CHAPTER 2

REVIEW OF LITERATURE
Many research workers have studied the effects of PMC, distillery effluent, flyash and compost on crop productivity, soil fertility and biodiversity. Therefore, a good amount of literature on decomposition of agricultural and industrial wastes for compost have been accumulated which can be summarized as follows:

3:1. Farm yard manure (FYM)

Organic manure (FYM) not only provides essential plant nutrients but also leads to build up to organic carbon and improves the soil physical condition as well as the soil biotic life and finally crop yield. The organic manure exclusively can achieve the production sustainability in a highly intensive agriculture system for a well developed integrated nutrient supply system through recycling of organic wastes including crop residues (Yadav, 1991). Zende (1991) prepared compost from PMC and studied its effect on cane growth and yield and the application of PMC compost alongwith green manure and fertilizers recorded still higher yield to the tune of 5 mt/hectare when applied on equal N basis of press mud cake. It was found to be more effective than molasses or farm yard manure (FYM). Organic fertilizers have also been shown to be environmentally safer than the inorganic ones as their nutrients do not get easily reached to contaminate ground waters. Since they occur mainly as nitrates.

The high phosphorus content of bio-earth and organic acid produced during the decomposition of farm yard manure (FYM) might
have enhanced the available phosphorus content of the post harvest soil (Subramanian and Wahab, 1996). Beneficial effect of vermicompost may be attributed to its higher nutrient status in comparison to FYM (Mathur et al., 2000). Organic manure such as compost, farm yard manure, biofertilizers, press mud cake, etc. are the important source to increase the soil organic matter content, soil microflora population and sustain agricultural production (Christopher, 2002).

The amount of N-nutrient that could be provided to a growing cane crop through the use of organic fertilizers such as legumes (green manure) and farm yard manure has been reported by Gana (2006). Soundarajan et al. (2007) stated that the farm yard manure significantly increased the organic carbon exchangeable cations and available nitrogen, phosphorus and potassium (N.P.K.) contents and reduced the ESP of the post harvest soil due to increase in exchangeable Ca, Mg and K content of the soil.

3:2. Phospho-compost

The organic acids, carbonic acid and chelating substances produced during the course of decomposition might have helped in the liberation of P from the rock phosphate (Chein, 1979). Singh et al. (1983) have been reported that the composting of agricultural wastes with low grade rock phosphate and micronutrients like Fe and Zn was known to increase the solubility of insoluble rock phosphate by providing acidic condition. Citrate soluble phosphorus content increased throughout the period of composting. The results are in concordance with those of Mathur and Debnath (1983). Singh and
Yadav (1986) indicated that a significant increase in residual available phosphorus in the addition of phosphate enriched the compost.

Bhosale and Patil (1986) observed that adjustment of C:N ratio of 40:1 and addition of single super phosphate is ideal for quick decomposition of trash and gave the final product of better quality. Savithri and Perumel (1993) have showed that the addition of rock phosphate during composting could enrich of compost with phosphorus. The enrichment of compost with ZnSO₄ might have increased the solubilization of rock phosphate due to the creation of more acidic environment by ionisation and hydrolysis of ZnSO₄. Possibility of composting by spent wash with press mud cake (Patil and Shinde, 1995). These results corroborate the findings of Anand (1998).

3.3. Press Mud Cake (PMC)

Chand et al. (1977) noticed that the direct use of press mud cake have been reported beneficial in increasing the yield of sugarcane, mustard, sugar beet, green manure, maize, wheat, soybean and pea in acid soils, rice and wheat in sodic soils and sugar cane in calcareous saline sodic soils.

Kubista and Hasman (1977) observed that effect of moisture, temperature and N on microorganisms during the decomposition of straw and press mud cake to sugar cane. The PMC microflora is dominated by fungi imperfecti, *Aspergillus* and *Penicillium* (Salunkhe, 1983). PMC could save about half of the phosphorus required by the crop (Borde et al., 1984). Rakkiyappan et al. (1986) stated that the
PMC was as an ameliorating agent, effective as gypsum in increasing the cane yield in an alkali soil.

