CHAPTER II

REVIEW OF LITERATURE

An attempt was made to review the available literature on the management of growing an important pulse crop chickpea (*Cicer arietinum*) under rainfed conditions by using tobacco waste organically and to the extent possible eliminating chemicals like fertilisers and pesticides. The wide use of high doses of concentrate fertilisers and insufficient use of organic manures led to negative results by decreasing the soil physical and chemical properties. Chemical fertilisers and pesticides pollute the air and water. Agricultural chemicals including insecticides and fungicides leave residues in food material that may cause toxic effects on human health. Other aspects of food quality have also changed for the worse. Instead of recycling the agricultural waste back into the land as manures, it is allowed to polluting water and
soil. In future, we may be forced to make radical adjustments in such agricultural practices. Thus, organic farming requires the elimination of harmful chemicals and has to be supplemented with other products like organic manures and biopesticides. The recent trend is to use fertilisers and pesticides judiciously and protect the eco-system. Indiscriminate use of chemicals will always lead to destruction of population regulating biological agents. Thus, soil is the ultimate sink for chemicals, dynamic entity in terms of complex physical, chemical, biological system of interactions, besides being the reservoir of the waste products.

**Importance of Farmyard manure (FYM)**

Hegde (1988 b) reported based on research data generated under the All India Coordinated Research Project on dry land Agriculture and related projects during the last 25 years, that chemical fertilizers had significantly contributed to improved productivity in rainfed crops, even in areas where legumes are part of the cropping systems. However, long-term data suggest that even in dry lands, sustainability of higher yields over a period of time is possible only when optimum nutrients are supplied though organics or a combination of organics and chemical fertilizers but not when supplied as chemical fertilizers alone. Significant yield benefits were recorded in his studies in number of pulse and oil seed crops and
similar in the area of pest management also when organic manures were used alone or in conjunction with chemical fertilizer.

Pujar et al. (1998) found that application well decomposed powder farm yard manure (FYM) at 500 kg/ha in combination with 75% and 50% of the recommended chemical fertilizer schedules of 20:50 kg N : P / ha recorded 6% and 5% higher seed yield respectively in pigeonpea than recommended chemical fertilizer alone.

Puste et al. (1999) worked out the economy of fertilizer nitrogen through organic sources in rainfed rice-legume cropping systems in West Bengal, India. They revealed that the combined application of inorganic and organic nitrogen sources in a 75:25 ratio was a superior N-management practice with regards to crop yields as well as improvement of soil fertility.

Singh et al. (1999) described the effect of soil enrichment in conjunction with organics and chemical fertilizer on rice-chickpea cropping system. Application of fertilized green manure Sesbania rostrata proved superior to paddy straw and FYM. Rice yield and N uptake were significantly higher under combined application of green manure and urea on an equal N basis. Residual fertility in terms of OC was pronounced under FYM and paddy straw which reflected in terms of higher grain yield of chickpea grown after harvest of wet season rice.

Sharma, et al. (1999) reported from the long term studies conducted on finger millet on alfisols that continuous use of FYM @ 10 t/ha in combination with recommended level of NPK helped in giving higher grain yield and improved organic carbon in soil.
Pokharel. (2000) studied on the effect of organic manures, fertilizers and nematicide on the control of root-knot nematode and yield in chickpea. They proved that the root-knot index was lowest in the poultry manure treatment in both the years and highest in the control. Maximum chick pea yield was recorded with poultry manure in both the years.

Anchal Dass et al. (2006) revealed the influence of INM on production, economics and soil properties in tomato under on farm conditions in Eastern Ghats of Orissa. Application of 50% RDF+ FYM 10 t/ha was statistically at par with recommended dose of fertilizers. Application of FYM and vermi compost had favorable impact on bulk density, organic carbon, available N and available P status of surface soil after two years of experimentation. All the treatments were superior to control in terms of bulk density.

Ramesh et al. (2006) evaluated the effect of organic manures on the productivity, soil fertility and economics of soybean-duram wheat cropping system in vertisols and concluded that organic nitrogen applied as manure was available slowly over long duration compared to chemicals. Poultry manure application recorded higher grain yield of Wheat (4480 kg / ha) compared to chemical fertilisers (4340 kg) Application of either vermicompost or cattle dung manure recorded similar yields of wheat and superior to control plots.

Jai Paul et al. (2008) described the verification of fertilizer recommend-dation modules for conjoint use of organic and inorganic fertilizers for specific yield in rainfed soybean - wheat cropping sequence. Application 3.0 t/ha FYM to soybean
can reduce the dose of N, P\textsubscript{2}O\textsubscript{5} and K\textsubscript{2}O by about 20, 8 and 20 kg /ha respectively and incase of wheat application of FYM @ 5 t /ha, resulted in NPK reduction by 20, 13 and 30 kg/ha respectively. The use of phosphobacteria in soybean and wheat, there was complementary reduction by 20 kg /ha P\textsubscript{2}O\textsubscript{5}. And ensured economy in the use of mineral fertilizers. Suri et al. (2002) and Suri et al. (2005) also reported similar results for complementary use of FYM and bio-fertilizers for specific yield in rainfed soybean and wheat.

Panwar (2008) reported the effect of integrated nutrient management in Maize - Mustard cropping system in mid hills altitude and reported that application of 50 % N through FYM in the rainy season and 100% NPK through fertilizer in pre rabi season recorded maximum and at par with 75% NPK through fertilizer + 25% N through FYM in Kharif season. Maximum 100 seed weight of 23.9 g was recorded with 75 % NPK through fertilizer + 25% N through FYM. Lowest values were observed with control. Organic matter applied to preceding maize crop had residual effect on succeeding mustard which improved yield attributes of plants. Maximum maize yield of 3.95 tones/ha was recorded with application of 75 % NPK through fertilizer and 25 % substitution with FYM. This treatment was significantly superior in grain yield, test wt, cob lengths, plant height with conjunctive use of FYM at 75 % NPK with 25 % FYM.

