CHAPTER II

REVIEW OF LITERATURE

There is lot of literature on the use of Farm Yard Manure and other organic materials such as Press Mud in different type of soils and to different crops with positive effect on soil fertility and crop productivity. Recently, press mud was converted in to amendment called Acidified Press Mud (APM) by treating it with low cost sulphuric acid (Mehta, 1998). The APM of two pH levels were prepared i.e. of pH 2.0 and pH 4.0. APM of pH 2.0 was effectively used for reclamation of alkali soils in the experiments conducted at CSSRI, research center Shivery farm near Lucknow. Application of 9.0 t/ha of APM produced better results than the use of 15t/ha of gypsum on the alkali soil having pH more than 10.2. Acidified Press Mud having pH of 4.0 was used for improving the sodic waters from farmer’s fields from Karnal district of Haryana (Mehta, 2003). Being acidic in nature, this APM can be very useful for soils having calcium carbonate. Although there is very little work done on APM but some of the literature, which relates to acidifying materials has been included in this review of literature. Similarly, literature on cotton based inter cropping systems with crops like moong (Solaiappan, et al 1999) is available but there are no references of growing fruit trees like Citrus (Citrus limon) and Aonla (Emblica officinalis) in cotton crop grown on soils having Calcic/Kankar layer in the root zone. There are also examples of growing many crops in-between the fruit trees but there is no reference of growing cotton crop in some fruit plantations. With regard to methods of planting, there are many publications from CSSRI, Karnal in which Auger holes have been dug manually or mechanically to break the Kankar layer in the Alkali soils (Abrol and Sandhu, 1980; Singh et al 1988; Gill and Abrol, 1991, Tomar, 1997 and Dager, 2001) but there are no such studies on plantation of fruit trees like Citrus limon and
*Emblica officinalis* in cotton-wheat crops in soils of arid regions having *Kankar* layer in the soil profile.

**Growth:**

Aggarwal, *et al* (1994) reported that they tested eight multipurpose tree species, in field studies at the Research Farm of the Central Arid Zone Research Institute at Jodhpur in western Rajasthan in which six-month-old saplings were planted after digging pits of 70 cm wide and 70 cm deep, in which gypsum along with sheep and goat manure were applied. The amendments were mixed into the top 15 cm of the soil. Best height growth was obtained in *Eucalyptus camaldulensis, Acacia tortilis, A. nilotica, Azadirachta indica and Prosopis juliflora*. However, *Prosopis cineraria* performed very poorly.

Dhar, *et al* (1998) reported that there was need of mechanical perforation for planting trees in calcareous and alkaline soils. They emphasized that some modifications in tree planting techniques are required due to site-specific requirements of the planting stock. Poplar may fail due to the high calcareousness (CaCO$_3$ up to 11%) in the top 52 cm of soil. Acacia species will not be satisfactory due to the high CaCO$_3$ (12-18%) and *kankar* nodules mixed with hard soil in the top 67 cm and a hard *kankar* pan below this depth.

Venugopalan and Pundarikakshud, (1998) evaluated the productivity of three rain fed cotton based cropping systems under different combinations of N, P, and K with and without FYM since 1986. Substituting half the dose of N with 7.5 t/ha FYM increased cotton yield by more than 15%.

Singh, *et al* (1999) reported the results of comparative effect of gypsum, pyrite and sulphitation-cane-filter-cake (SCFC) on establishment of pomegranate and soil properties. It was found that SCFC proved much superior in increasing growth and biomass of pomegranate.
Shukla, et al (2001) in a field experiment conducted in Faizabad, Uttar Pradesh, India, during 1995-96, studied the effect of irrigation and mulching on growth of aonla (*Emblica officinalis*). Among mulching treatments, the maximum P, K, Ca and Mg values were found in FYM treatment, whereas, the level of nitrogen was more in paddy straw treatment.

Agnihotri, et al (2002) studied the effects of edaphic conditions on the growth of Aonla (*Emblica officinalis*) in a field experiment conducted in Agra, Uttar Pradesh, India during 2000. The treatments comprised calcium carbonate removal (T1), T1 + 15% fine fractioning of soil (T2), T1 + 30% fine fractioning of soil (T3) and T2 + 45% fine fractioning of soil (T4). Soil pH, electrical conductivity and calcium carbonate content decreased with increasing fine fractioning of the soil, whereas the organic carbon content, plant survival and plant height increased with increasing fine fractioning of the soil.

