Chapter II

REVIEW OF LITERATURE

For boosting crop production chemical fertilizers play a major role. But today, their increasing prices, soil health deterioration, sustainability and pollution consideration in general have led to renewed interest in the use of organic manures. However it is not possible to supply all the nutrient requirements of crops wholly through organic manures. So by taking into consideration the above facts, integrated plant nutrient management system has been developed.

In vermicomposting, the capacity of feeding and excretion of earthworms is exploited to degrade organic materials and convert it into high grade manure called ‘vermicompost’. Application of organic manures in soil effects the physico-chemical and microbiological properties of soil. The effects are pronounced on growth and development of crop plant, which in turn influence yield and yield attributes of crop.

The relevant literature pertaining to the present investigation has been reviewed under the following heads and subheads. In view of dearth of non-availability of literature on paddy crop, the relevant literature on other field crops has also been included.

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2.1 VERMICOMPOST PREPARATION/PRODUCTION

2.1.1 Substrate for vermicomposting

  In India, nearly 7000 million tonnes of organic materials such as farm wastes, kitchen waste, dairy and industry waste are produced every year, which has a large potential for production of organic manures, be it be composting or
vermicomposting (Bhaiday, 1994). Gujral and Vasudevan (1983) reported that *Lantana camara* is one of the most problematic weed in nature and is spreading rapidly throughout India.

The green leaves of *Lantana* contain 2.3% N and thus provide tremendous potential for being used as organic manure (Bhardwaj *et al.*, 1988). Biddappa *et al.* (1996) reported that the waste from arecanut field had a potential to supply 5260, 1337 and 6230 t of N, P and K respectively; while cocoa waste could contribute 540, 72 and 244 tonnes of nitrogen, phosphorus and potassium, respectively (Chowdappa *et al.*, 1999).

Vasanthi and Kumarswamy (1999) prepared vermicompost from cane trash, neem waste, *Parthenium*, banana waste, *Ipomoea* etc. and tested these vermicomposts on rice crop. Vermicompost prepared from *Ipomoea* weed was superior most and was at par with vermicompost from *Parthenium*. Similarly Shinde and Raut (1999) used six agriculture wastes as substrates for vermicomposting *viz.*, tur husk, sunflower, paddy straw, wheat straw and glyricidia leaves and urban waste from vegetable market, slaughter house waste and FYM was used as a check. Maximum NPK was found in vermicompost prepared from slaughter house waste and least from FYM. Biradan *et al.* (2000) reported that vermicompost prepared from sugarcane trash and sunflower residue resulted in significantly higher yields of crops. Moreover higher quantity of vermicompost was also obtained when these two crop residues were used. Singh and Kumar (2000) used cattle waste, pig waste and potato waste as
substrate for vermicomposting and normal composting and reported that nutrient status in vermicompost was always higher than normal compost. Sharma (2001) used Lantana and Parthenium weeds for the production of vermicompost and found that vermicompost prepared from Lantana resulted in significantly higher wheat yield than vermicompost prepared from Parthenium.

2.1.2 Method of vermicomposting

Survival and development of earthworms is highly influenced by environmental factors viz. temperature, bed moisture, relative humidity, rainfall, direct sunlight etc. (Giraddi and Lingappa, 1997; Valle et al., 1997). Vermicomposting site is also influenced by seasonal variations (Kulkarni, 1997). Earthworms can tolerate a temperature range of 25-35°C and can live at or below soil surface (Ganesh, 2000; Singh and Kumar, 2000). The production and multiplication of earthworms were higher in winter rainy seasons as compared to hot summers as reported by Giraddi (2000). Kulkarni (1997) studied the effect of different methods of vermicomposting and observed that pit method was much superior than heap method, whereas, pit system and brick column were considered to be at par with each other, but superior over heap system of vermicomposting as also reported by Giraddi (2000).

2.1.3 Manurial value of vermicompost

Nutrient content of vermicompost mostly depends on the type of substrate being used for its preparation. Nutrient composition of vermicompost is always higher than that of ordinary compost, whereas C:N ratio was much lower
than ordinary compost (Jambhekar, 1992). Singh and Kumar (2000) and Purakayastha and Bhatnagar (1997) found that most of the macro- and micro-nutrients were higher in vermicompost than FYM, while C:N ratio was nearly half of FYM. Chowdappa et al. (1999) prepared vermicompost and normal compost from arecanut and cocoa wastes and reported that nutrient concentration and microbial population was higher in vermicompost than normal compost and also than that of its substrate. Similarly Vasanthi and Kumarswamy (1999) also made similar observations in case of sugarcane trash, neem leaves, *Parthenium* weed and banana wastes. The reduction in CN ratio was also observed by Talashilkar et al. (1999) and Biradan et al. (2000).