Ghugare et al. (1988) observed that PMC contains all the macro and micronutrients through in small amounts. On an average the press mud contains 1.0-3.0 % N, 0.6-3.6% P, 0.3-1.8%K, 33-37% organic carbon. All these nutrients become available to the growing plants after the degradation of PMC added to the soil. In PMC rich content of organic carbon as well as P₂O₅ and when applied to soils as an organic manure and in comparison with single super phosphate had no distinct effect on the fertility status of the soils, as noted by Ingole et al. (1989). Jauhari (1990) have shown that PMC was be very effective in maintaining higher population of Azatobacter chroococum and Rhizobium japonicum. Narwal et al. (1991) suggested that the press mud cake was a sulphur source and proved equally good in comparison to other sources like single super phosphate, gypsum, pyrite, elemental sulphur etc. for sugar cane and mustard crop.

Chalapathi (1991) and Patel et al. (1991) revealed that PMC was effective only when it was supplemented with N₂, P₂O₅ and K₂O and it was found on N basis to be more effective than molasses or compost (FYM). The streptomyces, Nocardia rujasa and Micromonospora represent actinomycetes and the filter mud is more and more transferred to the organic complex fertilizer plant to provide organic matter and phosphates to manufacture the organic complex fertilizer (Chen et al., 2000). PMC disposal was health
hazardous and it pollutes the soil and atmosphere in the vicinity of sugar mills (James and Hasibuan, 2002).

It is a good way to utilize the nutrition form the press mud cake, to improve the soil and plant health and more improvement to solve the environmental problem (Yuan et al., 2004). PMC or filter mud cake, a solid waste byproduct from sugar factory being organic in nature, it is soft, spongy, amorphous and dark brownish white material containing fibre sugar coagulated colloids and including cane wax, albuminoids in organic salts and soil particles (Satisha and Devrajan, 2004; Chauhan et al., 2007).

3:4. **Flyash as a soil conditioner**

For preparing good quality compost from bagasse ash or flyash, it is necessary to use cellulolytic microorganisms such as *Sporotrichum pulverulentum* (Yadav and Subha Rao, 1980). Spreading in the field as a fertilizer has been the usual practice of its disposal as it is a rich source of silica, potash, iron oxide and lime and encouraging results due to the presence of potassium and phosphorus (Paturau, 1982). At present, it is used in agriculture either as mulch or as a soil conditioner (Zende and Patil, 1988). Composting of bagasse ash by mixing it with PMC or spent wash or both and adding suitable culture can be produce a compost of good quality within 12 week times (Jadhav and Baber, 1990). Saxena et al. (1995) observed that flyash contains Cu, Ag, Pb, CO, Cd, Fe, Na, K, Cl and S etc. Berman et al. (1999) showed the accumulation of heavy metals in vegetables, pulse and wheat grown in the flyash
amended soil. The degradable dish were made from flyash have been used widely (Yang et al., 2001).

3.5.1. **Nutritional value of Distillery Spent Wash (DSW)**

Spent wash of molasses based distilleries also contains large amounts of potassium, calcium, chlorides, sulphates and BOD around 50,000 mg l⁻¹, which are very high as compared to spent wash from other countries (Patil et al., 1987). Pathak et al. (1998) studied the composition of distillery spent wash with very high organic load (95000 mg l⁻¹-COD, 1000 mg l⁻¹-N₃, 40 mg l⁻¹-P₂O₅, 11.000 mg l⁻¹ K₂O, 1.500 mg l⁻¹ sulphate, 15 dsm⁻¹-EC and 4.5-pH value). The spent wash is acidic (pH 3.94 to 4.30) and loaded with organic and inorganic salts resulting in high EC (30-45 ds/m⁻¹). Considerable amounts of plant nutrients and organic matter N-1660 to 4200 mg/l, P-225 to 3038 mg/l, K-9600 to 17475 mg/l, Ca, Mg, SO₄, Cl are also present in appreciable amounts and plant growth promotors viz. gibberlic acid (GA) and indole acetic acid (IAA) have also been detected which further enhances the nutrient value of spent wash (Murugaragvan, 2002). Metals like Fe, Mn, Zn, Cu, Cr, Cd and CO are also found in spent wash with EC in the range of 15-23 ds/m⁻¹ (Singh et al., 2007).

