

**BIOCHEMICAL STUDIES ON HOMA ORGANIC
FARMING PRACTICES IN CABBAGE
(*Brassica oleracea* var. Saint)**

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1. INTRODUCTION

Vegetables are considered as protective food of great value because of their high nutrient content and richness in vitamins and minerals. Thus they constitute a valuable supplementary food and form an important constituent of our diet. In vegetable production, India is the second largest producer in the world next only to China with an annual production of 81 metric tones from 5.12 m ha of land. However, due to heavy post harvest losses (30%) and high population in the country, the per capita availability of vegetables is only 140 g per day, when compared to 300 g recommended by nutritional experts (Fageria *et al.*, 2001).

Cole crops which include cabbage, cauliflower, knol-khol *etc.* are the most abundantly consumed vegetables all over the world. They belong to the genus *Brassica* of the family *Brassicaceae*. This group includes a wide variety of vegetable crops. Cabbage (*Brassica oleracea* Var. Saint) is a leafy winter vegetable grown for its edible enlarged terminal bud. In addition to several minerals such as calcium, phosphorus, potassium, sulphur and iron present in cabbage, it also contains high percentage of protein and vitamins A, B and C. It is consumed either cooked or raw as salad.

Cabbage is of Cyprus and Mediterranean origin. It is cultivated extensively in tropical and temperate regions of the world viz., China, Germany, India, Indonesia, Japan, Korea, Poland, Russia, Taiwan, Turkey, Ukraine, USA, Uzbekistan and several other countries (Rai and Yadav, 2009).

More than 48.2 per cent of the area under this crop is contributed by Asian continent which accounts for 42.3 per cent of total world production (Anon., 2009a). India is one of the important cabbage growing countries in Asia with an area of 331.023 thousand ha and production of 7,28,1501 thousand metric tones with a productivity of 21,997 tones per ha. In Karnataka, it is grown in all the seasons over an area of 8,900 hectares with an annual production of 176.200 lakh metric tones having an average productivity of 19.798 tones per ha (Anon., 2010). Cabbage is cultivated extensively in North Western Karnataka especially in Dharwad, Belgaum and Bidar districts.

Modern agriculture, which largely depends on chemical fertilizers, pesticides, herbicides, *etc.*, had shown promise by increasing production in the beginning but adversely affected the soil productivity and environmental quality later. During the era of green revolution, spectacular increase in crop yields resulted primarily from the introduction of fertilizer responsive high yielding varieties, use of high quantity of chemical fertilizers and pesticides. The heavy use of chemical pesticides and fungicides caused health hazards and environmental pollution apart from imparting resistance to the causal agents against chemical pesticides and fungicides. This conventional and modern or industrial farming is also beset with a variety of concerns including ecological, economical philosophical, and soil, human health. Sustainable agriculture is supposed to be the right answer for tackling various issues cropped up during the recent times due to invariably excessive dependence on synthetic chemicals (Grewal, 2003).

Organic farming is a form of agriculture in which synthetic fertilizers, fungicides, insecticides and pesticides, plant growth regulators, livestock feed additives and genetically modified organisms are avoided. The role of organic agriculture whether in farming, processing, distribution or consumption is to sustain and enhance the health of ecosystem and organism from the smallest in the soil to human beings.

Agnihotra is a smallest Yajnya or Homa and forms the basis of Homa farming or Homa organic farming (HOF). Its use in agriculture is called Agnihotra or Homa farming and makes some interesting promises based on Vruksh Ayurveda (Johnson and Heschl, 2009) which may be examined by the agriculture scientists with an open mind. This HOF needs organic farming as a base. It is a zero technology process for betterment of crops and plants in agriculture, horticulture, forestry, microbes, animals and human beings. It is a process of purifying the atmosphere through a specially prepared fire.

The process involves preparing a small fire with dried cow dung cakes in a copper semi-pyramid of fixed size and putting some whole unpolished, uncooked grains of rice and ghee (clarified unsalted butter) in to the fire exactly at sun rise and sun set. It's three requirements are as follows:

1. Burning of specific substances in a copper semi-pyramid
2. Chanting of specific mantras and
3. Specific timing of a place according to 'Circadian rhythm' of nature *i.e.* sun rise and sun set timing of a particular place depending upon its longitude and latitude.

India is the birth place of Agnihotra. Over 75 countries are taking advantage of HOF technique. The leader among them is South American Republic of Peru. Three agricultural Universities, namely Tamil Nadu Agriculture University, Coimbatore; CSK Himachal Pradesh Krishi Vishwavidyalaya, Palampur and University of Agricultural Sciences, Dharwad have initiated experiments based on this Vedic technique.

Ancient science of 'Homa therapy' states that more than 75 per cent of nutrition to the plant comes through atmosphere (Johnson and Heschl, 2009) which is unfortunately most neglected area in agriculture. If the atmosphere is made more nutritious and fragrant by performing homa, a type of protective coating covers the plants preventing diseases, fungi and pests to thrive. Capacity of the plant to breath increases and the toxic effect of chocking to death due to atmospheric toxins is eliminated due to 'Homa therapy'.

In the soil rejuvenated by homa, different types of microorganisms thrive, thus a healthy micro-flora and micro-fauna is created. After creation of such an environment, creatures like earth worms thrive. They eat the soil, digest it and again replenish the soil. Some other benefits of HOF have also been observed like increased quantity and quality in production, healthy crop, superior taste of the produce, size, texture and nutrition, reduced cost of labour, saving the cost of agrochemicals and protection of the farmer and his family from the deadly poisonous chemicals *etc.* It also prolongs the shelf life and makes the produce more suitable for export and shortens the productive cycle. The present investigation was therefore, carried out with the following objectives:

To study the effect of Homa organic farming on

1. Growth and yield and quality of cabbage
2. Soil fertility and soil biological activity in the rhizosphere.
3. Pest and disease management of cabbage.

2. REVIEW OF LITERATURE

The literature available on organic farming and HOF on cabbage, other crops and fruits and vegetables is discussed here under.

2.1 Organic farming in relation to growth and yield

Silva *et al.* (1984) reported that N increased the total yield; however, cattle manure increased commercial to total yield ratio in cabbage. The highest commercial yield (14.9 t/ha) was achieved with cattle manure or combination of N and K₂O. The response to P₂O₅ was found to be absent.

Saciragic and Orelilovic (1986) found that after the application of vermicompost (@ 4, 6 and 8 kg/m²), the cabbage dry matter production increased from 1 to 66 per cent.

Increased head weight, reduced compactness and increased incidence of black rot in cabbage was observed by Silva (1986) in his studies on combined effect of ammonium sulphate and farm yard manure in cabbage.

Smith and Hadley (1988) reported that yield response of summer cabbage to surface applied top dressings of the organic N material was only 10 to 50 per cent of that with ammonium nitrate.

Subhan (1988) reported that application of organic manure increased plant diameter at 60 days after planting and the average number of leaves per plant and reduced the number of days to crop maturity in cabbage.

Farooque and Islam (1989) reported that better growth and maximum yield of cabbage was observed with the application of combination of cow dung, oil cake, urea, triple super phosphate and muriate of potash.

Subhan (1989) studied the effect of maize and rice straw compost and sheep manure on yield of cabbage and reported that all the treatments increased cabbage yield over control. However, the highest gross yield of 101.7 tones per hectare was obtained with maize compost at 30 tones per hectare.

The experiment conducted by Maynard (1991) and Krospise (1992) showed good response for organic substrates, such as composted pine bark, FYM, compost and spent sludge in vegetables like cabbage, onion, carrot, eggplant, pepper, tomato, cauliflower, spinach and garlic.

Bambal *et al.* (1995) reported early curd initiation (66.22 days) and curd maturity (98.33 days) with 100 per cent N and *Azotobacter* with *Azospirillum* than 100 per cent N alone in cauliflower.

Gupta and Samnotra (2000) recorded spear head compactness (45.27) and head diameter (14.63 cm) in cabbage by application of 75 per cent N (90 kg/ha) with *Azospirillum*.

Spraying of 0.5 per cent borax on cabbage was seen to produce highest number of wrapper leaves (44.67) and superior compactness of head (36.08%) in cabbage as reported by Sharma and Arya (2001).

Londhe (2002) reported that the treatment of 50 per cent N through FYM with 50 per cent N through inorganic recommended dose recorded maximum number of leaves per plant, weight of leaves, polar diameter, stalk length and was earliest to harvesting of cabbage.

Selvaraj *et al.* (2002) found that the biodynamic treatments were superior to the conventional as well as combination of conventional and biodynamic treatments in increasing the size of the cabbage head, head weight and head yield as compared to control.

Chitrakar (2004) found that application of 50 per cent RDF with 50 per cent FYM resulted into early head initiation (32.29 days), early head maturity (62.27 days) and more staying capacity of cabbage heads (9.57 days) as compared to 100 per cent RDF (100:50:50 kg NPK/ha).

2.2 Quality of organic farming produce

Quality is as complex phenomena involving not only different nutrients but also plant protective agents such as phenols.

Phenolic compounds have been found to play important roles in determining resistance or susceptibility of a host to parasitic infection. A resistant variety may contain more phenolic compounds than a susceptible variety (Rubin and Akesenova, 1957 and Raghunathan *et al.*, 1958).

Barooh and Ahmed (1964) reported that the response of N, P and K fertilizers at different levels on growth yield and ascorbic acid content of tomato. Friend (1979) observed that for the realization of their protective action, phenolic compounds must be liberated from inactive forms, since it is precisely in the free state that polyphenols manifest the higher fungi and cytotoxicity.

Sulphur is a macronutrient normally present in soil as an anion (SO_4^{2-}). Higher plants obtain sulphur principally through uptake of sulphate ion by roots. It is a component of lipoic acid, coenzyme A, glutathione, biotin and of amino acids like L-cysteine and L-methionine and thus of proteins. These amino acids are found in proteins as building blocks and also in the form of disulphide bridges between different polypeptide chains. Sulphur is also a component of adenosine-5'-phosphosulphate formed by reaction of sulphate ion with ATP catalyzed by an enzyme ATP-sulfurylase (Blancher *et al.*, 1965).

Kolhe and Ruikar (1987) reported that graded levels of N and bio-fertilisers significantly increased the chlorophyll a and b, ascorbic acid and protein content as well as yield of cabbage. Bindu (1994) reported that cabbage seedling treated with *Azotobacter* and *Azospirillum* supplemented with 75 per cent nitrogen of the recommended dose resulted in increased chlorophyll content in leaves.

Pansare *et al.* (1994) found that TSS was highest with 100: 00: 100 kg NPK per hectare in tomato fruits. Mahendran and Kumar (1996) found that TSS of cabbage head, head compactness index and ascorbic acid was 4.04 °Brix, 0.250 and 37.8 mg per 100 g, respectively on receiving 75 per cent RDF with *Azospirillum* treatment with phosphobacteria and digested organic supplement and vermicompost (2.5 t/ha) which was significantly superior over 100 per cent RDF (135:135:135 kg NPK/ha).

Bambal *et al.* (1998) in trial with cauliflower cv. Snowball-16, application of *Azotobacter* with *Azospirillum* and 100 per cent nitrogen resulted in highest chlorophyll content (1.98 mg/g) and leaf area (634.58 cm²/plant) when compared with other treatment combination.

Rembialkowska *et al.* (2000) compared the nutritive and sensory quality of white cabbage from organic and conventional forms and reported the organic cabbage contain 15 per cent more dry matter.

Patil *et al.* (2001) reported that highest values of total soluble solids (6.08 °Brix) and ascorbic acid (26.76 mg/100 g) in tomato treated with 50 per cent RDF with 50 per cent FYM followed by 50 per cent RDF and 50 per cent vermicompost (5.87 °Brix and 26.53 mg/100g, respectively) in comparison with treatment with 100 per cent RDF (100 :50:50 kg NPK/ha) (9.23 °Brix and 22.60 mg/100 g, respectively).

Sengupta *et al.* (2001) reported that tomato supplied with *Azospirillum* culture treatment recorded highest TSS (5.90 °Brix) followed by *Azotobacter* (5.89 °Brix) over inoculated control (5.62 °Brix).

Worthington (2001) recorded that organic crops contained significantly more vitamin C, iron, magnesium, and phosphorus and significantly less nitrates than conventional crops. There were non significant trends showing less protein but of a better quality and a higher content of nutritionally significant minerals with lower amounts of some heavy metals in organic crops compared to conventional ones.

Pokluda (2008) recorded that the evaluation of nutritional quality of Chinese cabbage and the effects of cultivar, weed incidence, plant density and growing season were observed in integrated cultivation system. Mean contents of analysed compounds were as follows: dry matter (6%), crude fiber (10%) and K (2,199 mg/kg), Ca (289 mg/kg), Mg (146 mg/kg), Na (111 mg/kg) and vitamin C (316 mg/kg).

Wang *et al.* (2010) recorded the effects of cow manure and vermicompost on plant growth, metabolite content and antioxidant activities of Chinese cabbage in pot cultures. Vermicompost application significantly increased the nutrient content of Chinese cabbage leaves, especially in the different organic treatment, with increases in the contents of soluble sugar, soluble protein, vitamin C, total phenols, and total flavonoids (%) 62, 18, 200, 25, and 17, respectively as compared to the full soil treatment.

Sarma *et al.* (2011) recorded the cabbage head mineral content which was influenced by the application of organic manures and bio-fertilizers. Maximum nitrogen content (4.33%) in cabbage head and maximum content of phosphorus and potassium (0.62% and 3.85%) were measured on application of *Azotobacter* with optimal compost with Rock phosphate (RP) and Phosphate solubilizing bacteria (PSB), *Azotobacter* with RP with PSB and *Azotobacter* with cow dung with RP and PSB, respectively.

2.3 Soil macro and micronutrients

Singh *et al.* (1980) reported that continuous application of FYM had resulted in a build up of available K in sandy loam soil.

Association of organic matter and availability of these nutrients has been confirmed by high values of coefficients of correlation between these soil attributes through a range of studies (Lal and Kang, 1982). Stevenson (1982) also listed organic matter as the most influential factor modulating nutrient availability across diverse soils.

In plant nutrition, organic matter level of soil is the key property that decides the availability status of essential nutrients. This arises from the fact that organic matter is the basic resource of several nutrient essential elements including nitrogen. It is estimated that about 95 per cent of nitrogen resides in organic matter (Stevenson, 1982). Thus, availability of N in soil is mainly influenced by the organic matter status of the soil.

Katyal (1986) reported that the application of FYM @ 20 tones per hectare maintained the levels of available micronutrients, such as Fe, Zn and Cu at much higher than initial level. Single application of coir pith increased the Fe, Mn, Zn and Cu availability in red and black soil (Krishna, 1986).

Muthuvel *et al.* (1990) opined that the available N content of soil with FYM addition could be due to favourable microbial activity and enhanced biomass addition to the soil, probably as a result of improved soil physical properties.

Prasad and Rokima (1991) reported that the application of organics and *Azospirillum* had resulted in build up of available K. *Azospirillum* inoculation enhanced assimilation of N and increased its availability (Wani and Lee, 1991).

Tandon (1991) reported that sulphur is recognised as fourth major plant nutrient after N, P and K. Crops in general require as much sulphur as their P requirement. The requirement of S to cabbage crop is more than that of calcium or magnesium. It has assumed more importance with high production goals. Sulphur is required for synthesis of sulphur containing amino acids. It is essential for formation of proteins and chlorophyll and is a constituent of vitamins and coenzyme-A sulphur deficiency affects protein synthesis in plants. Soil deficient in sulphur produces S-deficient crops and sub-optimal yields. Most of the sulphur absorbed by plants is taken up through roots as sulphate (SO_4^-). Plant dry matter generally contains 0.2 to 0.5 per cent sulphur which is comparable to its phosphorus content. Bulk of the organic sulphur in plants is present as proteins in the form of sulphur containing amino acids like L-Methionine, L-Cysteine and Cystine with sulphur content 27, 26 and 27 per cent, respectively.

Balaji (1994) reported high levels of available potassium in the treatments that received either vermicompost or FYM in combination with chemical fertiliser than control.

The post-harvest available soil N was markedly influenced by the interaction of N and *Azospirillum*. At 50 per cent of the recommended dose of N and soil application of *Azospirillum* @ 2 kg per hectare registered the highest available N (225.8 kg/ha) in tomato (Subbiah, 1994).

Suresh *et al.* (1995) observed increase in soil available K due to application of organic manure along with bio fertilisers.

Deka and Pooma (1996) reported that inclusion of FYM on long term basis increased the available copper content in semi-arid and humid region. Venkatesh *et al.* (1998) indicated that the application of vermicompost at five tones per hectare with 30 per cent RDF recorded the highest soil micronutrient content.

In general, addition of organics is expected to increase the availability of phosphorus in soils. It was observed that the incorporation of coir pith into the potting medium increased the available P status of the soil (Saravanan and Baskar, 1997).

Saravanan and Baskar (1997) reported that the incorporation of coir pith into the potting medium increased the total N and available N status of the soil.

The application of FYM at graded levels increased available P content of soil. The increase in available P was 30.1 and 66.6 per cent with 10 tones per hectare and 20 tones per hectare of FYM, respectively over no FYM application. The increase in available P was thought to be due to chelating effect of organic matter lowering the fixation of Al-P and Fe-P in soil (Saravanapandian, 1998).

Selvi and Augustine (1999) reported that the mushroom-spent compost was superior to other organic manures in increasing the available N content. Maximum available N was recorded with the application of mushroom-spent compost along with 100 per cent recommended dose of inorganic fertilisers.

Appavu *et al.* (2000) found that the availability of Zn and Fe content increased by the incorporation of organic manures with no effect on the availability of Mn and Cu. Ploughing and burning the stubbles and composting stubbles increased the availability of Zn, Fe and Mn. All the four micronutrients' cations were higher in the surface than in sub-surface soil. Katyal (2000) valued phosphorus contribution of organic manures as 60 to 80 per cent and observed that 70 per cent of zinc and copper in soils occur in organic form.

Jadhav *et al.* (2001) studied the available micronutrient content of soil as influenced by application of vermicompost and *in-situ* vermiculture. A significant increase in the available Fe, Mn, Zn and Cu status was observed in the treatment that received vermicompost with RDF than in the treatment that received N, P and K alone.

In an investigation, the available soil nitrogen was significantly higher in plots receiving organics and *Azospirillum* than inorganic fertiliser applied plot (Bhanushalini *et al.*, 2002). They also reported that the application of organic manures had a marked effect on the availability of P in the soil after harvest. The highest P availability was recorded with vermicompost that might have decomposed vermicompost readily releasing nutrients at faster rate than FYM.

The micronutrients, such as Fe, Cu and Zn availability was significantly higher in the treatments receiving FYM as compared to all commercial manures (Prakash *et al.*, 2002).

Chaudhary *et al.* (2003) reported that maximum increase in the available N, P and K content of the soil of tomato and cabbage due to combined application of vermicompost and FYM after harvest.

Gupta and Ranganekar (2003) observed that the application of higher dose of FYM was effective in increasing the availability of Mn after 60 days and 90 days in case of medium black and alluvial soils, respectively.

Chithesh (2005) observed higher available N after harvest of tomato and hyacinth beans in plots receiving organic amendments.

Nelson and Cox (2005) reported that zinc in its cationic form (Zn^{++}) is an essential component of nearly 100 enzymes. A few among them are NAD^+ and $NADP^+$ linked dehydrogenases, alcohol dehydrogenases, DNA and RNA polymerases, carbonic anhydrase and peptidase. Several DNA- binding motifs have been described, one among them Zinc finger. In Zinc finger, about 30 amino acid residues form an elongated loop held together at the base by a single Zn^{++} ion which lends stability to DNA molecule

Thippeshappa *et al.* (2005) revealed that among different organic wastes, pongamia leaves blended with biogas spent recorded significantly higher available nitrogen content of 0.913 per cent. He observed that that composting of sericulture wastes treated with biogas-spent slurry decomposed very fast in soil and showed significantly higher amount of available P (0.104%) and 0.216 ppm of available K and significantly higher amount of available Cu (0.73 ppm), Mn (7.26 ppm) and Zn (1.33 ppm).

Nandani (2006) observed higher available N after harvest of tomato in plots receiving organic amendments. Zhongqi *et al.* (2006) reported that single application of manure impacted soil bio-available P in a manner similar to fertiliser but did not significantly impact soil P properties and environment. Mineralogical characters of soil, nature of weathering and various physico-chemical reactions that are occurring in soil influence the status of soil K and its availability to the plant. The availability of K in soil is also influenced by the various sources of organic manures.

Suma (2007) observed higher available N after harvest of hyacinth beans in plots receiving organic amendments.

2.3.1 Organic farming in relation to soil biological properties

The beneficial soil biochemical reactions mediated by enzymes are associated with soil microbes. Favourable influences on their activities by addition of organics are documented by many workers.

Cooke (1982) opined that excessive use of chemical fertilizers and practices in agriculture has received serve criticism from the environmentally conscious people who opined the increase in agricultural production was achieved at the cost of soil health.

Conversion of organic substances by mixed population of microorganisms with time was studied by Gaur (1982). He observed that various groups of microorganisms such as bacteria, fungi and actinomycetes got established performing a special role in the process. Macro and micronutrients were also found to increase during the process of composting due to volume reduction and due to loss of organic as CO_2 .

Kamalesh *et al.* (1991) reported that continuous application of FYM increased the total microbial biomass in the soil. They also reported that the activity of soil dehydrogenase activity was increased with FYM treatment than the other treatments.

Serra-Wittling *et al.* (1995) observed good soil enzymatic response to addition of compost prepared from municipal solid waste. Similarly vermi compost from biological sludge was incorporated into clay soil and soil biochemical activity was assessed (Masciandaro *et al.*, 1997) which stimulated the activity of dehydrogenase, protease and phosphatase.

The application of vermicompost to tomato and pepper @ 4.5 tones per hectare increased the soil bacteria, fungi and actinomycetes (Gunadi *et al.*, 1999). The activity of dehydrogenase, protease, cellulase, amylase and urease showed significant increase over control.

Masciandaro *et al.* (2000) reported that the application of vermicompost to soil significantly increased the soil microbial population. They reported that the addition of vermicompost caused an increase in dehydrogenase activity.

The presence of naturally occurring, beneficial, effective micro organisms (EMO's), in panchagavya predominantly, lactic acid bacteria, yeast, actinomycetes, photosynthetic bacteria and certain fungi besides beneficial and proven fertilizers such as *Azetobacter*, *Azospirillum* and *Phosphobacterium* were detected which have the beneficial effect especially in improving soil quality, growth and yield of crops (Xu and Xu, 2000).

Improvement in soil biological properties (dehydrogenase activity, total fungi, total actinomycetes and total bacteria count) in tomato and hyacinth bean crops that received organic amendments with or without inorganic fertilisers were recorded by Chithesh (2005), Nandani (2006) and Suma (2007).

2.4 Effect of organic and biological sources of nutrients on pest and diseases management on crops

Increased head weight, reduced compactness and increased incidence of black rot in cabbage was observed by Silva (1986) in his studies on combined effect of ammonium sulphate and farm yard manure.

Marz (1989) reported that for the control of diamond back moth on cabbage, higher concentrated neem suspensions can be used as economic substitute for deltamethrin.

Garcia (1991) recommended *Bacillus thuringiensis* sub sp. *kurstaki* at one kg per hectare as the best control for the larvae of *Plutella xylostella* with no adverse effect.

Gunjal (1991) observed that more comprehensive and analytical approach based on large volume of on farm trials are essential to examine the comparative feasibility of organic farming versus modern farming can not be ignored. The environmental degradation due to faulty agricultural practices has made several experts to focus their attention on ecologically sound, viable and sustainable farming system. There has been a series of scientific and policy conferences on this issue (Venkataraman, 1991) for developing such a system that will help to overcome the problem of soil erosion and environmental pollution through organic farming which aims at cooperating rather the confronting with nature.

Nagaraj (1991) substituted N: P: K with compost from cow dung, grass and dry leaves, cow and ox urine which served as a good source of growth promoters for the control of insect and diseases. Spraying of 10 per cent cow urine (1:10 dilution) once in 15 days helped to fetch 680 kg of paddy per hectare.

Srinivasan and Krishnamoorthy (1991) suggested the use of Indian mustard as a trap crop for the management of major lepidopterous pest on cabbage.

Tangaswami (1991) reported that organic farming yields were comparable to conventional agriculture. It improved the soil health and crops grown with rich organic manure resisted pest and disease attack. He opined that it is an ecologically sound and sustainable way of growing more food.

Bhaskar and Ashok (1993) who shifted to natural farming because modern agriculture practices have made important observations and pointed out following defects in the conventional practices in agriculture. They are (i) dependence on external input to a great extent (ii) killing of all types of insects due to chemical spray (iii) lesser gross profits (iv) reduction in soil fertility due to use of chemical fertilizers and (v) low cost : benefit ratio.

Budhathoki (1993) reported that application of cattle urine is a traditional practice used by farmers in Nepal to manure vegetable crops in the form of top dressing. The diluted solution (1:1) animal urine (preferably 7-10 day old) was applied at the rate of 50 ml per plant. This practice when verified at Lumle Regional Agricultural Research Centre, Nepal was found to be as good as application of urea or ammonium sulphate. Similarly, diluted urine when sprayed on plants, controlled diseases and was also very effective in controlling powdery mildew on broad leaf mustard.

Pawar and Lawande (1995) reported that planting of mustard in cabbage lowered the incidence of diamond back moth on cabbage crop and recorded 75 per cent higher yield of marketable heads than the untreated ones.

Rabindra *et al.* (1995) found that *Bacillus thuringiensis* was equally effective in checking the population of *Plutella xylostella* as compared with the chemical insecticides.

Morallo *et al.* (1996) reported that the cabbage yield increase in IPM managed field (*Bacillus thuringiensis* sub sp. *aizawai*) was 48 per cent greater than in the farmers control practice (weekly spraying of fenvalerate) and 123 per cent greater than in the untreated control.

Rai and Satpathy (1996) reported that 12 rows of cabbage intercropped with mustard proved useful for the successful management of diamond back moth in cabbage.

Sannaveerappanavar and Viraktamath (1997a) reported that neem seed kernel extract (NSKE) at 2-4 per cent was highly detrimental to the third and fourth instar larvae of *Plutella xylostella* causing complete mortality within 5 to 11 days.

Sannaveerappanavar and Viraktamath (1997b) reported that conventional insecticides are not effective against DBM because of development of resistance to these compounds, whereas the new insecticides, such as *Bacillus thuringiensis* products and the NSKE were highly effective.

Facknath (1999) reported that the joint effect of neem extract and intercropping was more efficient in protecting cabbages in the field.

Moorthy and Kumar (2000) used 4 per cent neem seed kernel extract (NSKE) for managing insecticide resistant diamond back moth. As an alternative to this, NSKE (4%) was evaluated in field trials in Karnataka, India, in October-December 1996 and was found to be effective against diamond back moth, *Plutellaxylostella* and leaf webber, *Crocidolomiabinotalis*.

Mixture of extracts from Pongamia (10%), aloe (5%), NSKE (10%) and cow urine (30%) recorded highest antifeedant activity with 75.57 and 68.63 per cent reduction in larval weight of *S. litura* and *H. armigera* respectively (Barapatre, 2001).

Biju (2001) reported that the total reliance on insecticides, for insect pest control in most of the developing countries has resulted in certain ecological and economic imbalance with grave consequences to crop production, human health and environmental quality. It has become a common practice among the farmers to increase the application of insecticides, if the desired control of a target pest is not achieved. When the control becomes still inadequate, they switch over to another insecticide. This leads to resurgence of target pests. The widespread development of these manmade or entomogenic pest outbreaks is one of the most serious indictments of our present day pest control technology.

Gopalkrishnan (2001) reported that five applications of *Bacillus thuringiensis* formulation @ one kg per hectare right from primordium initiation effectively controlled the larval population of *Plutella xylostella* L. and increased the yield of cabbage as compared to untreated control.

Rajareddy and Krishanmohan (2001) reported that application of *Azadirachtin* (Fortune Aza) at all the concentrations effectively controlled larval population of diamond back moth as compared to control and most pronounced effect was observed at 10 ml per litre in cabbage.

Rameshwar *et al.* (2009) conducted an experiment at the College of Agriculture, CSK Himachal Pradesh Krishi Vishwavidyalaya, Palampur on the 'Impact of Integrated organic crop management on productivity of medicinal plant based system'. The objective of experiment was to study the effect of organic nutrients on crop productivity and soil health and effect of integrated organic management on weed dynamics, insect, pest and diseases. The indicator crop used for this experiment was Lemon grass, Wild Marigold and Aloe-Vera. The land selected for this experiment was barren and abandoned for long period and was ideal for conducting trials on organic farming. Before laying out the field experiment, the initial status of soil was assessed chemically. It was found that soil was acidic, medium in organic carbon and available nitrogen, low in phosphorous and high in potassium. Various treatments with organic manures, vermicompost, bio-pesticides, homa bhasm, *Bacillus thuringiensis* Himbio, Biodynamic 500 and their combinations were exposed. Homa bhasm was reported to be superior over organic treatments.

2.5 Homa organic farming research

The literature on the effect of homa organic inputs on cabbage is next to nil. Hence effect of homa organic farming (HOF) on other crops is presented here.

Bhujbal (1981) conducted some experiments on germination of grape seeds and cuttings in Agnihotra homa atmosphere. Despite the use of modern technology like use of hormones, scarification, stratification *etc.*, germination of grape vines was very low (only 20%) and took as much as 300 days to sprout. With these lacunae in mind, seeds of popular varieties like Anab-e-shahi, Kali sahebi, local Vinefra and some crossed seeds were chosen by him for study. These seeds were kept in Agnihotra homa environment and were also treated with Agnihotra homa ash. First sprouting took place only after 21 days after sowing (DAS) as against control taking six month or more. Besides this, 100 per cent rooting in Agnihotra homa ash treated cuttings was observed as compared to only 80 per cent rooting in control without Agnihotra homa ash treatment. The loss at harvest was nil, the crop was disease free and the colour was golden yellow with quality TSS of 24 per cent in Agnihotra homa ash treated cuttings as compared to 30 per cent loss at harvest and yellow green colour in the control group. He also observed that Agnihotra homa atmosphere helps in raisin making from grapes. Drying of bunches in Agnihotra homa atmosphere was complete in 21 days and good taste was developed in 35 days.