Srikanth et al. (2000) observed that organic carbon content in vermicompost (15.2%) was much lower than FYM (37.4%) while N content in vermicompost (1.40%) was much higher than FYM (0.9%). Bansal and Kapoor (2000) reported that vermicompost prepared from mustard residue and sugarcane trash by using *Eisenia fetida* resulted in significant increase in mineral nitrogen and microbial activities. Sharma (2001) also reported higher N content in vermicompost prepared from *Lantana* than that of *Parthenium*.

### 2.2 Effect of Vermicompost on Plant Growth, Yield Attributes, Yield, Nutrient Uptake and Soil Properties

#### 2.2.1 Plant growth

Positive effect of vermicompost on the respiratory and photosynthetic activities in tomatoes and chemical composition of potatoes and maize were reported by Gorodnii et al. (1994). Karemegam et al. (1999) studied the effect of
vermicompost on germination efficiency and growth of green gram and found that germination efficiency in green gram was 93.33% in vermicompost treated plots as compared to 84.17% in untreated plots. The growth and yield performance in vermicompost treated plots was also significantly higher over the control. Murali and Setty (2000) while working on scented rice reported that vermicompost @ 5 t/ha resulted in significantly higher plant height, number of tillers/hill and dry matter accumulation over no vermicompost. Patil and Bhilare (2000) reported a significant increase in plant height and number of tillers due to the application of vermicompost in wheat. Growth parameters like plant height and head diameter in sunflower were found to be higher in vermicompost treatments as compared to FYM and no manure (Chinnamuthu and Venkatakrishnan, 2001). Kachpur et al. (2001) while working on sorghum reported a non-significant variation in plant height due to various levels (0.5, 1.0, 1.5 t/ha) of vermicompost though there was higher plant height with higher level of vermicompost. Variation in days to 50% flowering due to levels of vermicompost indicated no significant trend and were non-significant. Agarwal et al. (2003) reported that application of vermicompost significantly increased biomass production and yield of wheat crop.

2.2.2 Yield attributes

Sharma and Madan (1988) reported positive effect of application of organic waste and vermicompost on the dry matter of wheat and maize. Jaikumar (1995) also reported higher fresh and dry matter yield of fodder maize
by the addition of vermicompost. The increase in the yield of rice by increasing two times of the ears and grain per plant were reported with the application of vermicompost by Sitajanaki and Sreehari (1997). Karemegram et al. (1999) while working in green gram reported that number of pods/plant, length of pod, number of seeds per pod and total weight of seeds per plant were significantly higher in experimental plots than control as well as FYM, when vermicompost was used.

In scented rice, use of vermicompost @ 5 t/ha resulted in significantly higher number of panicles, number of grains/panicle, and 1000 seed weight over no vermicompost (Murali and Setty, 2000). Samawat et al. (2001) while working on tomato reported that in 100% vermicompost treatments, fruit weight and fruit number and shoot and root weight were 3, 4, 5 and 9 times more than the control treatment, respectively. Yadav and Vijaykumari (2003) reported maximum number of fruits per plant, fruit weight per plant and fruit length in vermicompost treatments than other treatments involving chemical fertilizers and organic manures.

2.2.3 Yield

Sacirazic and Dzelilovic (1986) while working on leek crop reported that after the application of 4, 6, 8 kg/m² of vermicompost, the dry matter yield increased from 1 to 66%. Highest dry matter yields were obtained when leek was grown with vermicompost than with the application of mineral fertilizers. Gorodnii et al. (1994) from Kiev, reported that worm compost increased the yield
of potato, tomatoes, cabbage and silage maize. Kalembasa (1996) studied the effects of vermicompost prepared from activated sludge, saw dust and meat processing factory waste on tomato. Vermicompost was applied @ 15 g/m² and it was found that highest yields were recorded from the application of vermicompost containing saw dust (3.15 kg/plant) as compared to FYM (1.93 kg/plant). Dhane et al. (1996) reported that pod yield of groundnut was significantly increased by application of vermicompost and vermicompost was found to be as effective as FYM.