Dudi, et al (2003) studied effect of N fertilizer (0.0, 0.750 or 1.125 kg per plant) and farmyard manure (FYM: 0, 50, 100 or 150 kg per plant) rates on the growth of 12-year-old plants of kinnaw mandarin (*Citrus reticulata*) were studied in Ghursal, Hisar, Haryana, India, during 1998 and 1999. Increasing the N and FYM rates increased shoot length, number of leaves per shoot, leaf area, plant height, and plant spread, although greater increases in these parameters were obtained with N than with FYM. Shoot length and number of leaves per shoot increased by almost 2.0-fold with the application of 1.125 kg N per plant, and by almost 1.4-fold with the application of 150 kg FYM per plant compared to the control. The leaf area also increased with N and FYM but to a lower extent. Plant height increased by more than 2.0-fold and plant spread increased by more than 2.3-fold with the application of 1.125 kg N per plant compared with the control. The combined application of N and FYM further enhanced plant height and spread. The greatest increases in plant height (18.66%) and
spread (19.88%) were obtained with 1.125 kg N and 150 kg FYM per plant in 1999.

Mehta and Nehra, (2003) observed that there is frequent failure of rains even during the monsoon period. Farmers were unable to grow crops like Jowar, Bajra in those areas, which were totally dependent on rains. Only the trees like Khejri (Prosopis cineraria) continue to grow which were mainly used for fodder and fuel.

Haroon, et al (2004) reported Neem plantation using pit (60cm) dimension and Auger hole up to 120cm depths. The pits and Auger hole were filled with FYM, DSW, and DSW +Gypsum. Height and Girth was more where application of Distillery Spent Wash and Gypsum. In the same studies of three years experiments revealed that irrigation with Distillery Effluent @ 60 liters/ree recorded highest yield with compared to control in coconut tree. Such beneficial results were also obtained in Cashew tree in rain-fed conditions on farmer’s fields.

**Planting Techniques:**

Many studies have been conducted on planting techniques for fruit and forest trees in different soils. Some of the relevant literature is as follows: Abrol and Sandhu, (1980) reported results of studies on planting of forest trees on alkali soils by making pits (1m deep and 1m dia) and auger holes (15 cm. dia. up to 120cm depths) to break the Calcic layer in the soil profile in which roots of eucalyptus grew up to 200cm. depth in the soil profile where auger hole method of planting was used. Height of eucalyptus was also more in auger hole method than in pit method.
Singh, et al (1988) also conducted similar studies at CSSRI Karnal on planting of forest trees on alkali soils by making auger holes to break the Calcic layer.

Gill and Abrol, (1991) reported the results of a field experiment carried out since 1971 at the Central Soil Salinity Institute in which selected tree species were planted in auger-holes refilled with the original sodic soil mixed with gypsum and farmyard manure. It was observed that auger hole method of planting was an easier and more economic form of establishment than the previously used pit method. They reported reduction of soil pH, electrical conductivity and salinity and increase of soil organic carbon.

Tomar (1997), reported that the pit-auger hole and furrow method was recommended over the pit planting method. The use of soil amendments and farmyard manure (FYM) was necessary to counteract the harmful effect of exchangeable sodium and also to meet plant nutritional requirements.

Dagar, et al (2001) observed that a suitable technology for forest and fruit tree establishment by comparing two methods of planting were i.e. deep auger piercing the kankar pan and shallow augers not piercing the kankar pan. They found that making deep auger holes was suitable and cheap technology for forest tree establishment.

Effect of Amendments on soil properties, Nutrients availability and their uptake by crops:

Dixit (1987), reported that salinity and sodicity were the major problems in arid and semi arid regions in our country. Aonla seemed to be a potential fruit crop in years to come especially for proper utilization of degraded lands in
hot arid and semi arid regions. There are reports that Aonla could be grown successfully up to ECE of 9.20 dSm\(^{-1}\) in soils.

Dawood and Kadban, (1989) reported that is calcareous soils from central and northern Iraq were treated with two sources of sulfur. Results showed a significant change in sulfur oxidation and soil pH with respect to the levels of sulfur. No significant change was observed in P sorption by soil after harvesting with respect to the levels of agricultural S while levels of sulfur significantly increased P sorption compared with P sorption before planting.

Deb (1990), reported that laboratory study was conducted under controlled conditions on three calcareous soils in north Bihar to study the effect of FYM, P and Fe application. On the recovery of native and applied Fe in DTPA extract under upland and submerged soil conditions. The recovery of applied Fe did not differ significantly with respect to the levels of Fe application and moisture regimes. Application of 30ppm P and 10 t FYM/ha increased the recovery of applied Fe significantly. Increase in incubation period up to 60 days reduced the recovery of applied Fe significantly. An increase in incubation period up to 60 days reduced the recovery of applied Fe by about 50% of that of 20 days incubation period. The availability of native Fe and P increased significantly at 5 cm standing water treatment. Application of 10 and 20ppm Fe and 60 days period of incubation reduced the available Fe content in soil significantly. FYM treatment did not affect the available Fe content in soil. Application of P and FYM increased the available Zn and P content of soil. Sixty days period of incubation reduced the available Zn content but increased the available P content in soil.