3.5.2. **Water pollution by Disposal of spent wash in rivers**

Verma and Dalela (1976) have reported high sensitivity of some fresh water fish to diluted spent wash. Anaerobic biological removal of organics in distillery waste waters can be more economical because energy recovery in the form of methane gas (Sheehan and Greenfield, 1980). Lowering of pH value of the stream, increase in
organic load, depletion of oxygen content, discoloration, destruction of aquatic life and bad smell are some of the major pollution problems due to distillery waste water (Kulkarni et al., 1987). Ali Khan and Dhaka (1989) reported the effect of distillery effluent (anaerobic lagooning) on ground water at Simbhaoli. The addition of DSW to subsidiary and river Ganga results in high concentration of organic matter and salts in the river which is responsible for decrease in DO and pH and increase in BOD, COD and TDS in river water (Chauhan, 1991). The destruction of aquatic life in water bodies like river Ganga and Gomti due to indiscriminate disposal of spent wash was reported in India (Joshi, 1988, 1994). Ali and Ahmed (1998) reported that **Ecological Time Bomb** explosion at Simbhaoli due to distillery lagoon percolation and in sediments of Kali River, Baboogarh.

The effect of ground water contamination of spent wash on aquatic life was investigated through simple biodiversity study on fingerlings of a fresh water fish species *viz*.* Cyprinus carpio* var. *communis*. Mobility and transport of salts and the possible ground water contamination with spent wash application were studied by Malthi (2002), Mahimaraja and Nanthi (2004) and Ali Khan (2007).

**3:5.3. DSW application as soil reclaiming agent**

Sweeney and Grantez (1991) reported that addition of DSW regardless of rate, raised the soil pH, owing to increase in soil K, Ca, Mg and Na levels. Jadhav et al. (1992) have shown that application of spent wash compost to soil is responsible for bringing about reduction of pH increase in the status of total nitrogen, available P
and K and improvement in physical parameter of the soil. Jaysubha et al. (2001) reported that significant increase in micronutrient contents in the soil due to the spent wash application. Distillery effluent could be considered as a liquid manure and controlled application of the treated effluent can increase the productivity of soils and crops (Anandurai et al., 2001). Murugaragvan (2002) recorded that the increase in organic carbon content of soils. Initial enhancement in enzymes (phosphates, dehydrogenase and urease) and microbial (actinomycetes yeast and bacteria) activities were evident in soil amended with the spent wash and its effect was also observed in vertisol and alfisol. Saliha (2003) reported that DSW application significantly reduced the pH of sodic soil. Madhusudhana et al. (2007) application of distillery spent wash slightly increased soil pH and EC and there was significant increase in soil organic crop, available nitrogen, potassium and sulphur.

3:5.4. Impact on crops

Higher concentration of the DSW decreased the height of the Bhendi [Abelmoschus esculentus (L.) Monch] plant and the concentration of DSW decreased fruit yield (Mohite and Shingthe, 1981). Someshekher et al. (1984) stated that raw spent wash altered the physiochemical properties of soil and reduced the rate of germination of seeds. Anjumfarooqui (1994) found that diluted effluent increased plant height and number of nodes per plant in lentil (red gram). Rathinasamy and Narashimhan (1995) reported that the use of 50-77 times diluted spent wash increased crop quality.
and yield of Behndi PKM-1. Dilution with water resulted in improved growth parameters viz. Plant height (Singaram, 1996). Joshi et al. (1996) reported that effluent treatment at 20% dilution with 50% N application had given the best yield in case of maize, saving 50% N and P and 100% K. Zalawadia et al. (1997) reported that application of distillery spent wash increased the level of organic carbon, N, P, K and Ca in soils with significant increase in yield of crops like sugar cane, rice, cotton, maize, sorghum, bajra and red gram. Devarajan et al. (1998) reported that gypsum application was more effective in removing the soluble salts and improving the soil properties thereby enhanced the fruit yield.