Buckerfield et al. (1998) studied the effect of varying concentrations of vermicompost in a mixture with sand ranging from 0-100% on radish. They reported that harvest weights were proportional to the rates of addition of vermicompost, with the yield of plants in 100% vermicompost were upto 10 times greater than in 10% vermicompost. Kopczynski et al. (1999) studied the effect of vermicompost @ 6 t/ha on yield of sugar beet roots. Vermicompost increased the yield of roots and sugar and enhanced the content of sugar in the roots. Atiyeh et al. (1999) also reported higher yields of tomato crop in horticulture potting media amended with vermicompost.

In scented rice application of vermicompost @ 5 t/ha resulted in significantly higher grain yield and straw yield over no vermicompost (Murali and Setty, 2000). Kachpur et al. (2001) reported that vermicompost @ 1.5 t/ha resulted in higher grain yield (41.4 t/ha) of sorghum as compared to vermicompost application @ 1 t/ha (38.8 t/ha) and 0.5 t/ha (37.4 t/ha). Similarly Sood and Sharma (2001) reported that vermicompost @ 5 t/ha increased the
tuber yield of potato by 34 to 65 q/ha. Prakash and Bhadoria (2002) reported that the treatments with vermicompost recorded highest grain yield of rice and imparted maximum tolerance to pathogen than any other nutrient sources. Similarly Chinnamuthu and Venkatakrishanan (2001) reported that vermicompost @ 2 t/ha as band placement in seed rows recorded significantly higher seed yield of sunflower (1094 kg/ha) as compared to FYM (890 kg/ha) and no manure (747 kg/ha).

2.2.4 Nutrient uptake

Patil and Patil (1999) reported that highest increase in nutrient uptake (72 kg/ha) was recorded in the wheat crop with the highest increase in protein content (15.16%) under the treatment where vermicompost prepared from ½ press mud cake and ½ FYM was applied. Sreenivas et al. (2000) also reported that the nitrogen uptake increased significantly with the increasing levels of vermicompost at all the growth stages in ridge gourd. Similarly Kale et al. (1992) and Sudhakar et al. (2002) has also reported that availability and uptake of nitrogen and phosphorus were more in vermicompost treated plots as compared to FYM treated plots.

2.2.5 Soil properties

Earthworms have been reported to increase the availability of the plant nutrients in soil (Krishnamoorthy and Vajranabbiah, 1986) and also production of plant growth regulators. An increase in the density of microbes and nitrogen fixers due to vermicompost application has also been reported by Kale et al. (1992). Venkatesh et al. (1997) reported that application of chemical fertilizers along with vermicompost resulted in greater availability of micronutrients. Similar results were also reported by Sudhakar et al. (2002).
Chowdappa et al. (1999) reported that the content of all major and micronutrients were slightly higher in all soil samples containing vermicompost than the normal samples. Application of vermicompost alone or with chemical fertilizers decreases the bulk density, improved the soil porosity and maximum water holding capacity of the soil, but it increases the pH and organic carbon of the soil as reported by Maheswarappa et al. (1999). Similarly highest available content of N in soil was observed in plots, which received 5 t/ha of vermicompost. It also improved the pH of soil towards neutrality as reported by Nethra et al. (1999).

### 2.3 EFFECT OF INTEGRATED NUTRIENT MANAGEMENT ON PLANT GROWTH, YIELD ATTRIBUTES, YIELD, NUTRIENT UPTAKE AND SOIL PROPERTIES

#### 2.3.1 Plant growth

Sharma (1983) observed that application of FYM produced taller plants, higher number of shoots per meter square and higher dry matter production in direct seeded rice. Similar results in the transplanted rice were also observed by Ganai (1983). Jadhav et al. (1997) reported highest dry matter production from 75 kg N/ha as urea plus 25 kg N as vermicompost. Reddy et al. (1998) reported that maximum plant height of pea at harvest was recorded in treatment which received 10 t of vermicompost + 100% NPK. Rani and Shrivastava (2001) reported that all integrated treatments significantly increased plant height of wheat. Similarly ½ press mud cake + ½ FYM treatment recorded the highest values for plant height (Patil and Bhilare, 2000). Treatment with 75% vermicompost + 25% FYM also resulted in the greatest plant height of wheat.
Jain and Poonia (2003) reported that use of FYM and vermicompost at half the rates in integration with inorganic sources @ 40-88 kg/ha recorded significantly higher growth in pearlmillet. Murali and Setty (2001) reported that application of NPK @ 150-75-75 kg/ha recorded an increase in total drymatter production of rice than other treatments. Dry matter production and crop yield of basmati rice were higher in plants treated with organic fertilizers in combination with chemical fertilizers compared to those treated with chemical fertilizers only. Vanaja and Raju (2002) reported that treatment with poultry manure @ 2 t/ha + 75% of recommended dose of fertilizer showed the highest dry matter yield of rice at flowering, which was 92.9% higher over control. Similarly Jadhav et al. (1997) reported that when 75 kg of N was applied from chemical fertilizer alongwith 25 kg N/ha from vermicompost resulted in significantly highest dry matter production.