Fenn, et al (1990) reported that acidification of <1% of the effective root zones of mature Pecan trees on Riverside rootstocks, growing in an orchard at El Paso, significantly increased Zn uptake and maintained increased leaf Zn content for 9 years. Application of sulphuric acid and ZnSO\(_4\) in a shallow trench
between trees reduced soil pH to a depth of 60 cm and increased Zn solubility in the soil solution.

Khattab, et al. (1990) reported that during the growing season of 1986 and repeated in 1987, 1-year-old 35-cm-high pomegranate plants were planted in 9 kg plastic bags in highly calcareous soils. The soil surface was sprayed with bitumen emulsion (25% active material) at rates of 75, 150 or 300 g/m², or bitumen emulsion was incorporated into the soil at 0.5, 1 or 2%. In 1987, nutrient uptake was increased by applying bitumen emulsion, particularly when it was applied at 3% increased N, P, K and Ca uptake. The costs of using bitumen as a soil conditioner are economically justified.

Cabrera, et al. (1991) reported that the effect of successive applications of urban compost (up to 150 and 400 t/ha over eight years) on the status of phosphorus in a calcareous soil was tested in a greenhouse experiment. Results suggested that continuous use of urban compost increased levels of soil organic and available P resulting in increased P uptake by plants.

Sharma and Dakshini, (1991) reported that evaluation of the ecological impact of replacement of native tree species by foreign plants during introduction or revegetation programmes is important. The performance of a native species (Prosopis cineraria) and an introduced alien species (Prosopis juliflora) in semiarid was studied. The introduced P. juliflora had a higher nutrient demand than the native P. cineraria. The results suggested that the practice of introducing plants in to alien environments should be reviewed.

Yadav, et al. (1991) reported that in a pot experiment groundnuts cv. GAUG 10 were given 0 or 1% FYM, 0, 10 or 20ppm phosphorous as diammonium phosphate and 0 or 5ppm Zinc as zinc sulphate. Results revealed that the FYM increased P and K concentration, P application increased P content and Zn application had no effect on N, P and K concentration in pods.
Sakr, et al (1992) reported that in a pot experiment, wheat was grown in calcareous or alluvial soil amended with the equivalent of 30t poudrette or town refuse/feddan and/or 60 kg N/feddan as urea. Plant dry weight (DW) was increased by urea or organic fertilizers and was highest in both soils with poudrette + urea. Plant N, P and K concentrations were increased by organic fertilizers. Maize K concentration was decreased by the residual effects of urea only, but N, P and K concentrations were increased by most other treatments. Total nutrient uptakes by both crops were highest in treatments including organic fertilizers.

Sutaria, et al (1992) investigated the effect of sulfuric acid equivalent to 0, 25, 50 and 100% of acid titratable basidity on the pH, electrical conductivity (EC) and available micronutrient status of three calcareous soils. Results indicated that treatment of such soils with sulfuric acid increased the availability of micronutrients by decreasing the pH of the soil. Available P also increased.

Pawar, et al (1992) reported that the possibility of improving the physico-chemical properties of a typical saline calcareous (Vertisol) soil by the application of spent wash, the potash rich acidic (pH 3.7) byproduct of alcohol distillery. There were significant changes in the exchangeable K+, Ca2+ and Mg2+. The nutrient supplying status of the experimental soil improved considerably as evidenced by the performance of sugarcane grown on this soil in a pot-culture experiment.

Bernal and Roig, (1993) observed the influence of pig slurry applications on the nutrient composition of Capsicum annuum (cv. Lamuyo) and tomato (cv. Luxor) plants and fruits and lettuce (cv. Empire) plants grown on 2 calcareous soils under irrigated conditions. Soil characteristics had a large influence on the amount of P taken up by the plants. This was due to the large amount of P added in the slurry. Amounts of slurry within 100-150 m³/ha were required for adequate K nutrition. However, soil characteristics, particularly the amount of
clay and thus its exchange capacity, had a significant influence on plant K uptake.

Cifuentes and Lindemann, (1993) reported the effect of organic matter on elemental sulfur SO oxidation in calcareous soils. Organic matter stimulation of SO oxidation, decreased pH values 0.24 and 0.16 units, increased soil SO4 246 and 1455 mg/kg, and increased soil EC 0.42 and 0.48 dS/m in the laboratory and field, respectively. Enhanced SO oxidation consistently increased Mn availability in the field.

