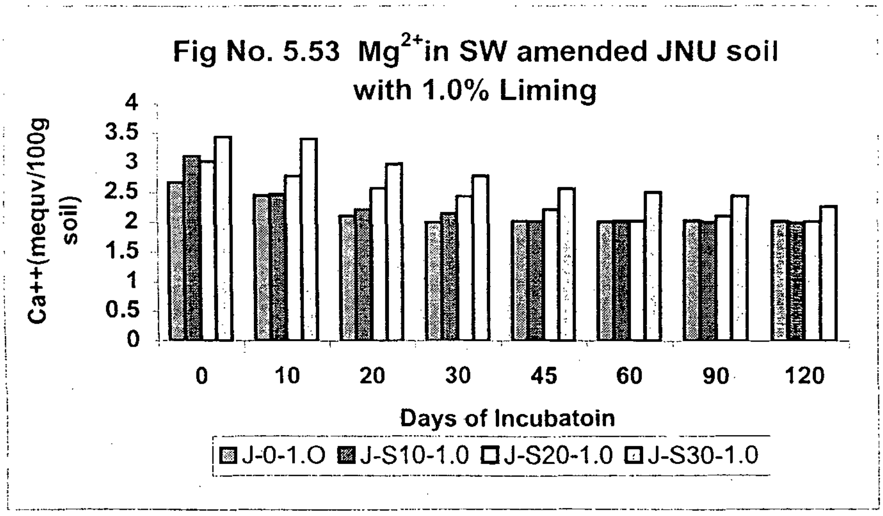


Fig No. 5.53 Mg2+in SW amended JNU soil with 1.0% Liming
Ca++(mequv/100g soil)
4
3.5
3
2.5
2
1.5
1
0.5
0
0 10 20 30 45 60 90 120
Days of Incubatoin
J-0-1.O
J-S10-1.0
J-S20-1.0
J-S30-1.0

CONCLUSION

CONCLUSION

The available calcium and magnesium are increased with the increasing days of incubation (till 30^{th} day of incubation), after that the values of available calcium and magnesium has got stability. It is also very clear that lime treatment in soil increases the availability of calcium. But, affects reversly in case of magnesium. The availability of magnesium in wastes mixed soil has decreased with the application of lime, but as less as pure soil has.

Overall Chhattarpur soil has high exchangeable calcium and magnesium than JNU soil in case of magnesium it was very surprising that addition of lime has decreased the available magnesium with increase in incubation period. The low availability of exchangeable magnesium is supported by many studies.

Ca^{++} and Mg^{++} are macronutrients for plants; it is very essential for growth of plants. It is well established that acidic soil have low Ca^{++} but if that soil contains high amount of organic carbon there is a probability of high CEC, Ca^{++} ions, that was observed with our wastes. it contains high amount of organic carbon, so many major cations may be present there(other than H^{+}ions)that is reflected on our experiments that with the increasing incubation period the availability of Ca^{2+} and Mg^{2+} has increased.

So from the present study it is clear that the wastes contain high organic carbon, Ca and Mg, so that plants can easily avail the cations. For that we try to find out the proper eco-friendly use of wastes. Dumping is not a solution. They have to dispose by thinking both the beneficial sides of ecology and economy.

Our experimental design has shown us that 10% waste with 0.5% lime treatment will give us better results. But by adding the dose up to 20% solid waste we can get better results with the threats of the metal toxicity too, which we should keep in mind. We are getting good results of each parameter within 20 days of incubation-45 days of incubation, so volume of solid waste can easily reduced by applying it in soil as fertilizer. But till now it is under study and in near future we are going to apply it in the field.

Future research should be undertaken under Pot culture experiments and field trials with different crops.

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