Bhujbal (1982) studied spoilage of food grains due to pest. Chemical pesticide, BHC (1%) and Agnihotra homa ash (1%) were found to be effective when these grains were observed for 90 days. However, housewives rejected BHC due to offensive smell.

Mishra (1982a) studied effect of Agnihotra homa ash on Varuna variety (mustard) seeds. During the study, seeds were treated with fresh cow dung and cow urine and Agnihotra homa ash for 24 h before sowing and equal quantity was kept untreated as control. The experiment consisted of four treatments-(i) seed treatment with dusting of Agnihotra homa ash on standing crop at an interval of 15 days (ii) seed treatment without dusting of Agnihotra homa ash, (iii) no seed treatment but dusting of Agnihotra homa ash and (iv). no seed treatment and no dusting of Agnihotra homa ash. Agnihotra homa ash treated seeds with dusting of ash gave 30 per cent higher yield.

Mishra (1982b) studied the effect of Agnihotra homa on grain preservation in mustard crop and reported that there was reduction in infection from *Alternaria* blight while experimenting with Agnihotra homa ash.

Mondkar (1982) studied the effect of Agnihotra homa atmosphere on aerial micro flora. Agar Petri plates were kept away from Agnihotra pot, distances varying from 5'8" to 7'6". After exposure to Agnihotra atmosphere for 2 h microbial count was recorded. Bacterial colonies of *Staphylococcus albus*, *Bacillus subtilis*, *Escherichia coli*, *Enterococci*, *Streptococcus pyogenens* and *Diplococcus pneumonia* grown before Agnihotra homa showed a definite reduction in colony count in 30-60 min.

Davis (1983) observed that Gypsy Moth infestation was defoliating large area of forest. In an experiment conducted on chosen site in Cecil county of Maryland (USA), he observed that Agnihotra homa ash served as an adjunct, whereas only chemical spraying did not control the pest in that area.

Fernandes (1985) did 'Homa farming' in Chile, South America on fruit plants such as tangerins, oranges, lemons, grape fruits, peaches, pears, apricots, apples, almonds, plums, figs, avocados *etc.* and experienced beneficial effect on fruit yield even when they were only one year old. Fernandes also found that with the use of Agnihotra homa ash, height of Lima-beans reached 1.6 meter as against 0.8 meter commonly found in that area and the yield improved abundantly. He further reported in case of Canadeal Barba Negra variety of wheat that seeds were planted very close to the place where daily Agnihotra was performed but no ash was used. The wheat received only smoke from Agnihotra fire which enabled the wheat to grow very high and yield was found to be doubled.

Medina (1985) observed the following effects of 'Homa therapy' techniques: Size of Zucchini (a kind of vegetable), increased to as large as 40 cm in length and 15 cm in diameter. The vegetable changed genetically in a positive way and the flavour too was better than before. In the previous year, there was 'Grapholita' kind of insect infection on the Pear fruits. Following year with the use of 'Homa therapy' technique, beautiful big size fruits were grown. The taste was superb and yield was great. Termites on grapes were found. Phosphorus with insecticides killed only adult termites but larvae continued burrowing in to the plants. When Agnihotra ash solution was used for disinfection, termites disappeared totally.

Mishra (1987) conducted experiments on germination, yield per plant, pest control *etc.* in cereal crops. He observed that in cultivation of wheat crop, Agnihotra homa farming gave better yield as compared to traditional method. Germination was found to be 95 per cent in Agnihotra Homa farming as compared to traditional farming, whereas in control it was only 80 per cent. More number of tillers per plant was also recorded in Agnihotra Homa farming as compared to traditional farming and control.

Tung Ming (1987) reported that Agnihotra homa ash (0.02 g ash/g soil) when mixed with soil increased the soluble phosphates. 0.02 g of Agnihotra homa ash was shaken with 25 ml of water for 48 h and water soluble phosphates measured. The same amount of Agnihotra homa ash was mixed with 5 g each of Weld loam and Red Feather Loamy sandy soils, 25 ml of water was mixed and shaken for 48 h and measured for water soluble phosphates. It was found that phosphates increased from 4.2 to 17.2 μg per g of soil in Weld loam soil and from 2.3 to 11.5 μg per g of soil in Red Feather Loamy Sandy soil, clearly establishing the role of Agnihotra ash in trapping water soluble phosphates in soils.

Fukuoka (1988) of Japan, popularly known as father of natural farming, opined that organic farming is the only answer to bring sustainability in agriculture in future.

Flanagan (1989) provided physical explanation of de-polluting effect of Agnihotra. He stated that colloidal molecule of cow ghee and cow manure could chelatingly attract and grab pollutants in the air, the way water is purified by being flocculated. The seized molecule settled on the ground and makes the soil alkaline and when come in contact with plant, stuck to leaves, acted as time-released foliar nutrient. Because of ghee and manure, smoke was electrically charged.

Potdar (1992) reported scientific values of the ingredients used in Agnihotra in a book edited by him in Hindi - 'Agnihotra - Oushadhi nirman tatha chikitsa'. The values were reported for uncooked rice, rice ash, fresh cow dung, cow's ghee and Agnihotra homa ash. In the rice ash, K was reported to be 21.37 per cent and 53.68 per cent phosphoric acid. The Agnihotra homa ash was reported to possess 97 per cent P_2O_5 and smoke from Agnihotra homa was reported to contain substances like formaldehyde, ethylene oxide, propylene oxide and β -propiolactone.

Bizberg (2009) reported excellent homa farming results from Tara Mountains in the hilly region of Poland. He reported that the overall acidity of the soils in Poland was very high (pH 4.85) and worst was his garden soil with pH 4.4. It was impossible to grow anything in such acidic soil conditions, except for acid-loving fruits like berries and pine trees, which grew dominantly in that region. Due to pine forests, the soil was acidic. The soil in the region was also rock hard with high clay content, making it extremely difficult to farm normally. He started performing Agnihotra in 1996 daily and a couple of years later started Om Tryambakam homa for two hours daily. Ploughing was very shallow, about 5-10 cm deep due to sticky and hard condition of the clay in his farm house. Later he added truck load of compost over an area of 2500 m^2 . In spite of adding only small amount of compost, everything grew well in the first year-cucumbers, tomatoes, lettuce, capsicum *etc.* Each following year he grew more varieties of vegetables and expanded his garden to 5000 m^2 . He also increased the Om Tryambakam homa period to four hours per day. He used Agnihotra homa ash mixed in the compost, soil and water and used Agnihotra homa ash for transplanting and seeding as well.

Bizberg's farm was not free from weeds and cabbage white butterfly larvae. He solved the problem by attracting nature's predators-frogs, lizards, ladybugs, dragonflies, beetles, birds *etc.* Within a few years, nature began to bring itself in to balance. He also used fermented liquid manure from fresh cow dung and Agnihotra homa ash for fertilizing the plants. All the vegetables, herbs and fruits produced excellent harvests free of all diseases. A study was conducted by the Agricultural Centre, Krakow, Poland to find out what was exactly missing in the soil of his farm. It turned out to be low lime content in the farm soil. About 1- 4.5 t ha^{-1} of lime was recommended for different patches of soils. Dried cow dung powder and Agnihotra ash was also added. At present he is growing every kind of disease free vegetables and grains under the sun.

Garcia (2009) from Caracas, Venezuela reported that black Sigatoka (*Mycosphaerella fijiensis*) and fungal disease appeared in Fiji and has since then become a Global threat to bananas. It causes brown wounds on leaves and premature fruit ripening. The disease cuts fruit yield by 50-70 per cent and reduces the productive life from 30 years to as little as 2-3 years. The central idea of 'Homa therapy' is that you heal the atmosphere and the healed atmosphere heals you (Paranjpe, 1989). The truth of this central idea was tested in Peru. Within four months of practicing Homa farming, Yellow Sigatoka (*Mycosphaerella Musicola*), Black Sigatoka, Panama disease and nematodes were eradicated.

The observations made by Rosa Cortez Morales from The Republic of Peru have been reported by Garcia (2009). A fifth generation of 'Seda' plantation with 90 per cent Panama disease infestation was observed by Morales for four months after application of Homa therapy. Plants were found to be very healthy and gave over 200 fruits per bunch.

She further reported that Plantain 'Isla' with 87 per cent Black and Yellow Sigatoka, 70 per cent fungi *Fusarium* and 40 per cent mucus *Pseudomonas solanace* with 6-7 off-springs with minimum production and small bunches with productive cycle of 8 ½ months was turned in to a uniformly rejuvenated banana and plantain plantation. Bunches were much bigger and heavy with an average of 120 bananas per bunch. It had 17-20 productive off-springs with a productive cycle of only six months. These observations gave a boost to the Homa therapists in smaller states in South America.

Johnson (2009) reported promising results in cotton from 'Tapovan' in Maharashtra. A fungal weed disease locally known as Lalya seems to attack only varieties of *Bt* cotton. Lalya causes an initial reddening of leaves, then the whole plant turns red and after a few days it completely dries up and dies. Fifty per cent farms surrounding 'Tapovan' showed signs of Lalya wilt. Some farmers removed the cotton crop and prepared their land for the next crop which resulted in massive economic loss to the farmers who were already in serious financial trouble. At 'Tapovan', a non-*Bt* American hybrid, Ankur 651 was tried which was smaller in height than the *Bt* varieties but had comparable boll count with the *Bt* varieties. *Bt* plants are normally much bigger in size, but do not necessarily translate in to more bolls per plant. About 80-90 bolls per plant were obtained at 'Tapovan' as against 50-60 bolls per plant reported by other farmers. He attributed this beneficial effect to HOF technology and use of Biosol bio-fertilizer. He reported that chemical *Bt* cotton registered 66 per cent profit, whereas homa cotton raised at 'Tapovan' per acre registered 149 per cent profit.

Heschl (2009) conducted an experiment on soybean crop in cooperation with Prestige Feed Mills, Indore, Madhya Pradesh for the entire season practicing Homa Organic farming (HOF) by performing Agnihotra and Om Tryambakam Homas and observed that while using agro-chemicals the soybean yield from the Prestige Farm in the year 2000 was 350 kg per ha but using HOF technique, the yield in the subsequent year went up to 1800 kg per ha. The yield in conventional agro-chemical farming was 1120 kg per ha. Other farms in the neighbourhood averaged 700 to 800 kg per ha. Nearest best result was 1200 kg per ha who had not performed homa. Beans from the Prestige Farm were of superior colour and roots of the plants bore twice the number of nitrogen fixing nodules when compared with the neighbouring farms. Profit in conventional agro-chemical farming was Rs.4,720 per ha (96.7%), whereas profit in HOF was Rs.10,702 per ha (232.8 %). It was concluded from the experiment that HOF in soybean had less cost of production, greater yield per hectare (usually >50 %) and better economy.

She further reported the efficacy of Agnihotra homa ash in reducing the radioactivity in milk and fodder samples which were affected by Chernobyl nuclear accident in 1986. When the Chernobyl nuclear accident took place, she was a homa volunteer and had a farm near Graz in Austria. Immediately after the accident, the Austrian Government had issued instructions that every farmer had to submit milk and fodder samples for detection of radio activity. The health inspectors were shocked to find normal radioactivity in the fodder and milk samples of her farm. She attributed this effect to daily performance of Agnihotra homa.

Hernandez and Macan (2009), the Directors of AGROHOMA, PIURA, PERU reported that the first HOF results made by the Governmental institutions of the Republic Peru in South America were released more than 10 years ago. It is officially documented that Sigatoka Negra (Black Sigatoka) was eradicated in areas where HOF Resonant Points were established.

Sigatoka Negra is a very resistant fungal disease in bananas and plantains that affects all Central and South American countries and continues its spread worldwide and now has reached India. They summarized that over the years many farmers in South America have experienced the astonishing results of Homa farming and they believe that this is the only holistic way to prosperity in agriculture and personal health which includes physical and mental health and protect, nurture and support our planet at the same time.

Mutalikdesai (2009), a chemical engineer turned in to progressive farmer due to Homa Organic Farming (HOF) has a success story to narrate from 1989 to 2009. He has 45 acres of land in the Sutagatti village of Belgaum district of Karnataka where for the past 30 years chemical farming was followed by the elders in his family. In 30 acres, they could grow 2000 tons of sugarcane and from 15 acres, 400 bags of paddy. In 1974 they faced deforestation, decreased rainfall and water scarcity in summer. Higher use of chemicals resulted in degradation of soil affecting soil health and life of the diverse flora and fauna. Mismanagement of the soil resulted in erosion of top soil, lower crop response and reduced productivity against higher chemicals and energy inputs, water and labour needs. The soil was drying and chemical farming became a painful experience by 1989, when sugarcane production reached the record low of 14 t ha⁻¹. Reduced usages of chemicals increased the soil fertility and mulching created a favourable microclimate. By 1995, the whole farm was covered with abundant vermicast indicating peak activity of earthworms due to maintenance of soil moisture for longer period in summer to get 1200 tons of sugarcane from 25 acres (48 t/ha).

In 1989, at the expense of 1000 kg per acre of chemical NPK with 900 gallons of water for flood irrigation using 50 HP tractors, Mutalikdesai could get 14 MT per acre yield of sugarcane variety CO-740. Since 1990 he had started following HOF and was growing organic vanilla, coffee, pepper, soap nut, teak, vegetables, cereals, pulses and oil seeds in 15 acres of his farm land. Between 1990-95 with the same sugarcane variety using 240 gallons of water per minute of sprinkler irrigation and nearly half the dose of NPK, he could get a yield of 25-50 MT per acre. Mutalikdesai had used a 50 HP tractor for field operations from 1989 to 1999. In the year 1999, he completely switched over to HOF. During 1999-2009 he used sugarcane varieties, CO 89014 and CO 94012 with 240 gallons of water per minute using sprinkler irrigation. Without using any chemicals and only with the help of one pair of bullocks and 10 HP power tiller he could get 40-45 MT of sugarcane per acre. The use of electric power came down from 30 HP for 24 h to 20 HP for six hours while working with HOF technique. He was recognised as Krishi Pandit by the Government of Karnataka in the year 2006 for his achievements in agriculture through HOF technique.

Mutalikdesai (2009) further reports that he had highest vanillin content in processed vanilla beans (2.91%) in the year 2000 in India and highest vanillin content i.e. 36 per cent in CO-2 vanilla oil in 2004 as against 27-28 per cent vanillin content reported in International commercial oils. He further reports that woolly aphid attack on sugarcane was controlled in his farm by natural predators like *Dipha aphidivora* and *Micromus igorotus*. His farm has an important distinction in having maximum activity of red millipede which produces millipede compost which has not been observed in any of the organic farms in India.

Naik (2009) experimented with HOF technique on sericulture crops in his green house since 1996 and reported that the mulberry crop which suffered due to disease gradually improved. Leaf quality and size of leaf improved tremendously which reflected positively on yield per acre. He got 80 kg per 100 disease free layings which was 30 per cent higher than the State's average and 20 per cent higher than the productivity by any good sericulturist. He also observed that number of earthworms in his farm increased and herds of millipede were also found.

Agnihotra is the main focus under University PG program of Environmental Sciences at CSK Himachal Pradesh Agricultural University, Palampur. This research program was undertaken under a Govt. of India sponsored ICAR project "Niche Area of Excellence in Organic Farming in Hill Agriculture-CSKHPKV, Palampur-Himachal Pradesh". Rameshwar *et al.* (2009) of the same university conducted an experiment at the College of Agriculture, Palampur on the 'Impact of Integrated organic crop management on productivity of medicinal plant based system'. The objective of the experiment was to study the effect of organic nutrients on crop productivity and soil health and effect of integrated organic management on weed dynamics, insect, pest and diseases. The indicator crops used for this experiment were

Lemon grass, Wild Marigold and Aloe-Vera. The land selected for the experiment was barren and abandoned for long period and was ideal for conducting trials on organic farming. Before laying out the field experiment, the initial chemical status of soil was assessed. It was found that soil was acidic, medium in organic carbon and available nitrogen, low in phosphorus and high in potassium. Various treatments with organic manures, vermicompost, bio-pesticides, Homa bhasm, *Bacillus thuringiensis* Himbio, Biodynamic 500 and their combinations were tried. The Homa bhasm was reported to be superior over organic treatments.

Ringma and Ringma (2009), the Directors of Homa Therapy Association of Australia have been developing and managing the Om Shri Dham Homa Farm in the Hunter Valley, NSW, Australia from 1994. They are working under the umbrella of Fivefold Path Mission, Dhule, Maharashtra, India. They reported about a bio-assay carried out by them to study the effect of Agnihotra homa ash on the biotic life. The effluent for the study was collected from a textile process industry. Different dilutions of effluent were prepared. Agnihotra homa ash dose was given and fish were kept under observation for 48 h. biotic life was tested in concentrations of 15 per cent effluent with 0.5 g l⁻¹ of Homa ash and 20 per cent effluent with 2 g homa ash per liter. Biotic life was absent in 20 per cent effluent with 0.5 g l⁻¹ homa ash and 15 per cent effluent with no homa ash.

A water diviner turned up to their farm and told that there were no underground streams in their farm. They, however, drilled up to 40 meters (130 feet) and found sub-artesian water which was highly alkaline (pH 9.5) and saline (1150 ppm). They saw an opportunity to see what Homa therapy could do to improve the water quality. They did Agnihotra homa by the bore and regularly placed filtered Agnihotra homa ash water down the bore well. The State Department of Water Resources was conducting regular tests on the bores in their neighbourhood and they notified that the salinity and alkalinity dropped with each laboratory report until after about six months they had stable, potable drinking water (pH 7.2 and salinity 720 ppm). It was noticed that the standing water level of the bore had never changed since beginning at 16.5 meters throughout periods of drought and intense rain. Their results indicate that 'Homa therapy' brings balance in nature.

Selvaraj *et al.* (2009) of Tamil Nadu Agricultural University, Coimbatore has been studying the effect of Agnihotra homa on vegetables, fruits and flowers at Ooty. He mixed 200 g of Agnihotra homa ash in 1 liter of cow urine, kept for fermentation for 25 days, 10 liters diluted in water and sprayed on the crop once in 15 days. His observations are summarized below:

In Rose cultivar Passion, organic and Agnihotra homa ash treatment showed 8.5 per cent increase in flower yield, 34 per cent reduction in the incidence of powdery mildew and 14 per cent extension in shelf life of rose over organic treatment. In Carnation variety Chipro, Agnihotra homa ash treatments registered increase by 13 per cent in yield, 20 per cent reduction in the incidence Leaf spot, 32 per cent decrease in the incidence of *Fusarium* wilt and 7.0 per cent increase in shelf life over organic treatment. In Gerbera variety Ruby Red, organic and Agnihotra homa ash treatment registered 11 per cent increase in the yield of flowers, 44 per cent reduction in the incidence of Leaf spot, 63 per cent reduction in the incidence of *Fusarium* wilt and 23 per cent increase in the shelf life over organic treatment. In Questo variety of cabbage, Agnihotra homa ash treatment registered 8 per cent increase in yield and 40 per cent reduction in the incidence of Leaf spot disease over organic treatment. In potato cultivar Kufri Jyoti, Agnihotra homa ash treatment registered increase by 14 per cent and reduction in the incidence of Late blight by 75 per cent over organic treatment establishing thereby that Agnihotra homa treatments score over organic treatments and homa technique works better in combination with organic farming techniques.

Shendye (2009) studied the mode of energy transfer during Agnihotra using scientific energy detection techniques like Poly-contrast interference photography (PIP), Electro sound meter, Resonant frequency imaging, Gas discharge volume and Electro-interstitial scanning. He postulated that Far Infra Red (FIR) is the bio-energy produced by fire from Agnihotra and observed that Agnihotra homa generates useful energy which is transferred to all the surroundings. FIR is specifically produced by all the transition elements including copper. He further postulated that FIR is more specifically produced when the transition elements are heated to their oxides. The Agnihotra semi-pyramid absorbs energy from the sun and produces copper oxides during the performance of Agnihotra.

The specific FIR is known to kill microbes and inhibit growth of cancer cells i.e. negative energy, pastes and diseases. Agnihotra semi-pyramid retains positive life-energy for several hours after Agnihotra homa is performed. Next cycle of Agnihotra after about 12 h recharges the pot. Agnihotra homa ash also has specific positive bio-energy which works in similar way.

Kumari Namrata (2010) during *kharif* 2009 studied the biochemical efficacy of HOF in soybean crop (Var. JS-335) at UAS, Dharwad. The conventional control and control without homa were maintained almost 1 km away from the homa site. All the seeds used in homa treatments received fresh cow dung and cow urine as basal treatment. Agnihotra homa was performed at sun rise and sun set and Om Tryambakam homa was performed for 3-4 h daily throughout the experimental period which yielded smoke and ash. The homa ash was used for the seed treatment and for furrow application. Agnihotra homa ash (ASH) as seed treatment with Biosol as soil application was significantly superior over control in case of DMA in stem, total biomass per plant, nodule count and nodule dry weight wherein homa ash as furrow application and biosol as soil application increased in nodule count by 5-100 per cent over control exposed to homa atmosphere and 46-180 per cent over control without homa. The status of macro and micro nutrients in the soil was higher in case of furrow application of homa ashes as well as soil application of Biosol, a bio-digester in combination with both the ashes as compared to control. Soil Zn content at harvest stage increased by 3-151 per cent with homa ash and soil and foliar application of Biosol applied at 30, 45 and 60 DAS as compared with organic control exposed to homa atmosphere. The soil dehydrogenase activity increased by 50-430 per cent over control exposed to homa atmosphere and by 7-278 per cent due to conventional practices as compared to different homa treatments including Biosol treatment. Increase in total protein content (0-4%) and oil content (2-9%) due to different homa treatments including Biosol treatment and decrease in the incidence of rust (30%), insect attack (26%) and *Spodoptera litura* larvae per row meter (31%) due to foliar application of Biosol as compared with control exposed to homa was observed. The conventional practices without homa were found to be totally ineffective in controlling the rust and insect attacks on soybean crop. The foliar application of Biosol was superior over its soil application in controlling rust and insect attack.

Brunda (2011) studied the effect of Homa organic farming (HOF) practices on tomato (Var.DMT-2) during *kharif* 2010 at UAS, Dharwad. Homa smoke, homa ashes and Gloria Biosol, a special bio-digester, were used in the investigation. The Non-homa controls were maintained about 1 km away from the homa site. Two homas (yajnya) were conducted daily in the organically maintained field during the period of study namely, Agnihotra at sun rise and sun set and Om Tryambakam homa for 3-4 h. One month old tomato seedlings received fresh cow urine and cow dung treatment which gave overall better results with ash and Gloria biosol amendments over other homa and Non-homa treatments. Overall, Gloria Biosol gave excellent results when compared with other homa treatments.

At crop harvest stage, the tomato yield (t/ha) registered 42 per cent increase over organic control exposed to homa atmosphere due to soil and foliar application of Gloria Biosol. Soil macro nutrients registered increase (N-74%, P-10% and K-32%) as compared to organic control. Micronutrients also showed increase in their soil status (Cu-28%, Zn-28%, Mn-29% and Fe-8%) as compared to organic control exposed to homa atmosphere. Increase in the bacterial (18%), fungal (48%) and Actinomycetes (47%) population due to soil and foliar application of Gloria Biosol was registered as compared to organic control exposed to homa atmosphere.

Increase in the activities of soil dehydrogenase (52%) and phosphatase (34%); quality parameters like ascorbic acid (49%), lycopene (41%) and phenols (7%) and also 26 per cent increase in shelf life due to soil and foliar application of Gloria Biosol was noticed as compared with organic control exposed to homa atmosphere at crop harvest stage. Decrease in the incidence of leaf spot (37%) and insect attack (40%) was observed due to soil and foliar application of Gloria Biosol as compared to organic control exposed to homa atmosphere at crop harvest stage. The soil and foliar application of Gloria Biosol was more effective than its foliar application alone in improving growth and yield parameters and soil biological activity. Soil and foliar application of Agnihotra homa ash and Gloria Biosol was equally effective in increasing shelf life of the tomato fruits.

3. MATERIAL AND METHODS

A field experiment was conducted to study the response of Homa organic farming practices on growth, quality and yield of cabbage during *kharif* 2010. The information on the material used and experimental techniques adopted during the study period are presented in this chapter.

3.1 Experimental site

The experiment was conducted at C - block of Institute of Organic Farming, Main Agriculture Research Station, University of Agricultural Sciences, Dharwad. The G - block of University of Agricultural Sciences, Dharwad was selected as control which was about 1 km away from the C-block to avoid homa effect.

3.2 Soil characteristics

The experimental site had mixed Red and Black soil. The soil of the experimental and control was homogenous. Random soil samples from the experimental area were collected before and after sowing and analysed for various chemical and biological properties.

3.3 Experimental details

The field experiment was laid out in randomized block design (RBD) with 13 treatments replicated three times.

Plot size: Cabbage seedlings were planted in 45 cm × 45 cm spacing in 3.6 m × 4.0 m size plots. Net plot size was 3.0 m × 3.6 m.

Crop/Variety: Cabbage/Saint

Salient features of variety

The cabbage variety, Saint used in this study is characterized by round head, blue green colour, 1.25-1.50 kg head weight, excellent internal structure and maturity of 60-65 days with a field holding of 30 days.

RDF dose of fertilizer :120:60:60 (N:P₂O₅:K₂O kg/ha)

Date of sowing of seeds in nursery : 18.06.2010

Date of transplanting of seedlings : 21.07.2010

3.3.1 Layout of the experimental site

C - block

R-I	R-II	R-III
T ₄	T ₈	T ₂
T ₉	T ₃	T ₅
T ₆	T ₁₁	T ₈
T ₂	T ₆	T ₁₀
T ₅	T ₁	T ₃
T ₁₁	T ₇	T ₆
T ₈	T ₄	T ₁₁
T ₁	T ₁₀	T ₄
T ₇	T ₉	T ₁
T ₃	T ₅	T ₉
T ₁₀	T ₂	T ₇

G – block

T ₁₃
T ₁₂

T ₁₂
T ₁₃

T ₁₃
T ₁₂

3.3.2 Treatments

Treatment No.	Treatment details
T ₁	Organics equivalent to RDF without seedling treatment (organic control) in homa atmosphere
T ₂	No organic manures and no seedling treatment (absolute control) in homa atmosphere
T ₃	Seedling dipped in fresh cow urine and cow dung only
T ₄	Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Non-homa ash at 30 and 60 DAP
T ₅	Seedlings dipped in fresh cow urine and cow dung with foliar application of Non-homa ash at 30 and 60 DAP
T ₆	Seedlings dipped in fresh cow urine and cow dung and soil and foliar application of Agnihotra homa ash at 30 and 60 DAP
T ₇	Seedlings dipped in fresh cow urine and cow dung with foliar application of Agnihotra homa ash at 30 and 60 DAP
T ₈	Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Om Tryambakam homa ash at 30 and 60 DAP
T ₉	Seedlings dipped in fresh cow urine and cow dung with foliar application of Om Tryambakam homa ash at 30 and 60 DAP
T ₁₀	Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Gloria Biosol at 30 and 60 DAP
T ₁₁	Seedlings dipped in fresh cow urine and cow dung with foliar application of Gloria Biosol at 30 and 60 DAP
T ₁₂	Recommended package of practices (Non-homa and Non-organic site) in G-block of UAS, Dharwad (conventional control)
T ₁₃	Organics equivalent to RDF without seedling treatment at Non-homa site

Two homa products viz. smoke and ash were useful in this study. In the first treatment, vermicompost and FYM were used as soil application without seedling treatment (T₁). The treatment T₁ was given to all the plots from T₄ to T₁₁ in C- block prior to transplanting.

The second treatment was exposure of cabbage crop to only homa atmosphere without seedling treatment and organic manures (T₂).

In the third treatment (T₃), seedlings were dipped in a mixture of fresh cow dung and cow urine. This treatment was common to all the treatments from T₄ to T₁₁.

In the fourth and fifth treatments, Non-homa ash was used. It was collected from burning of agricultural waste products and stored in separate bag and used for soil and foliar application (T₄) and only foliar application (T₅).

In the sixth (T_6) and seventh (T_7) treatments, the ash collected from daily performance of Agnihotra homa at sun rise and sun set was used. It was stored separately in earthen pots and used for soil and foliar application (T_6) and foliar application alone (T_7) and for the preparation of Gloria Biosol (Appendix - I).

In the eighth and ninth treatments, ash collected from daily performance of Om Tryambakam homa for 3-4 h was used. It was stored separately in earthen pots and used for the soil and foliar application (T_8) and foliar application alone (T_9).

The 10th and 11th treatments were that of a bio-digester called Gloria Biosol. It was prepared and used for soil and foliar application (T_{10}) and foliar application alone (T_{11}).

All the treatments from T_4 to T_{11} were imposed after transplanting the seedlings. The observations taken will, therefore, be referred to as Days after planting (DAP) hereafter in this investigation.

Some special terms used in this investigation are given in Appendix-II. The control treatment without homa (T_{12}), received recommended package of practice (conventional control). The treatment T_{13} , did not receive any treatment including Farm Yard Manure (FYM) and vermicompost. These two treatments were maintained in G - block of MARS, UAS, Dharwad about 1 km away from the homa site (C - block) to avoid influence of homa on the crop.