El-Desoky and Ragheb, (1993) reported that samples of sandy calcareous soils were incubated at room temperature for 168 days with various levels of dairy dung (DD), clover straw (CS) and super phosphate (SP). Sodium bicarbonate extractable P increased with increasing rates of the two organic materials (OM). The recovered percentage of soil P and soil pH decreased with increasing SP rates. Results suggest that dairy dung, clover straw and super phosphate should be added to these soils 14 days before planting.

Ibrahim, et al (1993) reported the effect of Triple Super phosphate and Press Mud in a field experiment at Faisalabad in 1989 in Maize-Wheat crops. It was concluded that TSP proved a better source of P for the 1st two crops, but its effectiveness decreased with time; the effectiveness of Press Mud increased with time. The effectiveness of Press Mud is due to presence of other nutrients and organic matter and available P in soil was higher with Press Mud.

Juwarkar, et al (1993) studied the effect of NPK and Press Mud on Wheat, Moong and Sugarcane grown in clayey soil. It was reported that inclusion of Press Mud increased content of organic carbon and N, P and K. The residual effect of Press Mud continued at least three years. Soil pH was reduced with Press Mud.

Narwal, et al (1993) reported the effect of application of Sulphitation Press Mud and Carbonation Press Mud on sandy loam soils. NH4+ and NO3-
were higher for SPM amendments due to higher content of both substances in SPM. NO$_3^-$ contents were higher for CPM treatments, possibly due to higher amounts of CaCO$_3$ and lower amount of N in CPM.

Sinha and Sakal, (1993) applied 0, 200, 400 or 800 kg pyrite (containing 10.6%S)/ha and 10 t/ha FYM or press mud in a field experiment in a calcareous soil deficient in S. Groundnut pod yield and wheat grain yield were increased and uptake of S by groundnut and wheat and availability of S in soil were increased by pyrite, FYM and press mud.

Sinha and Sakal, (1993) reported that in a field experiment in S deficient calcareous soil (Calciorthents), during the rabi [winter] season in Bihar, lentils cv. No. 26 was supplied with 0, 200, 400 or 800 kg pyrite (containing 10.6% S)/ha and 0 or 10 t/ha FYM or press mud. Application of pyrite, FYM and press mud increased leaf chlorophyll content, seed yield, S concentration and uptake in seed and available S in the soil.

Pawar, et al (1993) reported that in a pot experiment in a saline calcareous Vertisol, sugarcane cv. Co 740 was watered with centrifuged spent wash from a distillery with added K. Compared with watering with canal and well water, root and shoot DW, Fe$^{2+}$ and leaf chlorophyll concentrations were increased with spent wash. It is suggested that irrigating with spent wash could prevent iron chlorosis in sugarcane plants grown on saline calcareous soils.

Balsaraf and Mohite, (1994) reported that in a field trial in 1988-89, maize cv. African Tall grown and wheat cv. HD 2189 grown were given different combinations of 20 t FYM, 5 t PMC [press mud cake] and 0-2 t pyrites/ha. Maize DM yield and wheat straw yield were increased more by FYM than by PMC. Uptakes of N, P, K, S and Fe were generally increased by each fertilizer, and the best results were given by a combination of 1.0 t pyrites and FYM.

Khorsandi (1994), reported the effect of sulfuric acid on the availability of Fe and P in two calcareous soils. Addition of sulfuric acid increased soil acidity.
salinity, DTPA-extractable Fe, available P (NaHCO₃ extractable) and crop yield. The change in soil pH was the key to the increased nutrient availability and subsequent crop yield.

Khorsandi (1994), studied that the effects of sulfuric acid on P fractions and suggested that application of acid caused the conversion of P from low solubility calcium-bound P to the more soluble carbonate P fraction.

Tiwari, et al (1994) reported that in a pots experiment Aonla plants were grown in sandy loam soil saturated with bicarbonate solution. Observed that seedling survival, growth and foliar N, P, K, Ca & Mg concentrations decreased significantly as sodicity increased.

Virmani (1994), was noted according to some environmentalists, we needs to reduce our agricultural area from the current 140 million ha to 110 million ha by the year 2000 to 2010. The area thus released can be used for alternate land use, most likely for forestry because of the low production of land area under forest cover (11%) against the required (23%). This would also help in increasing diversity of biological species and improving the quality of environment. Alternate land use systems, viz., agro-forestry, agro-horticulture and agro-silviculture are more remunerative for soil organic carbon restoration as compared to sole cropping systems.

Kapur (1995), reported that field experiments were carried out to determine the fertilizer- N equivalence of sulphitation cane filter cake for maize and rice in sandy loam soil of Punjab. The advantages of SCFC were greater for rice than for maize and higher grain yields were found of both crops with SCFC treated plots. Soil treated with SCFC had higher contents of OC, available N and Olsen’s P. Soil treated with SCFC increased soil EC and decreased the soil pH.