The higher concentration of DSW decreased the chlorophyll 'a' and 'b' content. This was due to inhibition of enzyme concerned with chlorophyll biosynthesis (Bera and Bokaria, 1999). Annandurai et al. (2001) reported that 50 times diluted effluent was found to suitable for rice and the undiluted effluent was not suitable for rice crop. The effect of spent wash at rates equivalent to single application of 0, 25, 50, 125, 250 and 500 m³/hactare with and without amendments viz. FYM, GLM and BC on selected properties (EC, pH, N, P, K, organic carbon and exchangeable sodium percentage, ESP) and production of selected dryland crops (ragi, groundnut, gingelly, sorghum, rice and green gram) were examined by Murugaragavan (2002) and Saliha (2003). Application of DSW significantly improved the first rice crop growth, yield attributes, grain and straw yield of rice (Oryza sativa) (Balasubhramanian et al., 2007).
3:6. Utilization of water hyacinth in decomposition

Water hyacinth (*Eichhornia crassipes*) is a fast growing aquatic weed, which may be used for the decomposition and decreased of some aquatic weed problem for water reservoir (Trivedy *et al.*, 1985). The plants ability to absorb mercury from the industrial effluents with the knowledge that water hyacinth can with stand a wide range of pH 5-8 (Jamil *et al.*, 1987).

3:7. *Trichoderma viride* as biodegradant of agro-industrial wastes

According to Rote *et al.* (1981) the combination of sugarcane trash with legume and fungus cultures benefits the process of decomposition of trash in heap method of composting. Earlier reports indicate the use of various agricultural wastes and byproducts for multiplication of cellulolytic fungi (Kousalya and Jayarajan, 1990). It can be used decomposing agent as well as prophylactic agent against several diseases to plant or biocontrol agents (Bhai *et al.*, 1994; Anandraj and Sharma, 1997). *Trichoderma viride* is green coloured antagonistic free living fungus, multiplies and spreads very fast in the organic matter or soil (Thomas, 2004). The organic residues added to the soil must be decomposed for nutrient recycling and availability of nutrients for crop plants were recorded by Pathakar *et al.* (2006).

3:8. Compost

Compost product can be used as a good soil conditioner by enhancing clumping and therefore, improving texture and permeability of soil to air and water and most importantly promoting recycling the
utilization of valuable resources in the organic wastes. Similar finding was revealed by Bertoldi et al. (1983). Zende and Patil (1988) studied about importance of DSW and PMC as a source of organic manure. Bertraman et al. (1989) stated that available K content of soil increased due to the spent wash application which contained large quantities of K. Prasad et al. (1989) also noticed that the application of Fe enriched organic wastes increased due to Fe uptake. Subha Rao et al. (1990) showed that spent wash and press mud cake produce good quality of organic manure in 7:1 against 2:1 which is rich in nutrients like nitrogen, phosphorus, potassium and trace elements. Similar attempts were made by Jadhav and Baber (1990) to prepare compost from PMC, spent wash and bagasse ash by adding bacteria which as a source of culture can produce a compost of good quality necessary to use cellulolytic microorganisms such as *Sporotrichum pulverulentum*.

Mineralization of organic matter of spent wash studies related to the development of ammonifying bacteria were carried out (Singh et al., 1991). Observations conducted by Jadhav et al. (1992) have shown that application of spent wash or spent wash compost to a soil is responsible for bringing about reduction in alkaline soil pH, increase in the status of total nitrogen available P and K and improvement in physical and biological parameters of the soil. The population of *Azatobacter*, *Azospirillum* and total ammonifying bacteria increased several fold by the amendment of spent wash (Hemant et al., 1995).
Tiwari et al. (1998) observed the increase in available N₂ could be attributed to the release of N₂ from organic during the course of decomposition. Composting, biological stabilization of organic waste under controlled conditions can significantly reduce waste volume and pathogens were studied by Feng et al. (1998). Gajanana et al. (1999) studied that organic residues were good source of trace elements and the soils receiving continuous addition of organic manures seldom show micro nutrient deficiencies. Murugaragvan (2002) indicated that the initial enhancement in enzyme (phosphatase, dehydrogenase and urease) and microbial activities was evident in soil amendment with the spent wash. Lettinga (2008) reported that the use of the biological degradation sequence of organic wastes which proceed for decomposition under natural conditions from anaerobic and aerobic degradation processes (anaerobic and aerobic digestion, sulphate reduction and denitrification).