### 2.3.2 Yield attributes

Rani and Shrivastava (1997) reported that compared with N fertilizers alone, supplying 1/3rd or 1/4th of N from vermicompost increased various yield components of rice. Singh and Verma (1999) also reported that maximum yield attribute values in rice were noted in FYM @ 10 t/ha coupled with 50% of recommended N. Vermicompost @ 10 t/ha and 7.5 t/ha and FYM @ 10 t/ha in combination with 100 kg N/ha produced highest yield attribute values of wheat which were at par with N$_{120}$P$_{60}$K$_{25}$ under no organic manure treatments (Ranwa and Singh, 1999). Similarly use of FYM and vermicompost at half the rates in integration with inorganic sources @ 40-88 kg/ha recorded significantly highest yield attributes in pearlmillet.
In pea maximum number of pods were recorded in treatment which received 10 t/ha of vermicompost + recommended dose of NPK. Same treatment resulted in maximum number of seeds per plant. Minimum number of pods/plant and number of seeds per plant were recorded in control treatment (Reddy et al., 1998).

Integrated nutrient management system significantly increased number of effective panicles per plot and dry weight per panicle over the treatments having full nitrogen dose through inorganic fertilizers. Agronomic efficiency was also higher in case of integrated treatments than using fertilizers alone and the combined application of 2/3\textsuperscript{rd} N through fertilizers and 1/3\textsuperscript{rd} N through manures has a greater potential for fertilizers management for rice crops (Rani and Shrivastava, 1997). Highest yield components were recorded in paddy by integrated application of vermicompost and chemical fertilizers compared to other treatments (Das et al., 2002). Application of NPK @ 150-75-75 kg/ha recorded highest number of panicles/hill (12) and number of grains/panicle over other treatments. Vermicompost @ 5 t/ha also exhibited a significant influence on the aforementioned characters (Murali and Setty, 2001).

Patil and Bhilare (2000) reported that ½ press mud cake and ½ FYM treatment recorded the highest values for number of tillers per plant (3.00), weight of grains per ear head and 1000-grain weight of wheat over other treatments involving wheat straw, FYM and press mud cake treatments. Similarly Agarwal et al. (2003) reported that application of vermicomposting 75% + 25%
FYM to wheat resulted in greatest number of spikelets/plant, number of seeds per spike and test weight over other treatments. Maximum number of effective tillers of wheat were produced by vermicompost @ 15 t/ha + 100% RDF, which was statistically at par with recommended dose of NPK and vermicompost @ 15 t/ha + 75% RDF (Singh et al., 2004).

2.3.3 Yield

Rajput and Warsi (1992) revealed that application of organic material with or without nitrogen significantly increased the grain yield of rice as compared to control. Grain yield of rice and wheat increased significantly with increasing levels of NPK fertilizers upto 100% of recommended dose. The response to added 100% NPK dose was 38.9 and 32.7 q/ha over control yield of 23.9 and 11.2 q/ha in rice and wheat, respectively (Bhandari et al., 1992). Moore (1994) reported that addition of 25 t/ha FYM and 20 t/ha press mud cake was the best for increasing the yield of rice and wheat. Jadhav et al. (1997) reported that when 75 kg N was applied from chemical fertilizers along with 25 kg N/ha from vermicompost, it resulted in significantly highest grain yield of rice. Similarly Rani and Shrivastava (1997) reported that compared with the N fertilizers alone, supplying 1/3rd or 1/4th of nitrogen from vermicompost increased grain yield of rice.