Chouliaras and Tsadilas, (1996) reported the effectiveness of elemental S to reduce soil pH in a calcareous soil in a pot experiment in which kiwifruit was grown. 1.8 units reduced soil pH. Organic P was significantly reduced while
inorganic P increased, exchangeable K increased from 0.183 to 0.33 cmol/kg whereas Cu and Mn increased to above the recommended level.

Thompe and More, (1996) reported that in a field trial on sunflower crop at Piabhani (Maharashtra), total N, P and K uptake were highest with 10-ton Press Mud Cake per ha. and half the recommended fertilizer rate of 40:60:40 kg per ha.

Adhikari, et al (1997) reported that the direct incorporation of crop residues in the field as a means of quick disposal was not always practicable because it delayed the transplantation of the following crops, produces phytotoxic compounds for young seedling, restricts the root penetration by the \( \text{CO}_2 \) evolution, and rapidly immobilizes plant nutrients.

Ali Wabel, et al (1998) reported that Sewage sludge was applied to the surface layer (0-10 cm) of two sandy soils, slightly calcareous. The results dictated that total soluble salts (EC) of the treated layer increased with increasing sewage sludge rates. Soluble salts also increased with an increase in soil depth for both soils. The pH values of treated layers in two soils decreased with increasing sewage sludge rates. Suggest that this material may be used for agricultural crop production without any toxic effect on plants.

Ferreira, et al (1998) reported that sulfuric, acetic, nitric, phosphoric and citric acids were applied to a Santiago soil, an alluvial Mollisol from Chile, in order to decrease soil pH. All acids were effective in acidifying the soil except the citric acid. Nitric and acetic acids increased the soil electrical conductivity. Drip irrigation with water acidified with sulfuric acid to a pH 4.5-5.5 maintained low pH of the soil solution in the planting hole.

Kaplan and Orman, (1998) reported that the effect on soil pH of application of 0-2000 kg ha\(^{-1}\) of elemental sulphur (S) and 0-100 t ha\(^{-1}\) of S-containing waste was determined in a field (in Turkey) and in pots. After 30 weeks the applications of S or waste for the determination of dry matter yield
and phosphorus (P), iron (Fe), zinc (Zn), manganese (Mn), and copper (Cu) uptake by shoots. EC, NaHCO₃-extractable P, and DTPA-extractable Fe, Zn, Mn, Cu also were measured. All treatments led to a decrease in soil pH. Elemental S and waste applications in pots increased dry matter yield and uptake of P, Fe, zinc (Zn), Mn and Cu. There was also an increase in EC of soil due to both S treatments. The concentration of available P extracted by NaHCO₃ in the pot soil, though not significantly different, was slightly higher compared with the control. Waste applications increased DTPA-extractable Fe, Mn and Cu contents but decreased Zn content.

Raul, et al (1998) reported that an experiment was carried out to observe the comparative effect of sulphuric, acetic, nitric, phosphoric and citric acids applied to an alluvial soil, in order to decrease soil pH. All acids were effective in acidifying the soil except the citric acid. Nitric and acetic acids increased soil EC to restrictive for plant growth. Drip irrigation with water acidified with sulphuric acid to a pH 4.5-5.5 maintained low pH of the soil solution in the planting hole through three growing season, when alkaline CO₃⁻ had been previously removed the hole.

Mustafa and Falatah, (1999) reported that thirty-six calcareous soil samples varying in clay content, available Fe, organic matter and CaCO₃ were sampled in Saudi Arabia. Soya bean was grown under green house conditions to assess chlorosis and Fe uptake. The results indicated that CaCO₃ content was important in influencing availability of Fe and organic matter and Soya bean positively correlated clay content with Fe uptake.

Singh, et al (1999) reported the comparative effects of gypsum, pyrite and sulphitation cane filter cake (SCFC) on establishment of pomegranate and soil properties. SCFC proved much superior in increasing growth and biomass of pomegranate. Mean concentration of P, K, Ca, Mg and S in the harvested biomass was significantly higher in case of SCFC treatment than in case of
gypsum and pyrite treatments. Sodium concentration in leaf, branch, stem and root of pomegranate was minimum in SCFC and maximum when no amendments were applied. Both gypsum and pyrite decreased soil salinity significantly whereas SCFC resulted in a large increase in soil electrical conductivity.

Shukla and Pathak, (1999) conducted studies in 30cm. earthen pots in an experiment to evaluate the performance of Aonla in saline and sodic soils and reported that nutrient status of N, P and K in the leaves decreased in both soils. Ca & Mg contents were reduced in response to sodicity. Leaf Na accumulation was in toxic quantities in response to salinity and alkalinity.