Singh et al. (2008 a) reported the nutritional quality of soy bean, wheat and chickpea through biological manures. Application of cattle dung manure(FYM) + vermi compost recorded highest seed yield of chickpea (1551 kg/ha) compared to
other organic combination and control (1185 kg/ha). Where as , highest protein (20.1%), minerals (2.8%), methionine (1.73 g /16 g N) and cystine content (1.52 g/16 g N ) in chickpea were more in cattle manure + Vermi compost + poultry manure combination compared to other organic manure combinations and control.

Arunkumal *et al.* (2008) studied the effect of integrated nitrogen management, on growth, yield and quality of baby corn. Perusal of the data revealed that application of 100% N through fertilizer has resulted in production of tallest plants with larger leaf, area index, height, drymatter production were on par with 75 % N through poultry manure, sheep manure or FYM and also significantly superior to rest of nitrogen management practices.

Barik *et al.* (2008) worked on the yield performance and soil fertility through organic sources of nitrogen as substitute to chemical fertilisers in wet season rice and observed that the treatment receiving 40% RDN from vermicompost produced significantly higher number of panicles, filled grain per panicle and grain yield (5.17 t / ha) than all other treatments. By including 100% RDN along with application of phosphorous and FYM significantly influenced the fiber yield of sunnhemp and their nutrient uptake. The nitrogen, phosphorous and potassium uptake by wheat crop increased significantly with conjunctive use of P$_2$O$_5$ and FYM.

Basir *et al.* (2009) showed the results on the effect of phosphorous and farm yard manure on nitrogen nutrition and grain yield of chick pea and opined that the phosphorous fertilizer application up to 60 kg P$_2$O$_5$ / ha linearly increased the grain
and nitrogen uptake of chickpea and that beyond 60 kg /ha the yields were declined.

Gedam et al. (2008) reported by their study of organic resource management for sustaining the productivity of groundnut-rice cropping system that application of RDF, organic manures like Swastic (Branded organic manure), poultry manure and phospho compost proved their superiority and also maintained the productivity of groundnut-rice which was remunerative.

Meena et al. (2008) reported that 10 t/h FYM+ 10 t/ha of sewage sludge was superior and gave maximum yield of pearl millet (1.16 tones/ha) and mustard (1.73 t/ha) which was comparable with 10 t/ha of FYM + 5 tones/ha of sewage sludge. The maximum up take of zinc (23.13 g/ha) by grain as well as Fe uptake by grain 46.3 g, straw 290 g and a total of 336.4 g/ha by pearl millet. They also worked on long term effect of sewage sludge and farm yard manure on grain yield and availability of zinc and iron under pearl millet - mustard cropping sequence revealed an increase in pearl millet and Indian mustard seed yield by 0.41 t/ha (59%) and 0.25 ton/ha (17%) respectively due to over all effect of farm yard manure + sewage sludge.

Singh et al. (2008 b) working on the effect of nutrient management practices on soybean - chickpea cropping system for improving seed yield, quality and soil biological health under rainfed condition and revealed that integrated nutrient management treatment 100% RDF + FYM 2 t/ha to soybean followed by 50 %
recommended dose of fertilizer in chickpea resulted in maximum net returns to chickpea (Rs.7,217/- ha) followed by 150% RDF + FYM 2t/h in soybean.

Venkateswarulu (2008) expressed that the sustainability of higher yields over a period of time is possible only when optimum nutrients are supplied through organic manures or a combination of organics and chemical fertilizers but not when applied as chemical fertilizers alone.

Rajat and Ahlawat (2009) evaluated the effect of farm yard manure, source and level of Sulphur on growth attributes, yield, quality and total nutrient uptake in pigeonpea and groundnut intercropping system and reported that application of FYM increased the yield of both pigeonpea and groundnut by 14.47 % and 16.31 % in 2003 and 2004 respectively. Application of FYM @ 5.0 t/ha recorded higher total N, P, and S uptake (186.65; 17.90 and 20.10 kg/ha respectively) as compared to without FYM in both the years of study.

**IMPORTANCE OF FILTER PRESS CAKE / PRESS MUD.**

Palaniappan and Natarajan (1993) found the importance of filter press cakes and press mud containing about 1.2 % N, 3.84 % P₂O₅, 1.42 % K₂O and 11.1 percent CaO and recommended as a good source of organic matter. Singh and Dagar (1993) worked on sugar factory waste as organic amendment in the reclamation and management of problem soils and proved the importance of the
sugar factory wastes such as press mud, filter cakes, bagasse and molasses. Addition of filter press cake / press mud improved soil aeration and drainage in heavy soils, where as in sandy soils it helped in improving the retention of moisture when added to sugarcane fields. It increased the cane yield, juice quality and enhanced the ammonifying power of soils.

Srivastava et al. (2001) drawn the conclusions from the experiment on enhancing soil health and sugarcane productivity in a plant ratoon system through organic nutrition module in sub tropics and expressed that supply of nutrients to sugarcane crop through combined use of sulphitation press mud 10 t /ha + FYM 10 t /ha gave the highest cane yield (84.6 and 74.2 t /ha for plantation and ratoon cane respectively). The treatment also effected significantly by 35.2 % increase in organic carbon, 158.4 % increase in microbial biomass and 118.9 % enhancement in soil microbial bio mass nitrogen. Significant effect on soil physical properties and fertility such as bulk density, water infiltration rate and size of stable aggregates was also recorded under the organic nutrition modules.