The treatments T_{12} and T_{13} were imposed in Plot No.174 at G - block of UAS, Dharwad where no homa was performed, whereas in C - block, regular Agnihotra homa was performed at sun rise and sun set everyday during experimental period while chanting specific mantras (Appendix - III). In addition, Om Tryambakam homa, which does not have specific timings, was performed daily during experimental period for minimum 3-4 h in C-block. The ashes from both the homas were stored separately and used for different treatments. Recommended organic practices were followed for the production of cabbage during *kharif* season.

For higher coverage of the effects of these homas, a technique called resonance point technique (RPT) has been introduced in the field by Fivefold Path Mission (FFPM), Dhule, Maharashtra, India. This RPT used in 'Homa therapy' extends the zone of effectiveness of Agnihotra homa from a few feet to nearly 150-200 acres of diseased land (Johnson and Heschl, 2009) in a short time. For this purpose, 10 new semi-pyramids were charged (Plate1a) with specific mantras and placed on the C - block of organic farm in the specific configuration by 'Homa therapy' volunteer who was authorized by FFPM to install it.

For this purpose, two simple huts were built with inexpensive, natural material found in the field like wood, bricks, bamboo, stones etc. No body lived in these huts. These huts simply protected the person performing the healing fires of 'Homa therapy' from sun, rain and from stray animals.

For maintaining two plots in G - block with conventional practices (T_{12}), and organics equivalent to RDF without seedling treatment (T_{13}), the experimental site was ploughed once, harrowed twice and brought to fine tilth. The weeds were removed before sowing *Kharif* cabbage seedlings. For conventional practices, the seed treatment was given by using Thiam 75 with Carbendazin 50 wp (@ 3 g/kg seeds) to control seed borne diseases. Before transplanting, FYM (@ 10 tons/ha) and N:P:K (@ 115: 100:60 kg/ha), respectively were applied at the time of sowing as basal dose. For controlling weeds, two hand weeding were carried out with two hoeings. For controlling the fruit borer, Sevin was sprayed (@ 2 g/l) at 30 and 60 DAP twice. The leaf spot diseases were managed by spraying Mancozeb (@ 2 g/l). The Black rot and Black spot of leaf diseases were managed by spraying Captan (@ 2%) and also with neem based pesticide (@ 5 ml/l) at 45 and 60 DAP.

The Agnihotra homa was performed in a copper semi-pyramid of size 14.5 cm x 14.5 cm at the top, 5.25 cm x 5.25 cm at the bottom and 6.5 cm in height.

For the performance of Agnihotra homa, dried cow dung cakes, whole unpolished, uncooked organically grown rice grains and cow's ghee were used. Two pinch-full of whole rice grains smeared in cow's ghee were offered to the fire after chanting 'swaha' portion of every line of the Agnihotra mantra at sun rise and sun set (Plate1b).

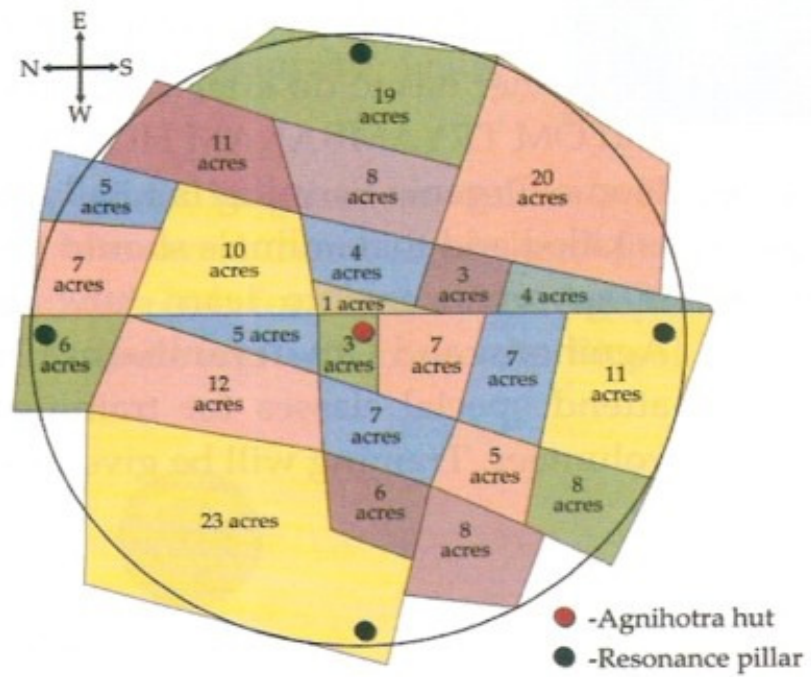


Plate 1a. Homa organic farm complex



Plate 1b. Agnihotra setup



Plate 1c. Shree Yantram of copper

The ash in the semi-pyramid was not disturbed till the performance of next Agnihotra and stored in mud pots. The semi-pyramid was neither washed nor polished during the experimental period.

The 'Homa therapy' technique utilises, in addition to performance of Agnihotra, another homa called Om Tryambakam homa which was performed for 3-4 h daily which did not have specific timings. This homa required addition of one small spoonful of cow's ghee to the fire at the end of chanting 'swaha' of the mantra every time. This homa can be performed for 24 h except at Agnihotra homa timings at sun set and sun rise. The ashes from both the homas were used for different treatments. The conventional practices were followed for the production of cabbage (T_{12}) in G-block. For furrow application, 80 g of Agnihotra and Om Tryambakam homa ash each was used for a plot size of 16.2 m² as standardised by Kumari Namrata (2010). A Shree Yantram made of copper was buried at a depth of 3'6" per acre in the cabbage field keeping its embossed face upwards before transplanting the cabbage seedlings (Plate 1c).

3.3.3 Resonance point

In the main hut or Agnihotra homa hut (Plate 2) where Agnihotra fire was performed daily at sun rise and sun set as per the time table obtained for the period of this study from a special software which works on the longitude and latitude of a particular place (Appendix-IV). It was constructed in the center of the 45 acre farm at C- block. The size of the hut was 3 m x 4 m and longer side aligned with east/west axis with an opening from the west. Near the east wall and parallel to it, a pit of 2' x 2' size was dug. All this was done in presence of the 'Homa therapy' volunteer who came to install and activate the Resonance point. Ten copper semi-pyramids were activated while chanting specific mantras of 'Purushsukta' and 'Vyahruti homa' and lighting the fire with the help of dried cow dung cakes and cow's ghee (Plate 3). One activated semi-copper pyramid was lowered at the bottom of the pit. A pillar of mud and bricks was built on the top of it to an approximate height of 36" (18" from the ground level), filled in with dry soil, smeared with a slurry of mud and cow dung and another activated semi - pyramid was placed on top of it, directly above the buried semi- pyramid.

This way, the semi-pyramid on the resonance pillar was at the heart level of the person sitting on the floor in front of the pillar and served as a resonance semi-pyramid which was not used for any homa. Two other activated semi-pyramids were placed on the smaller brick-mud platforms on the right and left hand side in front of the main resonance point (Plate 4). The one on the left was used for the performance of daily Agnihotra and the one on the right was used for the performance of other occasional fires like Vyhruti homa. In all, four semi-pyramids were placed in the Agnihotra hut. This hut was the generator and conservator of subtle healing energies. Absolute silence was maintained inside the Agnihotra hut.

3.3.4 Resonance pillar

After utilizing four charged copper semi-pyramids in the Agnihotra hut, four charged copper semi-pyramids were installed on the boundary of the farm at a maximum distance of 350 meters exactly North, South, East and West of the central point of resonance in the Agnihotra hut (Appendix - V). On each point, a column of bricks and mud was erected which was at the heart level of a person standing (about 4') and an activated semi - pyramid was placed on the top of the column. All the semi pyramids kept on the columns were covered with stone slabs and sealed with mud to maintain the semi-pyramids clean and safe (Johnson and Heschl, 2009).

3.3.5 Om Tryambakam homa hut

A little larger than the Agnihotra hut known as 'Healing hut' or 'Om Tryambakam homa hut' (Plate 5) was constructed near the entrance of the farm for healing sick plants, animals and human beings. In this healing hut, two charged semi-pyramids were placed on two small columns near the eastern wall, one on the left for performing Agnihotra homa and the other one on the right for Om Tryambakam homa. Om Tryambakam homa was performed daily for 3-4 h avoiding sun rise and sun set timings of Agnihotra.

A liquid manure, Gloria Biosol was prepared in a plastic tank (Plate 6) with two valves and was used for the soil application and foliar spray in different treatments as described by Weir (2009).



Plate 2. Outside view of Agnihotra hut



Palte 3. Charging of pyramids



Plate 4. Inside view of Agnihotra hut



Plate 5. Om Tryambakam homa hut



Plate 6. Biosol tank



Plate 7. Nursery bed of cabbage seedlings

3.4 Cultural operations

3.4.1 Nursery

The nursery area was ploughed, harrowed and soil was brought to a fine tilth. Raised seed bed of required size was prepared and the top soil was mixed well with vermicompost and Agnihotra homa ash. Later seeds were sown in the bed and watered regularly on alternate days. The four weeks old seedlings were transplanted in the main field (Plate 7).

3.4.2 Preparation main field

The experimental field was ploughed and harrowed twice to bring the soil to fine tilth. As per layout plan, the field was divided in to different plots as depicted in 3.3.1. The weeds were removed before transplanting.

3.4.3 Seed treatment and sowing

The experimental cabbage seed material (Var. Saint) was sown in two nursery beds (5.0 m × 1.0 m × 10 cm). In each nursery bed 10 kg of well decomposed FYM with 5 kg of Vermicompost was applied, mixed well in the soil. Seeds were treated with vermiwash for 2 min and dried in shade. Little amount of Agnihotra homa ash was dispersed on the bed after sowing.

3.4.4 Transplanting of seedlings and treatment

Thirty-day old seedlings were dipped in the slurry of fresh cow dung and cow urine (T_3) for 2 min and transplanted. Seedling of treatments T_1 , T_2 , T_{12} and T_{13} did not receive this treatment. The period after transplanting is referred to as days after planting (DAP) in this dissertation

3.4.5 Irrigation

The plots were irrigated uniformly depending upon the soil and climate conditions so as to maintain adequate moisture.

3.4.6 Weeding and plant protection measures

Weeding was carried out from time to time to keep the plots free from weeds. The general view of the cabbage field in Homas block (C-block) and control block (G-block) are presented in Plates 8 and 9.

3.4.7 Harvesting

Harvesting of the crop was carried out after complete maturity when the heads were firm and compact.

3.5 Scientific observations

3.5.1 Plant growth parameters

In each experimental net plot, five randomly selected plants were tagged. These were used to record the growth and yield parameters.

3.5.1.1 Plant height

The height of the randomly selected tagged plants was recorded in centimeter by measuring the height from the ground level to the terminal growing point of the shoot.

3.5.1.2 Number of outer leaves per plant

The total numbers of outer leaves were counted and average number of outer leaves per plant was calculated.

3.5.1.3 Leaf area

The maximum length and breadth of the fully expanded third outer leaf was measured and the area of individual leaf (cm^2) was calculated (Rao, 1977) by using following equation.

$$A = a B^b L^c$$

Where,

A = Leaf area (cm²) a = 0.9817

B = Breadth of leaf (cm) b = 1.1270

L = Length of leaf (cm) c = 0.7503

(a, b and c are the constant values estimated by method of least square analysis)

3.5.1.4 Dry matter production

Three randomly selected plants were uprooted from each plot at 30, 60 DAP and at crop harvest stage. Uprooted plants were washed in water, air dried and separated in to leaf, stem and head and chopped in to small pieces. They were oven dried at 65-70° C to constant weight and the dry matter produced was expressed as g per plant.

The observations for cabbage head were recorded at 60 DAP and at the harvest stage.

3.5.1.5 Number of inner leaves per cabbage head

The inner leaves of selected heads were separated individually, counted and the average was calculated.

3.5.2 Yield and yield parameters

3.5.2.1 Days taken for the initiation of the cabbage head formation

The number of days taken for the visible initiation of head formation after planting in each of the three plants was recorded and average was calculated.

3.5.2.2 Days taken for maturity of the cabbage head

The period between planting and harvesting of the heads was calculated and recorded as the days taken for maturity of heads.

3.5.2.3 Weight of the cabbage head

After removing the non-wrapper leaves and stalk, the weight of head was recorded. The average weight of five observational plants was considered as weight of head and expressed as gramme per head.

3.5.2.4 Diameter of the cabbage head

The diameter of the head (cm) was recorded at 60 DAP and at harvest. The circumference of each head was measured at widest point of head using a thread and the diameter of head was calculated (Rao, 1977) by using the following formula:

$$d = \frac{C}{\pi}$$

Where d = diameter of the head (cm)

C = Circumference of the head (cm)

π = 3.14159

3.5.2.5 Surface area of cabbage head

The surface area of head (cm²) was recorded at 60 DAP and at harvest. Surface area of head was estimated by using the following formula (Rao, 1977).

$$A = (C)^2 / \pi$$

Where A = surface area of the head (cm²)

C = circumference of the head (cm)

π = 3.14159

3.5.2.6 Yield per hectare

The total yield of cabbage in terms of tones per hectare was calculated on the basis of total yield per net plot.

3.5.3 Quality parameters

3.5.3.1 Total soluble solids

Total soluble solids were determined with the help of 'Erma' (0-32°Brix) hand refractometer and recorded in degree brix (°Brix)

3.5.3.2 Ascorbic acid content

Five grammes of fresh cabbage head was taken from a transverse section of the longitudinal axis situated just above the stalk (Sorensen, 1984) and crushed with oxalic acid (4%) and filtered through muslin cloth to get a clear solution. Ascorbic acid content was estimated by titrimetry using 2, 6-dichlorophenol indophenol dye as per the modified procedure of AOAC (Anon., 1984) and expressed as mg of ascorbic acid per 100 g on fresh weight basis.

3.5.3.3 Total free phenol content

Total free phenol content (mg/100 g) was determined as described by Singleton *et al.* (1999). To 1 ml of cabbage head extract in distilled water exactly, 1ml of Folin – Ciocalteu reagent (FCR) was added. After mixing well, 2 ml of 2 per cent sodium carbonate in 0.1 N sodium hydroxide solution was added and the samples were placed in a boiling water bath for 1 min and cooled. The final volume was made up to 10 ml with distilled water and the absorbance was measured at 650 nm in a spectrophotometer and the concentration of total free phenols was calculated using standard catechol. From the standard curve, the concentration of phenols in the test sample was found out and expressed as mg of phenols per 100 g of sample.

3.5.3.4 Plant analysis

The cabbage head samples were separately analysed for their nitrogen, phosphorus, potassium, sulphur and protein contents at different stages of growth and at harvest. Micronutrient content of cabbage head was analysed only at the harvest stage.

3.5.3.4.1 Preparation of sample

After recording fresh weights, samples were dried in an oven at $60 \pm 2^\circ\text{C}$ for 48 h and dry weight was recorded. The dried samples were powdered in a mixer- grinder and stored in air-tight containers for chemical analysis.

3.5.3.4.1 Nitrogen content

To determine the nitrogen in the cabbage head, the powdered sample was digested with 3 ml of conc. H_2SO_4 and digestion mixture containing K_2SO_4 , CuSO_4 and Selenium powder (100:20:1 w/w). After complete digestion, the contents were transferred to the distillation unit of micro Kjeldahl unit and the liberated ammonia was trapped in 2 per cent boric acid. It was titrated against standard HCl (0.05 N) to estimate the nitrogen content (Jackson, 1973).

3.5.3.4.2 Digestion of cabbage for macro and micronutrients

One gramme of powdered cabbage head sample was pre-digested with conc. HNO_3 overnight. Further digestion was carried out with 5 ml of diacid mixture ($\text{HNO}_3 + \text{HClO}_4$) until clear solution was obtained. The residue was dissolved in 6 N HCl and the volume was made up to 50 ml using distilled water. Five ml of diacid mixture served as blank (Jackson, 1973).

3.5.3.4.2.1 Phosphorus content

The phosphorus content in the digested cabbage head sample was determined by vanadomolybdophosphoric acid yellow colour method using spectrophotometer at 660 nm (Jackson, 1973).

3.5.3.4.2.2 Potassium content

The potassium content in the digested cabbage head sample was determined using flame photometer after making proper dilution (Jackson, 1973).

3.5.3.4.2.3 Sulphur content

The sulphur content (%) in the digested cabbage head sample was determined by a turbidimetric method (Chesnin and Yien, 1951) using cassia gum as stabilizing agent.

3.5.3.4.2.4 Protein content

The protein content in the cabbage head was analysed by indirect method. First, the nitrogen content of the sample was estimated by micro Kjeldahl method (Jackson, 1973). Then the nitrogen value was multiplied by a factor 6.25 to get the crude protein content of the sample and expressed in percentage.

3.5.3.4.2.5 Micronutrient content

The copper, iron, zinc and manganese content (ppm) in the digested cabbage head sample was determined after making proper dilution by atomic absorption spectrophotometry (Jackson, 1973).

3.6 Soil analysis

3.6.1 Available N, P, K, and micronutrient content in soil

3.6.1.2 Collection and preparation of soil sample

The soil samples were collected from the field and brought to the laboratory in polythene bags. The soil samples were dried under shade, pounded with wooden pestle and mortar and passed through 2 mm sieve for the analysis of available N, P, and K and for micronutrients (Cu, Zn, Fe and Mn). Soil samples were again pounded in an agate mortar and passed through 0.5 mm sieve and preserved in polythene bags for further analysis.

3.6.1.2.1 Available nitrogen

The available nitrogen (kg/ha) was estimated by micro-Kjeldahl method (Black, 1965). Soil sample (20g) was digested in conc. H_2SO_4 with a pinch of digestion mixture comprising salicylic acid, K_2SO_4 and Na_2SO_3 . The digested sample was distilled with excess of 40 per cent Sodium hydroxide and ammonia released was trapped in 2 per cent boric acid. Ammonium borate thus formed was titrated against 0.05 N HCl.

3.6.1.2.2 Available phosphorus

Available phosphorus in the soil samples (kg/ha) was extracted by ascorbic acid method (Jackson, 1973). The phosphorous content in the extract was determined colourimetrically by developing blue colour and intensity of blue colored complex was measured at 660 nm in a spectrophotometer.

3.6.1.2.3 Available potassium

Available potassium (kg/ha) was determined by extracting the soil sample with neutral ammonium acetate solution and estimated by using flame photometer as outlined by Jackson (1973).

3.6.1.2.4 Micronutrient content of soil

Micronutrients zinc, iron, copper and manganese (mg/kg) were extracted from the soil samples in 0.5 N DTPA (Diethyl triamine penta acetic acid), 0.01 M CaCl_2 and 0.01 M Triethanolamine buffer at pH 7.3 and determined by using Atomic absorption spectrophotometer as described by Lindsey and Norvell (1978).

3.6.2 Microflora (bacteria, fungi and actinomycetes)

Collection of soil sample

The rhizosphere soil samples were collected from the field following standard method described by Jackson (1973). The soil samples were brought in polythene bags stored in ice buckets and stored in a cool place to maintain their physico-chemical properties for future use.

Isolation of bacteria, fungi and actinomycetes present in the rhizosphere soil was carried out by 10 fold serial dilution pour plate method. Ten grammes of soil was suspended in 90 ml of sterile distilled water and shaken on a mechanical shaker for 15 minutes. Further, 10-fold dilution series was prepared by transferring 10 ml of aliquot of soil suspension culture each time to 90 ml of sterile distilled water blanks till 10^5 dilutions was obtained. The contents of the flask were shaken between each transfer to ensure uniform suspension. One ml aliquot from desired soil dilution (10^5 for bacteria) was transferred to a sterile Petri plate and Nutrient agar medium was poured. In case of fungi and actinomycetes, one ml aliquot from desired soil dilution (10^4 and 10^3 , respectively) was transferred to separate sterile Petri plates containing specific media (Appendix- VI).

3.6.3 Collection of soil sample for enzyme assays

The rhizosphere soil that was adhering to the roots of cabbage plant was collected and was brought in polythene bags using ice buckets and analyzed immediately.

3.6.3.1 Activity of soil dehydrogenase

The activity of soil Dehydrogenase was determined following the procedure described by Casida *et al.* (1964). Five grammes of soil and 0.2 g of CaCO_3 were mixed and dispersed in test tubes. To each tube, one ml of 1 per cent aqueous solution of 2, 3, 5-triphenyl tetrazolium chloride (TTC) was added followed by distilled water, just sufficient to leave a thin film of water above the sample. The tubes were stoppered with rubber cork and incubated at 30°C for 24 h. At the end of the incubation period, the contents of the tube were rinsed with methanol and filtered in to a small beaker through Whatman No. 42 filter paper. Repeated rinsing of sample with methanol was continued till the filtrate was free of red colour. The volume of filtrate was made up to 50 ml with methanol in a volumetric flask. The intensity of red colour was measured at 485 nm against methanol blank in a spectrophotometer. The concentration of formazen formed in the soil sample was determined using graded concentration of formazen. The dehydrogenase activity was expressed as μg of Triphenyl formazen formed per g of soil sample per 24 h.

3.6.3.2 Activity of soil phosphatase

The reaction mixture comprising 1 g of soil, 0.2 ml toluene, 4 ml modified Universal buffer (pH 7.5) and 1 ml of *p*-nitrophenol phosphate (PNP) solution were mixed and incubated at 37°C for 1 h. One ml of 0.5 M CaCl_2 and 4 ml of 0.5 M NaOH were added, swirled and filtered. The intensity of yellow coloured complex was measured at 420 nm against a reagent blank. The results were expressed as amount of PNP released per g of soil sample per h (Evasi and Tabataba, 1979).

3.7 Disease incidence and insect attack

3.7.1 Head borer

At each harvesting, the numbers of damaged and healthy cabbage heads were recorded for computing heads damaged by head borer (*Hellua undalis*) from the net plot.

$$\text{Head damage (\%)} = \frac{\text{Number of heads damaged}}{\text{Total number of heads (50)}} \times 100$$

3.7.2 Diamond back moth

The number of larvae of diamond back moth (*Plutella xylostella*) in each observational plant was recorded and the average was worked out for 10 randomly selected plants from the net plot.

$$\text{Larval population} = \frac{\text{Number of larvae per plant}}{\text{Total number of plants (10)}} \times 100$$

3.7.3 Black rot on leaves

The intensity of black rot (*Xanthomonas campestris*) on leaves was calculated by counting the number of plants showing the symptoms of black rot from the net plot.

$$\% \text{ disease} = \frac{\text{Number of plants affected}}{\text{Total number of plants counted (50)}} \times 100$$

3.7.4 Black spot on leaves

The intensity of black spot (*Alternaria brassicae* (Berk)sacc.) was calculated by counting the number of plants showing symptoms of black spot on leaves from the net plot.

$$\% \text{ disease} = \frac{\text{Number of plants affected}}{\text{Total number of plants counted (50)}} \times 100$$

3.7.5 Caterpillar

Observations on larval population of *Spodoptera litura* were made on five randomly selected plants in each net plot. Larval population was counted by shaking the plant gently over a white cloth placed between the rows.

$$\text{Larval population} = \frac{\text{Number of larvae per plant}}{\text{Total number of plants (5)}} \times 100$$

3.8 Statistical analysis

The data of the experiment were analyzed statistically following the procedure described by Gomez and Gomez (1984). The level of significance used in 'F' and 't' test was $p < 0.05$. The critical difference was calculated wherever the 'F' value was found to be significant.



Plate 8. General view of cabbage field in C-block



Plate 9. General view of cabbage field in G-block

4. EXPERIMENTAL RESULTS

The results of the investigation conducted during *kharif* 2010 to study the effect of Homa organic farming (HOF) practices on growth, quality and yield of cabbage (Var. Saint) are presented in this chapter.

4.1 Horticultural observations

4.1.1 Plant height

The data on plant height (cm) are presented in Table 1 and Fig. 1. It is evident from the table that at 30 and 60 DAP and crop harvest stage, the plant height did not differ from organic control, T_1 (12.79, 19.52 and 22.85) when compared with conventional control treatment, T_{12} (12.64, 19.12 and 22.58), respectively.

The absolute control T_2 (9.96) differed significantly from treatment T_{13} (12.52) in which organics equivalent to RDF without seedling treatment were used at 30 DAP. However, the treatment T_2 at 60 DAP and crop harvest stage (16.32 and 20.45) known as absolute control, did not differ significantly from treatment T_{13} (17.60 and 22.32).

The data reveal that the treatment T_3 in which seedlings were dipped in a mixture of fresh cow dung and cow urine (11.56, 18.81 and 22.00) did not differ from the organic control treatment T_1 (12.79, 19.52 and 22.85) at 30 and 60 DAP and crop harvest stage, respectively.

The soil and foliar application of Non-homa ash, T_4 , (13.48, 21.23 and 23.84) and foliar application of Non-homa ash, T_5 (12.84, 20.23 and 23.36) did not differ significantly from T_3 (11.56, 18.81 and 22.00) and also among themselves at 30 and 60 DAP and crop harvest stage, respectively.

The soil and foliar application of Agnihotra homa ash treatment, T_6 (14.50, 24.27 and 25.45) and T_7 (14.05, 22.65 and 24.56) differed significantly from T_3 at 30, 60 DAP and crop harvest stage but did not differ significantly from each other.

The soil and foliar application of Om Tryambakam homa ash, T_8 (14.21, 23.19 and 25.38) and only foliar application of Om Tryambakam homa ash, T_9 (13.55, 21.94 and 24.20) did not differ significantly from T_3 (11.56, 18.81 and 22.00) and also from each other at 30 and 60 DAP and crop harvest stage, respectively.

At 30 and 60 DAP and harvest stage, the soil and foliar application of Gloria Biosol, T_{10} (14.91, 24.70 and 26.14) and only foliar application of Gloria Biosol, T_{11} (14.12, 22.70 and 24.92) differed significantly from T_3 , except at harvest stage, respectively. However, T_{10} did not differ significantly from T_{11} at all the stages studied.

Among the homa ash and Gloria Biosol treatments (soil and foliar), the treatments T_6 and T_8 did not differ significantly from T_1 at 30 and 60 DAP and crop harvest stage and T_{10} (Gloria Biosol) did not differ significantly from T_1 at 30 DAP. The treatment T_{10} differed significantly from T_1 at 60 DAP and harvest stage.

4.1.2 Number of outer leaves per plant in cabbage

It is evident from Table 2 and Fig. 2 that at 30 and 60 DAP and crop harvest stage, number of outer leaves per plant in cabbage did not differ significantly when T_1 , (12.22, 18.00 and 20.60) was compared with T_{12} (12.07, 17.96 and 19.92), respectively.

The treatment T_2 (9.05, 14.12, and 16.45) did not differ significantly from treatment T_{13} (11.04, 16.64 and 18.76) at 30, 60 DAP and crop harvest stage.

The treatment T_3 (15.24) did not differ significantly from T_1 (18.00) at 60 DAP. However, treatment T_3 at 30 DAP and harvest stage (10.11 and 17.60) differed significantly from T_1 (12.22 and 20.60), respectively.

The Non-homa ash treatments, T_4 (12.32 and 20.96) and T_5 (12.24 and 20.63) differed significantly from T_3 at 30 DAP and harvest stage, respectively. However, T_4 at 60 DAP (18.21) and T_5 at 60 DAP (18.05) did not differ significantly from T_3 (15.24).