Tsadilas, et al (1999) in a field experiment with cotton, conducted investigations on a well drained, calcareous clay loam (Typic Xerochrept) soil in Greece on the use of sewage sludge as a partial substitute for fertilizers and the influence of its application on the basic soil properties and heavy metal concentrations. The results showed that sewage sludge application increased cotton yield and K and P concentrations in cotton leaves. Soil pH was reduced in the case of higher sewage sludge rate. Electrical conductivity, organic matter content, total N, and available P were significantly increased. DTPA-extractable Zn, Cu and Mn were also significantly increased.

Mehta (2000), reported that acidified-press-mud was developed at CSSRI Karnal. Application of this acidified press mud @ 9.0 t/h produced better crop yields of paddy than 15t/h of gypsum at CSSRI, research farm Shivery (Lucknow) during 1996-98. Being acidic in nature, application of this amendment is expected to nullify the adverse effects of Kankar layer.

Orman and Kaplan, (2000) reported that a study was conducted to investigate the effects of two different sulfur sources, elemental sulfur and flotation waste from Keciborlu Sulfur Factory in Turkey. Results showed that after 5 and 10 weeks of application, soil pH significantly decreased by 0.35 to
1.25 units. Flotation waste had a more significant effect (1.08-0.84) on the decrease of soil pH.

Negm, et al (2002) reported that a field experiment was carried out at the Agricultural Research Station Farm of Noubaria (Egypt) on a calcareous soil to study the efficiency of farmyard manure (FYM). FYM were significantly effective in increasing most of the absorbed macro- and microelements by different parts of plant. The lowest increase was obtained from the treatment, which was fertilized with K alone.

Perez, et al (2002) observed the effect of increased treatments with sewage sludge on macro (N, P, K, Ca, and Mg) and micronutrient (Fe, Cu, Mn, and Zn) input and dynamics in a calcareous soil in Spain. Anaerobically digested sewage sludge was applied at the rates of 20 and 40 g sewage sludge/kg soil dry weight, equivalent to 60 and 120 t ha⁻¹. Treatments were compared with a control, which was not fertilized at all. The soil used was a Calcic Petrocalcic. The availability of macronutrients and micronutrients was analyzed in the soil. Total N was increased by organic treatment as it was expected, and also for P, Ca, and Mg. Organic amendment improved available Fe, Zn, and Cu in soil.

Jen Hshaun and Ching Fong, (2002) reported that in five calcareous soils, with varying CaCO₃ content, collected from Taiwan were used to investigate the soil pH reducing capacities of sulfur and aluminium sulfate. Different amounts of sulfur and aluminium sulfate were added into the soils to adjust the pH. Results showed that soil pH decreased with the increasing amounts of sulfur and aluminium sulfate.

Moral, et al (2002) observed the pollution associated with non-essential heavy metals in sewage sludge is a hazard usually taken into consideration with land application of such biosolids. The risk of contamination may also be a factor for elements that are essential for plant growth because they are present in sewage sludge in very high concentrations. Calcareous soils, however, are often
deficient in elements like Fe and Zn. In this experiment, attempts were made to estimate the contribution of sewage sludge application to the input and availability of Fe, Mn, Cu, and Zn in amended soils. In order to study the dynamics of these essential elements, the experimental design was based on the incubation of two calcareous soils having different textures (sandy clay loam and clay loam) amended with composted and non-composted sewage sludge. Sewage sludge application rates to the soils were 30 and 50 g dry sludge kg⁻¹ soil. Also, for each soil, a control treatment with no organic amendment was established. Seven samples were taken from each soil-sludge treatment combination at 0, 15, 30, 60, 90, 120 and 150 days after the start of the incubation. A significant increase in available Fe, Cu, Mn and Zn was observed. The application of increasing rates of sewage sludge slightly increased the available fraction of the micronutrients studied. The influence of soil texture was to increase the available fraction in the clay loamy soil compared to the sandy clay loamy soil. Availability of Fe, Cu, Mn and Zn was continued to increase throughout the incubation period.