**AGRICULTURAL CROP WASTES.**

Dhar (1962) reported that the nitrates produced in the soil from the added nitrogenous fertilizers can react with the organic matter and may deplete even the native humus. This situation can be avoided only by adding additional amounts of
organic wastes/residues and manures and cautioned that by adding large doses of nitrogenous fertilizers in modern agriculture without the use of organic manures there is always the danger of humus depletion and fall in crop production.

Thampan (1995) concluded from the organic amendments in the reclamation of problem soils and reported that conservation and use of crop wastes in agriculture and their influence on the physico-chemical and biological characteristics of the soil as well as on crop yields.

Palaniappan and Annadurai (1999) reported that organic farming definitely included application of agricultural crop waste, crop residues, green manures, off farming organic wastes, crop rotations involving legumes and biological pest control to maintain soil productivity. Organic farming prohibits the use of synthetic fertilizers, pesticides, growth regulators and livestock feed additives.

Sharma et al. (2002) reported that the conjunctive use of inorganics and organics such as loppings of Gliricidia (1:1 ratios on N equaling) had considerable effect on raising the sorghum grain yield to the levels of 16.9 and 17.2 q/ha respectively and thus revealed that a minimum of 50% N requirement of sorghum can be easily met from farm based organic sources of nutrients. This information can be used to supplement fertilizer nitrogen up to 50% by using crop material of Gliricidia and will be useful while planning for raising organic produce.

Sharma et al. (2005) proved that organic carbon in the soil was significantly influenced by application of crop wastes and crop residues such as sorghum Stover and gliricidia @ 2 t/ha under minimum and conventional tillage in sorghum-castor rotation in rainfed alfisols. Further, they reported that increase in nitrogen levels from
0 to 90 kg N /ha-1 also helped in significantly improving the organic carbon status in these soils over a period of eight years. From these studies, they concluded that continuous application of organic residues was inevitable to see the significant effect on organic carbon status in soils.

Sharma et al. (2007) have reported that non conventional farm based materials such as castor stalks, sunflower stalks, loppings of gliricidia and cow dung can be successfully converted with or with out small quantity of rock phosphate and pyrite into a nutritive compost containing total N as high as 1.08 to 1.6 % mineral N 108 to 208 ppm, C:N ratio 15.58 to 21.52 and total hydrolysable N 6870 to 9724 ppm.

**EFFECT OF RHIZOBIUM AND PHOSPHATE SOLUBILISING BACTERIA.**

Beg and Singh (2008) studied the effects of bio fertilizers and fertility levels on growth, yield and nutrient removal by green gram (*Vigna radiata*) under Kashmir conditions and proved that rhizobium and PSB inoculation alone significantly increased growth parameters over the control without N and P. However, the highest pods / plant (14.1) and seed yield (1108 kg /ha) obtained with 20 kg N / ha and 45 kg P₂O₅ / ha were remarkably increased by 64 and 72.9 % respectively compared to control. Net income (Rs.19, 942 /ha) and benefit cost ratio 1.91 were also higher with this treatment.

Ravi et al. (2001) revealed that activated rock phosphate improved nutrient uptake and protein content in pigeonpea and that mussorie rock phosphate (M R P)
activated with cow dung + cow urine resulted in the highest uptake of NPK and increased protein content in the seeds followed by M R P activated with cow dung + cow urine + PSB.

Sanjeev Kumar et al. (2002) revealed on the effect of pesticide seed dressing and rhizobium inoculation on nodulation and yields of chick pea that simultaneous treatment with pesticide and rhizobium enhanced nodulation and increased the fresh and dry weight of seeds over the control.

Gurmani et al. (2003) reported the effect of rhizobium inoculation and different P levels on the yield and economics of chickpea under arid conditions. Significantly higher mean grain yields of 2641 and 2607 kg / ha at 25 kg P<sub>2</sub>O<sub>5</sub> plus inoculums and 50 kg P<sub>2</sub>O<sub>5</sub> plus inoculums respectively. Similarly, the highest net income was observed at 25 kg P<sub>2</sub>O<sub>5</sub> + inoculums per ha<sup>-1</sup> (Rs. 12,356 / ha) followed by 50 kg P2O5 plus inoculums with Rs. 11,332 /ha. It was found that inoculums addition increased both the yield and net income. It was concluded from the results that the use of inoculums is highly economical practice.

Jayarama Soundari et al. (2003) reported on residual effect of phosphorous on the growth, yield and economics of green gram and concluded that a higher benefit- cost ratio was obtained when green gram was grown after the harvest of hybrid cotton, treated with mussorie rock phosphate (MRP) enriched with FYM + phosphobacteria + SSP at 50 % of the recommended rate for green gram.
Kumar and Nair (2003) reported acid tolerant strains of brady rhizobium species for acidic soils, development of efficient native strains of rhizobium or brady rhizobium alone was not sufficient but it should be along with a package of practice of recommendation consisting of application of organic manure and liming to neutralize the soil pH.

Saad and Sharma (2003) described efficacy of PSB with phosphoric fertilizers on the yield of chickpea grown on calcareous soil of North Bihar and reported that among the combination treatments namely DAP at 40 kg p /ha+ PSB that seeds treated first with rhizobium culture and then with PSB at 10 g / kg seed, produced higher yield than other treatments.SSP at 40 kg /ha +PSB (Mussorie Rock Phosphate 40 kg /ha + PSB). Plant height at 120 days after sowing, No. of secondary branches and grain yield were maximum (55.9 cm, 8.21, and 1667 kg /ha respectively) under DAP 40 kg /ha + PSB.