3:9. Compost effect on soil and crop

Zende (1991) has shown that its application improve soil moisture status organic matter content and nitrogen status. The direct incorporation of trash and PMC in the soil also improved the soil fertility which leads to significant increase in the cane and sugar yield of Adsali crop Shinde et al. (1992). Kumar (1992) concluded that increased application of organic manure and manganese sulphate resulted in increased curcumin content of rhizome. Application of PMC compost at the rate of 10 ha⁻¹ increased the maize and wheat yields (Datta and Gupta, 1993).
Patil and Shinde (1995) indicated that application of spent wash slurry press mud compost enhanced uptake of macro and micronutrients. Rathimasamy and Narashimhan (1995) revealed that the use of 50-77 times diluted spent wash or compost increased crop quality and yield of Bhendi var. PKM-1. Rajukannu et al. (1996) revealed that crops with heavy biomass removed large quantity of plant nutrients viz. N.P.K., Ca, Mg, Zn, Cu, Fe and Mn from soil. Pedro Luna-Orea et al. (1996) have worked on nutrient release dynamics and observed similar rate of mineralization for the two tropical legume cover crops (Desmodium and Pueraria).

Positive effect of bio-earth (compost) on sugarcane yield was also reported by Nagappan et al. (1996) and Rajannan et al. (1996b). Zalawadia et al. (1997) reported that application of spent wash increased the level of organic carbon, N.P.K. and Ca in soil with significant increase in yield of crops like sugarcane, rice, cotton, maize, sorghum, bajra and red gram.

The decrease in available potassium in post harvest soil using distillery effluent based compost was reported in sugarcane cultivation (Rajanan et al., 1998). Christopher et al. (1998) observed that a combined application of organic and inorganic fertilizers increased pod and halum yields of groundnut.

Gajanan et al. (1999) observed that organic residues and that the soils receiving continuous addition of organic manure seldom show micronutrient deficiencies. Haritha Joshphine et al. (2002) showed that onion responded well to application of sulphitation PMC
and sulphur. The effect of application of treated spent wash and press mud compost alongwith inorganic fertilizers have improved the status of soil and plant (turmeric) growth (Davmani et al., 2006). The favourable effect of humic substances on growth, yield and nutrient uptake by plants were studied by Soundarajan et al. (2007). Ali Khan et al. (2008) has been observed that the ecofriendly ferti-irrigation (liquid fertilizer) of distillery effluent at JOL and recorded early decomposition of green manure plant sesbania in soil. PMC inoculated by Trichoderma viride with aquatic weeds Eichhornia crassipes/Azolla have increased organic carbon, phosphorus, potassium, sulphur and magnesium content of treated soil. However, fertile soil provides nourishment to crops (cereals, pulses and oil crop) for better yield to revitalize agriculture in Indian scenario.

3:10. Prediction of compost maturity

3:10.1. Temperature: Initial decomposition is carried out by psychrophillic and mesophillic ammonifying bacteria, cellulolytic microorganisms (decomposers) have studied (Suler et al., 1977). Macgregor et al. (1981) reported that the second thermophillic phase maintained temperature in the heap method of water hyacinth composting. In the initial stage high temperature is caused by high metabolic rates when the readily available carbon is metabolized. In the later stage, lower temperature is due to metabolism of hemicellulose, cellulose and lignin, which metabolize in lower rate, hence the gradual decrease in temperature (Eiland et al., 2001). The final decline in temperature was more gradual which indicated the
stage of stabilization. Stabilization phase was constituted to remove confusion of II mesophillic phase (Ali Khan and Kasyap, 2007). This corroborated the earlier report of Volchattova et al. (2002). Organic continued to decompose and are finally converted to biologically stable humus. These results substantiated by the observation of Masood (2006). Muthuraju et al. (2007) have recorded PMC, spent wash compost the average maximum temperature was raised upto 73°C during thermophillic stage of composting. The high temperatures also accelerate the breakdown of proteins, fats and complex carbohydrates like cellulose and hemicellulose. The major structural molecules in plants to decrease the C/N ratio and chaetonium thermophillic bacteria are active in this process (Ali Khan and Kashyap, 2007).