Barakah, et al (2003) reported that a study was conducted to investigate the effect of 20 years irrigation with groundwater and treated sewage water (TSE) on some properties of calcareous soil. Results revealed that electrical conductivity of groundwater (2.25 dS m⁻¹) was significantly higher than TSE and consequently led to increase soil salinity among different sites and seasons. Soil irrigated with groundwater contained significantly higher quantities of Ca²⁺, Mg²⁺, Na⁺ and K⁺ cations and sulfate anion than soils irrigated with TSE. Both irrigation waters had a very low amount of NH₄-N, NO₃-N, Fe, Mn, Zn, and Cu, which below the levels recommended for water quality. This study demonstrated that after twenty years of using groundwater for irrigation of soils at Riyadh region, a major impact on soil salinity took place showing an inhibitory effect on soil microbial populations. Contradictory to that, treated
sewage effluent did not show any deleterious effects on soil properties but led to significant increase of useful biological processes especially which play an important role in soil fertility such as nitrogen fixation and nitrification. The minor effect on denitrifiers and sulfate-reducers may be attributed to the texture of soil in this region where anaerobic conditions is not prevalence. Results indicated that treated sewage effluent could be used for agricultural purposes as groundwater. This study suggests to reuse treated sewage effluent in a large scale in Saudi Arabia for irrigation of woody trees or forestry.

Bozkurt and Cimrin, (2003) reported that the objective of this study was to examine the effects of sewage sludge and barnyard manure on the nutrient and heavy metal concentrations of calcareous soil at Van, Turkey, and to estimate its ecological conditions during 2000 and 2001. Sewage sludge applied at five rates (0, 10, 20, 40 and 60 kg tree\(^{-1}\)) in an apple orchard on calcareous soil significantly increased the available Olsen P estimated by extraction with sodium bicarbonate, but also (DTPA)-extractable Fe, Mn, Zn, Cu, Ni and total N, Zn and Cu concentrations at the end of the study. The pH of topsoil \((0-30 \text{ cm})\) decreased from 8.6 to 7.8 at the highest application rate. Extractable P, Zn and total Zn and Cu concentrations of calcareous soil significantly increased at all depths in the profile. Sewage sludge application only increased total N, DTPA-extractable Fe and Ni concentrations of the topsoil. Treatment with barnyard manure at one rate \((25 \text{ kg tree}\(^{-1}\)) did not increase the nutrient and heavy metal concentrations of the soil compared with sewage sludge. Only DTPA-extractable Mn and total concentrations of Zn and Cu increased with manure application at the end of the experimental study.

Singh and Bhati, (2003) reported that an experiment was conduct to monitor the impact of municipal effluents on the soil properties, growth and seedling nutrient status of Euclayptus camaldulensis.
Jen Hshaun and Ching Fong, (2003) reported that high pH and the presence of CaCO₃ usually result in low availability of phosphorus (P) in calcareous soils. Lowering the soil pH by adding acidifying materials is an important method used to reclaim calcareous soils. The research on the reclamation of calcareous soils and the behavior of P during the lowering pH of calcareous soils are limited, and needed to be studied and evaluated. The objective of this study was to evaluate the effect of adding acidifying materials to lower the soil pH on the behavior of P in calcareous soil. Five different calcareous soils with various level of CaCO₃ content were selected for this study. Different amounts of sulfur (S0) and aluminum sulfate [Al₂(SO₄)₃.14H₂O] were added to the soil to adjust the soil pH to 6.5 and 7.0, and the soils were incubated at 25°C, -33kPa water potential, then the P availability index (solution P, resin-P, and Olsen-P) and the forms of phosphate were determined. Results showed that the contents of solution P, resin-P, Olsen-P, Fe, Al-P, and Ca-P increased as the amounts of applied S0 increased, however, except Fe, Al-P content, the contents of solution P, resin-P, and Olsen-P decreased with addition of Al₂(SO₄)₃.14H₂O. It was concluded that P availability in calcareous soils will be improved by adding S0 to lower soil pH. However, Al₂(SO₄)₃. 14H₂O addition will decrease P availability in calcareous soils along with soil pH decrease.

Aariff-Khan, et al (2004) reported that a field experiment was conducted in Andhra Pradesh, India, during the 1997/98 and 1998/99 rabi seasons, to determine the influence of the components of integrated nutrient management on fruit yield and quality of acid lime (Citrus aurantiifolia) in red calcareous soil. The fruit yield of acid lime was significantly and positively influenced by the application of iron pyrites [pyrites] (IP at 100, 200 and 300 g/plant), press mud (PM at 4 and 8 kg per plant), farmyard manure (FYM at 25 and 50 kg per plant) and VAM (150 g/plant), either individually or in combination, over the control
in both years. Among the treatments, the integrated use of 200 g IP/plant along with 25 kg FYM + 2 kg PM/plant out yielded the other treatments in both direct and cumulative effects. The total soluble solid was not significant by the direct effect treatments, while the cumulative effect treatments in the second year were significant. The acidity of the different treatments increased significantly in direct and cumulative effect treatments over the control. FYM at 50 kg per plant, alone, gave the highest cumulative effect (18 and 24 months) for acidity, whereas 25 kg FYM + 2 kg PM + 200 g IP/plant recorded the highest acidity at 12 months of direct effects.