Barhate et al. (2004) studied the effect of rhizobium strains on nodulation and grain yield of chickpea and reported the inoculation of rhizobium significantly enhanced grain yield and nodulation. Under this treatment, the grain yield and nodulation increased by 17.24% and 36.31 % over the control. Highest grain yield (26.24 q / ha) and highest number of nodules /plant (53.00) were recorded.

Jat and Ahlawat (2004) revealed the effect of vermicompost, biofertilisers and phosphorus on growth, yield and nutrient uptake by chickpea and their residual effect on fodder maize, found that seed inoculation with rhizobium and phosphate
solubulizing bacteria markedly enhanced growth and yield attributes, seed (2.40 t/ha) and straw (3.80 t/ha) yield of chickpea. Fodder yield (7.6 t/ha) of succeeding maize and total N (179.48 kg/ha), P (29.06 kg/ha) uptake by chickpea - maize cropping system over the un inoculated control. Phosphorous fertilizer application up to 26.4 kg/ha to chickpea also improved growth, seed (2.46 t/ha) and straw (3.92 t/ha) yields of chickpea and increased the fodder yield (7.91 t/ha) of succeeding maize.

Bairwa et al. (2009) reported the response of integrated nutrient management on growth, yield and quality of okra (Bhendi) that application of 60% recommended dose of N P K through inorganic fertilizers + neem cake 0.6 t/ha + vermi compost 1.0 t/ha + azatobacter + phosphate solubulizing bacteria resulted significantly maximum plant height 77.48 cm, total fruit yield 13.51 tones/ha and the fruit yield increase was by 29.30% along with highest benefit cost ratio (3.19) for this treatment.

Madhavi et al. (2009) reported the effect of different levels of vermin compost, caster cake, poultry manure and bio fertilizers on growth and yield of Indian spinach (Beta vulgaris) and observed that higher growth parameters and leaf yield by the application of RDF (80 N + 40 P + 50 K kg/ha) and were on a par with poultry manure 8 t/ha + Azospirillum (2 kg/ha) + PSB (2 kg/ha) than control.
IMPORTANCE OF PHOSPHOROUS AND POTASSIUM WITH ORGANIC MANURES.

Sarkar et al. (2008) found the effect of levels and sources of phosphorous with and without farm yard manure on pigeonpea under rainfed conditions. Seed yield was maximum with FYM 10 t/ha and 90 kg P\textsubscript{2}O\textsubscript{5} and among P sources SSP+Lime. recorded maximum values.

Sankaralingappa et al. (2000) reported on interaction effects of P and S on uptake of NPK & S on pigeonpea (*Cajanus cajan*) and showed the combined application of Phosphorus and Sulphur up to 50 kg P\textsubscript{2}O\textsubscript{5} and 20 kg / ha respectively gave significant synergistic effect on uptake of N and P by pigeonpea. Significant effect on uptake of K and S was observed with combined application of P and S up to 50 kg P\textsubscript{2}O\textsubscript{5} and 40 kg S/ ha.

Shivram et al. (2000) found the effect of phosphorus and Sulphur on pigeonpea (*Cajanus Cajan*) and succeeding wheat (*Triticum aestivum*) in pigeonpea- wheat cropping system. Maximum net return from the cropping system was obtained when pigeonpea was fertilized with 80 kg P\textsubscript{2}O\textsubscript{5} and 60 kg Sulphur / ha.

Poonkodi and Manikandan (2001) draw the results from the effect of levels of phosphorus on the growth, yield and protein content of green gram and reported
that the green gram crop responded to the application of phosphorous up to 60 kg P$_2$O$_5$/ha for higher grain yield and protein content.

Arya et al. (2002) mentioned the effect of phosphorous management on the growth, yield attributes and yield of maize – chickpea cropping system during rabi season plant height, dry matter accumulation per plant, No. of pods/plant, No. of grains per plant, grain wt per plant, 100 seed weight, grain and straw yield of chickpea were significantly greater with 60 kg P$_2$O$_5$/ha than 30 kg P$_2$O$_5$ / ha during both the years.

Kanwar Kamala and Paliyal (2002) reported the influence of P management and organic manuring on nutrients uptake and yield of chickpea. Application of 50-75 kg P$_2$O$_5$/ha gave the highest grain yield. Application P through organic manure or inorganic form increased P uptake. Increased levels of inorganic P also increased the P uptake. Reported the influence of phosphorous management and organic manuring on uptake and yield of chickpea (Cicer arietinum). Applications of farm yard manure and Vermi compost were equally effective in increasing the available P status of the soil and crude protein content of chickpea. The protein content increased due to P$_2$O$_5$ application upto 75 kg /ha. With in organic manure and up to 50 kg /ha when organic manure was applied.

Chawdary et al. (2003) obtained yield components of green gram (Vigna radiata L) as influenced by phosphorus and thiourea. The grain yield was higher
19.5% 28.3% and 31.3 % compared to control with the application of 20, 40, 60 kg P₂O₅ /ha respectively. P showed positive effects on plant, grain / pod and test weight.

Fathurrahman (2003) from the experiment on the effect of rice straw mulching and P fertilizer on leaf area index, chlorophyll content and yield of pigeonpea at different planting distances opined that increasing the rate of P resulted in the increase in chlorophyll content at 30 X 20 cm planting distance. The maximum seed yield (1.89 t/ha) was obtained with mulching level of 4.83 t/ha and P rate of 125.03 kg /ha .

Hakoomat Ali et al. (2004) found the interactive effect of seed (inoculation and phosphorus) application on the growth and yield of chickpea (*Cicer arietinum*). Yield of chickpea increased due to the increase in growth and development attributed to (PSB) inoculation.

