

DISCUSSION

Chapter V

Discussion

Part-A: Tobacco waste management as organic manure in chickpea cultivation:-

Good Agricultural Practices (GAP) play a major role in harnessing the maximum possible grain yields in any crop. This is more so emphasised in Rainfed farming. The semi-arid conditions of this agro-ecological situation pave ways for intervention of new technologies, suitable for conserving and continual supply of soil water for sustained crop growth. In the dryland farming situations, conservation of soil water and sustained release of soil water to the crop till it completes the grand growth period, flowering and grain filling stage is an essential requirement (Palaniappan and Annadurai, 1999).

In this pursuit, different composts available locally were evaluated for their suitability to retain and supply of soil water to the chickpea crop in vertisols of AP. Tobacco is abundantly grown in the coastal vertisols. As the leaf tobacco is harvested, the stems left out in the fields are either pulled out or burnt in heaps out side the fields. Tobacco stems are rich source of nutrients such as nitrogen, phosphorus and potassium. Besides the nutrients, the stems are having higher content of lignin and celluloses. Composting these stems and using it for growing field crops is totally a new venture in vertisols where chickpea crop is abundantly grown. The tobacco stem compost is evaluated with reference to locally available FYM, FPC and STC as against the normal practices where there is no

application of organic manures to the soil for growing *rabi* chickpea (Sharma, *et.al*, 2002).

The physical characters and water holding capacity of TSC is very much encouraging for cultivation of *rabi* crop on conserved soil moisture under vertisol conditions. TSC recoded 320% increase in weight after wetting for 24 h time under saturated conditions with maximum insoluble matter 12 % and with very low density compared to other organic manures tested. The low density undecomposed lignin and celluloses are very important in improving soil physical characteristics. The low density matter after application to the vertisols combines very quickly and loosens the soil from binding behaviour and avoids forming hard crust normally seen in heavy soils that impairs the root proliferation and lowers the absorption of nutrients and water. Thus TSC is an added advantage in reducing the soil bulk density, improving the water holding capacity and soil aeration sustains the same for a longer period, supplies nutrients due to proper mineralisation and encourages soil rhizosphere micro flora. Contrast to TSC, the FPC is highly soluble and saline-alkaline in reaction, contains lot of insoluble calcium and very low content of lignin and cellulose to retain soil water. The locally available FYM is already digested material and ejected by animals and to a larger extent is inferior in physical and chemical properties compared to TSC (Muthuvel, *et al.*1982).

The STC is a dry matter made up of insoluble material and decomposition in soil takes longer time as its water holding capacity is poor and thereby supporting the crop growth physically and nutritionally is at a lower profile. All these manures were compared in terms of chickpea grain production with the control where only fertilisers (with out organic manures) were applied.

In conjunction with these manures application @ 2.5 t/ha, along with the recommended dose of fertilisers were tested at 50 %, 75% and 100% .Since the soil is saline vertisol, with 7.86 pH and rich in soil calcium and potassium elements, the possibility of zinc combining with excess Ca and form calcium zincates which is not available to the crop (Pujar et al 1998) and (puste et al 1999). As zinc is the precursor to many life activities, non availability of this essential micronutrient limits the crop yields even at sufficient / optimum doses of N & P application. Hence, along with 100% RDF, zinc was also added @ 15 kg ZnSO₄/ha. keeping one control where no fertilisers were applied except the organics. For evaluation of the interaction of the manures with fertiliser schedules and to draw the combined effect or single effect either the manure or nutrient, one absolute control plot where no manures and fertilisers were applied was also maintained (Din et al, 2001, Sangwan and Raj,2004).