Abbaspour, et al (2004) reported that the possibility of using converter sludge, a steel factory byproduct, as an iron (Fe) fertilizer and amendment in some calcareous soils was investigated. Results showed that application of sludge especially acidified sludge increased AB-DTPA extractable Fe in soils. In a greenhouse experiment with 2 different soils, the various mixtures of converter sludge with sulfuric acid were used. Maize plant, variety 647 Single Cross, was used as a test plant. The results showed that application of 1 and 2%, in contrast to 4%, converter sludge remarkably increased the shoot dry matter and the Fe, copper (Cu), and P uptake of the plant. Application of 1% acidified sludge had better effects on yield and Fe uptake as compared to 2% acidified sludge.

Abbaspour, et al (2004) reported that the possibility of using a steel plant byproduct (converter sludge) as an iron fertilizer was investigated in Iran. To study the converter sludge, an incubation experiment was carried out on three calcareous soils. Results showed that converter sludge increased significantly extractable Fe proportional to the rate of sludge used. Sulfuric acid application increased Fe availability significantly. Elemental S and sulfuric acid application increased Fe and Mn availability significantly. Application of the sludge without and with elemental S and sulfuric acid slightly increased availability of P. The
A wastewater management plant in Zhejiang, China. No yield differences were found, but ascorbic acid content of fruits in the mud plots was a little higher than that in the fertilizer plots. The contents of Cu, Zn, Ni, and As in fruits were lower than the accepted standard, while the Hg content was much higher than the standard.

Wang, et al (2004) reported that the effects of acid materials, including furfural residue, solid oxalic acid, ferrous sulfate, sulfur powder and vinegar residue, on phosphate activation in calcareous soil were studied based on culture experiments. The results showed that all acid materials except vinegar residue significantly enhanced phosphate availability in calcareous soil. The order of effects on phosphate activation was furfural residue > solid oxalic acid > ferrous sulfate > sulfur powder, and compared with control. As a result, all of the materials helped the winter wheat (Triticum aestivum) increase uptake of phosphorus nutrient and crop yield.

Singh and Bhati, (2005) reported that an experiment was conducted at the AFRI, Jodhpur to monitor the impact of effluents on the changes in soil properties and their impact on soil nutrient availability and on seedling nutrient status, survival and growth. The experiment was done in a (35cm.dia x 55cm. height) plastic containers kept in a net house. Soil of container was loamy sand. Changes in soil properties were significant both due to species and treatments expect for soil Mg and SOC. Seedling had higher concentration of N, P, K, Ca, Mg, Mn, Zn, Fe and Cu where municipal effluent was applied.

Kaul, et al (1962) observed that young and old respondent explained the phenomenon during field surveys by saying that falling of the leaves and bird droppings increase soil fertility by adding humus and the healthier look of crops under this tree. The shade of tree provides shelter to cattle in summer, which add manure. Due to the above socio-economic dimensions the Khejri proves it self as a Kalpa taru of the arid areas.
Satynarayana (1964), reported that in rain fed areas, main crops of pearl millet and gram generally fail due to non-occurrence of rains. Khejri is one of the leguminous trees, which grows well against all the odd climatic conditions. Under such situations, Khejri (*prosopis cineraria*) holds an increasingly important place in the economy of Indian desert.

Singh and Lal, (1969) reported that increased soil fertility by adding leaves and pods of this tree. During rains, water drops from the leaves after the rain stops. These points indicate the reasons of increased and better growth of vegetation under this tree.

Aggarwal, *et al* (1975) reported that *Prosopis cineraria* promoted growth of crops in its vicinity and concluded that in general the growth of tree plantation and *P. cineraria* in particular improved the available micronutrients status of the soil.

Saxena (1977,80), reported that *Prosopis cineraria* tree was well distributed throughout the plains of western Rajasthan on sandy loam, loam & clay loam soil with a hard *Kankar* pan at varying depths of 50-150cm. An opinion poll of the local people has confirmed that crops grow better under this tree. All parts of Khejri are utilized and thus it is supposed to be the *Kalpataru/Kalpa Vraksha* of arid and semi-arid regions.

Sharma (2005), reported that effect of *Prosopis cineraria* and *Acacia albida* planted at three spacing (5x5, 5x10 and 10x10m) on availability of nutrients and moisture, and yield of clusterbean in arid environment was evaluated on a loamy sand soil. The soil under *P. cineraria* was richer in nutrients (N, P and K) and also maintained higher available moisture regimes as compared to the soil under *A. albida*. Nutrient uptake increased with decrease in the density of trees. The water expense efficiency was generally higher under *Prosopis cineraria* than *A. albida* at comparable spacing.