Rajiv Kumar et al. (2005) revealed the results from the experiment influence of potassium and phosphorus on growth and yield in chickpea under water stress, found a significant reduction in dry weight of different plant parts ( leaves, stem and root ). Water stress resulted in a significant decline in number of grains per pod and grain weight per plant. The reproductive stage proved to be more sensitive to water stress than the vegetative stage. All the yield attributes (No. of pods, number of grain per pod, grain weight / plant and 100 seed weight) were effected by the fertilizer
treatments. Combined fertilizer treatment proved more beneficial over individual effect. Combination with K withstands water stress and gave more yields.

Chesti and Tahir Ali (2008) proved that integrated phosphorous management in green gram (*vigna radiata*) under temperate conditions, grain yield was significantly increased with P application (0.89 t / ha). Highest grain yield of 1.01 t/ha was recorded with application of 10 tones FYM in combination with P @ 30 kg/ha. There was a build up of available N P K in soil by integrated nutrient management.

Maitra *et al.* (2008) described the effect of phosphorous and FYM applied to sunnhemp – wheat cropping system and fertility status under typic ustocrept of U.P. Proved that application of phosphorous and FYM significantly influenced the fibre yield of sunnhemp and their nutrient uptake. The nitrogen, phosphorous and potassium up take by wheat crop was increased significantly with conjunctive use of P₂O₅ and FYM.

**EFFECT OF ZINC AND SULPHUR**

Din *et al.* (2001) showed the results from their studies on optimizing productivity and profitability in rainfed legume crops through balanced nutrient management for chickpea and blackgram that missing of phosphorus (P) and boron (B) reduced the yields of both crops drastically and omission of zinc (Zn) reduced the yield of chick pea only.

Dube *et al.* (2001) studied the response of pigeonpea to apply Zinc in Ustifluvent soils of Western UP state and evaluated the positive response to graded
Zn amendment (1 to 25 mg / kg soil). The increase in height, No. of branches, production of pods and harvest index of pigeonpea was maximum at 5 mg Zn / kg soil which raised DTPA extractable soil Zn from 0.41 to 1.23 mg / kg.

Mali et al. (2003) studied on response of pigeonpea to sulphur and zinc fertilization on vertisols in south eastern plain of Rajasthan and reported that zinc at 5.0 kg /ha and Sulphur at 6.0 kg / ha gave the highest grain yield which was 66.98 % higher than that of the control.

Sangwan and Raj (2004) revealed the effect of zinc nutrition on yield of chickpea under dry land conditions and reported various levels of zinc application was compared with the control. Application of 15 kg Zn / ha gave significantly higher yield over lower levels.

Umeshsingh and Yadav. (2004) revealed the results from the experiment on the response of green gram to sulphur and zinc, that yield and yield components increased with increasing Sulphur rates up to 30 kg / ha and produced the highest grain and straw yields. Increase in yield due to zinc increased yield components such as No. of pods / plant, 1000 seed wt and seed weight /plant.

Sammavria and Yadav (2007) explained on the effect of phosphorous and zinc application on growth and yield of fenugreek and their residual effect on succeeding pearl millet under irrigated conditions of Northwest. Rajasthan and reported that increasing application of phosphorous up to 40kg P_{2}O_{5} /ha significantly improved the branches /plant, pods/ plant, seeds/pod and test weight. Increasing
levels of zinc up to 7.5 kg/ha as basal dressing significantly increased the branches/plant, pods/plant, seeds/pod. And with 5.0 kg Zn/ha, test weight increase was noticed.

Cimirin et al. (2007) revealed the results that Sulphur forms (two forms) and levels effected grain yield and some yield components significantly. The highest grain yield of 1488 kg/ha was found at 120 kg/ha sulphur application. The lowest grain yield was found in control plots 1031 kg/ha. The uptake of N, P, K, Ca, Mg, Fe, Zn and Cu of straw and grain of lentil were significantly effected with increasing elemental sulphur in both the years when studied the effect of different sulphur and pyrite levels on yield, yield components and nutrients up take of lentil.

Ashoka et al. (2009) reported the effect of macro and micro nutrients with organics on growth, quality, yield and economics of baby corn (Zea mays L) in Thungabhadra command area and found significantly higher yield and husk in the treatment receiving RDF with micro nutrient combined with organics over RDF alone (control). Higher baby corn yield (64.43 q/ha) and green fodder (232.33 q/ha) were also recorded under treatment receiving RDF + 25 kg Zn SO4 + 10 kg Fe2 SO4 + 35 kg vermi compost/ha.

Baljeet kaur and Misra (2009) drew the results from the effect of zinc on vegetative growth, chlorophyll and nutrient up take of karonda seedling under sand culture and reported that deficiency of zinc resulted in stunted growth, size of leaf,
fresh and dry leaf, leaf area, chlorophyll ‘a’, ‘b’ and total chlorophyll content of leaves. N P and K in leaves were effected due to zinc levels.

Rajat and Ahlawat (2009) worked on the effect of farm yard manure, source and level of sulphur on growth attributes, yield, quality and total nutrient uptake in pigeonpea and groundnut inter cropping system. They reported that application of FYM increased the yield by 14.47 % and 16.31 % increased the yield of both pigeonpea and groundnut. Application of FYM @ 5.0 t /ha recorded higher total uptake N, P and S (186.65, 17.90 and 20.10 kg /ha respectively) as compared to No FYM.

Yadav et al. (2008) found that application of sulphur through gypsum at 60, 90 and 120 DAS showed significant effect on drymatter accumulation at all stages of crop growth with 30 kg sulphur / ha and significantly superior over rest of the levels at all stages pods/plant, grain / plant, test weight from the experiment conducted on response of chickpea to source and levels of sulphur in salt effected rainfed soils of Eastern UP.