Table 1. Plant height of cabbage (Var. Saint) as influenced by different treatments

Treatment details	Plant height (cm)		
	30 DAP	60 DAP	Harvest
T ₁ - Recommended dose of organics equivalent to RDF without seedling treatment (Organic control) in homa atmosphere	12.79	19.52	22.85
T ₂ - No organic manures and no seedling treatment (Absolute control) in homa atmosphere	9.96	16.32	20.45
T ₃ - Seedlings dipped in fresh cow urine and cow dung	11.56	18.81	22.00
T ₄ - Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Non-homa ash at 30 and 60 DAP	13.48	21.23	23.84
T ₅ - Seedlings dipped in fresh cow urine and cow dung with foliar application of Non- homa ash at 30 and 60 DAP	12.84	20.23	23.36
T ₆ - Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Agnihotra homa ash at 30 and 60 DAP	14.50	24.27	25.45
T ₇ - Seedlings dipped in fresh cow urine and cow dung with foliar application of Agnihotra homa ash at 30 and 60 DAP	14.05	22.65	24.56
T ₈ - Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Om Tryambakam homa ash at 30 and 60 DAP	14.21	24.19	25.38
T ₉ - Seedlings dipped in fresh cow urine and cow dung with foliar application of Om Tryambakam homa ash at 30 and 60 DAP	13.55	21.94	24.20
T ₁₀ - Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Gloria Biosol at 30 and 60 DAP	14.91	24.70	26.14
T ₁₁ - Seedlings dipped in fresh cow urine and cow dung with foliar application of Gloria Biosol at 30 and 60 DAP	14.12	22.70	24.92
T ₁₂ - Recommended package of practices (Non-homa / Non-organic) at G - block of UAS, Dharwad (Conventional control)	12.64	19.12	22.58
T ₁₃ - Organics equivalent to RDF without seedling treatment (G- block) in Non-homa atmosphere	12.52	17.60	22.32
SEm ±	0.72	1.10	1.08
CD at 5%	2.12	3.22	3.17

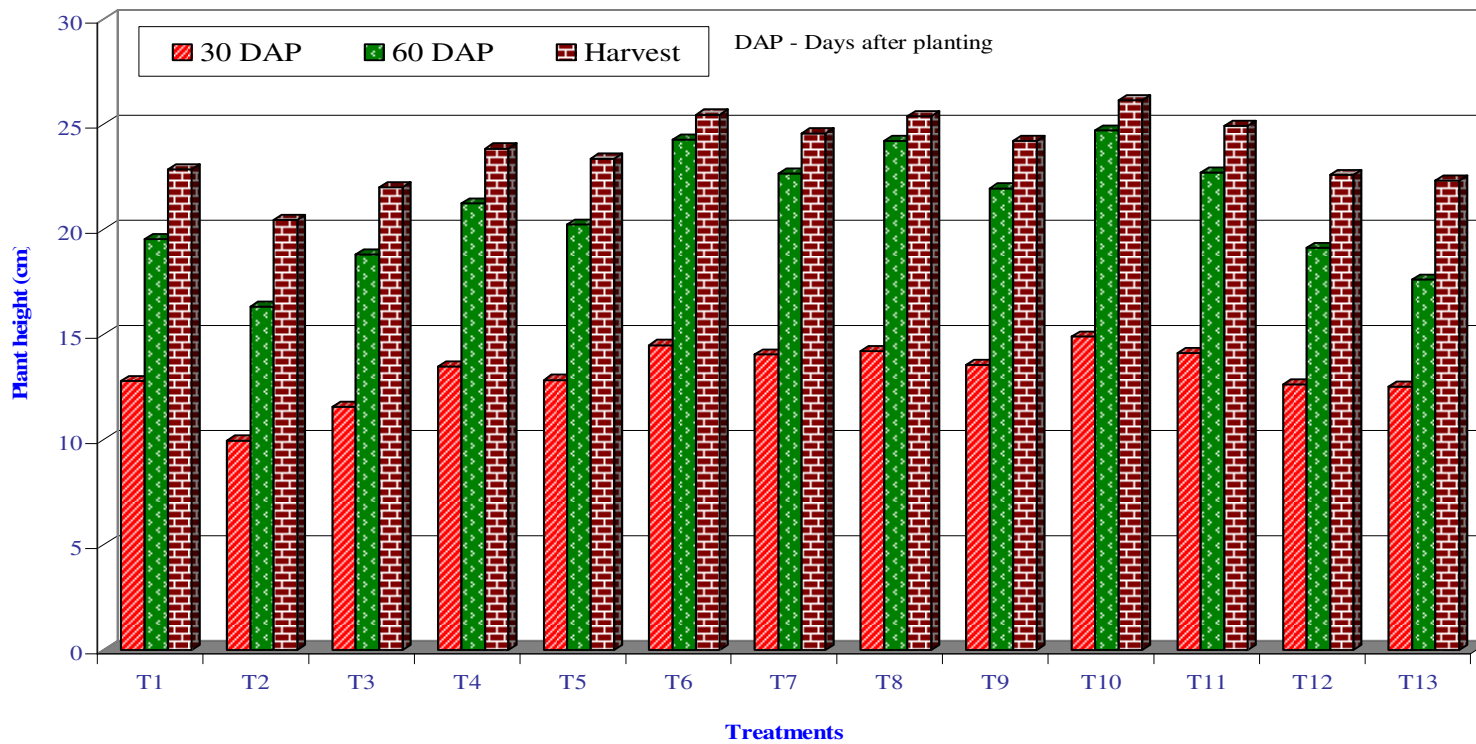


Fig. 1. Plant height of cabbage (Var. Saint) as influenced by different treatments

Fig. 1. Plant height of cabbage (Var. Saint) as influenced by different treatments

Table 2. Number of leaves per plant in cabbage (Var. Saint) as influenced by different treatments

Treatment details	Number of outer leaves / plant		
	30 DAP	60 DAP	Harvest
T ₁ - Recommended dose of organics equivalent to RDF without seedling treatment (Organic control) in homa atmosphere	12.22	18.00	20.60
T ₂ - No organic manures and no seedling treatment (Absolute control) in homa atmosphere	9.05	14.12	16.45
T ₃ - Seedlings dipped in fresh cow urine and cow dung	10.11	15.24	17.60
T ₄ - Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Non-homa ash at 30 and 60 DAP	12.32	18.21	20.96
T ₅ - Seedlings dipped in fresh cow urine and cow dung with foliar application of Non- homa ash at 30 and 60 DAP	12.24	18.05	20.63
T ₆ - Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Agnihotra homa ash at 30 and 60 DAP	14.48	20.29	22.86
T ₇ - Seedlings dipped in fresh cow urine and cow dung with foliar application of Agnihotra homa ash at 30 and 60 DAP	12.91	18.80	21.26
T ₈ - Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Om Tryambakam homa ash at 30 and 60 DAP	13.05	19.36	21.52
T ₉ - Seedlings dipped in fresh cow urine and cow dung with foliar application of Om Tryambakam homa ash at 30 and 60 DAP	12.52	18.48	21.07
T ₁₀ - Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Gloria Biosol at 30 and 60 DAP	15.04	20.50	23.42
T ₁₁ - Seedlings dipped in fresh cow urine and cow dung with foliar application of Gloria Biosol at 30 and 60 DAP	14.24	20.18	22.41
T ₁₂ - Recommended package of practices (Non-homa / Non-organic) at G - block of UAS, Dharwad (Conventional control)	12.07	17.96	19.92
T ₁₃ - Organics equivalent to RDF without seedling treatment (G- block) in Non-homa atmosphere	11.04	16.64	18.76
SEm ±	0.68	1.20	0.98
CD at 5%	2.01	3.50	2.88

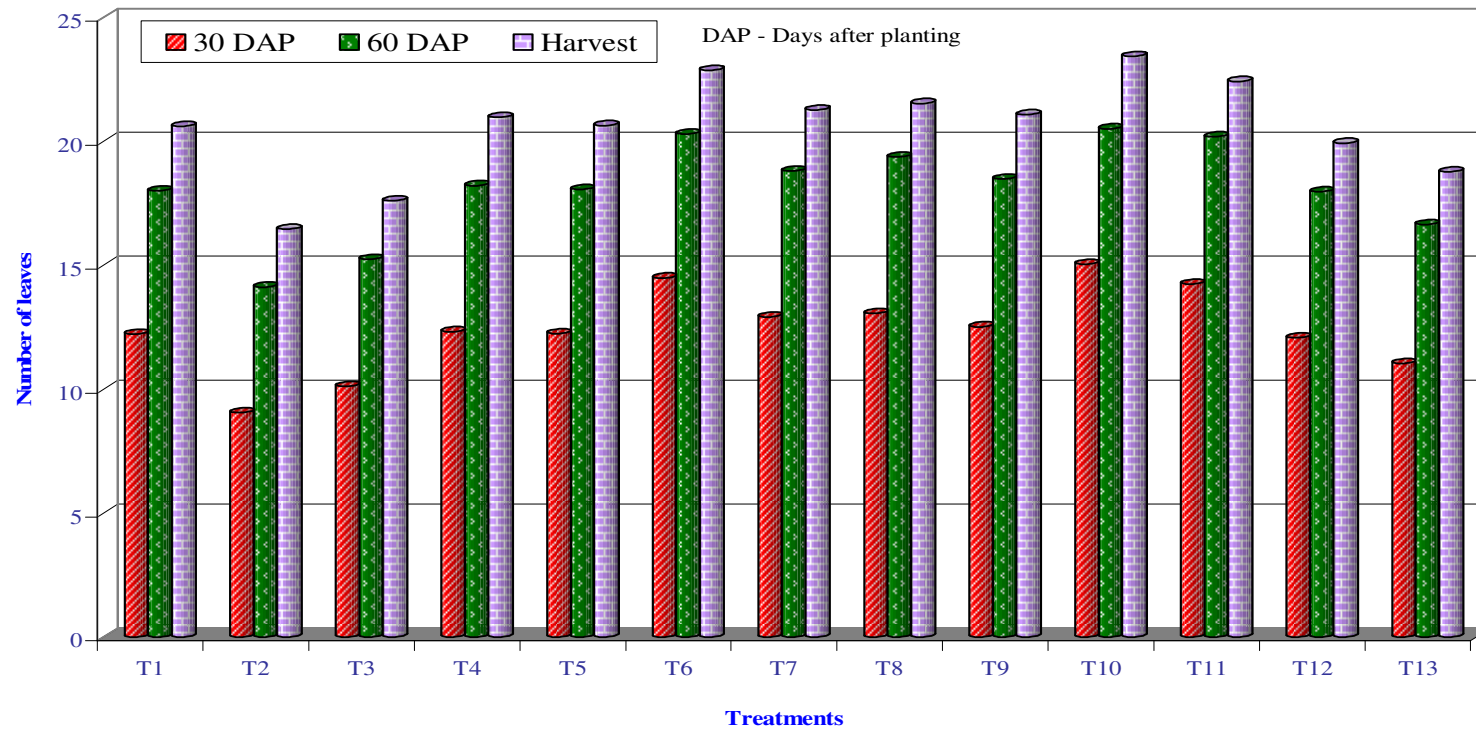


Fig. 2. Number of leaves per plant in cabbage (Var. Saint) as influenced by different treatments

Fig. 2. Number of leaves per plant in cabbage (Var. Saint) as influenced by different treatments

The Agnihotra homa ash treatments, T₆ (14.48, 20.29 and 22.86) and T₇ (12.91, 18.80 and 21.26) differed significantly from T₃ at 30 and 60 DAP and crop harvest stage but did not differ significantly from each other.

The Om Tryambakam homa ash treatment, T₈ (13.05, 19.36 and 21.52) differed significantly from T₃ (10.11, 15.24 and 17.60) at 30, 60 DAP and crop harvest stage. Only treatment T₉ (12.52 and 21.07) differed significantly from T₃ at 30 DAP and crop harvest stage, but T₉ (18.48) did not differ significantly from T₃ at 60 DAP.

At 30 and 60 DAP and harvest stage, Gloria Biosol treatments, T₁₀ (15.04, 20.50 and 23.42) and T₁₁ (14.24, 20.18 and 22.41) differed significantly from T₃ (10.11, 15.24 and 17.60) at 30 and 60 DAP and crop harvest stage, respectively and also among themselves.

Among the homa ash and Gloria Biosol treatments (soil and foliar), T₆, T₁₀ and T₁₁ differed significantly from T₁ at 30 DAP, but did not differ significantly at 60 DAP and crop harvest stage. The treatment T₈ did not differ significantly from T₁ at 30 DAP and crop harvest stage.

4.1.3 Leaf area of cabbage

The data on leaf area of cabbage (cm²/plant) are presented Table 3 and Fig. 3. It is evident from the table that at 30 and 60 DAP and crop harvest stage, the leaf area of cabbage did not differ significantly when T₁ (164.8, 182.1 and 193.3) was compared with T₁₂ (162.9, 179.3 and 188.9), respectively.

The treatment T₂ (156.8 and 167.9) did not differ significantly from treatment T₁₃ (160.4 and 176.2) at 30 and 60 DAP, respectively.

The data reveal that the treatment T₃ (160.0, 174.5 and 183.5) did not differ significantly from the treatment T₁ (164.8, 182.1 and 193.3) at 30 and 60 DAP, respectively but differed significantly at crop harvest stage.

The Non-homa ash treatments, T₄ (167.1, 186.6 and 196.8) and T₅ (165.6, 183.7 and 192.8) did not differ significantly from T₃ (160.0, 174.5 and 183.5) at 30 and 60 DAP but differed significantly from T₃ at crop harvest stage, respectively.

The Agnihotra homa ash treatments, T₆ (175.5, 201.3 and 208.1) differed significantly from T₃ (160.0, 174.5 and 183.5) at 30 and 60 DAP and crop harvest stage but T₇ (168.9, 194.8 and 202.6) differed significantly from T₃ both at 30 DAP and crop harvest stages, but did not differ significantly from T₃ at 60 DAP. The treatments T₆ and T₇ also did not differ significantly from each other.

The Om Tryambakam homa ash treatments, T₈ (169.3, 190.8 and 201.7) and T₉ (168.7, 186.9 and 198.6) did not differ significantly from T₃ (160.0, 174.5 and 183.5) at 30 and 60 DAP but differed significantly at crop harvest stage, respectively.

At 30 and 60 DAP and crop harvest stage, Gloria Biosol treatments, T₁₀ (179.7, 209.0 and 214.5) differed significantly from T₃ but T₁₁ (169.2, 199.6 and 205.2) differed significantly from T₃ (160.0, 174.5 and 183.5) at 60 DAP and crop harvest stage. It, however, did not differ significantly at 30 DAP. The T₁₀ and T₁₁ treatments differed significantly at crop harvest stage.

Among the homa ash and Gloria Biosol treatments, T₁₀ differed significantly from T₁ at 30 and 60 DAP and crop harvest stage. The treatment T₈ differed significantly from T₁ at crop harvest stage, T₆ differed significantly from T₁ at crop harvest stage but did not differ significantly at 60 DAP and T₇ and T₁₁ differed significantly from T₁ at crop harvest stage but did not differ significantly at 30 and 60 DAP.

4.1.4 Dry matter production per plant in cabbage

The data on dry matter production (DMP) per plant in cabbage (g) are presented in Table 4 and Fig. 4. It is evident from the table that at 30, 60 DAP and crop harvest stage, the dry matter production per plant in of cabbage did not differ significantly when T₁ (20.74, 44.16 and 69.87) was compared with the treatment, T₁₂ (20.69, 43.21 and 68.94), respectively.

The treatment T₂ (18.80, 41.03 and 66.06) did not differ significantly from treatment T₁₃ (20.02, 42.98 and 68.59) at 30, 60 DAP and crop harvest stage.

Table 3. Leaf area of cabbage (Var. Saint) as influenced by different treatments

Treatment details		Leaf area (cm ² / plant)		
		30 DAP	60 DAP	Harvest
T ₁	- Recommended dose of organics equivalent to RDF without seedling treatment (Organic control) in homa atmosphere	164.8	182.1	193.3
T ₂	- No organic manures and no seedling treatment (Absolute control) in homa atmosphere	156.8	167.9	172.8
T ₃	- Seedlings dipped in fresh cow urine and cow dung	160.0	174.5	183.5
T ₄	- Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Non-homa ash at 30 and 60 DAP	167.1	186.6	196.8
T ₅	- Seedlings dipped in fresh cow urine and cow dung with foliar application of Non- homa ash at 30 and 60 DAP	165.6	183.7	192.8
T ₆	- Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Agnihotra homa ash at 30 and 60 DAP	175.5	201.3	208.1
T ₇	- Seedlings dipped in fresh cow urine and cow dung with foliar application of Agnihotra homa ash at 30 and 60 DAP	168.9	194.8	202.6
T ₈	- Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Om Tryambakam homa ash at 30 and 60 DAP	169.3	190.8	201.7
T ₉	- Seedlings dipped in fresh cow urine and cow dung with foliar application of Om Tryambakam homa ash at 30 and 60 DAP	168.7	186.9	198.6
T ₁₀	- Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Gloria Biosol at 30 and 60 DAP	179.7	209.0	214.5
T ₁₁	- Seedlings dipped in fresh cow urine and cow dung with foliar application of Gloria Biosol at 30 and 60 DAP	169.2	199.6	205.2
T ₁₂	- Recommended package of practices (Non-homa / Non-organic) at G - block of UAS, Dharwad (Conventional control)	162.9	179.3	188.9
T ₁₃	- Organics equivalent to RDF without seedling treatment (G- block) in Non-homa atmosphere	160.4	176.2	190.9
SEm ±		4.23	7.73	7.04
CD at 5%		12.37	22.57	6.21

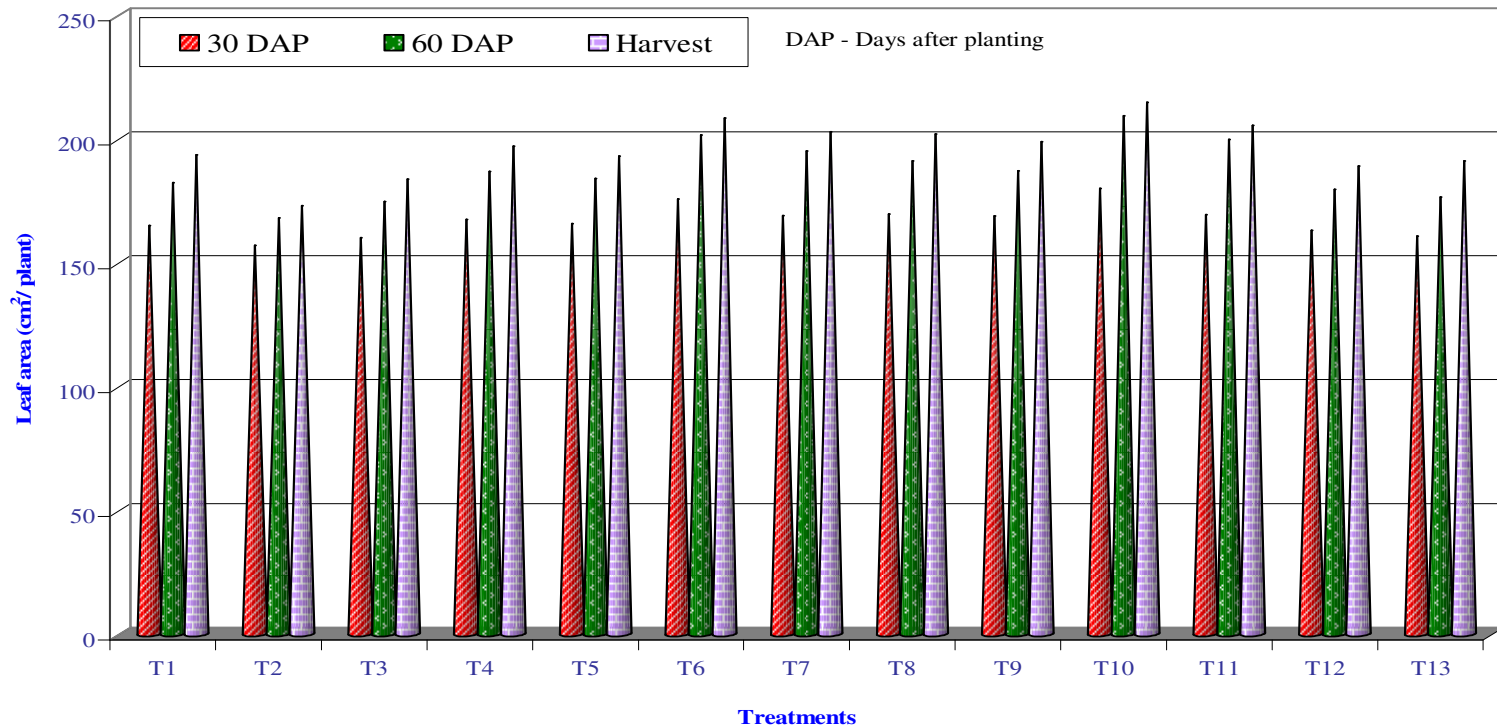


Fig. 3. Leaf area of cabbage per plant (Var. Saint) as influenced by different treatments

Fig. 3. Leaf area of cabbage per plant (Var. Saint) as influenced by different treatments

Table 4. Dry matter production (DMP) per plant in cabbage (Var. Saint) as influenced by different treatments

Treatment details		DMP / plant (g)		
		30 DAP	60 DAP	Harvest
T ₁	- Recommended dose of organics equivalent to RDF without seedling treatment (Organic control) in homa atmosphere	20.74	44.16	69.87
T ₂	- No organic manures and no seedling treatment (Absolute control) in homa atmosphere	18.80	41.03	66.06
T ₃	- Seedlings dipped in fresh cow urine and cow dung	19.58	42.58	68.03
T ₄	- Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Non-homa ash at 30 and 60 DAP	21.81	47.34	70.34
T ₅	- Seedlings dipped in fresh cow urine and cow dung with foliar application of Non- homa ash at 30 and 60 DAP	21.54	45.16	70.05
T ₆	- Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Agnihotra homa ash at 30 and 60 DAP	22.96	55.63	77.43
T ₇	- Seedlings dipped in fresh cow urine and cow dung with foliar application of Agnihotra homa ash at 30 and 60 DAP	22.29	50.37	75.58
T ₈	- Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Om Tryambakam homa ash at 30 and 60 DAP	22.57	52.50	76.39
T ₉	- Seedlings dipped in fresh cow urine and cow dung with foliar application of Om Tryambakam homa ash at 30 and 60 DAP	21.83	49.84	74.85
T ₁₀	- Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Gloria Biosol at 30 and 60 DAP	23.42	56.59	80.93
T ₁₁	- Seedlings dipped in fresh cow urine and cow dung with foliar application of Gloria Biosol at 30 and 60 DAP	22.45	51.25	76.34
T ₁₂	- Recommended package of practices (Non-homa / Non-organic) at G - block of UAS, Dharwad (Conventional control)	20.69	43.21	68.94
T ₁₃	- Organics equivalent to RDF without seedling treatment (G- block) in Non-homa atmosphere	20.02	42.98	68.59
SEm ±		0.90	1.94	3.02
CD at 5%		2.63	5.69	8.81

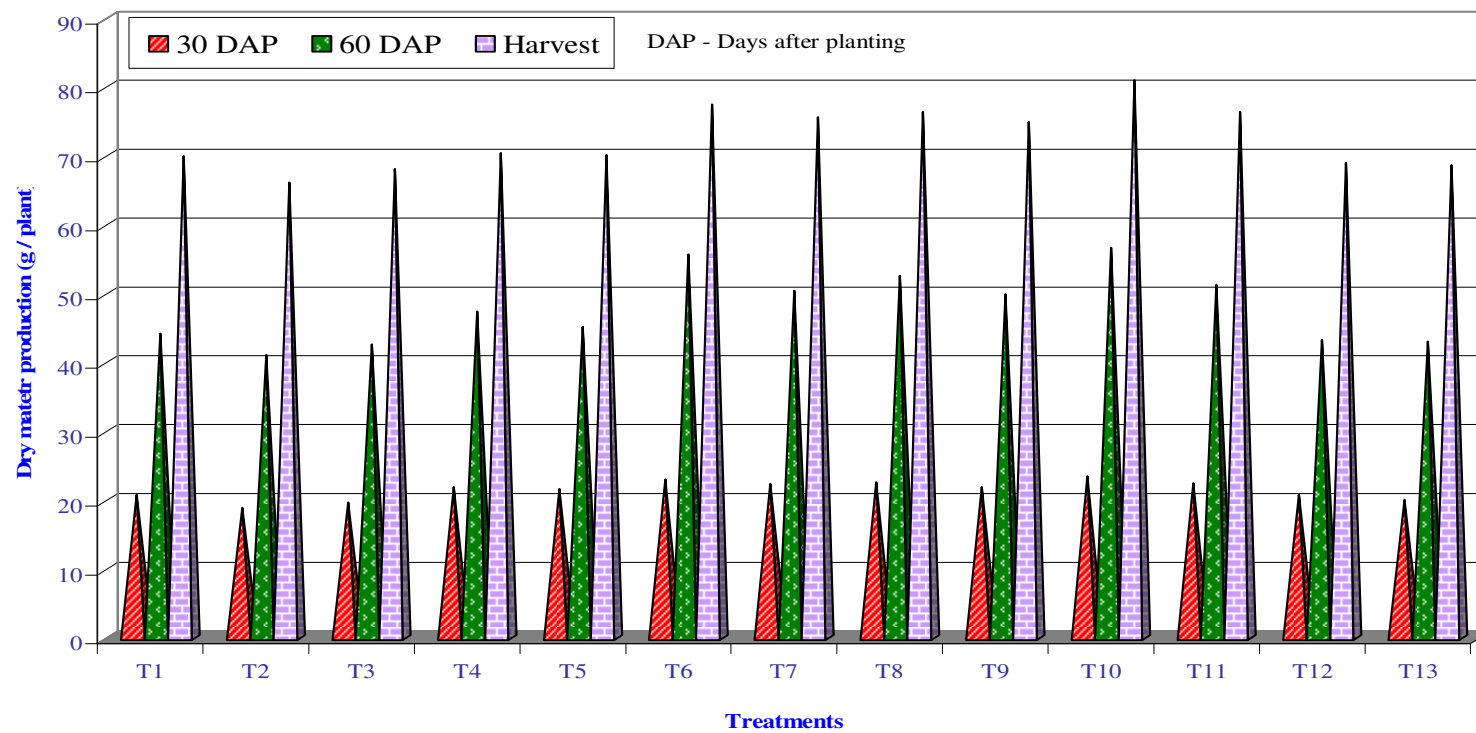


Fig. 4. Dry matter production per plant of cabbage (Var. Saint) as influenced by different treatments

Fig. 4. Dry matter production per plant of cabbage (Var. Saint) as influenced by different treatments

The data reveals that the treatment T₃ (19.58, 42.58 and 68.03) did not differ from T₁ (20.74, 44.16 and 69.87) at 30, 60 DAP and crop harvest stage, respectively.

The Non-homa ash treatments, T₄ (21.81, 47.34 and 70.34) and T₅ (21.54, 45.16 and 70.05) did not differ significantly in the expression of DMP from T₃ (19.58, 42.58 and 68.03) at 30, 60 DAP and crop harvest stage, respectively.

The Agnihotra homa ash treatments, T₆ (22.96, 55.63 and 77.43) differed significantly from T₃ at 30, 60 DAP and crop harvest stage. However, but T₇ (22.29, 50.37 and 75.58) differed significantly from T₃ (19.58, 42.58 and 68.03) at 30 and 60 DAP but did not differ significantly from T₃ at crop harvest stage. The treatment T₆ and T₇ also did not differ significantly from each other.

The Om Tryambakam homa ash treatments, T₈ (22.57, 52.50 and 76.39) differed significantly from T₃ (19.58, 42.58 and 68.03) at 30, 60 DAP but did differ significantly at crop harvest stage, and T₉ (21.83, 49.84 and 74.85) did not differ significantly from T₃ (19.58, 42.58 and 68.03) at 30 DAP and crop harvest stage but differed significantly at 60 DAP, respectively.

At 30, 60 DAP and crop harvest stage, DMP due to the Gloria Biosol treatments, T₁₀ (23.42, 56.59 and 80.93) differed significantly from T₃ (19.58, 42.58 and 68.03) but T₁₁ (22.45, 51.25 and 76.34) differed significantly from T₃ at 30 and 60 DAP. It however, differ significantly at crop harvest stage. The treatments T₁₀ and T₁₁ also differed significantly at crop harvest stage.

Among the homa ash and Gloria Biosol treatments, the treatment T₆ and differed significantly from T₁ at 60 DAP, but did not differ significantly at 30 DAP and crop harvest stage. The treatment T₁₀ differed significantly from T₁ at 30, 60 DAP and crop harvest stage wherein T₁₁, T₇ and T₉ differed significantly from T₁ at 60 DAP but did not differ significantly at 30 DAP and crop harvest stage.

4.1.5 Dry matter production per head of cabbage

The data on dry matter production (DMP) per head of cabbage (g) are presented in Table 5 and Fig. 5. It is evident from the data that at 60 DAP and at crop harvest stage, dry matter production per head of cabbage did not differ significantly when T₁ (15.98 and 54.09) was compared with T₁₂ (15.60 and 15.32), respectively.

The treatment T₂ (12.25 and 48.49) did not differ significantly from treatment, T₁₃ (14.28 and 52.22) with respect to DMP per head of cabbage.

The treatment T₃ (14.03 and 51.98) did not differ significantly from the treatment, T₁ (15.98 and 54.09).

The Non-homa ash treatments T₄ (16.18 and 57.28) differed significantly at 60 DAP in the expression of DMP but did not differ significantly from T₃ (14.03 and 51.98) at crop harvest stage, and T₅ (16.08 and 55.36) also did not differ significantly from T₃ (14.03 and 51.98) at 60 DAP and at crop harvest stage and also did not differ significantly among themselves.

The Agnihotra homa ash treatments, T₆ (18.90 and 62.62) and T₇ (17.22 and 59.92) differed significantly from T₃ (14.03 and 51.98) at 60 DAP crop harvest stage and also among themselves, respectively.

The Om Tryambakam homa ash treatments, T₈ (17.94 and 60.72) and T₉ (17.04 and 59.07) differed significantly from T₃ (14.03 and 51.98) at 60 DAP and crop harvest stage and also among themselves.

The Gloria Biosol treatments, T₁₀ (20.89 and 63.64) and T₁₁ (18.54 and 61.56) differed significantly as compared to T₃ (14.03 and 51.98) both at 60 DAP and crop harvest stages, whereas T₆, T₁₀ and T₁₁ differed significantly from T₁ (15.98 and 54.09).

The treatment T₁₀ produced highest dry matter (20.89) and was on par with T₆ (18.90) but differed significantly with all the other homa treatments.