The grain yield of chickpea indicated that TSC application to the soil resulted in the maximum grain production to an extent of 2.64 t /ha in contrast to the grain yield produced to the control plots (1.90 t /ha). It is clear that TSC

application has resulted in good soil physical conditions and helped to increase the storable soil water to a longer time as indicated in the soil moisture percentage recorded at 40 and 70 days of crop seeding. Continuous supply of soil water to the crop for a longer period helped to mineralize the soil nutrients, enhances absorption due to root proliferation to the deeper layers as the soil bulk density is considerably reduced and aeration increased. The results clearly indicated the superiority of TSC in many ways for the development of crop growth such as plant height, number of branches, number of pods, test weight and test volume. The increased physical growth of the crop has also contributed for the development, resulting into increased total bio mass production. The proportion of grain production to the total biomass was also higher due to TSC application indicating that larger part of the bio mass got into grain production where as in case of other organic manures and control plots it is relatively lower (Singh et al, 2008 and Jai Paul et al, 2007). The nutrient potassium is also very high in the applied TSC whose water relationship with crop, needs no explanation (Rajiv kumar *et al*, 2005). Probably, this helped in enhancing the physiological activities in the plant system. The total protein yield was maximum due to application of TSC when compared to other treatments indicates that applied nitrogen element utilization was more, besides the nitrogen supplied by the microbial fertilization as the root region PGPR activity seems to be good .It is also indicated by the reduced pH value and increased organic carbon (Sanjeevkumar *et al*, 2002 and Kumar and Nair, 2003). Since, carbon acts as the substrate for the multiplication of microbes, the changed soil atmosphere

enhanced the microbial activity and resulted in increased productivity of total protein yield. The improvement in residual soil N and P in this calcareous soil resulted in better crop nutrition compared to other organic manures because of nutritional build up. The available soil K did not show much variation because of high native soil K already present in the soil system. This helped for better utilization of N and P by maintaining proper soil -plant – water relationships that resulted into higher productivity, (Sankaralingappa *et al*, 2000).

The use efficiency of N and P nutrients threw more light on the role of TSC in maintaining and conversion of nutrients into grain production. In the actual use efficiency, TSC recorded the highest values of 58.56 kg grain / kg N applied when compared to control which recorded only 46.75 kg/kg N, Similar was the case when partial use efficiency was also tested which indicated the superiority of TSC .It also improved the physiological use efficiency, N uptake use efficiency, recovery of N use efficiency that had helped the crop to convert the N and other nutrients into higher grain production compared to others. As the soil moisture was retained for a longer period the applied nutrients and nutrients released by the micro organisms (Rhizobium and PSB) would have helped for increased metabolism of the crop that resulted into higher level of grain production, (Jayarama Soundari, *et al*.2003 and Madhavi *et al*. 2009). Similar was the case with agronomic use efficiency of K since TSC contained higher amount of K compared to other organics and hence, the actual use efficiency of this element was more.

From the above discussion, it is concluded that TSC application at 2.5 tones per hectare in the last preparatory cultivation of the soil, especially with vertisols under rainfed conditions the performance of chickpea was better with reference to grain yield. The activity is mediated basically through reduced bulk density, higher amount of storable moisture for a longer crop period, good root proliferation, increased activity of the root region micro flora due to increased OC, enhanced physiological activity due to higher K element absorption and subsequently improved metabolic activity to absorb and convert the applied N and P ions into biomass production, regulating into higher grain production (Muthuvel *et al*,1962, and Palaniappan and Natarajan,1993). In the absence of TSC, FYM or FPC are the next choices to be applied to the soil to grow chick pea crop under vertisol condition in *rabi* season with conserved soil moisture.

Regarding fertilizers response, the recommended dose of nutrient fertilisers were tested at 50%, 75% and 100%. However, in calcareous vertisols because of higher amounts of calcium, the availability of P ions and Zn become limiting factor as Ca reacts with P and Zn to form insoluble phosphates and zincates and the productivity is limited by these elements in spite of good N nutrition .Hence, the treatment containing of 100% RD NP along with 15 kg ZnSo₄ was also included (Arya *et al*, 2002, Chesti and Tahir Ali, 2007, and Maitra *et al*, 2008). The performance of the fertiliser doses are with the back ground of organic manures being tested in the experiment .However, the absolute control plot where no manure and fertiliser was applied acts as a check

plot. The interaction effect between organic manures and fertiliser doses was discussed together for a comprehensive understanding and to derive at correct dose of fertilisers under different manures application.