PART – B

TOBACCO LEAF WASTE AS BIOPESTICIDE.

Patel and Koshiya (1997) working on seasonal abundance of american boll worm, Helicoverpa armigera on different crop hosts at Junagadh (Gujarat) found that
in rabi season, the pest activity was observed in chickpea during November to February and the population was at its peak during December.

Biradar et al. (1998) reported development of spray schedule in chickpea for pod borer and loss estimation was reported by spraying at 30, 45, 60 and 75 days after sowing (DAS) was the best and gave the yield 11.5 q / ha. Next best was with three sprayings at reproductive phase (i.e., 45, 60 and 75 DAS) with 9.5 q / ha seed yield with 86.3% increase over the untreated control by avoiding losses upto 46.3%.

Punwar and Yadav (2003) evaluated the field efficacy of pest controlling agents from different origins against tobacco caterpillar, *Spodoptera litura* on soybean. The treatments included were synthetic chemical insecticides, plant extracts, animal origin, and insect growth regulators and entomo pathogenic fungi and found effective against *Spodoptera litura* larvae.

Saha (2006) revealed the results from the work on “Economic Threshold Limit” (ETL) on chickpea @ one larvae / five plants (1/5) on chickpea.

**IMPORTANCE OF NEEM EXTRACTS**

Koul (2004) reported that more than 140 neem active principles have been identified to date that occur in different parts of the tree. The most important components identified have been the tetrano triterponoids, the azadirachtins. These occur at concentrations of 0.1 to 0.9% in the seed core and it has been established
that a dose 30 to 60g azadirachtin per hectare is sufficient to combat and repel the key pests of various crops.

Schmutterer (1990) reported that although, all plant parts of neem show some characteristics of insect repellence or suppression, seeds or seed kernels provide the greatest amount of insecticidal liminoids. The numerous reported effects of neem on insects include repellence, feeding deterrence, oviposition deterrence, reduced growth and development, and interference with reproduction. Neem and its principal component azadirachtin are extremely low in mammalian toxicity.

Schumutterer (1995) reported that over 500 species of insects have been tested with neem products and 413 of these are reportedly susceptible at different concentrations.

Dharpure (2002) revealed the results from the experiment on effectiveness of botanicals and ethofenprox with phorate against *Myzus persicae* in seed potato production that application of phorate 1.0 kg / ha followed by two sprays of ethofenprox 0.02 percent, neem kernel extract at 10% and neem oil at 0.5% were found effective in keeping the population of *Myzus persicae* below critical level. Virus incidence in these treatments was also less.

Rao and Rajendran (2003) from the work on efficacy of botanical mixtures against the bhendi shoot borer *Earias vitella* reported that in the field evaluation among the botanicals tested, Need seed powder @ 0.42% was found at par in containing the damage caused by the shoot and fruit borer(13.27 t/ha) with endosufan (14.24 t/ha).
Radhe shukla et al. (2006) studied the efficacy and economics of neem based production on the incidence of pod borer complex of pigeonpea (*Cajanus cajan*) and reported the results among neem based products, the crude products i.e., NSKE and neem leaf extract @ 10% were better in suppression of pest population giving net profit than market products, however, monocrotophos 36 SL @ 0.04% concentration was found to be superior to other neem products tested.

Dhaliwal and Koul (2007) reported that NSKE at 5% on chickpea reduced egg laying, larval population and pod damage by *H. armigera*. They also reported that anti feedant activity of NSKE in pod borers.

Sharma et al. (2008) working on evaluation of pest management strategies in organic and conventional Tarai Basmati Rice (*Oryza sativa*) farming system revealed that spray of neem oil and Economic Threshold Level – based release of *T. japonicum* were able to suppress pest incidence significantly in comparison to indigenous traditional knowledge (ITK) and farmers practices. IPM recorded a yield of 3.29 t/ha with a C: B Ratio of 1.46 and ITK with 3.05 t/ha with a C: B ratio of 1.41. The IPM resulted in better conservation of natural enemies as evident from presence of predators like, spiders, egg parasites, damselflies, ants, beetles, wasps and mermithids.

Sardhana et al. (2008) reported the effect of large area validation of adoptable integrated pest management technology in okra that application of NSKE 5% was found to be very effective against leaf hoppers and whitefly as that of 10 rounds of chemical pesticides. There were no significant differences in the borer
incidences between chemical and NSKE, but was significantly less compared to untreated control.

Roy et al. (2008) working on the effect of pest control measures on beneficial soil micro arthropods in a year round fodder production system and reported that application of NSK powder @ 5% w/w (seed dressing) and TRI NEEM @ 10g / kg of Urea (soil application) along with foliar spray with neem seed kernel extract was adjudged as an ecologically safe plant protection package on account of significant build up of collembola and mite population. Whereas combination of seed treatment with carbofuran, carbendazim and spray with endosulfan + Dithane M– 45 reduced the population of these micro arthropods. The soil application of trineem and seed treatment with NSKE powder has significantly built up the mite population which eats the insect eggs.

Veena Khanna et al. (2009) draw the results from the evaluation of some microbial and botanical bio pesticides against *Helicoverpa armigera* in chickpea and reported that bio agents and botanicals can be effectively combined in the management of gram podborer, a major constraint in popularization of chick pea cultivation.