Table 5. Dry matter production (DMP) and number of inner leaves per head in cabbage (Var. Saint) as influenced by different treatments

Treatment details	DMP / cabbage head (g)		Number of inner leaves / cabbage head	
	60 DAP	Harvest	60 DAP	Harvest
T ₁ - Recommended dose of organics equivalent to RDF without seedling treatment (Organic control) in homa atmosphere	15.98	54.09	15.84	29.88
T ₂ - No organic manures and no seedling treatment (Absolute control) in homa atmosphere	12.25	48.49	11.62	25.52
T ₃ - Seedlings dipped in fresh cow urine and cow dung	14.03	51.98	13.02	27.18
T ₄ - Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Non-homa ash at 30 and 60 DAP	16.18	57.28	16.72	30.42
T ₅ - Seedlings dipped in fresh cow urine and cow dung with foliar application of Non- homa ash at 30 and 60 DAP	16.08	55.36	15.57	29.36
T ₆ - Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Agnihotra homa ash at 30 and 60 DAP	18.90	62.62	19.98	35.52
T ₇ - Seedlings dipped in fresh cow urine and cow dung with foliar application of Agnihotra homa ash at 30 and 60 DAP	17.22	59.92	18.42	33.24
T ₈ - Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Om Tryambakam homa ash at 30 and 60 DAP	17.94	60.72	19.12	32.80
T ₉ - Seedlings dipped in fresh cow urine and cow dung with foliar application of Om Tryambakam homa ash at 30 and 60 DAP	17.04	59.07	17.26	31.26
T ₁₀ - Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Gloria Biosol at 30 and 60 DAP	20.89	63.64	20.24	35.90
T ₁₁ - Seedlings dipped in fresh cow urine and cow dung with foliar application of Gloria Biosol at 30 and 60 DAP	18.54	61.56	19.04	34.26
T ₁₂ - Recommended package of practices (Non-homa / Non-organic) at G - block of UAS, Dharwad (Conventional control)	15.60	53.32	13.20	28.32
T ₁₃ - Organics equivalent to RDF without seedling treatment (G- block) in Non-homa atmosphere	14.28	52.22	14.99	28.96
SEm ±	0.71	1.85	0.86	1.32
CD at 5%	2.08	5.41	2.51	3.88

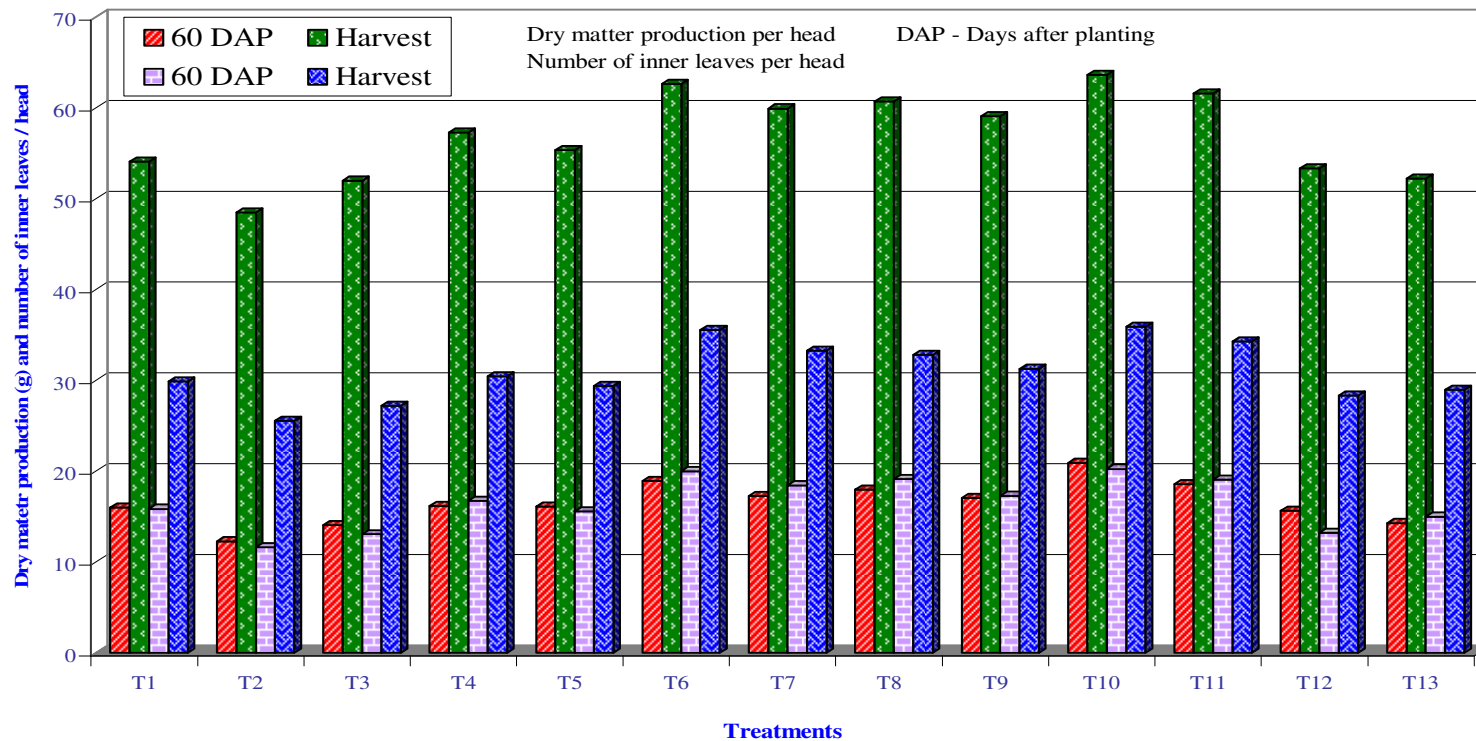


Fig. 5. Dry matter production and number of inner leaves per cabbage head (Var. Saint) as influenced by different treatments

Fig. 5. Dry matter production and number of inner leaves per cabbage head (Var. Saint) as influenced by different treatments

4.2 Yield and yield parameters

4.2.1 Number of inner leaves per head of cabbage

The data on number of inner leaves per head of cabbage are presented in Table 5 and Fig. 5. It is evident from the table that at 60 DAP, number of inner leaves per head of cabbage differed significantly when T_1 (15.84) was compared with T_{12} (13.20) but did not differ significantly at crop harvest stage.

The treatment T_2 (11.62) did not differ significantly from treatment T_{13} (14.99) at 60 DAP and at crop harvest stage. The treatment T_3 (13.02) differed significantly from T_1 (15.84) at 60 DAP but did not differ significantly at crop harvest stage.

The Non-homa ash treatments, T_4 (16.72) and T_5 (15.57) differed significantly from T_3 (13.02) at 60 DAP but did not differ at crop harvest stage and also from each other significantly.

The Agnihotra homa ash treatments, T_6 (19.98 and 35.52) and T_7 (18.42 and 33.24) differed significantly from T_3 (13.02 and 27.18) at 60 DAP crop harvest stage but did not differ significantly among themselves, respectively.

The Om Tryambakam homa ash treatments, T_8 (19.12 and 32.80) and T_9 (17.26 and 31.26) differed significantly from T_3 (13.02 and 27.18) at 60 DAP and crop harvest stage and also differed significantly among themselves.

The Gloria Biosol treatments, T_{10} (20.24 and 35.90) and T_{11} (19.04 and 34.26) differed significantly from T_3 (13.02 and 27.18) at 60 DAP and crop harvest stage, but did not differ significantly among themselves. The treatment T_{10} differed significantly from T_1 at both the stages of crop growth.

The highest number of inner leaves per head of cabbage was registered by T_{10} at both the stages studied but it was on par with T_6 - T_8 and T_{11} .

4.2.2 Diameter of cabbage head

The data on diameter of cabbage head (cm) on are presented in Table 6 and Fig. 6. It is evident from the table that at 60 DAP and also at crop harvest stage, diameter of cabbage head did not differ significantly when T_1 (4.94 and 14.62) was compared with T_{12} (4.76 and 14.24), respectively.

The treatment T_2 (4.24 and 13.92), did not differ significantly with respect to diameter of cabbage head from the treatment, T_{13} (4.63 and 14.03).

The treatment T_3 , (4.57 and 14.00) did not differ significantly from the T_1 (4.94 and 14.62) at both the stages studied.

The Non-homa ash treatments T_4 , (5.10 and 14.89) and T_5 (4.98 and 14.69) did not differ significantly from T_3 (4.57 and 14.00) at 60 DAP and at crop harvest stage and also did not differ significantly from each other.

The Agnihotra homa ash treatments, T_6 (5.52 and 15.83) differed significantly from T_3 (4.57 and 14.00) at 60 DAP and at crop harvest stage, respectively. The treatment T_7 (5.08 and 15.18) did not differ significantly from T_3 (4.57 and 14.00) at 60 DAP and crop harvest stage and also among themselves.

The Om Tryambakam homa ash treatments, T_8 (5.19 and 15.34) did not differ significantly from T_3 (4.57 and 14.00) at 60 DAP but differed significantly at T_3 at crop harvest stage, respectively. The treatment T_9 (5.00 and 14.97) did not differ significantly from T_3 (4.24 and 13.92) at 60 DAP and crop harvest stage.

The Gloria Biosol treatments, T_{10} (6.52 and 16.09) and T_{11} (5.69 and 15.79) differed significantly as compared to T_3 both at 60 DAP and crop harvest stages and T_{10} significantly differed from T_1 .

The highest diameter of cabbage head was registered by the treatment, T_{10} at both the stages studied followed by T_{11} and T_6 .

4.2.3 Surface area of cabbage head

The data on surface area of cabbage head (cm^2) are also presented in Table 6 and Fig. 6. It is evident from the table that at 60 DAP and crop harvest stage, the surface area of cabbage head did not differ significantly when T_1 (118.94 and 412.74) was compared with T_{12} (112.39 and 410.44), respectively.

The treatment T_2 , (95.35 and 350.20) did not differ significantly from treatment T_{13} (100.18 and 380.56) at both 60 DAP and crop harvest stages, respectively.

The treatment T_3 , (98.78 and 362.62) differed significantly from the T_1 (118.94 and 412.74) both at 60 DAP and crop harvest stages, respectively.

The Non-homa ash treatments, T_4 (122.60 and 422.50) and T_5 (120.46 and 416.87) differed significantly from T_3 (98.78 and 362.62) both at 60 DAP and crop harvest stages, respectively but did not differ significantly among each other.

The Agnihotra homa ash treatments, T_6 (158.32 and 612.29) and T_7 (140.29 and 524.64) differed significantly from T_3 (98.78 and 362.62) both at 60 DAP and crop harvest stages and also among themselves.

The Om Tryambakam homa ash treatments, T_8 (138.42 and 555.36) and T_9 (130.63 and 490.84) differed significantly from T_3 (98.78 and 362.62) both at 60 DAP and crop harvest stages but did not differ significantly among themselves.

The Gloria Biosol treatments, T_{10} (173.45 and 705.09) and T_{11} (157.49 and 602.18) differed significantly from T_3 (98.78 and 362.62) both at 60 DAP and crop harvest stages, whereas both the treatments T_{10} (173.45 and 705.09) and T_{11} (157.49 and 602.18) significantly differed from T_1 (118.94 and 412.74) at both the stages but differed significantly among each other at crop harvest stage only.

The T_{10} treatment was the best among all the homa treatments at both the stages studied.

4.2.4 Days taken for the initiation of cabbage head formation

It is evident from Table 7 and Fig. 7a that the days taken for initiation of cabbage head formation did not differ significantly when T_1 (39.9) was compared with T_{12} (41.6).

The treatment T_2 (44.6), did not differ significantly from T_{13} (40.3) and also from T_1 (39.9) and the treatment T_3 (42.4) did not differ significantly from T_1 (39.9).

The Non-homa ash treatments, T_4 (37.9) and T_5 (39.4) did not differ significantly from T_3 (42.4) and T_1 (39.9) and also among themselves.

The Agnihotra homa ash treatments, T_6 (35.5) and T_7 (34.9) differed significantly from T_3 (42.4) but T_6 and T_7 did not differ significantly from T_1 (39.9) and were on par with each other.

The Om Tryambakam homa ash treatments, T_8 (35.8) differed but T_9 (37.2) did not differ significantly from T_3 but treatments, T_8 and T_9 did not differ significantly from T_1 (39.9). Both T_8 and T_9 were on par with each other.

The Gloria Biosol treatments, T_{10} (30.6) and T_{11} (32.8) differed significantly from T_3 (42.4) and T_1 (39.9) but were on par with each other.

The treatment which took least days for the initiation of cabbage head formation among all the treatments was T_{10} (30.6)

4.2.5 Days taken for maturity of cabbage head

The data on days taken for maturity of cabbage head are presented in Table 7 and Fig. 7a. It is evident that T_1 (74.7) did not differ significantly from T_{12} (76.9).

The treatment T_2 (80.6), did not differ significantly from T_{13} (76.0) and also from T_1 (80.6) and the treatment T_3 (77.2) did not differ significantly from T_1 (74.7).

The Non-homa ash treatments, T_4 (72.5) and T_5 (74.2) did not differ significantly from T_3 (77.2) and T_1 (74.7) but were on par with each other.

Table 6. Diameter and surface area of cabbage head (Var. Saint) as influenced by different treatments

Treatment details		Diameter of cabbage head (cm)		Surface area of cabbage head (cm ²)	
		60 DAP	Harvest	60 DAP	Harvest
T ₁	- Recommended dose of organics equivalent to RDF without seedling treatment (Organic control) in homa atmosphere	4.94	14.62	118.94	412.74
T ₂	- No organic manures and no seedling treatment (Absolute control) in homa atmosphere	4.24	13.92	95.35	350.20
T ₃	- Seedlings dipped in fresh cow urine and cow dung	4.57	14.00	98.78	362.62
T ₄	- Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Non-homa ash at 30 and 60 DAP	5.10	14.89	122.60	422.50
T ₅	- Seedlings dipped in fresh cow urine and cow dung with foliar application of Non- homa ash at 30 and 60 DAP	4.98	14.69	120.46	416.87
T ₆	- Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Agnihotra homa ash at 30 and 60 DAP	5.52	15.83	158.32	612.29
T ₇	- Seedlings dipped in fresh cow urine and cow dung with foliar application of Agnihotra homa ash at 30 and 60 DAP	5.08	15.18	140.29	524.64
T ₈	- Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Om Tryambakam homa ash at 30 and 60 DAP	5.19	15.34	138.42	555.36
T ₉	- Seedlings dipped in fresh cow urine and cow dung with foliar application of Om Tryambakam homa ash at 30 and 60 DAP	5.00	14.97	130.63	490.84
T ₁₀	- Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Gloria Biosol at 30 and 60 DAP	6.52	16.09	173.45	705.09
T ₁₁	- Seedlings dipped in fresh cow urine and cow dung with foliar application of Gloria Biosol at 30 and 60 DAP	5.69	15.79	157.49	602.18
T ₁₂	- Recommended package of practices (Non-homa / Non-organic) at G - block of UAS, Dharwad (Conventional control)	4.76	14.24	112.39	410.44
T ₁₃	- Organics equivalent to RDF without seedling treatment (G- block) in Non-homa atmosphere	4.63	14.03	100.18	380.56
SEm ±		0.30	0.43	5.56	14.82
CD at 5%		0.89	1.25	16.25	43.26

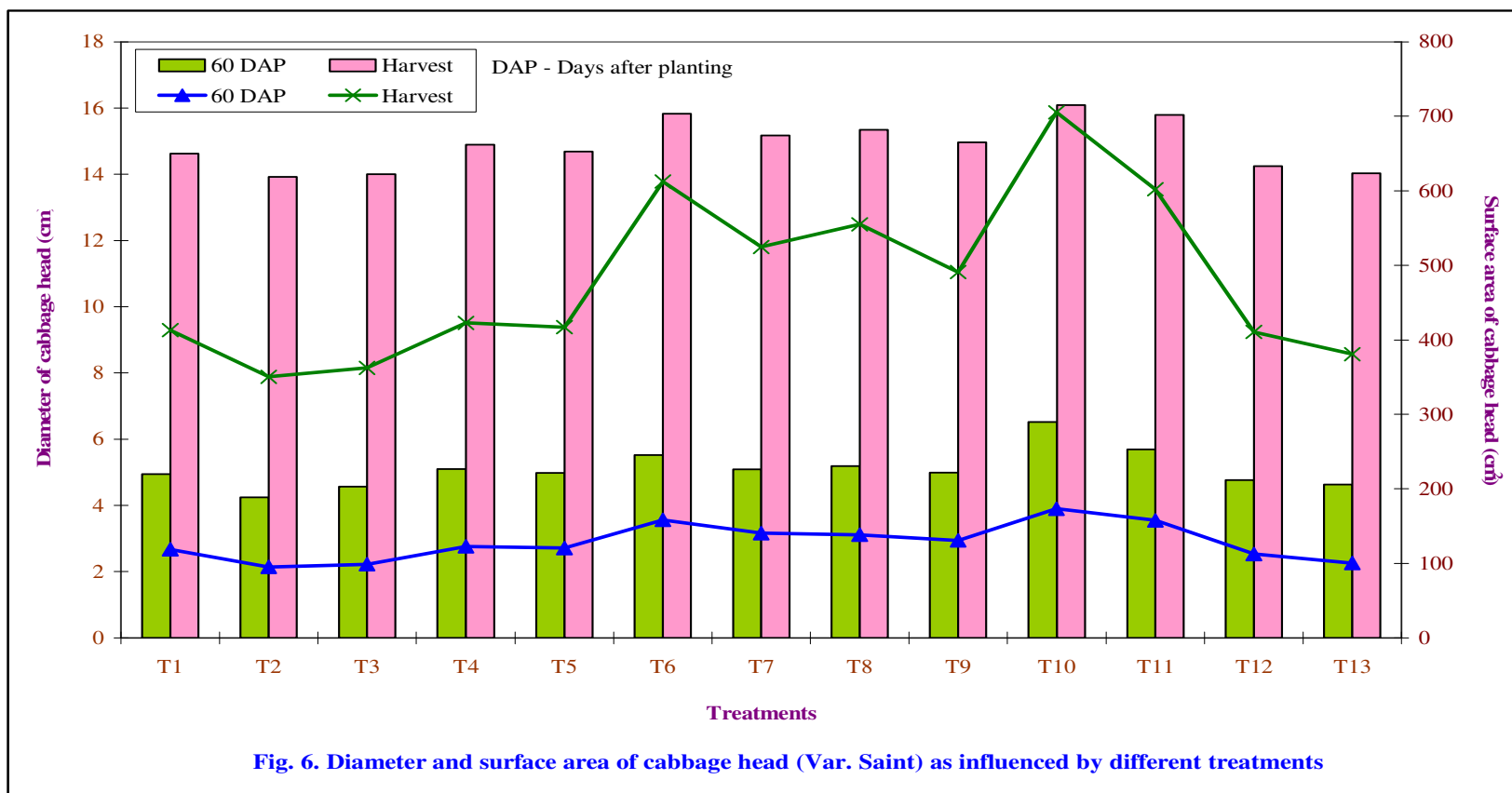


Fig. 6. Diameter and surface area of cabbage head (Var. Saint) as influenced by different treatments

The Agnihotra homa ash treatments, T₆ (66.8) and T₇ (67.9) differed significantly from T₃ but treatments T₆ and T₇ did not differ significantly from T₁ (74.7) but were on par with each other.

The Om Tryambakam homa ash treatments, T₈ (68.6) and T₉ (69.5) did not differ significantly from T₃ and T₁ but were on par with each other.

The Gloria Biosol treatments, T₁₀ (62.4) and T₁₁ (65.3) differed significantly from T₃ and T₁ but were on par with each other.

The least days for maturity of cabbage head were taken by T₁₀ treatment but other treatments (T₆ - T₁₁) were on par with T₁₀.

4.2.6 Weight of cabbage head

The data on weight of cabbage head (g) at harvest stage are presented in Table 7 and Fig. 7b. It is evident from the table that weight of cabbage head did not differ significantly when T₁ (660) was compared with T₁₂ (638).

The treatment T₂ (504), differed significantly from treatment T₁₃ (624) and also from T₁ (660).

The treatment T₃, (618) did not differ significantly from the treatment T₁ (660).

The Non-homa ash treatments, T₄ (671) and T₅ (637) did not differ significantly from T₃ (618) and T₁ (660) at crop harvest stage and also were on par with each other. The Agnihotra homa ash treatments T₆ (842) and T₇ (786) differed significantly from T₃ (618) and T₁ (660) at crop harvest stage but were on par with each other.

The Om Tryambakam homa ash treatments, T₈ (745) differed and T₉ (637) did not differ significantly from T₃ but treatments T₈ and T₉ did not differ significantly from T₁ (660) at crop harvest stage but differed significantly among themselves.

At crop harvest stage, Gloria Biosol treatments T₁₀ (958) and T₁₁ (834) differed significantly from T₃ and T₁ and also differed significantly among themselves.

4.2.7 Yield per hectare

It is evident from the Table 7 and Fig. 7c that at the crop harvest cabbage yield (t/ha) did not differ significantly when T₁ (32.70) was compared with T₁₂ (31.93).

The treatment T₂ (30.88) differed significantly from T₁₃ (32.06) and T₂ did not differ significantly from T₁ (32.70). The treatment T₃, (31.18) did not differ significantly from the treatment T₁ (32.70).

The Non-homa ash treatments, T₄ (34.22) and T₅ (32.93) did not differ significantly from T₃ (31.18) and T₁ (32.70) at the crop harvest stage and also among themselves.

The Agnihotra homa ash treatments, T₆ (35.88) differed from T₃ but T₇ (34.71) did not differ significantly from T₃ but treatments T₆ and T₇ did not differ significantly from T₁ (32.70) at the crop harvest stage and also did not differ among themselves.

The Om Tryambakam homa ash treatments, T₈ (35.34) differed but T₉ (34.54) did not differ significantly from T₃ (31.18) but treatments T₈ and T₉ did not differ significantly from T₁ (32.70) at the crop harvest stage and also among themselves.

At crop harvest stage, Gloria Biosol treatments T₁₀ (36.84) and T₁₁ (35.09) differed significantly from T₃ (31.18). However, T₁₀ differed but T₁₁ did not differ significantly from T₁. T₁₀ and T₁₁ were on par with each other.

Among the homa ash and Gloria Biosol treatments, the treatments T₆ (35.88) and T₈ (35.34) did not differ significantly but T₁₀ (36.84) differed significantly from T₁ (32.70) at the crop harvest stage.

The highest yield cabbage per hectare was recorded by T₁₀ (36.84) which were on par with all the other treatments (T₄ - T₁₁).

Table 7. Days taken for initiation of head formation and maturity of head, weight of head and yield per hectare of cabbage (Var. Saint) as influenced by different treatments

Treatment details		Days taken for initiation of cabbage head formation	Days taken for maturity of cabbage head	Weight of cabbage at harvest (g)	Yield (t / ha)
T ₁	- Recommended dose of organics equivalent to RDF without seedling treatment (Organic control) in homa atmosphere	39.9	74.7	660	32.70
T ₂	- No organic manures and no seedling treatment (Absolute control) in homa atmosphere	44.6	80.6	504	30.88
T ₃	- Seedlings dipped in fresh cow urine and cow dung	42.4	77.2	618	31.18
T ₄	- Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Non-homa ash at 30 and 60 DAP	37.9	72.5	671	34.22
T ₅	- Seedlings dipped in fresh cow urine and cow dung with foliar application of Non- homa ash at 30 and 60 DAP	39.4	74.2	637	32.93
T ₆	- Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Agnihotra homa ash at 30 and 60 DAP	35.5	66.8	842	35.88
T ₇	- Seedlings dipped in fresh cow urine and cow dung with foliar application of Agnihotra homa ash at 30 and 60 DAP	34.9	67.9	786	34.71
T ₈	- Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Om Tryambakam homa ash at 30 and 60 DAP	35.8	68.6	745	35.34
T ₉	- Seedlings dipped in fresh cow urine and cow dung with foliar application of Om Tryambakam homa ash at 30 and 60 DAP	37.2	69.5	637	34.54
T ₁₀	- Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Gloria Biosol at 30 and 60 DAP	30.6	62.4	958	36.84
T ₁₁	- Seedlings dipped in fresh cow urine and cow dung with foliar application of Gloria Biosol at 30 and 60 DAP	32.8	65.3	834	35.09
T ₁₂	- Recommended package of practices (Non-homa / Non-organic) at G - block of UAS, Dharwad (Conventional control)	41.6	76.9	638	31.93
T ₁₃	- Organics equivalent to RDF without seedling treatment (G- block) in Non – homa atmosphere	40.3	76.0	624	32.06
SEm ±		1.79	2.99	27.02	1.24
CD at 5%		5.23	8.73	78.88	3.62

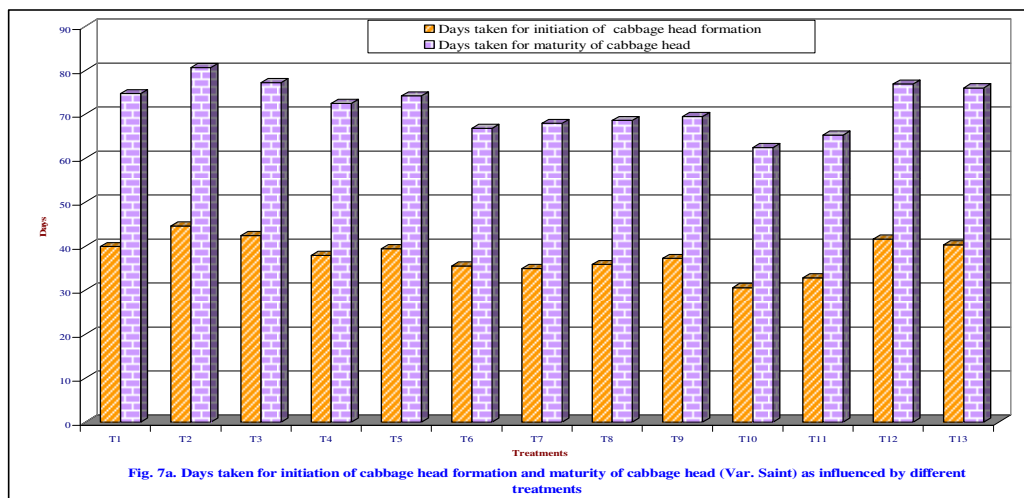


Fig. 7a. Days taken for initiation of cabbage head formation and maturity of cabbage head (Var. Saint) as influenced by different treatments

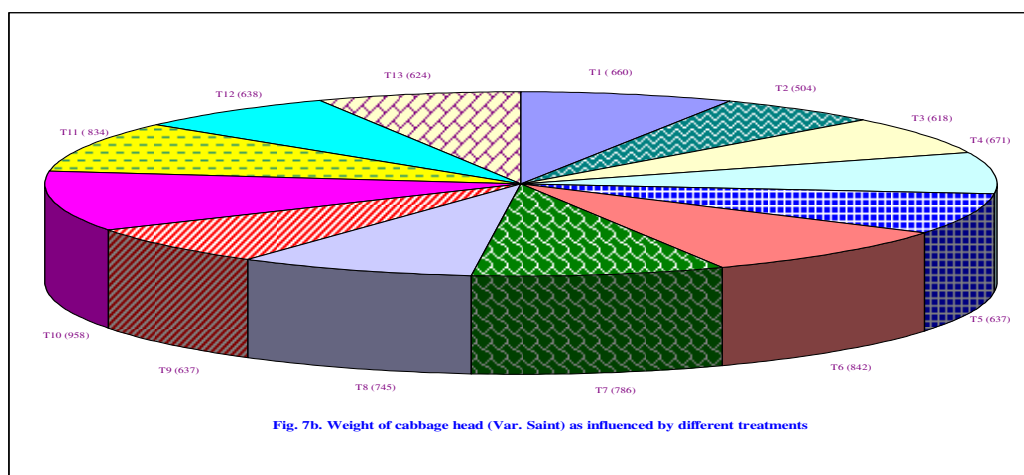


Fig. 7b. Weight of cabbage head (Var. Saint) as influenced by different treatments

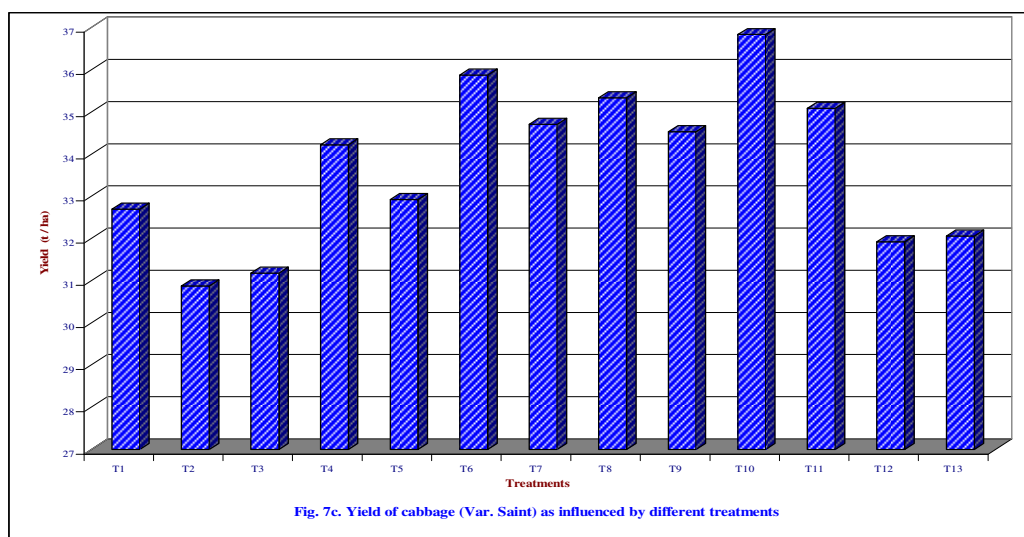


Fig. 7c. Yield of cabbage (Var. Saint) as influenced by different treatments

4.3 Quality parameters

4.3.1 Total soluble solids

It is evident from the Table 8 and Fig. 8 that the amount of total soluble solids (TSS) in cabbage head ($^{\circ}$ Brix) did not differ significantly at 60 DAP when the treatment T_1 (4.2 and 4.5) was compared with T_{12} (4.1 and 4.2) but differed significantly at crop harvest stage.

The treatment T_2 (3.5 and 3.8), differed significantly from T_{13} (4.2 and 4.4) and T_3 (3.8 and 4.0) differed significantly from the treatment T_1 (4.2 and 4.5) both at 60 DAP and crop harvest stages, respectively.

The Non-homa ash treatments, (T_4 4.3 and 5.5) and T_5 (4.3 and 4.7) differed significantly from T_3 (3.8 and 4.0) both at 60 DAP and crop harvest stages, respectively.

The Agnihotra homa ash treatments, T_6 (5.5 and 6.1) and T_7 (4.7 and 5.9) differed significantly from T_3 (3.8 and 4.0) both at 60 DAP and crop harvest stages and also among themselves, respectively.

The Om tryambakam homa ash treatments T_8 (4.8 and 6.0) and T_9 (4.4 and 5.6) differed significantly from T_3 both at 60 DAP and crop harvest stages, respectively and also differed significantly among themselves.

At 60 DAP and crop harvest stage, Gloria Biosol treatments T_{10} (5.6 and 6.2) and T_{11} (5.3 and 5.9) differed significantly from T_3 and also differed significantly among themselves.

Among the homa ash and Gloria Biosol treatments, T_6 (5.5 and 6.1), T_8 (4.8 and 6.0) and T_{10} (5.6 and 6.2) differed significantly from T_1 (4.2 and 4.5) both at 60 DAP and crop harvest stages, respectively.