The grain yield of chickpea was greatly influenced due to application of fertiliser schedules. Fertilisers in combination with organic manures, the effects were more pronounced compared to sole application effects. Hence, it is discussed in this angle only. Zinc supplementation to the fertiliser schedule 100% RDF recorded higher grain yield over sole 100% RDF. With out zinc addition, 75% and 100% RDF are at par as far as grain production is concerned. It is now understood that application of RDF to the calcareous soils did not bring significant difference in grain yields either at 75% or 100% RDF while addition of zinc shot the grain yield production to 2.63 t / ha. It is therefore inferred that the conversion of nutrients into grain production is limited by the micro nutrient Zn and replenishment with Zn, resulted in higher productivity. The interaction had magnificent effect shooting the grain yield to 3.22 t /ha under TSC application because of enhanced K application that maintains soil - plant - water relationships in a better way compared to other manures (Chawdary *et al.* 2003). Though K addition through FPC and TSC are the same, the soil physical properties improvement due to addition of TSC showed more beneficial effects over others due to maintaining proper soil water availability. The beneficial soil physical effects endured by TSC application besides mitigating Zn requirement through addition of Zn fertilisers along with RDF resulted in higher values for yield attributing characters. The root proliferation enabled to extract the soil water

to a longer period of crop growth with increased nodular development to harvest atmospheric N along with applied N resulted into better grain yield through improved grain characters such as test volume and weight. The improved biomass helped to convert the photosynthates into grain production as indicated by higher HI. It is needless to explain the role of Zn in improving the hormonal activity resulting into physical and physiological expressions for better development of the crop leading to higher productivity. The enhanced uptake of N nutrient not only resulted into higher grain outturn, but also increased the protein content tremendously indicating the improvement in the grain quality. The translocation of photosynthates by means of adequate K nutrient that was supplemented through TSC helped to improve protein percentage and total protein yield of the crop (Kanwarkamla, and Paliyal,2002). Under this combination, a total of 641.37 kg protein per hectare was realized being the highest recorded value among all treatments with 238 kg protein per hectare under absolute control plot.

Though, all the organic manures application reduced soil pH at the end of 2-year cropping cycle, the lowest was recorded under TSC + 100%RDF+Zn application. Soil OC also showed the beneficial effects by the above combination. The soil available N recorded very high values of 188 kg/ha indicate that mineralization of native N and N fixed by the bacteria are substantially high due to microbial degradation of TSC under improved soil physical and chemical properties. The high N contributed to increased grain production.

Though, soil Av. P was at very high level, addition of elemental P and the released P by microbes from the fixed P of the soil still enhanced the Av.P of soil under all organic sources.

The soil Av.K recorded higher values at FYM and TSC application only. Though, FPC contained equal K as that of TSC, the residual K was reduced because of higher content of Ca in FPC derived from sugar mills where Ca is used for clarification of the extract. Hence, it has reduced the residual soil K in vertisols which has already got substantial soil Ca. The comparatively higher soil water content in the two soil depths up to 70 DAS due to TSC + 100% RDF+ Zn made the crop to make use of the soil nutrients and there by the nutrient efficiencies are well improved and documented in the actual and partial use efficiencies, physiological use efficiency, N uptake use efficiency harvest index, recovery use efficiency of all N, P and K (Gedam *et al.* 2008).

The response curves were drawn for N and P under each of the manures Andre Guinard (1982). Under FYM and TSC application, N, P and N + P recorded curvilinear trend with very high significant R^2 values .Where as with FPC and STC, the response of these nutrients was linear. The response to chemical fertilisers was also linear indicating that the crop still responds to higher levels of nutrients. The curvilinear nature of response under TSC and FYM indicated that the costly chemical fertilisers dose could be reduced as the crop nutrition was supplemented with organic sources such as FYM and TSC. It is

therefore inferred that TSC is superior to other composts because of increased grain production at a given dose of N + P + Zn fertiliser nutrients under conserved soil moisture conditions.