**IMPORTANCE OF PONGAMIA OIL & SEED KERNEL EXTRACT**

Bajpai and Sehgal (2000) described the efficacy of neem, karanj, and tobacco formulations against *Helicoverpa armigera* (Hubner) in chickpea crop. Seven botanical insecticides, including neem, karanj (*Pongamia pinnata*) and tobacco
formulations, were compared with endosulfan for control of pod borer on chickpea cv. C235 at Pantnagar during 1992-94. Endosulfan gave the highest pod borer control (40.2% pod damage) and yields. Of the botanicals, pod damage at maturity was lowest with karanj oil followed by the neem product green mark or nicotine sulphate, and yield was highest with karanj oil. The benefit: cost ratio was highest for endosulfan (14.8) followed by Green Mark (6.3) and karanj oil (5.1) in 1992-93. In 1993-94, the benefit: cost ratio was highest for endosulfan (11.1) followed by the neem product NSKE (neem seed kernel extract) (9.2) and Green Mark (5.8).

Kumar et al. (2002) reported that resurgence of two spotted mites Tetrenychus urticae Koch and Acarina Tetranychidae due to acaricides and botanicals on Okra, found resurgence in mahua oil, PSKE, Pongamia oil, neem oil, and NSKE did not show any effectiveness against this pest. They were effective on soft bodied insect larvae like Spodoptera litura and H. armigera.

Prabhakar and Vekateswarulu, (2007) opined that pongamia and custard apple are other plant species with good potential in IPM in organic farming and explained that pongamia seed powder extracts, oil and cake can be used in similar manner as that of neem. Combined use of neem and pongamia oil in 5:1 ratio was found to be more effective than neem oil alone.

**IMPORTANCE OF NUCLEAR POLY HEDROYSIS VIRUS (NPV)**
Suganthy and Tej Kumar (2000) tested on IPM strategies against gram pod borer and revealed that integrated pest management (IPM) was adjudged as the best treatment in the management of *H. armigera* larvae and reported an improvement due to endosulfan (33%), Ha NPV (29%), Neem (25%) and bird perches (23%) over control. IPM registered least percentage of pod damage followed by HaNPV as against highest percentage of pod damage in control.

Bhagwat and Wightman (2001) concluded from the NPV based management of *Helicoverpa armigera* (Hub) in chickpea that application of NPV mixed with chickpea flour (1%) and Jaggery (0.5%) significantly lowered pod damage to 18.4% and increased yield by 72.0% over control. In another field trial, the use of NPV with sandovit (0.2%) or ranipal (0.5%) was found effective and recorded increased yield by 67.5% and 53.4% respectively. An on farm IPM research trial during 1995 – 96 and 96 – 97 in collaboration with KVK, Zaheerabad and the farmers in Medak District A.P. showed good performance of NPV against pod borer damage.

Gowda *et al.* (2004) reported on the evaluation of different integrated pest management (IPM) modules and intercropping systems for the management of pod borer in chickpea revealed the results from the work that both IPM modules significantly reduced pod damage and increased grain yield compared with the untreated control. With the pesticide based IPM module, recording better values for these parameter. However, considering the disastrous effects of chemicals, the bio intensive IPM modules were considered as a more eco friendly option to control pod borer infestation in chickpea. Ha NPV at 250 LE + NSKE 5% as bio intensive modules were promising.
Sachitanandam et al. (1989) reported from the pot culture studies on the efficiency of NPV formulations against the tobacco cut worm. The under greenhouse conditions on groundnut, wettable powder and dust formulations of NPV @ $4.6 \times 10^7$ polyhedral occlusion bodies (POB) / pot were as effective as Chlorpyriphos 0.04% spray or carbaryl 5% dust against 3rd instar larvae of *S. litura*.

Ramaprasad et al. (1997) studied the effect with SI NPV @ 250 LE/ha (3 sprays), Chlorpyriphos 0.08% + SI NPV @ 250 LE / ha (2 sprays) and initial spraying of SI NPV followed 3 days later with two sprays of Chlorpyriphos against *S. litura* on cowpea. An initial treatment of SI NPV followed three days later by two sprays of chlorpyriphos gave the greatest reduction in pest numbers and highest grain yield for both years (705 and 467 kg / ha, respectively).

Ramakrishnan et al. (1984) working on insecticide resistance in the population of *S. litura* in AP and observed that *S. litura* had developed multiple resistance (5.73 fold to malathion, 14.7 fold to parathion, 16.2 fold to lindane, and 85.9 fold to carbaryl) owing to excessive reliance on chemical insecticides which also killed its natural enemies. Integrated control programmes developed in India included the use of SI NPV.

Chari et al. (1985) evaluated the effectiveness of IPM on tobacco seedlings. A trap crop of castor was sown around the nursery for oviposition by *S. litura* in order to encourage natural enemies. The efficacy of 3% neem kernel suspension, SI NPV @ 100 LE/ha, diflubenzuron @ 300 g ai/ha and chlorpyriphos 0.05% was compared.
The population collected from castor revealed *Cotesia* (*Apanteles*) benefices as major mortality factor. All treatments were at par, thus indicating the need for judicious use of insecticides. NPV @ 250 LE/ha (2 x 10^6 PIBs/ml) was found to be effective in reducing the pod borer damage by *H. armigera* (Narayanan and Gopala Krishan 1987b). NPVs of *S. litura* and *H.armigera* were successfully utilized for control of tobacco caterpillar and budworm. SI NPV 250 LE/ha with boric acid 0.025% (or tanic acid 0.025%) enhanced its efficacy against *S. litura* (Rao et al, 1987) NPV at lower dose of 125 LE/ha in combination with *Bt. Kurstaki* and *Bt* Aizawai (Depel, Delfin or Bactospeine, centari) @ 0.5 kg/ha was also found effective in reducing damage to tobacco seedlings against *S. Litura* and tobacco capsules against *H.armigera* (Gunneswara Rao et al, 1998). *Bt. thuringinesis* preparations (Biotox) were evaluated against *Heliothes armigera* and *S. litura*, *Bt. Kurstaki* was found superior to *Bt. thuringiensis* in reducing damage by the two pests in tobacco (Ramaprasad et al. 1998).