The best treatments in increasing TSS were T_6 and T_{10} at both the stages studies but were on par with each other.

4.3.2 Ascorbic acid content

The data on ascorbic acid content (mg/100g) in cabbage heads are presented in Table 8 and Fig. 8. It is evident from the table that at 60 DAP and crop harvest stages, the ascorbic acid (mg/100g) content did not differ significantly when T_1 (39.75 and 42.92) was compared with the treatment T_{12} (37.75 and 41.46).

The treatment T_2 (36.68 and 39.52), did not differ significantly from treatment T_{13} (38.45 and 42.25) both at 60 DAP and crop harvest stages. The treatment, T_3 (36.94 and 40.39) also did not differ from the treatment T_1 (39.75 and 42.92) both at 60 DAP and crop harvest stages, respectively.

The Non-homa ash treatments, T_4 (39.28 and 43.85) differed significantly from T_3 (36.94 and 40.39) at 60 DAP and crop harvest stage and T_5 (39.06 and 43.24) did not differ significantly from T_3 at 60 DAP but differed significantly at crop harvest stage. However, these treatments did not differ significantly among themselves.

The Agnihotra homa ash treatments, T_6 (42.98 and 45.28) and T_7 (41.37 and 44.08) differed significantly from T_3 both at 60 DAP and crop harvest stages but did not differ significantly among themselves.

The Om Tryambakam homa ash treatments, T_8 (41.49 and 45.16) and T_9 (40.55 and 44.00) differed significantly from T_3 both at 60 DAP and crop harvest stages but T_8 and T_9 were on par with each other.

The Gloria Biosol treatments, T_{10} (43.66 and 46.72) and T_{11} (40.58 and 44.64) differed significantly from T_3 both at 60 DAP and crop harvest stages and also differed significantly among themselves.

Among the homa ash and Gloria Biosol treatments, T_6 (42.98 and 45.28), T_8 (41.49 and 45.16) and T_{10} differed significantly from T_1 (39.75 and 42.92), whereas treatment, T_{11} significantly differed from T_1 both at 60 DAP and crop harvest stage, respectively. Top score was achieved by T_{10} at both the stages and T_6 was the second best.

4.3.3 Total free phenol content in cabbage head

It is evident from the Table 8 and Fig. 8 that at 60 DAP and crop harvest stage, total free phenol content (mg/100g) in cabbage head did not differ significantly when T₁ (178 and 182) was compared with T₁₂ (176 and 179), respectively.

The treatment T₂ (172 and 175) did not differ significantly from T₁₃ (177 and 180) and the treatment T₃ (174 and 177) did not differ significantly from the T₁ (178 and 182) both at 60 DAP and crop harvest stages, respectively.

The Non-homa ash treatment T₄ (180 and 189) did not differ significantly from T₃ (174 and 177) at 60 DAP but differed significantly at crop harvest stage and T₅ (178 and 183) did not differ significantly from T₃ at 60 DAP and crop harvest stage and also among themselves.

The Agnihotra homa ash treatments, T₆ (185 and 196) differed significantly from T₃ (174 and 177) at 60 DAP and crop harvest stage but T₇ (183 and 191) did not differ significantly at crop harvest stage and also among themselves.

The Om Tryambakam homa ash treatments, T₈ (196 and 202) differed significantly from T₃ at both 60 DAP and crop harvest stages and T₉ (182 and 191) did not differ significantly from T₃ at 60 DAP but differed significantly at crop harvest stage and also among themselves.

The Gloria Biosol treatment T₁₀ (200 and 213) differed significantly from T₃ (174 and 177) at both 60 DAP and crop harvest stages and T₁₁ (184 and 197) did not differ significantly from T₃ at 60 DAP but differed significantly at crop harvest stage and also significantly differed among themselves.

Among the homa ash and Gloria Biosol treatments, the treatment T₁₀ (200 and 213) differed significantly from T₁ (178 and 182) both at 60 DAP and crop harvest stage and the treatment T₆ (185 and 196) and T₈ (196 and 202) did not differ significantly from T₁ (178 and 182) at 60 DAP but differed significantly at crop harvest stage.

4.3.4 Nitrogen content of cabbage head

The data on nitrogen content of cabbage head are presented in Table 9 and Fig. 9. It is evident from the table that at 60 DAP and crop harvest stage the nitrogen content (%) did not differ significantly when T₁ (0.51 and 0.79) was compared with the treatment T₁₂ (0.49 and 0.76), respectively.

The treatment T₂ (0.45 and 0.72), differed significantly from treatment T₁₃ (0.50 and 0.78) both at 60 DAP and crop harvest stages, respectively. The treatment, T₃ (0.47 and 0.75) also differed significantly from the treatment T₁ (0.51 and 0.79) both at 60 DAP and crop harvest stages, respectively.

The Non-homa ash treatments, T₄ (0.52 and 0.81) and T₅ (0.51 and 0.79) differed significantly from T₃ both at 60 DAP and crop harvest stages. However, these treatments did not differ significantly among themselves.

The Agnihotra homa ash treatments T₆ (0.56 and 0.87) and T₇ (0.53 and 0.83) differed significantly from T₃ both at 60 DAP and crop harvest stages and also differed significantly among themselves, respectively.

The Om Tryambakam homa ash treatments T₈ (0.55 and 0.84) and T₉ (0.53 and 0.82) differed significantly from T₃ both at 60 DAP and crop harvest stages but did not differ among themselves.

The Gloria Biosol treatments T₁₀ (0.58 and 0.89) and T₁₁ (0.54 and 0.85) differed significantly from T₃ both at 60 DAP and crop harvest stages and also differed significantly among themselves, respectively.

Among the homa ash and Gloria Biosol treatments, the treatments T₆ (0.56 and 0.87), T₈ (0.55 and 0.84) and T₁₀ (0.58 and 0.89) differed significantly from T₁ (0.51 and 0.79), whereas T₁₁ (0.54 and 0.85) differed significantly from T₁ both at 60 DAP and crop harvest stages.

Table 8. Total soluble solids (TSS), ascorbic acid and total free phenol content of cabbage head (Var. Saint) as influenced by different treatments

Treatment details	TSS (Brix)		Ascorbic acid (mg / 100 g)		Total free phenols (mg / 100 g)	
	60 DAP	Harvest	60 DAP	Harvest	60 DAP	Harvest
T ₁ - Recommended dose of organics equivalent to RDF without seedling treatment (Organic control) in homa atmosphere	4.2	4.5	39.75	42.92	178	182
T ₂ - No organic manures and no seedling treatment (Absolute control) in homa atmosphere	3.5	3.8	36.68	39.52	172	175
T ₃ - Seedlings dipped in fresh cow urine and cow dung	3.8	4.0	36.94	40.39	174	177
T ₄ - Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Non-homa ash at 30 and 60 DAP	4.3	5.5	39.28	43.85	180	189
T ₅ - Seedlings dipped in fresh cow urine and cow dung with foliar application of Non-homa ash at 30 and 60 DAP	4.3	4.7	39.06	43.24	178	183
T ₆ - Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Agnihotra homa ash at 30 and 60 DAP	5.5	6.1	42.98	45.28	185	196
T ₇ - Seedlings dipped in fresh cow urine and cow dung with foliar application of Agnihotra homa ash at 30 and 60 DAP	4.7	5.9	41.37	44.08	183	191
T ₈ - Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Om Tryambakam homa ash at 30 and 60 DAP	4.8	6.0	41.49	45.16	196	202
T ₉ - Seedlings dipped in fresh cow urine and cow dung with foliar application of Om Tryambakam homa ash at 30 and 60 DAP	4.4	5.6	40.55	44.00	182	191
T ₁₀ - Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Gloria Biosol at 30 and 60 DAP	5.6	6.2	43.66	46.72	200	213
T ₁₁ - Seedlings dipped in fresh cow urine and cow dung with foliar application of Gloria Biosol at 30 and 60 DAP	5.3	5.9	40.58	44.64	184	197
T ₁₂ - Recommended package of practices (Non-homa / Non-organic) at G - block of UAS, Dharwad (Conventional control)	4.1	4.2	37.75	41.46	176	179
T ₁₃ - Organics equivalent to RDF without seedling treatment (G- block) in Non-homa atmosphere	4.2	4.4	38.45	42.25	177	180
SEm ±	0.08	0.08	0.73	0.58	3.44	2.61
CD at 5%	0.25	0.25	2.13	1.69	10.06	7.62

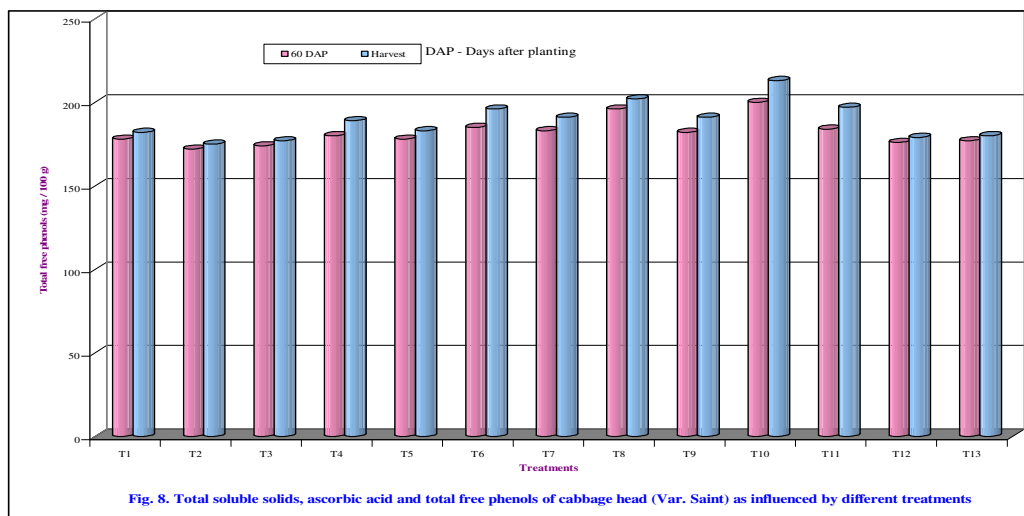
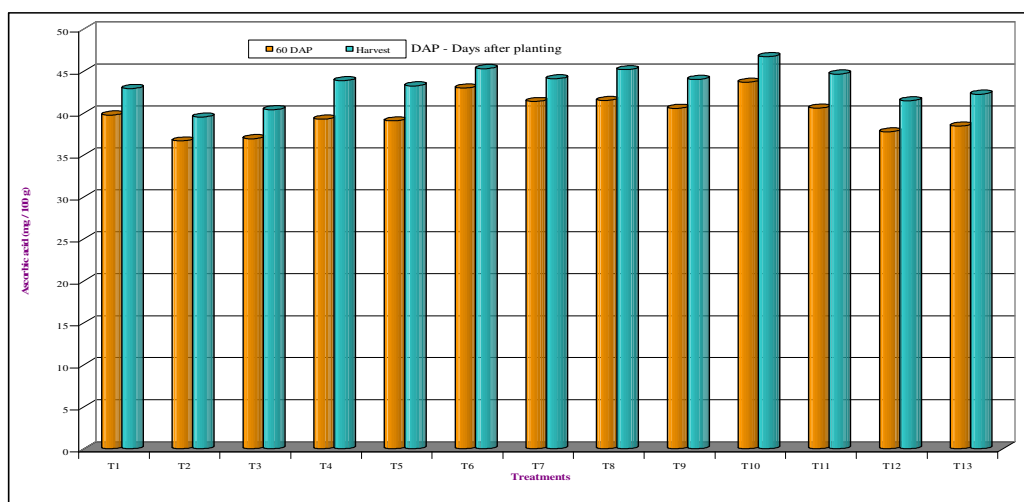
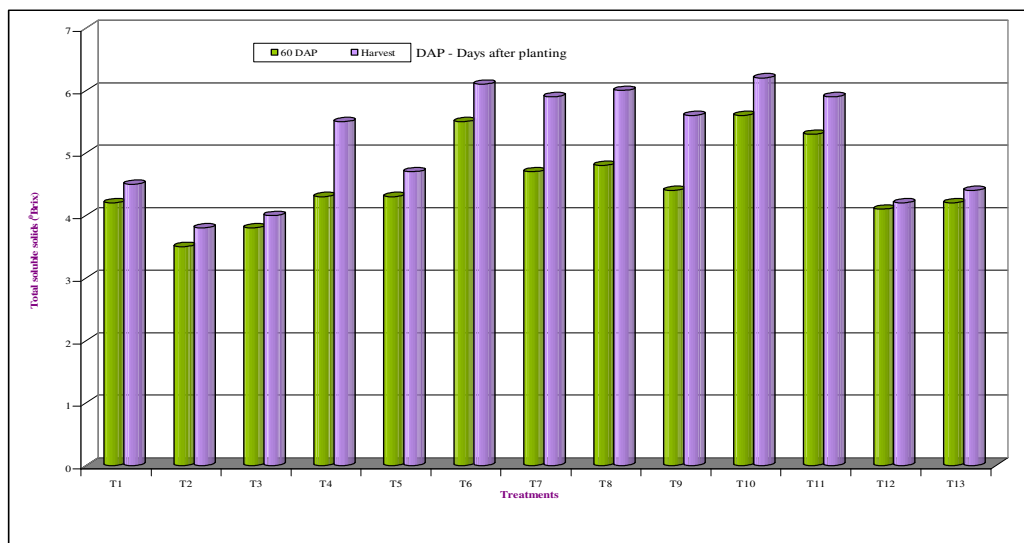


Fig. 8. Total soluble solids, ascorbic acid and total free phenols of cabbage head (Var. Saint) as influenced by different treatments

The highest amount of nitrogen content was found in treatment T₁₀ at both the stages of crop growth.

4.3.5 Crude protein content in the cabbage head

It is evident from Table 9 and Fig. 9 that at 60 DAP and crop harvest stage, the crude protein content (%) in the cabbage head did not differ significantly when T₁ (3.18 and 4.93) was compared with T₁₂ (3.06 and 4.75), respectively.

The treatment T₂ (2.81 and 4.50) differed significantly from treatment T₁₃ (3.12 and 4.87) and T₃ (2.93 and 4.68) differed significantly from the treatment T₁ (3.18 and 4.93) both at 60 DAP and crop harvest stages, respectively.

The Non-homa ash treatment T₄ (3.25 and 5.06) differed significantly from T₃ (2.93 and 4.68) at both 60 DAP and crop harvest stages and T₅ (3.18 and 4.93) differed significantly from T₃ at 60 DAP but did not differ significantly at crop harvest stage and also among themselves.

The Agnihotra homa ash treatments, T₆ (3.50 and 5.43) and T₇ (3.31 and 5.18) differed significantly from T₃ (2.93 and 4.68) both at 60 DAP and crop harvest stages, respectively and also among themselves.

The Om Tryambakam homa ash treatments T₈ (3.43 and 5.25) and T₉ (3.31 and 5.12) differed significantly from T₃ (2.93 and 4.68) both at 60 DAP and crop harvest stages and also differed significantly among themselves.

At 60 DAP and crop harvest stage, Gloria Biosol treatments T₁₀ (3.62 and 5.56) and T₁₁ (3.37 and 5.31) differed significantly from T₃ (2.93 and 4.68) and the treatments T₁₀ and T₁₁ differed significantly at 60 DAP among themselves but not at crop harvest stage.

Among the homa ash and Gloria Biosol treatments, T₆ (3.50 and 5.43), T₈ (3.43 and 5.25) and T₁₀ (3.62 and 5.56) differed significantly from T₁ (3.18 and 4.93) both at 60 DAP and crop harvest stages, respectively.

The treatment, T₁₀ was the top most treatment to register maximum crude protein content at both the stages of crop growth although T₁₁ was on par with T₁₀ at crop harvest stage.

4.3.6 Potassium content in cabbage head

The data on potassium content (%) in cabbage head are presented in Table 10 and Fig.10. It is evident from the table that at 60 DAP and crop harvest stage, the potassium content differed significantly when T₁ (0.75 and 0.81) was compared with T₁₂ (0.70 and 0.75).

The treatment T₂ (0.60 and 0.71) differed significantly from treatment T₁₃ (0.72 and 0.78) and T₃ (0.67 and 0.74) also differed significantly from the treatment T₁ (0.75 and 0.81) both at 60 DAP and crop harvest stages, respectively.

The Non-homa ash treatments, T₄ (0.79 and 0.86) and T₅ (0.76 and 0.82) differed significantly from T₃ both at 60 DAP and crop harvest stages. However, these treatments did not differ significantly among themselves.

The Agnihotra homa ash treatments T₆ (0.85 and 0.93) and T₇ (0.78 and 0.84) differed significantly from T₃ both at 60 DAP and crop harvest stages, respectively and also differed significantly among themselves.

The Om Tryambakam homa ash treatments T₈ (0.81 and 0.90) and T₉ (0.77 and 0.85) differed significantly from T₃ both at 60 DAP and crop harvest stages and also T₈ and T₉ differed significantly among themselves.

The Gloria Biosol treatments T₁₀ (0.89 and 0.95) and T₁₁ (0.82 and 0.88) differed significantly from T₃ at 60 DAP and crop harvest stages and also differed significantly among themselves, respectively.

Among the homa ash and Gloria Biosol treatments, T₆, T₈ and T₁₀ differed significantly from T₁, whereas T₁₁ (0.82 and 0.88) differed significantly from T₁ both at 60 DAP and crop harvest stage, respectively.

Table 9. Nitrogen and crude protein content of cabbage head (Var. Saint) as influenced by different treatments

Treatment details		Nitrogen (%)		Crude Protein (%)	
		60 DAP	Harvest	60 DAP	Harvest
T ₁	- Recommended dose of organics equivalent to RDF without seedling treatment (Organic control) in homa atmosphere	0.51	0.79	3.18	4.93
T ₂	- No organic manures and no seedling treatment (Absolute control) in homa atmosphere	0.45	0.72	2.81	4.50
T ₃	- Seedlings dipped in fresh cow urine and cow dung	0.47	0.75	2.93	4.68
T ₄	- Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Non-homa ash at 30 and 60 DAP	0.52	0.81	3.25	5.06
T ₅	- Seedlings dipped in fresh cow urine and cow dung with foliar application of Non- homa ash at 30 and 60 DAP	0.51	0.79	3.18	4.93
T ₆	- Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Agnihotra homa ash at 30 and 60 DAP	0.56	0.87	3.50	5.43
T ₇	- Seedlings dipped in fresh cow urine and cow dung with foliar application of Agnihotra homa ash at 30 and 60 DAP	0.53	0.83	3.31	5.18
T ₈	- Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Om Tryambakam homa ash at 30 and 60 DAP	0.55	0.84	3.43	5.25
T ₉	- Seedlings dipped in fresh cow urine and cow dung with foliar application of Om Tryambakam homa ash at 30 and 60 DAP	0.53	0.82	3.31	5.12
T ₁₀	- Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Gloria Biosol at 30 and 60 DAP	0.58	0.89	3.62	5.56
T ₁₁	- Seedlings dipped in fresh cow urine and cow dung with foliar application of Gloria Biosol at 30 and 60 DAP	0.54	0.85	3.37	5.31
T ₁₂	- Recommended package of practices (Non-homa / Non-organic) at G - block of UAS, Dharwad (Conventional control)	0.49	0.76	3.06	4.75
T ₁₃	- Organics equivalent to RDF without seedling treatment (G- block) in Non-homa atmosphere	0.50	0.78	3.12	4.87
SEm ±		0.008	0.01	0.04	0.09
CD at 5%		0.02	0.03	0.13	0.27

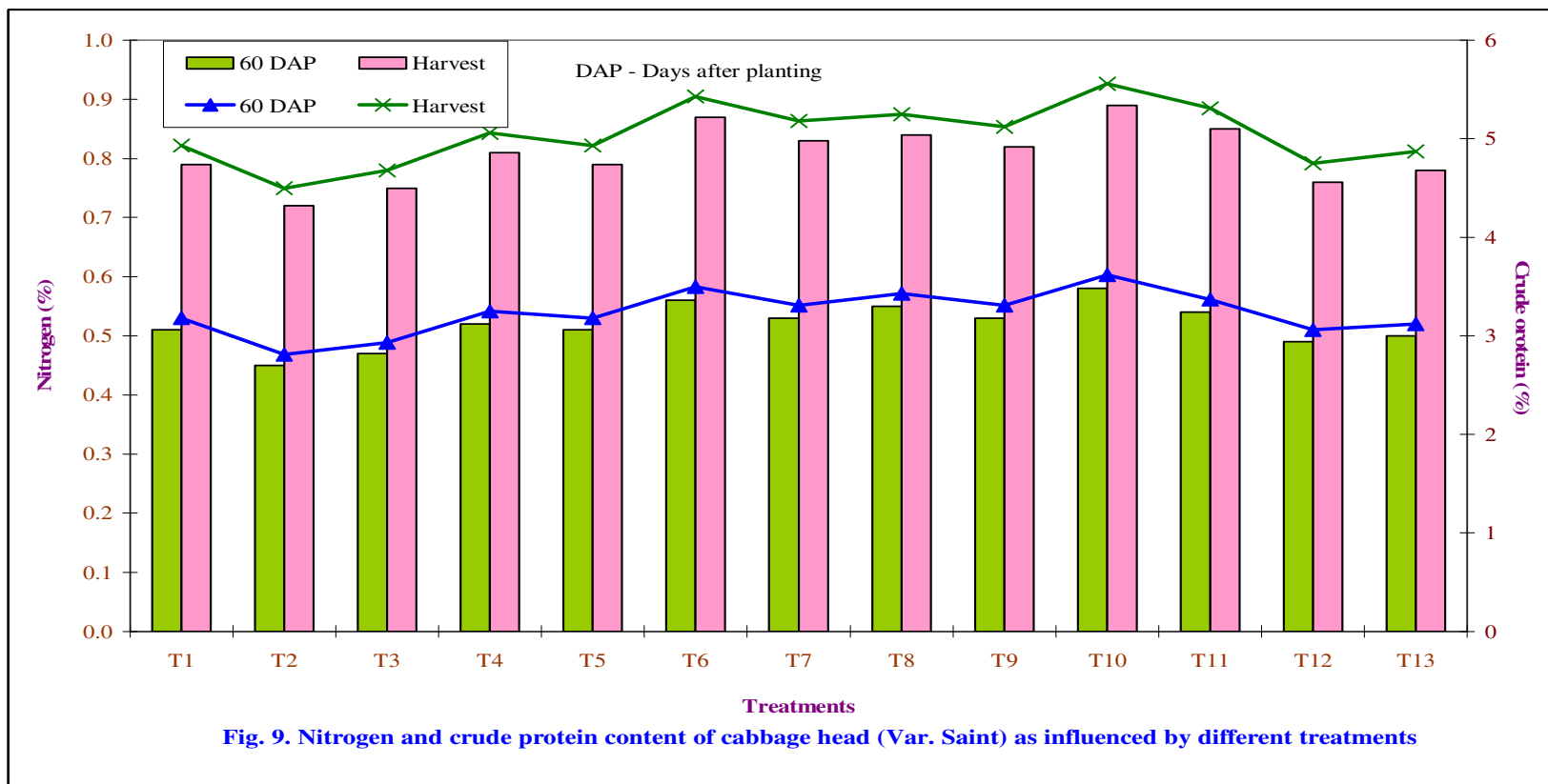


Fig. 9. Nitrogen and crude protein content of cabbage head (Var. Saint) as influenced by different treatments

The highest content of potassium was found in treatment T₁₀ at both the stages of crop growth.

4.3.7 Phosphorus content in cabbage head

It is evident from the Table 10 and Fig. 10 that at 60 DAP and crop harvest stage, the phosphorus content (%) in the cabbage head did not differ significantly when T₁ (0.26 and 0.28) was compared with T₁₂ (0.24 and 0.25) at 60 DAP but differed significantly at crop harvest stage.

The treatment T₂ (0.21 and 0.23) differed significantly from treatment T₁₃ (0.25 and 0.27) and T₃ (0.23 and 0.24) differed significantly from the treatment T₁ (0.26 and 0.28) both at 60 DAP and crop harvest stages, respectively.

The Non-homa ash treatments, T₄ (0.26 and 0.28) differed significantly from T₃ at both 60 DAP and crop harvest stages and T₅ (0.25 and 0.27) did not differ significantly from T₃ at 60 DAP but differed significantly at crop harvest stage. However, these treatments did not differ significantly among themselves at both the stages studied.

The Agnihotra homa ash treatments T₆ (0.29 and 0.32) and T₇ (0.27 and 0.30) differed significantly from T₃ both at 60 DAP and crop harvest stages and also among themselves.

The Om Tryambakam homa ash treatments T₈ (0.28 and 0.31) and T₉ (0.27 and 0.29) differed significantly from T₃ (0.23 and 0.24) both at 60 DAP and crop harvest stages but differed significantly among themselves at crop harvest stage only.

At the 60 DAP and crop harvest stage, Gloria Biosol treatments T₁₀ (0.30 and 0.33) and T₁₁ (0.28 and 0.30) differed significantly from T₃ (0.23 and 0.24) and the treatment T₁₀ and T₁₁ differed significantly at crop harvest stage only.

Among the homa ash and Gloria Biosol treatments, T₆ (0.29 and 0.32), T₈ (0.28 and 0.31) and T₁₀ (0.30 and 0.33) differed significantly from T₁ (0.26 and 0.28) both at 60 DAP and crop harvest stages.

4.3.8 Sulphur content in of cabbage head

The data on sulphur content (%) of cabbage head are presented in Table 10 and Fig.10. It is evident from the table that at 60 DAP and crop harvest stage the sulphur content differed significantly when T₁ (0.12 and 0.15) was compared with T₁₂ (0.10 and 0.13), respectively.

The treatment T₂ (0.09 and 0.11) differed significantly from treatment T₁₃ (0.11 and 0.14) and T₃ (0.10 and 0.12) also differed significantly from the treatment T₁ (0.12 and 0.15) both at 60 DAP and crop harvest stages, respectively.

The Non-homa ash treatments, T₄ (0.13 and 0.19) and T₅ (0.12 and 0.18) differed significantly from T₃ and also differed significantly among themselves at both the stages of crop growth studied.

The Agnihotra homa ash treatments T₆ (0.16 and 0.23) and T₇ (0.15 and 0.21) differed significantly from T₃ both at 60 DAP and crop harvest stages and also differed significantly among themselves.

The Om tryambakam homa ash treatments T₈ (0.15 and 0.23) and T₉ (0.14 and 0.20) differed significantly from T₃ (0.10 and 0.12) both at 60 DAP and crop harvest stages and also differed significantly among themselves.

The Gloria Biosol treatments T₁₀ (0.17 and 0.24) and T₁₁ (0.15 and 0.21) differed significantly from T₃ both at 60 DAP and crop harvest stages and also differed significantly among themselves, respectively.

Among the homa ash and Gloria Biosol treatments, T₆, T₈ and T₁₀ differed significantly from T₁, whereas treatments T₇ (0.15 and 0.21), T₉ (0.14 and 0.20) and T₁₁ (0.15 and 0.21) differed significantly from T₁ both at 60 DAP and crop harvest stage, respectively.