On economic front, inclusions of organic manures like FYM, FPC and TSC in the schedules along with 100 % RDF + Zn is always beneficial in terms of grain production and net benefit. Addition of TSC to the fertiliser schedule resulted in an additional net benefit of Rs 20,075 over inorganic fertiliser application alone. The benefit ratio was also more when organics were added to the fertiliser schedules amounting to 3.49 with TSC followed by 2.67 with FYM, 2.52 with FPC, 2.22 with STC and 2.42 with inorganic fertiliser application .

It is concluded that addition of organic manures is essential to the fertiliser schedule for growing chickpea in vertisols of Andhra Pradesh for harvesting more grain yields where the crop sustains basically on the conserved soil moisture. Tobacco Stem Compost (TSC) along with 100% RDF+15kg +ZnSO₄ is the best combination in terms of improving soil physical and chemical properties that helps for better crop growth resulting into higher productivity and monetary benefit to the chickpea growers.

Part B : Tobacco waste leaf management as biopesticides:

To evaluate the efficacy of bio pesticides against lepidopterous pests *viz.*, *H.armigera* and *Spodoptera litura*. a field experiment was carried out during 2005-06 and 2006-2007 at CTRI Research farm Katheru, Rajahmundry, Andhra Pradesh. The bio pesticides tried in the experiment are presented in table 3.6.4.2 in the chapter of materials and methods.

The chickpea field was prepared with recommended standard agronomical practices and sown in the month of November in both the years, and bio pesticides were sprayed treatment wise with the help of ASPEE high tech sprayer. The observations were recorded before giving each spray i.e. at 56, 60, 70 and 80 days after sowing (DAS) the crop.

From the results presented in the tables, it is revealed that all the bio pesticide treatments were significantly superior to control in checking the *H.armigera* and *S.litura* infestation on chickpea. Kalmegh (*Andrographis paniculata* Nees), Tobacco midrib power water extract and neem seed kernal water extract sprayed plots had the lowest larval count and were at par with chemical pesticide Chlorpyriphos closely followed by NPV, PSKS and Tobacco leaf extraction was the next best.

From the results, it is seen that the percentage of damage was very low (1.17%) in Kalmegh, (2.17%) in NSKS and 3.0 % in tobacco midrib, followed by (4.17 %) PSKS and were at par to chemical pesticide chlorpyriphos. NPV (15%);

neem oil (19%), Pongamia oil (18.67) and tobacco leaf (20 %) were the next best: and the percentage of damage in control plot was 43.33.

Natural enemy population:

The results revealed that there was significant difference in natural enemy population between bio pesticides and chemical pesticide applied plots. Observations on both predators and parasites were recorded after one week of the last spray i.e., 90 DAS spray. The predators recorded were coccinellids, spiders and reduvids, where as the parasites found were Apanteles, Peribeia and Chelonus. More no of predators and parasites were found in control plot than all other treatments. Nuclear poly hedrosis virus treated plot had more parasites and predators followed by tobacco midrib extraction, kalmegh, pongamia and neem products. Though the control plot had more number of parasites and predators, the damage of chickpea crop was also more because of high population of H.armigera and S. litura present in it.

Grain yield:

At the end of the experiment chickpea yields were recorded in various treatments the maximum grain yield (2.39 t/ha) was recorded in Kalmegh (Andrographis paniculata) 2% treated plot followed by chlorpyrifos 0.2% (2.32 t/ha), Tobacco midrib powder waste extraction 2% (2.30 t/ha), NSKS 25 (2.16 t/ha), NPV 250 LE/ha (2.08 t/ha) and PSKS 2% (2.03 t/ha). However, these treatments were at par with each other. Lowest yield of 1.30 t/ha was recorded in control plot which was significantly lower to all other bio pesticides treatments.

Neem oil 2% and Pongamia oil 2% showed toxic effect on chick pea foliage and advanced the crop maturity that caused lower yields than other treatments. In comparison with control, neem oil (38%) Pongamia oil (34 %) and tobacco leaf (37%) recorded more grain Yield.