Rao *et al*. (1994) found *H.armigera* to prefer a few crops for oviposition. It was felt that those crops, when grown around the main crop will attract it for egg laying and the early instars larvae can be destroyed by spraying NPV on trap crops, keeping this in view, a novel method of regulating its damage and incidence in FCV tobacco was tried at CTRI, by raising two border rows of trap crops viz., *N. rustica*, bengalgram and Tagetus around different FCV plants. A single spray of Ha. NPV @ 250 LE / ha was give at peak incidence of armigera on trap crops. This method of management helped in checking the damage to FCV tobacco. These trap crops create crop diversity which prevented spread and establishment of the pest.
IMPORTANCE OF ANDROGRAPHIS PANICULATA (KALMEGH).

Subramanian et al. (2008) studied on the inhibitory action of cerrado plants and reported that in vitro α glucosidase and α – amylase enzyme inhibitory effects of *Andrographis paniculata* extract and Andrographolide i.e. (Lc 50 of 17.2 mg ml$^{-1}$) (ethonolic extract) and 11 mg ml$^{-1}$ for pure diterpene andrographolide.

Everton Silva et al. (2009) studied the inhibitory action of cerrado plants against mammalian and insect α – amylases and reported that total of 185 hexanic dichloro methonic ethonolic and hydro ethonolic extracts from 24 species of cerrado plants, were tested. Twelve crude extracts presented inhibition rates greater than 80% against digestive α amylases of the insect pest *Z. subfaciatus*, at a concentration of 1 mg / ml.

These results suggest that the application of plant extracts against insect, α amylases represent a promising biotechnological tool for development of new insect pest control strategies, with noticeable affinity and specificity of action against different target enzymes.

Abhishek Niranjan et al. (2010) studied on biological activities of Kalmegh (*Andrographis paniculata* Nees) and its active principles. He reported that Kalmegh had wide range of medicinal and pharmacological applications. It is used in different traditional systems of medicine, nematicidal and various other activities.

IMPORTANCE OF (NICOTINE SULPHATE) TOBACCO PRODUCTS AS INSECTICIDE.
Bajpai and Sehgal (2003a) reported the morphogenetic effect of botanicals on three day old larvae of *Helicoverpa armigera*. The treatment of diets with Benzene extract (BE) 0.2 per cent, chloroform extract (CE), 0.025 to 0.1 per cent, Ethyl acetate (EAE), Methanol (ME) and Butanol extracts (BUE), 0.05 to 0.2 per cent, Neem seed kernel water extract oil, 2 to 6 per cent, karanj oil 6 per cent and nicotine sulphate, 0.3 to 0.4 per cent resulted in 100 per cent larval mortality in different developmental period indicating zero success index. The maximum larval duration, 28.9 days with minimum pupal weight, 145.6 mg was observed on diets treated with ME 0.025 per cent among the remaining test concentrations. Treatments with BE 0.15 per cent, EAE, ME and BUE at 0.025 per cent; NSK.WE 4 per cent; Neem oil 1 per cent, Karanj oil 4 per cent; and nicotine sulphate 0.2 per cent resulted in 100 per cent pupal mortality. The treatment of diets with BE, 0.05 and 0.1 per cent, NSKWE 2 per cent, Green Mark and Neem guard 0.2 per cent; Neem oil 0.5 per cent, NSKWE 2 per cent; Green Mark and Neem guard 0.2 per cent, Neem oil 0.5 per cent, Karanj oil 2 per cent and nicotine sulphate 0.1 per cent gave 100 per cent abnormal pupae which could not emerge.

Bajpai and Sehgal (2003b) studied on the effect of botanicals on oviposition behaviour of *Helicoverpa armigera* moths at Pantnagar, India. The findings showed that the methanol and chloroform extracts of neem seed kernel and Nicotine sulphate were very effective against the oviposition of *Helicoverpa armigera* female moth, whereas water extract of NSK and neem oil were effective at higher concentrations only.
Chari et al. (1990) found that the effect of locally prepared nicotine sulphate was compared to a commercial preparation of the chemical in Andhra Pradesh, India. The compounds were tested against eggs and larvae of the noctuids Spodoptera litura and Helicoverpa armigera and the aphid Myzus persicae in the laboratory, both products were toxic to all the test organisms. In the field, the local products gave control of H. armigera comparable to the commercial products.

Doshi and Thampan (1995) revealed the results from their case studies that for pest control only natural methods were adopted. The extracts obtained from hot pepper, garlic, onion, leaves of mint and tobacco and tomato were used after diluting with equal quantity of water to ward off the common pests. The other preparations used were tobacco decoction made with tobacco leaf.

Jack and Nancy (2008) worked on the biological and biotechnological control of insect pest, and revealed that basic nicotine and nicotine sulphate are very toxic to humans as well as insects. It is to note worthy that the dermal toxicity of nicotine poses real dangers to users. Oral and dermal LD 50 values have been estimated in the range of 50 to 60 mg / kg body weight. Many natural pest control recommendations suggest the preparation of tobacco tea from tobacco products. Tobacco preparations are very effective against soft bodied insects on kitchen garden. Nicotine poisons insects and mammals in a similar mode of action as described. As the pure nicotine sulphate is toxic, crude tobacco leaf nicotine can be used safely to protect insect pest damage particularly caused by soft body insects like plant lice and caterpillars.