Table 10. Potassium, phosphorus and sulphur content of cabbage head (Var. Saint) as influenced by different treatments

Treatment details	Potassium (%)		Phosphorus (%)		Sulphur (%)	
	60 DAP	Harvest	60 DAP	Harvest	60 DAP	Harvest
T ₁ - Recommended dose of organics equivalent to RDF without seedling treatment (Organic control) in homa atmosphere	0.75	0.81	0.26	0.28	0.12	0.15
T ₂ - No organic manures and no seedling treatment (Absolute control) in homa atmosphere	0.60	0.71	0.21	0.23	0.09	0.11
T ₃ - Seedlings dipped in fresh cow urine and cow dung	0.67	0.74	0.23	0.24	0.10	0.12
T ₄ - Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Non-homa ash at 30 and 60 DAP	0.79	0.86	0.26	0.28	0.13	0.19
T ₅ - Seedlings dipped in fresh cow urine and cow dung with foliar application of Non-homa ash at 30 and 60 DAP	0.76	0.82	0.25	0.27	0.12	0.18
T ₆ - Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Agnihotra homa ash at 30 and 60 DAP	0.85	0.93	0.29	0.32	0.16	0.23
T ₇ - Seedlings dipped in fresh cow urine and cow dung with foliar application of Agnihotra homa ash at 30 and 60 DAP	0.78	0.84	0.27	0.30	0.15	0.21
T ₈ - Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Om Tryambakam homa ash at 30 and 60 DAP	0.81	0.90	0.28	0.31	0.15	0.23
T ₉ - Seedlings dipped in fresh cow urine and cow dung with foliar application of Om Tryambakam homa ash at 30 and 60 DAP	0.77	0.85	0.27	0.29	0.14	0.20
T ₁₀ - Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Gloria Biosol at 30 and 60 DAP	0.89	0.95	0.30	0.33	0.17	0.24
T ₁₁ - Seedlings dipped in fresh cow urine and cow dung with foliar application of Gloria Biosol at 30 and 60 DAP	0.82	0.88	0.28	0.30	0.15	0.21
T ₁₂ - Recommended package of practices (Non-homa / Non-organic) at G - block of UAS, Dharwad (Conventional control)	0.70	0.75	0.24	0.25	0.10	0.13
T ₁₃ - Organics equivalent to RDF without seedling treatment (G- block) in Non-homa atmosphere	0.72	0.78	0.25	0.27	0.11	0.14
SEm ± CD at 5%	0.01 0.03	0.01 0.04	0.007 0.02	0.008 0.02	0.002 0.008	0.004 0.01

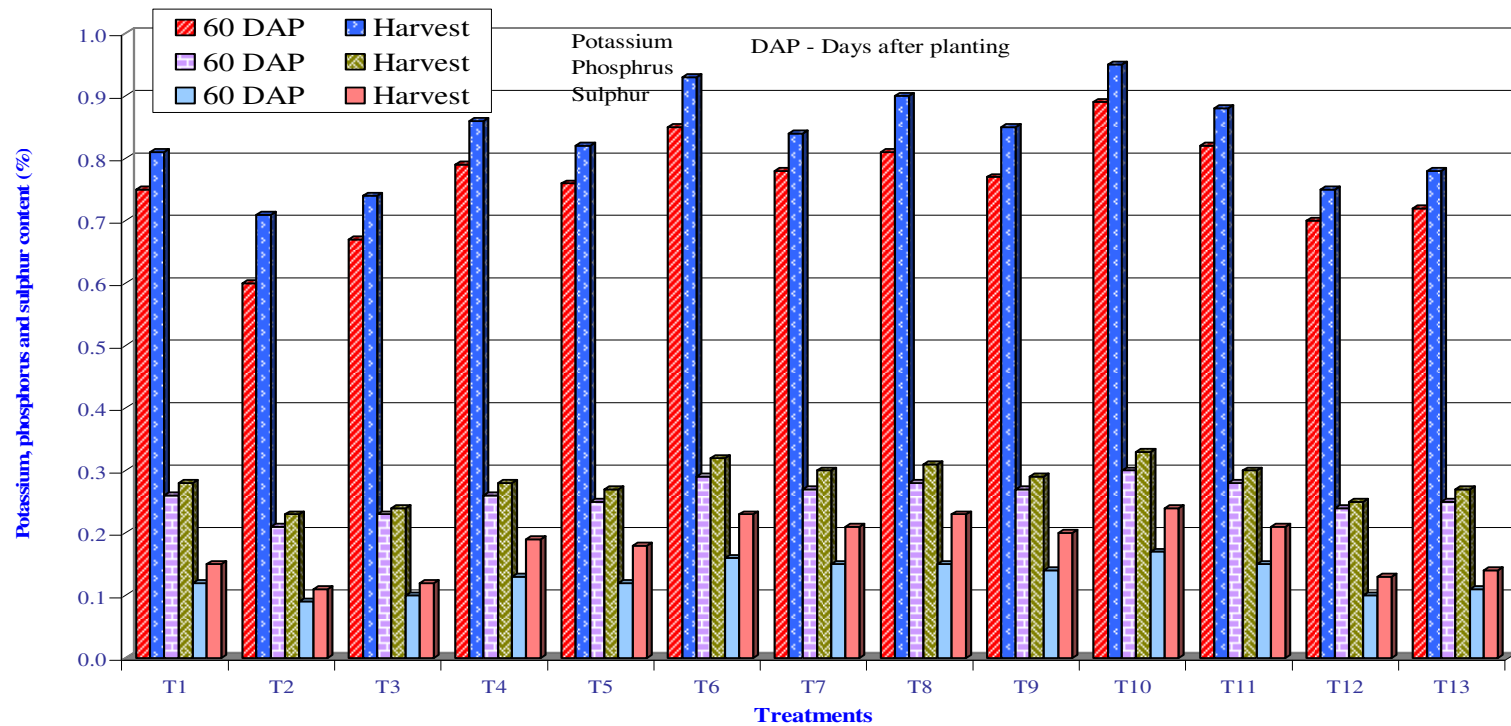


Fig. 10. Potassium, phosphorus and sulphur content of cabbage head (Var. Saint) as influenced by different treatments

Fig. 10. Potassium, phosphorus and sulphur content of cabbage head (Var. Saint) as influenced by different treatments

4.3.9 Copper content of cabbage head

The data on copper content (mg/kg) of cabbage head recorded at crop harvest stage are presented in Table 11 and Fig. 11. It is evident from the table that copper content did not differ significantly when T₁ (6.1) was compared with T₁₂ (5.8).

The treatment T₂ (5.5), differed significantly from treatment T₁₃ (6.0) and T₃ (5.7) did not differ significantly from the treatment T₁ (6.1).

The Non-homa ash treatments, T₄ (6.3) and T₅ (6.2) differed significantly from T₃ (5.7), however these treatments did not differ significantly among themselves.

The Agnihotra homa ash treatments T₆ (6.6) and T₇ (6.4) differed significantly from T₃ (5.7) and also among themselves. Similarly, the Om Tryambakam homa ash treatments T₈ (6.5) and T₉ (6.4) differed significantly from T₃ and also differed significantly among themselves.

The Gloria Biosol treatments T₁₀ (6.8) and T₁₁ (6.5) differed significantly from T₃ at crop harvest stage and also differed significantly among themselves.

Among the homa ash and Gloria Biosol treatments, the treatments T₆ (6.6) and T₁₀ (6.8) differed significantly from T₁ (6.1) but treatment T₈ did not differ significantly from T₁ at crop harvest stage.

The Cu content was highest in treatment T₁₀ (6.8) but was on par with T₆ - T₉ and T₁₁.

4.3.10 Zinc content of cabbage head

It is evident from the Table 11 and Fig.11 that zinc content of cabbage head (mg/kg) did not differ significantly when the treatment T₁ (18.4) was compared to T₁₂ (18.0).

The treatment T₂ (17.6) did not differ significantly from T₁₃ (18.3) and T₃ (17.9) but did not differ significantly from the treatment T₁ (18.4).

The Non-homa ash treatments T₄ (18.6) and T₅ (18.4) did not differ significantly from T₃ (17.9). However, these treatments differed significantly from each other. The Agnihotra homa ash treatments T₆ (19.5) and T₇ (18.8) also did not differ significantly from T₃ (17.9) and also among themselves.

The Om Tryambakam homa ash treatment T₈ (19.3) differed significantly but T₉ (18.7) did not differ significantly from T₃ and T₈ and T₉ did not differ among themselves at the crop harvest stage.

At the crop harvest stage, Gloria Biosol treatment T₁₀ (19.8) differed significantly from T₃ (17.9) but T₁₁ (19.0) did not differ significantly as compared to T₃ (17.9) and also did not differ among themselves.

Among the homa ash and Gloria Biosol treatments, the treatments T₆ (19.5) and T₈ (19.3) did not differ from T₁ (18.4) but treatment T₁₀ (19.8) differed significantly from T₁.

Although T₁₀ scored higher Zn content (19.8), other homa treatments T₆, T₈ and T₁₁ were on par with each other and with T₁₀.

4.3.11 Manganese content of cabbage head

It is evident from the Table 11 and Fig. 11 that manganese content of the head of cabbage head (mg/kg) did not differ significantly when T₁ (28.6) was compared with T₁₂ (28.0).

The treatment T₂ (27.7) did not differ significantly from T₁₃ (28.3) and T₃ (27.9) did not differ significantly from the treatment T₁ (28.6). The Non-homa ash treatments, T₄ (29.2) and T₅ (28.8) did not differ significantly from T₃ (27.9) and also did not differ significantly among themselves.

The Agnihotra homa ash treatments T₆ (30.7) and T₇ (30.1) differed significantly from T₃ (27.9) but did not differ significantly among themselves.

Table 11. Copper, zinc, manganese and iron content of cabbage head (Var. Saint) as influenced by different treatments

Treatment details		Crop harvest stage			
		Cu	Zn	Mn	Fe
		(mg / kg)			
T ₁	- Recommended dose of organics equivalent to RDF without seedling treatment (Organic control) in homa atmosphere	6.1	18.4	28.6	53.9
T ₂	- No organic manures and no seedling treatment (Absolute control) in homa atmosphere	5.5	17.6	27.7	53.2
T ₃	- Seedlings dipped in fresh cow urine and cow dung	5.7	17.9	27.9	53.4
T ₄	- Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Non-homa ash at 30 and 60 DAP	6.3	18.6	29.2	54.3
T ₅	- Seedlings dipped in fresh cow urine and cow dung with foliar application of Non- homa ash at 30 and 60 DAP	6.2	18.4	28.8	54.1
T ₆	- Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Agnihotra homa ash at 30 and 60 DAP	6.6	19.5	30.7	55.7
T ₇	- Seedlings dipped in fresh cow urine and cow dung with foliar application of Agnihotra homa ash at 30 and 60 DAP	6.4	18.8	30.1	54.6
T ₈	- Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Om Tryambakam homa ash at 30 and 60 DAP	6.5	19.3	30.6	55.2
T ₉	- Seedlings dipped in fresh cow urine and cow dung with foliar application of Om Tryambakam homa ash at 30 and 60 DAP	6.4	18.7	29.8	54.4
T ₁₀	- Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Gloria Biosol at 30 and 60 DAP	6.8	19.8	31.0	56.0
T ₁₁	- Seedlings dipped in fresh cow urine and cow dung with foliar application of Gloria Biosol at 30 and 60 DAP	6.5	19.0	30.3	54.9
T ₁₂	- Recommended package of practices (Non-homa / Non-organic) at G - block of UAS, Dharwad (Conventional control)	5.8	18.0	28.0	53.5
T ₁₃	- Organics equivalent to RDF without seedling treatment (G- block) in Non-homa atmosphere	6.0	18.3	28.3	53.7
SEm ±		0.15	0.40	0.74	0.54
CD at 5%		0.43	1.17	2.18	1.58

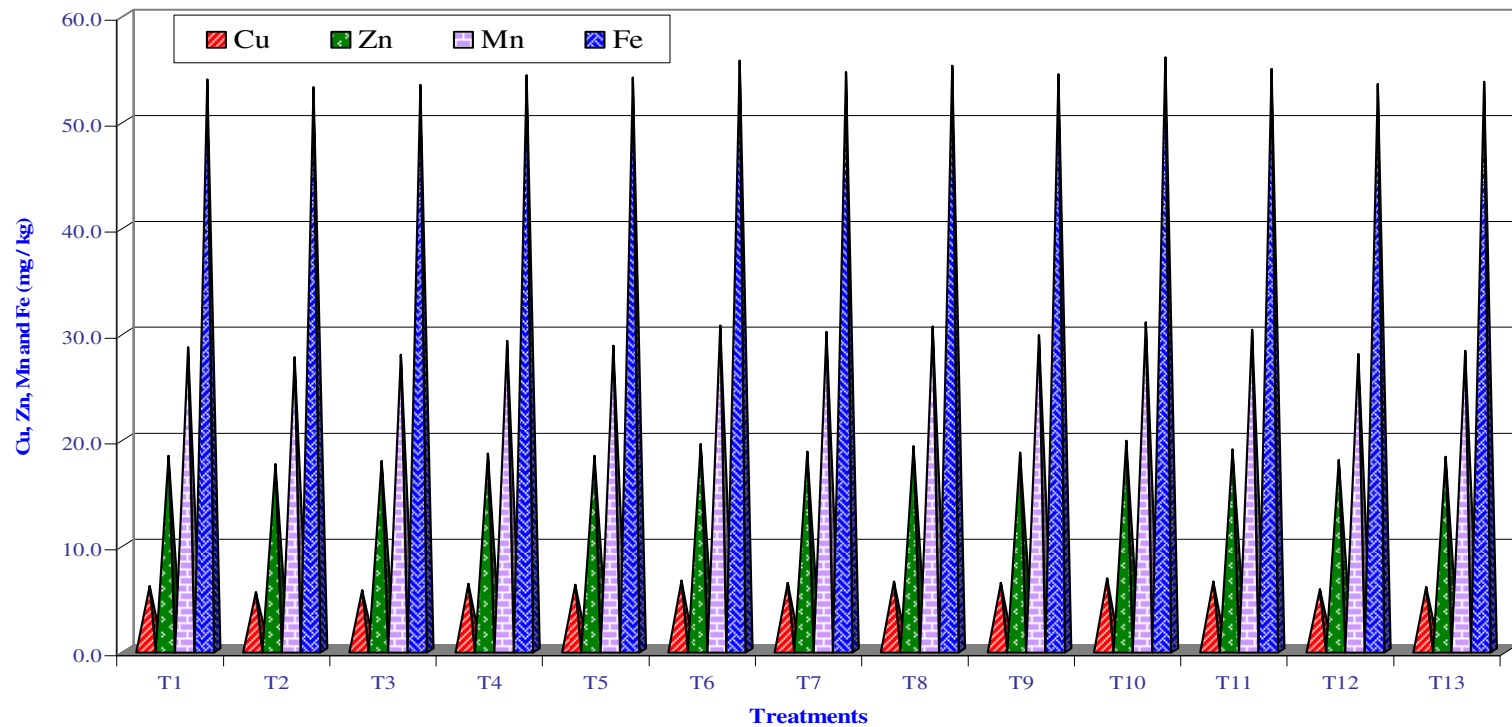


Fig. 11. Copper, zinc, manganese and iron content of cabbage head (Var. Saint) as influenced by different treatments at crop harvest stage

Fig. 11. Copper, zinc, manganese and iron content of cabbage head (Var. Saint) as influenced by different treatments at crop harvest stage

The Om Tryambakam homa ash treatments T₈ (30.6) differed significantly from T₃ but T₉ (29.8) did not differ significantly from T₃ and T₈ and T₉ did not differ among themselves at the crop harvest stage.

At the crop harvest stage, Gloria Biosol treatments T₁₀ (31.0) and T₁₁ (30.3) differed significantly from T₃ (27.9) but did not differ significantly among themselves.

Among the homa ash and Gloria Biosol treatments T₆ (30.7) and T₈ (30.6) did not differ but treatment T₁₀ (31.0) differed significantly from T₁ (28.6).

The highest Mn content was recorded by treatment T₁₀. Other treatments from T₆ – T₉ and T₁₁ were on par with each other and with T₁₀.

4.3.12 Iron content of cabbage head

The data on iron content of cabbage head are presented in Table 11 and Fig. 11. It is evident from the table that iron content in the head of cabbage (mg/kg) did not differ significantly when T₁ (53.9) was compared with T₁₂ (53.5).

The treatment T₂ (53.2) did not differ significantly from treatment T₁₃ (53.7) and T₃ (53.4) did not differ significantly from the treatment T₁ (53.9). The Non-homa ash treatments T₄ (54.3) and T₅ (54.1) did not differ significantly from T₃ (53.4) and also did not do so amongst each other.

The Agnihotra homa ash treatment T₆ (55.7) differed significantly from T₃ (53.4) but T₇ (54.6) did not differ significantly from T₃ and also did not differ significantly among themselves.

The Om Tryambakam homa ash treatments T₈ (55.2) differed significantly from T₃ but T₉ (54.4) did not differ significantly from T₃ and also among themselves at crop harvest stage.

The Gloria Biosol treatment T₁₀ (56.0) differed significantly from T₃ but T₁₁ (54.9) did not differ significantly from T₃ at crop harvest stage. These Gloria Biosol treatments also did not differ among themselves significantly.

Among the homa ash and Gloria Biosol treatments, the treatment T₆ (55.7) and T₁₀ (56.00) differed significantly from T₁ but treatment T₈ (55.2) did not differ significantly from T₁.

The maximum Fe content was recorded by T₁₀ (56.00) but other homa treatments T₆ – T₈ were on par with it.

4.4 Soil analysis

4.4.1 Soil micronutrients

The data on soil micronutrients Cu, Zn, Mn and Fe (mg/kg) are presented in Table 12 and Fig. 12. At crop harvest stage the copper content did not differ significantly when T₁ (1.12) was compared with T₁₂ (1.10) at crop harvest stage.

The treatment T₂ (1.08), differed significantly from T₁₃ (1.11) but did not differ significantly from T₁ (1.12) and T₃ (1.09) also did not differ significantly from the treatment T₁.

The Non-homa ash treatments T₄ (1.14) and T₅ (1.13) did not differ significantly from T₃ (1.09) and T₁ (1.12) at crop harvest stage and also among themselves.

The Agnihotra homa ash treatment T₆ (1.25) differed significantly from T₃ (1.09) but T₇ (1.15) did not differ significantly from T₃. The treatment T₆ differed significantly from T₁ (1.12) but T₇ did not differ significantly from T₁. However, T₆ and T₇ differed significantly from each other at crop harvest stage.

The Om Tryambakam homa ash treatments T₈ (1.30) differed significantly from T₃ (1.09) but T₉ (1.16) did not differ significantly from T₃. The treatment T₈ differed significantly from T₁ (1.12). Although T₉ did not differ significantly from T₁, T₈ and T₉ differed significantly from each other at crop harvest stage.

At crop harvest stage, Gloria Biosol treatments T₁₀ (1.30) and T₁₁ (1.18) differed significantly as compared to T₃ (1.09). The treatment T₁₀ differed significantly from T₁ (1.12) but T₁₁ did not differ significantly from T₁. However, T₁₀ and T₁₁ differed significantly amongst each other.

Among the homa ash and Gloria Biosol treatments, T₆ (1.25), T₈ (1.30) and T₁₀ (1.30) differed significantly from T₁ (1.12) at crop harvest stage but did not differ significantly between themselves.

The treatments T₆, T₈ and T₁₀ were on par with each other and had higher content of copper from 1.25 -1.30 mg per kg.

The soil Zn content (mg/kg) differed significantly when treatment T₁ (0.72) was compared with T₁₂ (0.66) at crop harvest stage. The treatment T₂ (0.63) differed significantly from T₁₃ (0.69) and also from T₁ (0.72) and T₃ (0.65) differed significantly from the treatment T₁ (0.72).

The Non-homa ash treatments T₄ (0.78) and T₅ (0.75) differed significantly from T₃ (0.65) and treatment T₄ differed significantly from T₁ (0.72) but T₅ did not differ significantly from T₁ and differed significantly among themselves at crop harvest stage.

The Agnihotra homa ash treatments T₆ (0.93) and T₇ (0.87) differed significantly among themselves and from T₃ (0.65) and T₁ (0.72) at crop harvest stage. The Om Tryambakam homa ash treatments T₈ (0.90) and T₉ (0.81) differed significantly among themselves and also from T₃ and T₁ (0.72) at crop harvest stage.

At crop harvest stage, Gloria Biosol treatments T₁₀ (0.85) and T₁₁ (0.79) differed significantly from T₃ (0.65) and T₁ (0.72) and also among themselves at crop harvest stage.

Among the homa ash and Gloria Biosol treatments, the treatment T₆ (0.93), T₈ (0.90) and T₁₀ (0.85) differed significantly from T₁ (0.72) at crop harvest stage.

It is evident from Table 12 and Fig. 12 that at crop harvest stage the Mn content (mg/kg) did not differ significantly in T₁ (6.59) as compared to T₁₂ (6.38), respectively.

The treatment T₂ (5.34) differed significantly at crop harvest stage from T₁₃ (6.42) and T₁ (6.59) and T₃ (6.01) differed significantly from the treatment, T₁ (6.59).

The Non-homa ash treatments T₄ (6.83) and T₅ (6.51) differed significantly among themselves and also from T₃ (6.01) but treatments T₄ and T₅ did not differ significantly from T₁ (6.59) at crop harvest stage.

The Agnihotra homa ash treatments T₆ (8.05) and T₇ (7.52) differed significantly among themselves and from T₃ and T₁ at crop harvest stage. The Om Tryambakam homa ash treatments T₈ (7.95) and T₉ (7.29) also differed significantly among themselves and also from T₃ and T₁ at crop harvest stage.

At crop harvest stage, Gloria Biosol treatments T₁₀ (8.92) and T₁₁ (7.64) differed significantly as compared to T₃ (6.01) and T₁ (6.59) but also differed significantly among themselves.

Among the homa ash and Gloria Biosol treatments, T₆ (8.05) and T₁₀ (8.92) differed significantly from T₁ (6.59). The treatments T₇, T₉ and T₁₀ also differed significantly among themselves at crop harvest stage.

It is evident from the Table 12 and Fig. 12 that at crop harvest stage the Fe content (mg/kg) did not differ significantly when T₁ (6.55) was compared with T₁₂ (6.49).

The treatment T₂ (6.23) differed significantly from T₁₃ (6.51) but did not differ significantly from T₁ (6.59) and T₃ (6.41) did not differ significantly from T₁ (6.55) at crop harvest stage.

The Non-homa ash treatments, T₄ (6.97) differed significantly from T₃ (6.41) but T₅ (6.82) did not differ significantly from T₃. The treatments T₄ and T₅ did not differ significantly from T₁ (6.55) and were on par with each other at crop harvest stage.

Table 12. Soil copper, zinc, manganese and iron content of cabbage crop (Var. Saint) as influenced by different treatments

Treatment details		Crop harvest stage			
		Cu	Zn	Mn	Fe
		(mg / kg)			
T ₁	- Recommended dose of organics equivalent to RDF without seedling treatment (Organic control) in homa atmosphere	1.12	0.72	6.59	6.55
T ₂	- No organic manures and no seedling treatment (Absolute control) in homa atmosphere	1.08	0.63	5.34	6.23
T ₃	- Seedlings dipped in fresh cow urine and cow dung	1.09	0.65	6.01	6.41
T ₄	- Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Non-homa ash at 30 and 60 DAP	1.14	0.78	6.83	6.97
T ₅	- Seedlings dipped in fresh cow urine and cow dung with foliar application of Non- homa ash at 30 and 60 DAP	1.13	0.75	6.51	6.82
T ₆	- Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Agnihotra homa ash at 30 and 60 DAP	1.25	0.93	8.05	7.93
T ₇	- Seedlings dipped in fresh cow urine and cow dung with foliar application of Agnihotra homa ash at 30 and 60 DAP	1.15	0.87	7.52	7.49
T ₈	- Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Om Tryambakam homa ash at 30 and 60 DAP	1.30	0.90	7.95	7.81
T ₉	- Seedlings dipped in fresh cow urine and cow dung with foliar application of Om Tryambakam homa ash at 30 and 60 DAP	1.16	0.81	7.29	7.34
T ₁₀	- Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Gloria Biosol at 30 and 60 DAP	1.30	0.85	8.92	7.55
T ₁₁	- Seedlings dipped in fresh cow urine and cow dung with foliar application of Gloria Biosol at 30 and 60 DAP	1.18	0.79	7.64	7.21
T ₁₂	- Recommended package of practices (Non-homa / Non-organic) at G - block of UAS, Dharwad (Conventional control)	1.10	0.66	6.38	6.49
T ₁₃	- Organics equivalent to RDF without seedling treatment (G- block) in Non-homa atmosphere	1.11	0.69	6.42	6.51
SEm ±		0.02	0.01	0.07	0.15
CD at 5%		0.07	0.03	0.22	0.45

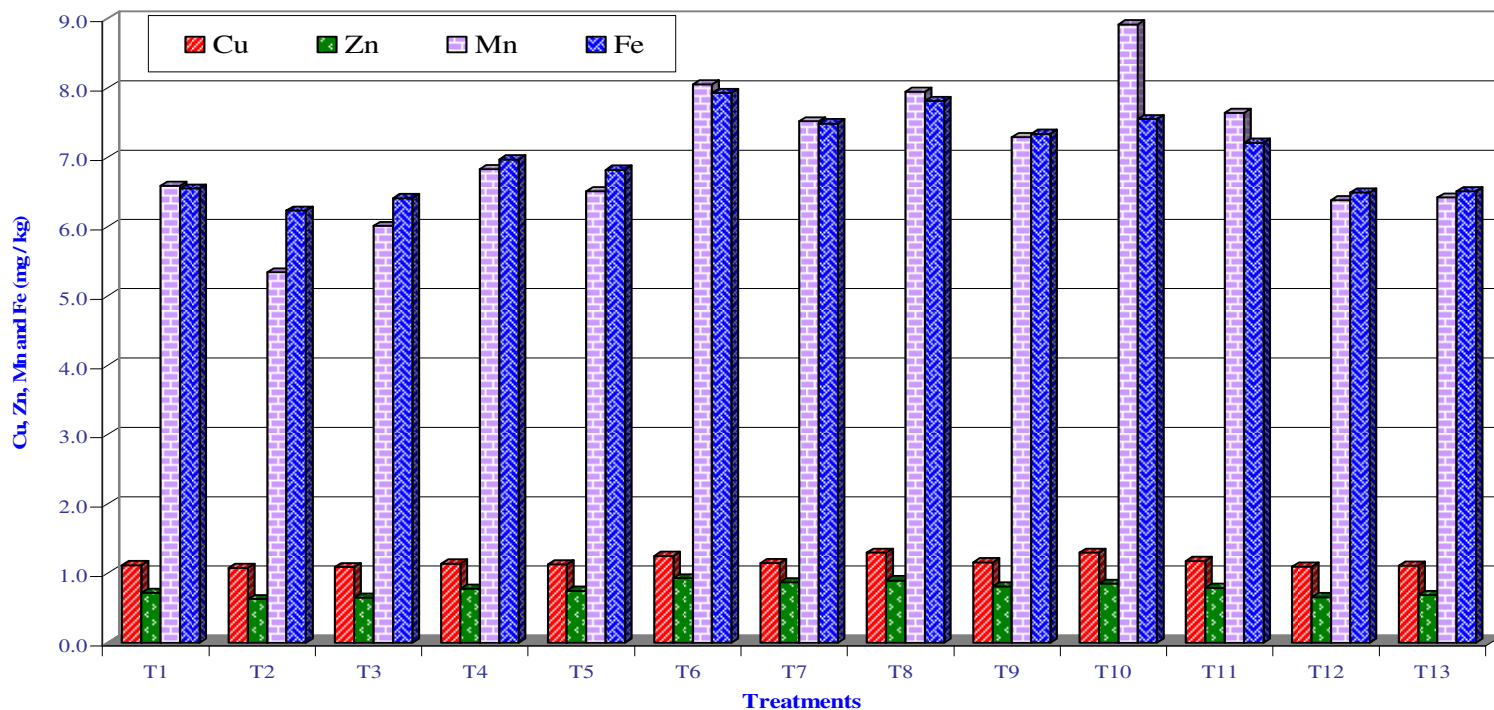


Fig. 12. Soil copper, zinc, manganese and iron content in cabbage crop (Var. Saint) as influenced by different treatments at crop harvest stage

Fig. 12. Soil copper, zinc, manganese and iron content in cabbage crop (Var. Saint) as influenced by different treatments at crop harvest stage

The Agnihotra homa ash treatments T₆ (7.93) and T₇ (7.49) differed significantly from T₃ (6.41) and T₁ (6.55) at crop harvest stage and also differed significantly among themselves.

The Om Tryambakam homa ash T₈ (7.81) and T₉ (7.34) differed significantly from T₃ and T₁ but also differed significantly among themselves at crop harvest stage.

At crop harvest stage, Gloria Biosol treatments T₁₀ (7.55) and T₁₁ (7.21) differed significantly among themselves and also from T₃ and T₁ (6.55). Among the homa ash and Gloria Biosol treatments, T₆ (7.93), T₈ (7.8) and T₁₀ (7.55) differed significantly from T₁ at crop harvest stage.

The maximum soil iron content was found in treatment T₆ followed by T₈ and T₁₀.

4.4.2 Macronutrients

4.4.2.1 Available N

The data on available soil N, P and K are presented in Table 13 and Fig.13. It is evident from the table that available nitrogen (kg/ha) did not differ significantly when T₁ (168) was compared with T₁₂ (164) at crop harvest stage.

The treatment T₂ (153) did not differ significantly from T₁₃ (168) but differed significantly from T₁ (168) and T₃ (159) did not differ significantly from the treatment T₁ at crop harvest stage studied.

The Non-homa ash treatments, T₄ (171) differed significantly from T₃ (159) but T₅ (169) did not differ significantly from T₃ and treatments T₄ and T₅ did not differ significantly from T₁ (168) but differed significantly among themselves at the crop harvest stage.

The Agnihotra homa ash treatments T₆ (191) and T₇ (184) differed significantly from T₃ (159) and T₁ (168) but did not differ significantly among themselves at crop harvest stage.

The Om Tryambakam homa ash treatments T₈ (189) and T₉ (183) differed significantly from T₃ and T₁ but were on par with each other at crop harvest stage.

At crop harvest stage, Gloria Biosol treatments T₁₀ (194) and T₁₁ (185) differed significantly from T₃ and T₁ but did not differ significantly among themselves.

Among the homa ash and Gloria Biosol treatments, T₆ (191), T₈ (189) and T₁₀ (194) differed significantly from T₁ (168) at the crop harvest stage.

The top most score for soil nitrogen content was that of T₁₀ (194) followed by T₆ (191), T₇ (184), T₈ (189) and T₁₁ (185) which were on par with T₁₀.

4.4.2.2 Available P

It is evident from Table 13 and Fig.13 that the available phosphorus (kg/ha) differed significantly when T₁ (26) was compared with T₁₂ (23) at crop harvest stage.

The treatment T₂ (20) differed significantly from T₁₃ (25) and also from T₁ (26) and T₃ (22) differed significantly from the T₁ (26) at crop harvest stage.

The Non-homa ash treatments T₄ (30) and T₅ (27) differed significantly from T₃ (22). The treatment T₄ differed significantly from T₁ (26) but T₅ did not differ significantly from T₁ at crop harvest stage and also among themselves.

The Agnihotra homa ash treatments T₆ (39) and T₇ (29) differed significantly from T₃ (22) and T₁ (26) and also among themselves at crop harvest stage.

The Om Tryambakam homa ash treatments T₈ (35) and T₉ (28) differed significantly from T₃ and treatment T₈ differed significantly from T₁ (26) and T₉ did not differ significantly from T₁ and also among themselves at crop harvest stage.

At crop harvest stage, Gloria Biosol treatments T₁₀ (31) and T₁₁ (28) differed significantly from T₃ (22) but treatment T₁₀ differed significantly from T₁ (26). The treatment T₁₁ did not differ significantly from T₁ and also did not differ significantly among themselves at crop harvest stage.

Highest potassium content was registered by T₆ (39), followed by T₈ (35) and T₁₀ (31) which significantly differed from each other.

4.4.2.3 Available K

It is evident from Table 13 and Fig. 13 that the available K (kg/ha) differed significantly when T₁ (291) was compared with T₁₂ (284) at crop harvest stage.

The treatment T₂ (282) differed significantly from T₁₃ (289) but did not differ significantly from T₁ (291). However, T₃ (287) differed significantly from the T₁ (291).