Foliar application of vermisol to winter wheat in field studies gave a mean yield of 7.62 t/ha in combinations with 30 kg N/ha, compared with 7.28 t from N alone and 6.71 t in unfertilized control (Lozek and Facenko, 1998). Hattab et al. (1998) reported that in rice, grain and straw yield was higher with
25% organic and 75% inorganic nitrogen (4.77 t/ha), followed by 50% organic and 50% inorganic N (4.62 t/ha). Desai et al. (1999) while working on wheat-coriander cropping system, reported that highest grain yield of wheat was recorded when 50% N was applied through urea and 50% through vermicompost over all other treatments. Ranwa and Singh (1999) reported that vermicompost @ 10 t/ha and 7.5 t/ha in combination with 100 kg N/ha produced grain yield of wheat statistically at par with recommended fertilizers (NPK). Vasanthi and Kumaraswamy (1999) reported that vermicompost @ 5 t/ha was found to be sufficient alongwith recommended NPK dose. Significantly higher grain yield of wheat were recorded in treatments that received vermicompost and recommended NPK fertilizers and grain yield increased by 20% due to application of vermicompost @ 5 t/ha over NPK treatments alone.

Thakur et al. (1999) reported that application of 10 t/ha organic manures alongwith recommended NPK resulted in same yield as obtained with 125% recommended NPK, but significantly higher than the application of 150% recommended NPK. FYM @ 10 t/ha coupled with 50% of recommended N resulted in increased grain yield of wheat to the tune of 77.63% over control and it was followed by recommended dose of fertilizer N (Singh and Verma, 1999).

Ushakumari et al. (1999) reported that vermicompost as an organic source alongwith full recommended dose of inorganic fertilizers produced the highest yield and was at par with vermicompost + basal dose of NPK (25:8:25) and vermicompost + ¾ recommended dose of NPK. 10 t of vermicompost and
recommended dose of NPK treatment recorded the highest pod yield of pea (8828 kg/ha) as compared to control (3614 kg/ha) as reported by Reddy et al. (1998). Desai et al. (1999) also reported highest grain and straw yield of wheat was obtained due to the application of 120 kg N/ha, half through vermicompost and half through urea.

Santhy et al. (2000) reported from long term fertilizer experiment that maximum sustained yield was obtained in fingermillet-maize-cowpea cropping sequence with the application of 100% NPK with 10 t/ha FYM and maximum build up of organic carbon was also obtained from the same treatment than the fertilizers alone.

Chinnamuthu and Venkatakrishnan (2001) reported that recommended NPK (40:20:20) gave statistically highest seed yield of sunflower over other treatments. Similarly when 50% NPK was integrated with vermicompost @ 2 t/ha, it produced higher seed yield than NPK + FYM and vermicompost alone. Kachpur et al. (2001) reported a significant increase in yield over absolute control in sorghum. They concluded that the crop has to be supplied with vermicompost @ 0.5 t/ha + 3/4th to full dose of recommended NPK fertilizers for higher yields. Similarly Patil and Bhilare (2001) reported that ½ press mud cake + ½ FYM recommended treatment recorded highest grain and straw yield of wheat as compared to other treatments. Das et al. (2002) reported that highest grain and straw yields of paddy were obtained with 50% vermicompost + 50% chemical fertilizers. Jeyabal and Kupposwamy (2001) reported that integrated
application of 50% N through vermicompost and 50% through fertilizer N and biofertilizers to wheat crop recorded a grain yield of 6.25 t/ha and was 12.2% higher than that obtained with 100% NPK alone.

Nehra and Hooda (2002) reported that highest wheat yield was recorded when vermicompost @ 15 t/ha was applied alongwith recommended dose of fertilizers (NPK). Das et al. (2002) recorded highest paddy yield by application of 50% vermicompost + 50% chemical fertilizer and yield components increased more by integrated application of vermicompost and chemical fertilizers, whereas, Sudha and Chandini (2002) reported highest grain and straw yield of rice by application of 100% NPK alone as compared to FYM or vermicompost or different integrated treatments. Singh et al. (2003) observed that application of FYM, vermicompost or green manure reduced the rate of NPK fertilizers by 1/3\textsuperscript{rd} without reducing rice or wheat yields. 75% vermicompost + 25% FYM resulted in highest grain yield as observed by Agarwal et al. (2003).