3.10.2. pH value: The concentration of \( \text{NH}_4^+ \) decreased with the progress of composting result in low pH and consequently pH dropped to near neutrality (Eiland et al., 2001). The acidic pH indicates the lack of maturity due to short composting period or anaerobic process (Kadalli et al., 2004). The high pH values just before 1\(^{st}\) turning were caused by ammonia liberated form proteins of composting substrates and urea used for boosting of microbial growth and interplay of the biological and chemical factors (Chaterjee et al., 2005). High pH were caused by ammonia liberated from proteins of composting materials and \( \text{N}_2, \text{P}_2\text{O}_5 \) and \( \text{K}_2\text{O} \) from the spent wash used for the compost. Further, it is also studied high pH and high \( \text{NH}_3 \) concentration in thermophillic stage leaded to \( \text{NH}_3 \) volatilization (Ali Khan et al., 2006).
3:10.3. Turning: Turning of decomposable materials facilitate recalcitrant organic molecules to be composted by special group of microbes under relatively higher O₂ and moisture status maintained during the turning (Macgregor et al., 1981).

3:10.4. Odour: Chanayasak et al. (1982) stated that lower fatty acids are one of the major components causing the obnoxious odour of refuse. Kadalli et al. (2004) reported that the anaerobic decomposition results in partial breakdown of organic matter and often produces obnoxious or disagreeable odour. Proper and odour free composting is necessary to aerate the compost so as to maintain adequate supply of oxygen, lack of which encourages the growth of anaerobic microbes that produce disagreeable odours. High carbon will slow down decomposition and high nitrogen will cause unpleasant odours due to release of excessive nitrogen into the air in the form of ammonia and nitrous oxide (Masood, 2006).

3:10.5. Appearance: Saugahara et al. (1979) proposed a simple technique to determine the degree of darkness with standard calorimetric systems. The final produce after sufficiently long period of maturation is dark brown or almost black in colour. The maturity of compost was monitored on the basis of degree of darkening by visual observation (Kadalli et al., 2004). Masood (2006) reported that the final finished product has a dark colour, a crumbly texture and an earthy smell.

3:10.6. Moisture content: Steven and Clark (1979) and Atchley and Dark (1979) observed that the static state of oxygen and urgently needs further turning for better humification and significant
drop in temperature and pH. Macgregor et al. (1981) noticed that after turning, the heap reconstructed and huge amount of air is trapped. The trapped $O_2$ and adjusted moisture content expedite microbial respiration for decomposition of organic carbon.

3:10.7. Electrical conductivity (EC) : Anonymous (1993) indicated that one time application of treated undiluted distillery effluent before planting of the crop did not raise EC of the soil beyond 0.25 dsm$^{-1}$ even at 500+ ha$^{-1}$ of treated effluent application support to the present findings. The high EC (ds/m$^{-1}$) could cause a significant inhibition of root growth and germination of *Vigna radiata* L. (Ali Khan and Kasyap, 2007).

3:10.8. Organic carbon : The increase in content of organic carbon in pit was due to the less aeration resulting in lower rate of degradation of organic residues was noticed by Sahai et al. (2000). Rao et al. (2001) reported that the significant and gradual decrease in the organic carbon content with the progress of composting. Ma and Wu (2002) noticed that the curing time this extractable fraction of carbon decreased through the gestation period of composting. Chatterjee et al. (2005) stated that rice straw was superior to water hyacinth in maintaining higher amount of organic carbon during composting.

3:10.9.1. Nitrogen (N) : Elserafy et al. (1980) observed a steady increase in nitrogen content of compost material. The increase in available $N_2$ could be attributed to the release of nitrogen from organics during the course of decomposition as observed (Tiwari et al., 1998). N supply as well as the increased microbial activity due to
added organic matter which in turn might have increased the release of native N source. Nitrogen is difficult to retain in the soil due to ammonia volatilization leading and denitrification process confirms the findings of Magar (2004). The increase in available N, P and K content was due to the application of spent wash, biocompost and biosuper (Davmani et al., 2006).

3:10.9.2. Phosphorus (P): Singh and Yadav (1986) observed a significant increase in residual available phosphorus in soil with the addition of phosphate enriched compost. The addition of rock phosphate during composting could enriched the compost with phosphorus (Savitri and Perumal, 1993). Possibility of composting higher proportions of spent wash with press mud cake was reported by Patil and Shinde (1995). The phosphorus as well as the HCO₃⁻ content of distillery effluent and organic acids produced during the decomposition of distillery effluent would have helped to solublize the immobile native soil P (Rajukannu et al., 1996).