The incidence and transition of pod borer *Helicoverpa armigera*, usually starts from November to February in chickpea (*Cicer arietinum*) i.e., from the flower initiation (50-60 days old chickpea crop) and continue up to February (i.e. 90 days of the crop) in rabi season. The caterpillars feed in the crop voraciously on chickpea pods. In case of severe infestation there is every possibility that the farmer may have to lose the crop from 50 to 100%. The population trend of the pest warrants maximum care to be taken from December to February i.e up to the pod maturity or the temperature goes up by March 1st week. The pest activity was observed in chickpea during November to February and the population was at its peak during December (Patel and Koshiya, 1997) and reported on seasonal abundance of American boll worm *Helicoverpa armigera* on different crop hosts at Junagadh (Gujarat). Similar observations were also made by them in 1999. Explaining the population dynamics of the gram pod borer (*H.armigera*) in chickpea and found that the pest was observed in the 3rd week of November and reached a peak in the 3rd week of December when the crop was at pod formation stage and the pest was active from November to February. Saha (2006) revealed the results from the work on economic threshold limit (ETL) on chick pea as one larva/five plants (1/5) on chickpea. Biradar et al, 1988. working on development of spray schedule in chickpea due to pod borer and loss estimation

reported that spraying at 30, 45, 60 and 75 days after sowing (DAS) was the best and gave the highest yield 11.5 q/ha followed by with three sprayings at reproductive phase (i.e. 45, 60 and 75 DAS) with 9.5 q/ha seed yield and 86.3 % increase over the untreated control by avoiding losses up to 46.3%.

The results of the trial on bio pesticides conducted for 2005-06 and 2006-07 years to control *Helicoverpa armigera* indicated that *Andrographis paniculata* (Kalmegh), Tobacco midrib powder water extraction and (NSKS), neem seed kernal suspension / water extraction are the most effective bio insecticides which can be comparable to chemical insecticides. The percentage of damage in kalmegh was 1.17%, NSKS 2.17, Tobacco mid rib powder extraction 3.0 and in chlorpyrifos 2.17%, PSKS 4.17 and NPV 15.0% as against control with 43.33%. The yields in kalmegh are 2.398 t/ha, tobacco mid rib 2.303 t/ha, NSKS 2.158 and chlorpyrifos 2.321 t/ha NPV 2.081 t/ha PSKS/WE 2.031, Neem oil 1.796; Tobacco leaf 1.783 and pongamia oil 1.7461 as compared to control with 1.303 t/ha. These results are confirmative with Bajpai and Sehgal (2003). Who conducted a trial on morphogenic effect of botanical on three day old larvae of *Helicoverpa armigera*. Treatments with NSKWE 4 %, Neem oil 1% Karanj Pongamia oil 4% and nicotine sulphate Tobacco leaf mid rib powder water extract @ 0.2 % resulted in 100% pupal mortality. The treatments of NSKWE 2%, Neem guard 0.2%, Neem oil 0.5%, Karanj oil 2% and nicotine sulphate 0.1% gave 100 per cent abnormal pupae which could not emerge.

Abhishek Niranjana et al., (2009) reported on biological activities of Kalmegh (*Adrographis paniculata nees*) and its active principles. Kalmegh was used in different traditional systems of medicine, nematicidal and various other activities of insect pest control strategies. The results in H.NPV applied plots were also encouraging and almost at par to botanical insecticides. The percentages of damage in HI.NPV 250 LE/ha 15% and the yields in HINPV plot is 2.081 t/ha. These results were confirmative with Bhagawat and Wightman (2001) reported that "NPV based management for *Helicoverpa armigera*(Hub) in chickpea" as 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, Andhra Pradesh, showed good performance of NPV against pod borer damage.

Hence, it is clear that the Tobacco midrib extract, Kalmegh, N.S.K.S, and HI.NPV are at par with chlorpyrifos and are economical.