2.3.4 Nutrient uptake

Singh et al. (1988) reported that highest NPK uptake by wheat from the soil was recorded at 80 kg N/ha with FYM @ 10 t/ha over individual application. Increase in NPK uptake with application of organic manures was also reported by many workers (Bhandari et al., 1992); Rathore et al. (1995). Minhas and Sood (1994) observed that the application of FYM was beneficial in enhancing the uptake of major nutrients. Jaggi et al. (1995) reported that phosphorus and FYM application showed a synergistic interaction effect of NPK
uptake by potato crop. 75 kg N/ha as urea and 25 kg N as vermicompost resulted in highest N, P, K and Mg uptake by rice as reported by Jadhav et al. (1997). A considerable increase in the uptake of major and secondary nutrients was observed in all vermicompost treatments and highest N uptake was recorded when 75% N through urea and 25% N through vermicompost was applied to rice crop (Jadhav et al., 1997).

Nutrient uptake increased with integration as organic sources were helpful in increasing availability of nutrients for a longer period and also reduced losses (Rani and Shrivastava, 2001), whereas, total N uptake was highest with 150:75:75 kg NPK/ha as reported by Murali and Setty (2001). Vanaja and Raju (2002) reported that highest total N uptake by rice crop at maturity was recorded with the application of poultry manure @ 2 t/ha + 75% of recommended dose of fertilizer N. 150% of NPK resulted in highest N, P, K uptake as compared to 50%, 100% RDF and 5 t/ha of vermicompost treatments.

2.3.5 Soil properties

Singh et al. (1980) reported that continuous application of FYM to a sierogen soil resulted in lowering the pH and increasing the organic carbon, cation exchange capacity and built up of NPK in soil. Sharma (1983) found that application of FYM to upland rice resulted in significantly higher content of N, organic carbon, available P and higher soil pH. Significant improvement was found in the levels of available N and P with the integrated use of manures and fertilizers in long term fertilizer experiments (Gupta et al., 1998). Bhandari et al.
(1992) also obtained higher value of available N and P in the plot receiving organic manures in addition to mineral fertilizers in comparison to those treated with chemical fertilizers alone. Dudhat et al. (1997) reported that application of FYM alone or in combination with chemical fertilizers increased the residual status of available N and P in soil.

Organic carbon content in soil increased significantly in the treatments that received vermicompost from any of the organic sources plus N, P and K. Similarly available N, P, K, Fe, Mn, Zn status in soil was significantly higher in the treatments that received vermicompost besides NPK. Significant reduction in bulk density was recorded in treatments receiving vermicompost (Vasanthi and Kumaraswamy, 1999). Combined use of organic manures increased the organic carbon content of soil over control and 100% NPK (Bhandari et al., 1992). Hangarge et al. (2000) reported that vermicompost resulted in improvement in water holding capacity, porosity and bulk density.

2.4 Residual effect of Vermicompost and Integrated Nutrient Management on succeeding crop

Padalia (1980) reported that the residual effect of inorganic N levels in absence of organic manures were beneficial only during 1st year of residual study and compost not only increased the yields during the year of application but also had beneficial residual effects on succeeding rice crop even upto 5 years. Singh and Rai (1998) reported higher wheat yield from residual effects of poultry manures alone as compared to chemical fertilizers only. Harnowo (1998) found that residual effects of fertilizers on rice and its interaction effects with fertilizers
application to soybean were significant for soybean seed yield. Desai et al. (1999) obtained maximum growth, dry matter and green yield (25.30 q/ha) of coriander from the residual effect of 120 kg N/ha (half through vermicompost and half through urea) applied to wheat crop.

The residual effect of integrated manuring given to pearlmillet through organic sources like FYM (10 t/ha) and vermicompost alone or partially supplemented with inorganic nutrients and recorded significantly higher yields of wheat than other inorganic nutrient application (Jain and Poonia, 2003). Residual effect of vermicompost @ 5 t/ha to rice and vermicompost @ 5 t/ha + NPK (80:40:40) to rapeseed showed higher grain yield of green gram which was statistically at par with recommended NPK to all three sequential crops. Application of vermicompost @ 5 t/ha to rice and vermicompost @ 5 t/ha alongwith NPK (80:40:40) to rapeseed was found to have maximum residual effect on green gram in respect of productivity, soil health and economic returns in rice-rapeseed-green gram sequence (Pramanik et al., 2004). Application of vermicompost @ 5 t/ha also increased the residual availability of NPK status of soil over control (Patil and Bhilare, 2000) in rice crop.

Rajput and Warsi (1992) found residual effect of organic manures on wheat followed by rice crop. Shivankar et al. (1993) reported that various organic manures differed significantly in respect of residual effect on number of grains/spikelet and grain and straw yield in paddy, whereas, different N levels were at par with each other for yield and yield attributes.