3:10.9.3. Potassium (K): Bertranon et al. (1980) reported that the increase in available K content of soil due to the spent wash compost application which contained large quantities of K. Zalawadia et al. (1997) that the increase in micronutrients of soil might be due to the presence of trace amount of macro and micro nutrients (N, P, K, Ca, Mg, Zn, Cu, Fe and Mn) in spent wash and compost. The decrease in available potassium in post harvest soil during cultivation of sugarcane using distillery effluent based press mud compost was also reported by Rajanan et al. (1998).
3:11. C/N Ratio

Allison (1973) investigated the relevance of the C/N ratio relies on the fact that a decrease in the ratio implies an increase in the degree of humification of organic matter. C/N ratio below 20 is indicative of an acceptable maturity degree observed by Pincelot (1974). Hirai et al. (1983) suggested ratio of five to six (5 to 6) could be used as an essential indicator of compost maturity. Meena et al. (1986) also reported that the DSW application to soil increase the total N, C and organic matter contents and modified the C:N ratio. Wider C/N ratio and higher amount of resistant constituents like lignins are responsible for slow decomposition (Rao and Tarafdar, 1996). Bernel et al. (1998) have indicated that the C/N ratio is considered to be of the simple indice to evaluate any organic for its fitness for application. Infact, it is the index traditionally used to establish the degree of maturity of compost. Mishra et al. (2001b) reported that the faster decomposition could be due to lower lignin and narrow C/N ratio of legume straw. Masood (2006) recorded that it is necessary to have right amount of carbon to nitrogen (C/N) ratio (approximately 4:1 by volume). The cellulolytic fungus *Trichoderma viride* that have the maximum decomposing ability which caused complete decomposition of the organic substrate, narrowing the C/N and C/P and provides the essential value of N, P, K, S and Zn as reported by Chauhan et al. (2007).

3:12. Plant bioassay Test

Germination index, obtained by multiplying germination and root growth is the most sensitive parameter that is able to account
for low toxicity affecting root growth and seed germination have reported by Zucconi et al. (1981). Bioassays of phytotoxicity is described as an intoxication of living plants by substances present in the growth medium when these substances are taken up and accumulated in plant tissue (Chang et al., 1992). The seed germination bioassay was evaluated by computing germination index, a factor of relative seed germination and relative root elongation (Tam and Tiquia, 1994). The seed germination index of over 100 % suggests a growth stimulating effect on plant growth have proposed by Lau and Wong (2001). Seed germination % and plant growth bioassay are the most common techniques used to evaluate phytotoxicity (Kapanen and Itavaara, 2001). The germination index has been shown to be a very sensitive index of phytotoxicity (Nagda et al., 2006; Ali Khan and Kashyap, 2007).

3:13. Simbhaoli Organic Manure (SOM)

The Simbhaoli Sugar Mills Limited is a premier sugar manufacturer in Northern India. The industry has adopted biocomposting process for manufacture of biomanure which is highly rich in nutrients and organic matter and prepared by aerobic fermentation through use of bacteria and fungus from sugar factory byproduct press mud cake (PMC) and distillery treated effluent after “Ch. Charan Singh Compost” which contained organic humus enhances growth yields and it would be ecologically sound, environmental friendly and economically viable for sustainable development (Ali Khan, 1998). The product is named as “Simbhaoli
Organic Manure (SOM). The process of biocomposting adopted at Simbhaoli is based on hot solid state fermentation using press mud cake as nutrient support for micro organism and converting incoming residual carbon of primary treated distillery spent wash as energy source in its multiplication. Press mud cake mixed with treated spent wash is inoculated with bioculture containing Thermophilic bacteria and Mesophilic fungi of Actinomycetes group. Cellulolytic bacteria, which are Thermophilic which release energy in the multiplication process, resulting in higher temperature. Due to loss of carbon dioxide and water, the weight of biomass reduces and the elemental nitrogen, phosphorus pentaoxide and potassium get concentrated. Hence there is increase in N.P.K. values. The Simbhaoli Organic Manure thus obtained is a natural ‘Humus’ supplement, contains no weed seeds pathogens, provide micro-nutrients, make nitrogen readily available to plants, handling and transportation is easier and cheaper increases soils water retention capacity energizes soil micro organisms and improve fertility status.

*********