The Non-homa ash treatments, T₄ (323) and T₅ (295) only differed significantly from T₃ (287). The treatment T₄ differed significantly from T₁ (291) but T₅ did not differ significantly from T₁ and also among themselves.

The Agnihotra homa ash treatments T₆ (336) and T₇ (306) differed significantly from T₃ (287) and treatment T₄ differed significantly from T₁ (291) but T₅ did not differ significantly from T₁ and also differed significantly among themselves at crop harvest stage.

The Om Tryambakam homa ash treatments T₈ (328) and T₉ (306) differed significantly from T₃ (287) and treatment T₈ differed significantly from T₁ (291) but T₉ did not differ significantly from T₁ and also differed significantly among themselves at crop harvest stage.

The Gloria Biosol treatments T₁₀ (357) and T₁₁ (310) differed significantly from T₃ and treatment T₁₀ differed significantly from T₁ (291) but T₁₁ did not differ significantly from T₁. However, the treatments T₁₀ and T₁₁ differed significantly among themselves at crop harvest stage.

Among the homa ash and Gloria Biosol treatments, T₆ (336), T₈ (328) and T₁₀ (357) differed significantly from T₁ (291), whereas only (T₇), (T₉) and (T₁₁) significantly differed from T₁ at crop harvest stage.

4.5 Activity of soil dehydrogenase

The data on the activity of soil dehydrogenase are presented in Table 14 and depicted in Fig.14. It is evident from the table that the activity of soil dehydrogenase (μg of TPF formed / g soil / 24 h) did not differ significantly when T₁ (4.9) was compared with T₁₂ (4.6) at crop harvest stage.

The treatment T₂ (4.3) differed significantly from T₁₃ (4.8) and also from T₁ (4.9) but T₃ (4.5) did not differ significantly from the treatment T₁ at crop harvest stage.

The Non-homa ash treatments T₄ (5.5) and T₅ (5.4) differed significantly from T₃ (4.5) and T₁ (4.9) but did not differ significantly among themselves at crop harvest stage.

The Agnihotra homa ash treatments T₆ (6.6) and T₇ (6.1) differed significantly from T₃ (4.5) and T₁ (4.9) at crop harvest stage and also among themselves.

The Om Tryambakam homa ash treatments T₈ (6.3) and T₉ (5.8) differed significantly from T₃ (4.5) and T₁ (4.9) and also among themselves at crop harvest stage.

At crop harvest stage, Gloria Biosol treatments T₁₀ (7.4) and T₁₁ (6.9) differed significantly as compared to T₃ (4.5) and T₁ (4.9) and also among themselves.

The highest activity of soil dehydrogenase was observed in treatment T₁₀ followed by T₁₁, T₆ and other homa treatments.

4.6 Activity of soil phosphatase

It is evident from the Table 14 and Fig. 14 that at crop harvest stage activity of soil phosphatase (μg of PNP formed / g soil / h) differed significantly when T₁ (15.4) was compared with T₁₂ (14.3).

The treatment T₂ (13.5) differed significantly from T₁₃ (14.7) and also from T₁ (15.4) and T₃ (13.9) differed significantly from T₁ (15.4).

The Non-homa ash treatments T₄ (15.6) and T₅ (15.4) differed significantly from T₃ (13.9) but treatments T₄ and T₅ did not differ significantly from T₁ (15.4) at crop harvest stage and also among themselves.

Table 13. Soil available nitrogen, phosphorus and potassium content in cabbage crop (Var. Saint) as influenced by different treatments

Treatment details	Crop harvest stage		
	Available N	Available P	Available K
	(kg / ha)		
T ₁ - Recommended dose of organics equivalent to RDF without seedling treatment (Organic control) in homa atmosphere	168	26	291
T ₂ - No organic manures and no seedling treatment (Absolute control) in homa atmosphere	153	20	282
T ₃ - Seedlings dipped in fresh cow urine and cow dung	159	22	287
T ₄ - Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Non-homa ash at 30 and 60 DAP	171	30	323
T ₅ - Seedlings dipped in fresh cow urine and cow dung with foliar application of Non- homa ash at 30 and 60 DAP	169	27	295
T ₆ - Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Agnihotra homa ash at 30 and 60 DAP	191	39	336
T ₇ - Seedlings dipped in fresh cow urine and cow dung with foliar application of Agnihotra homa ash at 30 and 60 DAP	184	29	306
T ₈ - Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Om Tryambakam homa ash at 30 and 60 DAP	189	35	328
T ₉ - Seedlings dipped in fresh cow urine and cow dung with foliar application of Om Tryambakam homa ash at 30 and 60 DAP	183	28	306
T ₁₀ - Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Gloria Biosol at 30 and 60 DAP	194	31	357
T ₁₁ - Seedlings dipped in fresh cow urine and cow dung with foliar application of Gloria Biosol at 30 and 60 DAP	185	28	310
T ₁₂ - Recommended package of practices (Non-homa / Non-organic) at G - block of UAS, Dharwad (Conventional control)	164	23	284
T ₁₃ - Organics equivalent to RDF without seedling treatment (G- block) in Non-homa atmosphere	168	25	289
SEm ±	3.86	0.80	6.82
CD at 5%	11.29	2.35	19.90

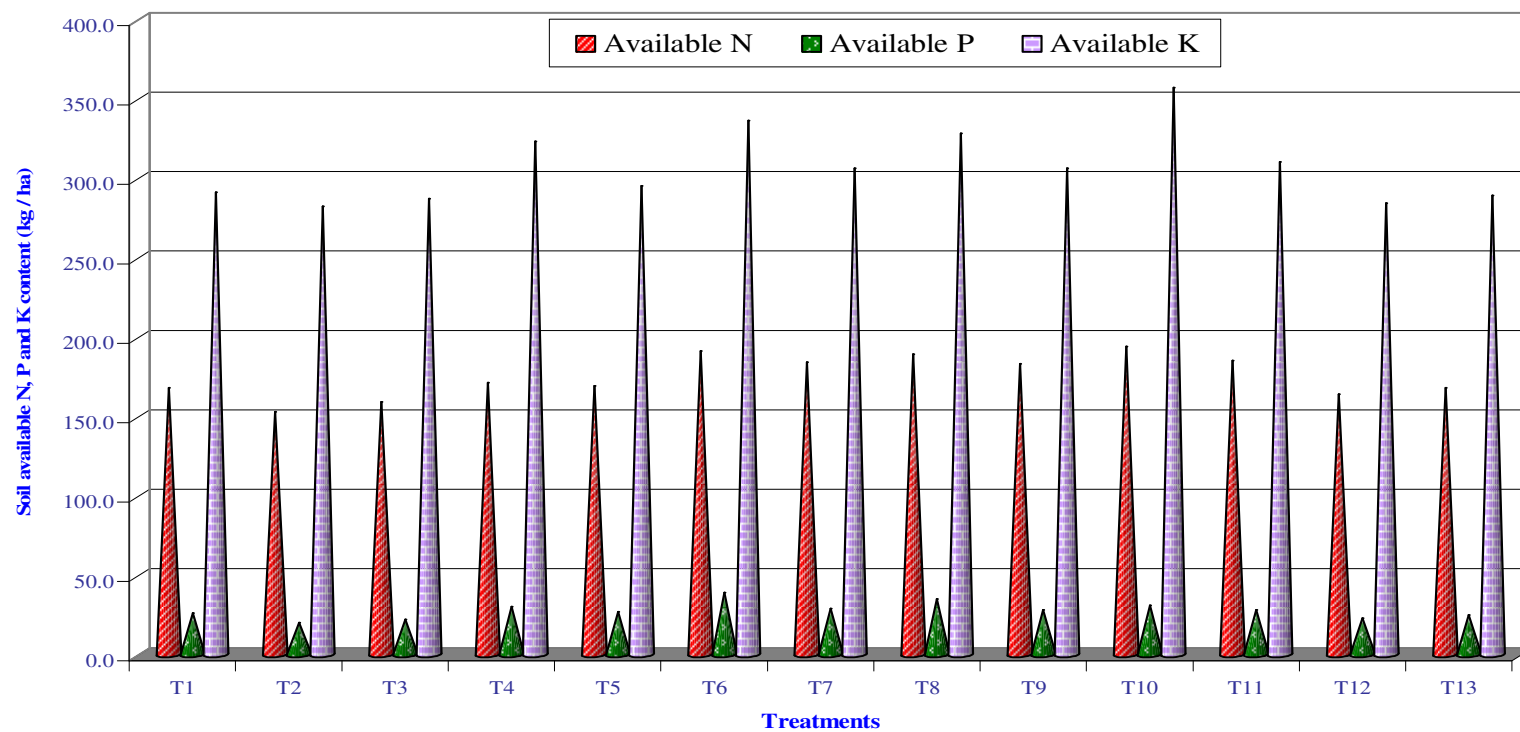


Fig. 13. Soil available nitrogen, potassium and phosphorus in cabbage crop (Var. Saint) as influenced by different treatments at crop harvest stage

Fig. 13. Soil available nitrogen, potassium and phosphorus in cabbage crop (Var. Saint) as influenced by different treatments at crop harvest stage

Table 14. Activities of soil dehydrogenase and phosphatase of cabbage crop (Var. Saint) as influenced by different treatments at crop harvest stage

Treatment details	Activity of Dehydrogenase (μg of TPF formed / g / 24 h)	Activity of Phosphatase (g of <i>p</i> -nitro-phenol released /g/ h)
T ₁ - Recommended dose of organics equivalent to RDF without seedling treatment (Organic control) in homa atmosphere	4.9	15.4
T ₂ - No organic manures and no seedling treatment (Absolute control) in homa atmosphere	4.3	13.5
T ₃ - Seedlings dipped in fresh cow urine and cow dung	4.5	13.9
T ₄ - Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Non-homa ash at 30 and 60 DAP	5.5	15.6
T ₅ - Seedlings dipped in fresh cow urine and cow dung with foliar application of Non- homa ash at 30 and 60 DAP	5.4	15.4
T ₆ - Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Agnihotra homa ash at 30 and 60 DAP	6.6	17.2
T ₇ - Seedlings dipped in fresh cow urine and cow dung with foliar application of Agnihotra homa ash at 30 and 60 DAP	6.1	16.3
T ₈ - Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Om Tryambakam homa ash at 30 and 60 DAP	6.3	16.5
T ₉ - Seedlings dipped in fresh cow urine and cow dung with foliar application of Om Tryambakam homa ash at 30 and 60 DAP	5.8	15.9
T ₁₀ - Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Gloria Biosol at 30 and 60 DAP	7.4	17.4
T ₁₁ - Seedlings dipped in fresh cow urine and cow dung with foliar application of Gloria Biosol at 30 and 60 DAP	6.9	16.3
T ₁₂ - Recommended package of practices (Non-homa / Non-organic) at G - block of UAS, Dharwad (Conventional control)	4.6	14.3
T ₁₃ - Organics equivalent to RDF without seedling treatment (G- block) in Non-homa atmosphere	4.8	14.7
SEm $\pm$ CD at 5%	0.13 0.40	0.27 0.80

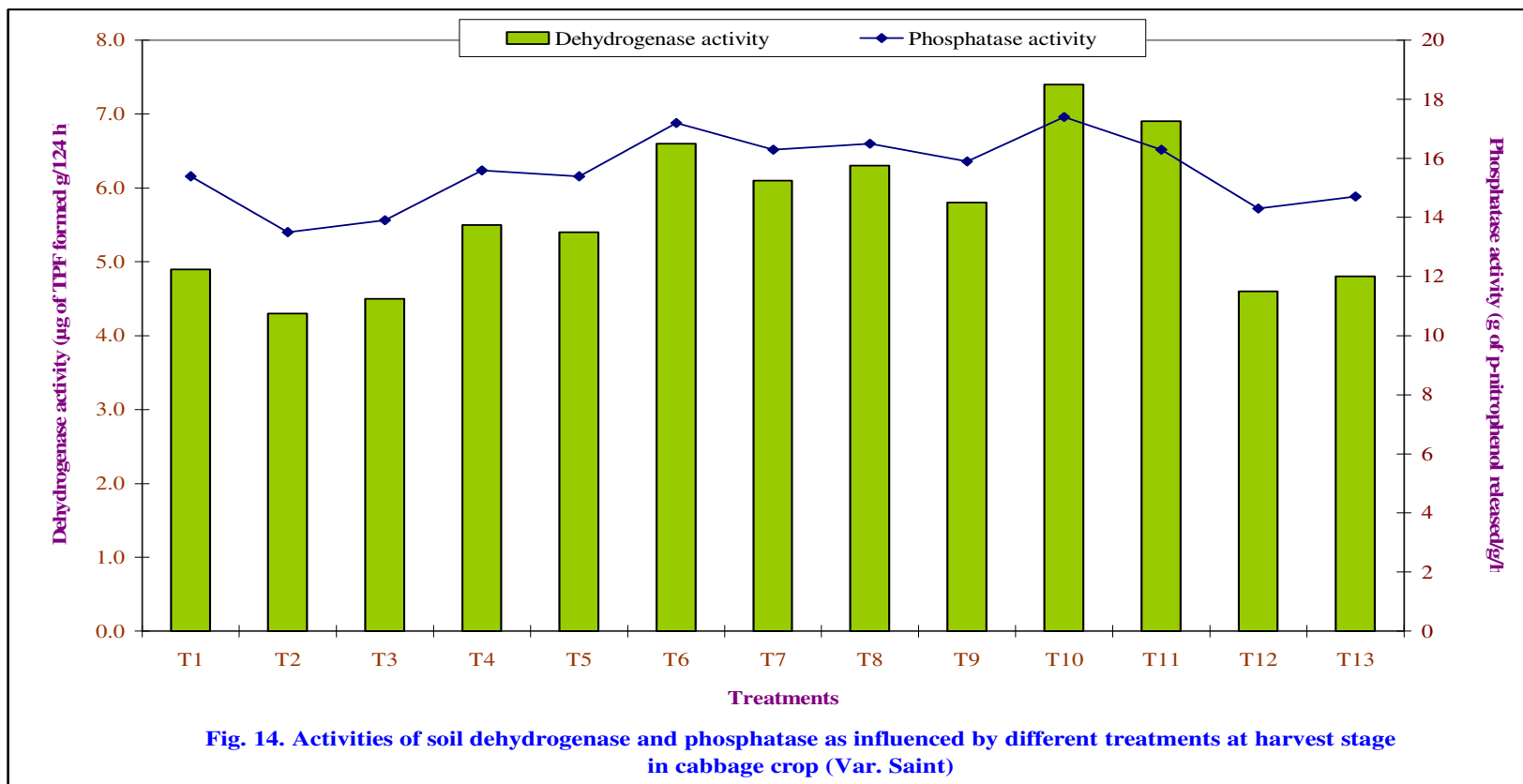


Fig. 14. Activities of soil dehydrogenase and phosphatase as influenced by different treatments at harvest stage in cabbage crop (Var. Saint)

The Agnihotra homa ash treatments T₆ (17.2) and T₇ (16.3) differed significantly from T₃ and T₁ and also differed significantly among themselves at crop harvest stage.

The Om Tryambakam homa ash treatments T₈ (16.5) and T₉ (15.9) differed significantly from T₃ (13.9) and treatment T₈ differed significantly from T₁ (15.4) but T₉ did not differ significantly from T₁ at crop harvest stage. The treatments T₈ and T₉ also did not differ significantly among themselves.

At crop harvest stage, Gloria Biosol treatments T₁₀ (17.4) and T₁₁ (16.3) differed significantly from T₃ (13.9) and T₁ (15.4) and also differed significantly among themselves.

Among the homa ash and Gloria Biosol treatments T₆ (17.2), T₈ (16.5) and T₁₀ (17.4) differed significantly from T₁ (15.4) at crop harvest stage.

The highest activity of soil phosphatase was found in T₁₀ followed by T₈, T₇ and other homa treatments.

4.7 Microbial observations

4.7.1 Soil bacterial population

The data on bacterial population (CFU × 10⁵ / g) are presented in Table 15 and Fig. 15. At crop harvest stage, the bacterial count did not differ significantly when T₁ (82) was compared with T₁₂ (78).

The treatment T₂ (73) differed significantly from T₁₃ (80) and also from T₁ (82) and T₃ (76) did not differ significantly from the treatment T₁ (82) at crop harvest stage.

The Non-homa ash treatments, T₄ (87) and T₅ (83) differed significantly from T₃ (76) but treatments T₄ and T₅ did not differ significantly from T₁ (82) and also did not differ significantly among themselves at crop harvest stage.

The Agnihotra homa ash treatments T₆ (105) and T₇ (91) differed significantly from T₃ (76) and T₁ (82) but also differed significantly among themselves at crop harvest stage.

The Om Tryambakam homa ash treatment T₈ (103) differed significantly from T₃ (76) but T₉ (89) did not differ significantly from T₃. The treatments T₈ and T₉ differed significantly from T₁ (82) at crop harvest stage and also differed significantly among themselves.

At crop harvest stage, Gloria Biosol treatments T₁₀ (112) and T₁₁ (95) differed significantly from T₃ (76) and T₁ (82) but also differed significantly among themselves.

Among the homa ash and Gloria Biosol treatments, T₆ (105), T₈ (103) and T₁₀ (112) differed significantly from T₁ (82) at crop harvest stage.

The highest bacterial count was found in the treatment T₁₀ (112) followed by T₆ (105) and T₈ (103).

4.7.2 Soil fungal population

It is evident from Table 15 and Fig.15 that the fungal population (CFU×10⁴/g) in T₁ (19) differed significantly from T₁₂ (17) at crop harvest stage.

The treatment T₂ (14) differed significantly from T₁₃ (18) and also from T₁ (19) and also differed significantly among themselves. The treatment T₃ (16) differed significantly from the T₁ at crop harvest stage studied.

The Non-homa ash treatments T₄ (20) and T₅ (19) differed significantly from T₃ (16) but treatments T₄ and T₅ did not differ significantly from T₁ (19). T₄ and T₅ also did not differ significantly among themselves at crop harvest stage..

The Agnihotra homa ash treatments T₆ (26) differed significantly from T₃ but T₇ (22) differed significantly from T₃ (16). The treatments T₆ and T₇ also differed significantly from T₁ (19) and also differed significantly among themselves at crop harvest stage.

The Om Tryambakam homa ash treatments T₈ (25) and T₉ (21) differed significantly from T₃ (16) and T₁ (19) and also differed significantly among themselves.

At crop harvest stage, Gloria Biosol treatments T₁₀ (28) and T₁₁ (23) differed significantly from T₃ (16) and T₁ (19) and also differed significantly among themselves.

Among the homa ash and Gloria Biosol treatments, T₆ (26), T₈ (25) and T₁₀ differed significantly from T₁ (19) at crop harvest stage.

The maximum fungal count was recorded by T₁₀ (28) followed by T₆ (26) and T₈ (25). The treatments T₆ and T₈, however, did not differ significantly from each other.

4.7.3 Soil actinomycetes population

It is evident from Table 15 and Fig.15 that the actinomycetes population (CFU×10³/g) differed significantly when T₁ (30) was compared with T₁₂ (26).

The treatment T₂ (23) differed significantly from T₁₃ (29) and also from T₁ (30) and T₃ (25) differed significantly from the T₁ at the crop harvest stage.

The Non-homa ash treatments, T₄ (35) and T₅ (32) differed significantly from T₃ (25). The treatment T₄ differed significantly from T₁ (30) but T₅ did not differ significantly from T₁ at crop harvest stage. The treatments T₄ and T₅ significantly differed among themselves.

The Agnihotra homa ash treatments T₆ (39) and T₇ (36) differed significantly from T₃ (25) and T₁ (30) and T₆ and T₇ also differed significantly among themselves at crop harvest stage.

The Om Tryambakam homa ash treatments T₈ (37) and T₉ (34) differed significantly from T₃ (25) and T₁ (30) at the crop harvest stage and also differed significantly among themselves.

At crop harvest stage, Gloria Biosol treatments T₁₀ (40) and T₁₁ (37) differed significantly from T₃ and T₁ and also differed significantly among themselves at crop harvest stage.

Among the homa ash and Gloria Biosol treatments, the treatments T₆ (39), T₈ (37) and T₁₀ (40) differed significantly from T₁ (30) at the crop harvest stage.

The highest count of actinomycetes was recorded by treatment T₁₀ (40) followed by T₈ (37) and T₁₁ (37).

4.8 Disease incidence

4.8.1 Black rot

The data on the incidence of Black rot (%) are presented in Table 16 and depicted in Fig. 16. It is evident from the table that incidence of Black rot differed significantly when T₁ (9.14) was compared with T₁₂ (11.34).

The treatment T₂ (9.88) did not differ significantly from treatment T₁₃ (10.06) and also from T₁ (9.14). Similarly, T₃ (8.79) did not differ significantly from the treatment T₁ (9.14).

The Non-homa ash treatment T₄ (7.12) differed significantly from T₃ (8.79) and T₁ (9.14) but T₅ (8.32) did not differ significantly from T₃ (8.79) and T₁. However, T₄ and T₅ differed significantly among themselves.

The Agnihotra homa ash treatments T₆ (5.24) and T₇ (5.98) differed significantly from T₃ (8.79) and T₁ (9.14) but did not differ significantly among themselves.

The Om Tryambakam homa ash treatments, T₈ (6.00) and T₉ (6.35) differed significantly from T₃ and T₁ but were on par with each other.

The Gloria Biosol treatments T₁₀ (4.50) and T₁₁ (4.84) differed significantly from T₃ and T₁ but were on par with each other.

The lowest score of Black rot was registered by T₁₀ (4.50) followed by T₁₁ (4.84) which were on par with each other. Other treatments also showed significant reduction in the incidence of Black rot (T₄-T₉) as compared to T₁, T₂ and T₁₂.

Table 15. Soil microbial count for bacteria, fungi and actinomycetes in cabbage crop (Var. Saint) as influenced by different treatments at crop harvest stage

Treatment details		Bacteria (CFU × 10 ⁵ /g)	Fungi (CFU × 10 ⁴ /g)	Actinomycetes (CFU × 10 ³ /g)
T ₁	- Recommended dose of organics equivalent to RDF without seedling treatment (Organic control) in homa atmosphere	82	19	30
T ₂	- No organic manures and no seedling treatment (Absolute control) in homa atmosphere	73	14	23
T ₃	- Seedlings dipped in fresh cow urine and cow dung	76	16	25
T ₄	- Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Non-homa ash at 30 and 60 DAP	87	20	35
T ₅	- Seedlings dipped in fresh cow urine and cow dung with foliar application of Non- homa ash at 30 and 60 DAP	83	19	32
T ₆	- Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Agnihotra homa ash at 30 and 60 DAP	105	26	39
T ₇	- Seedlings dipped in fresh cow urine and cow dung with foliar application of Agnihotra homa ash at 30 and 60 DAP	91	22	36
T ₈	- Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Om Tryambakam homa ash at 30 and 60 DAP	103	25	37
T ₉	- Seedlings dipped in fresh cow urine and cow dung with foliar application of Om Tryambakam homa ash at 30 and 60 DAP	89	21	34
T ₁₀	- Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Gloria Biosol at 30 and 60 DAP	112	28	40
T ₁₁	- Seedlings dipped in fresh cow urine and cow dung with foliar application of Gloria Biosol at 30 and 60 DAP	95	23	37
T ₁₂	- Recommended package of practices (Non-homa / Non-organic) at G - block of UAS, Dharwad (Conventional control)	78	17	26
T ₁₃	- Organics equivalent to RDF without seedling treatment (G- block) in Non-homa atmosphere	80	18	29
SEm ±		2.12	0.51	0.91
CD at 5%		6.20	1.51	2.67

CFU – Colony forming unit

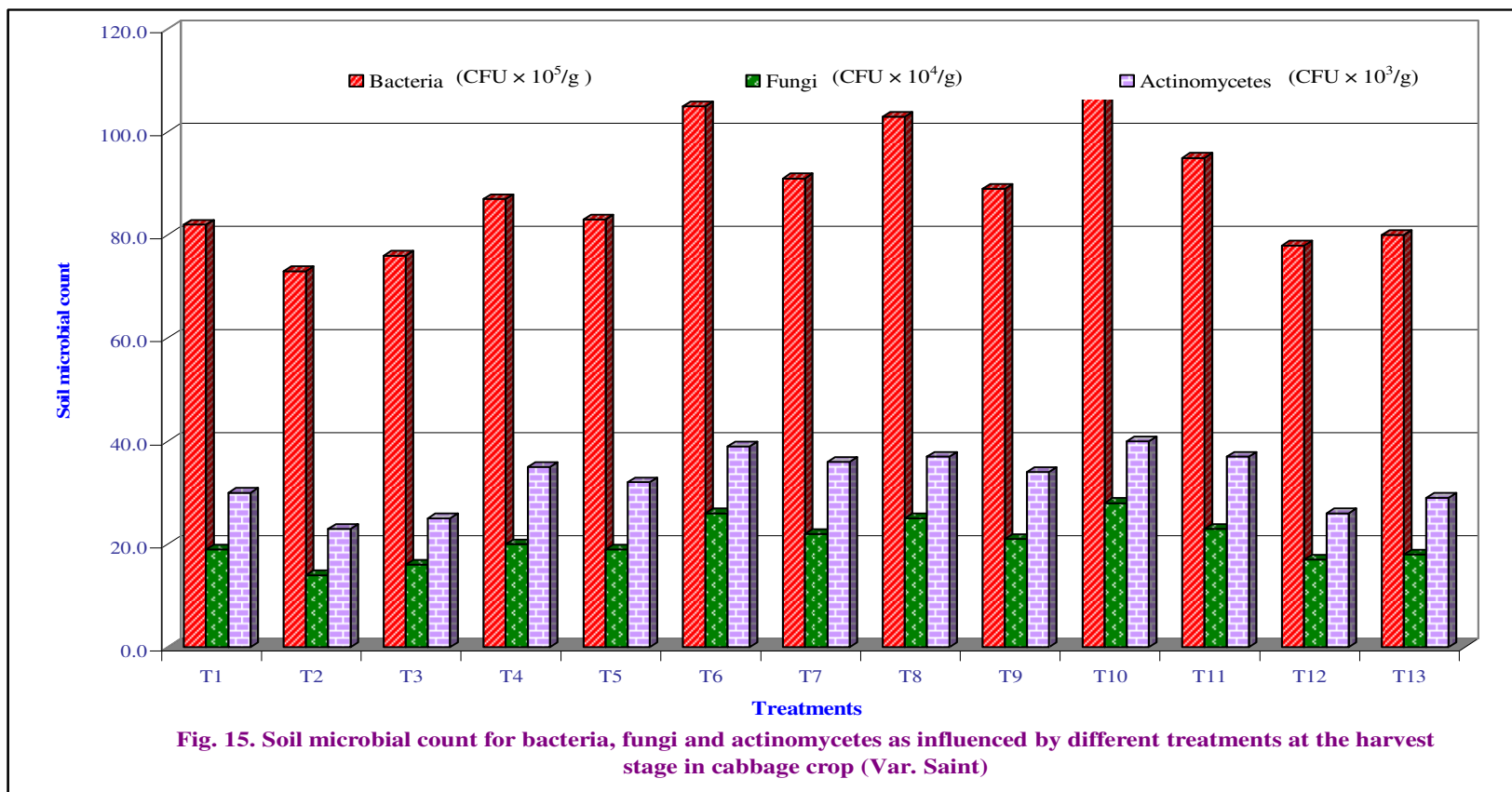


Fig. 15. Soil microbial count for bacteria, fungi and actinomycetes as influenced by different treatments at the harvest stage in cabbage crop (Var. Saint)

4.8.2 Black spot of leaf

The data on incidence of Black spot of leaf are presented in Table 16 and Fig. 16. It is evident from the table that incidence of Black spot of cabbage leaf (%) differed significantly when T₁ (15.22) was compared with T₁₂ (19.29).

The treatment T₂ (24.82) differed significantly from treatment T₁₃ (17.97) and T₃ (20.98) differed significantly from the treatment T₁ (15.22).

The Non-homa ash treatments, T₄ (10.91) and T₅ (12.52) differed significantly from T₃ (20.98). However, they did not differ significantly among themselves.

The Agnihotra homa ash treatments T₆ (7.17) and T₇ (8.89) differed significantly from T₃ (20.98) but were on par with each other.

The Om Tryambakam homa ash treatments T₈ (8.02) and T₉ (9.57) differed significantly from T₃ (20.98) but were on par with each other.

The Gloria Biosol treatments T₁₀ (4.88) and T₁₁ (5.21) differed significantly from T₃ (20.98) but did not differ from each other significantly.

The lowest score of Black spot of leaf was observed by T₁₀ (4.88) followed by T₁₁ (5.21) and other treatments showed significance decrease in the incidence of Black spot of leaf (T₄ - T₉) as compared to T₁, T₂ and T₁₂.

4.9 Pest incidence

4.9.1 Head borer

It is evident from the Table 16 and Fig. 16 that head borer damage of cabbage (%) did not differ significantly when organic control with homa T₁ (14.72) was compared with conventional control T₁₂ (15.95).

The treatment T₂ (18.08) differed significantly from treatment T₁₃ (14.59) but T₁ (14.72) did not differ significantly from T₂. The treatment T₃ (16.96) did not differ significantly from the treatment T₁ (14.72).

The Non-homa ash treatments T₄ (11.98) and T₅ (13.59) differed significantly from T₃ (16.96). The treatment T₄ differed significantly from T₁ (14.72) but T₅ did not differ significantly from T₁ and T₄ and T₅ also did not differ significantly among themselves.

The Agnihotra homa ash treatments T₆ (6.42) and T₇ (7.54) differed significantly from T₃ (16.96) and T₁ (14.72) but did not differ significantly among themselves.

The Om Tryambakam homa ash treatments T₈ (8.75) and T₉ (10.63) differed significantly from T₃ (16.96) and T₁ (14.72) but did not differ among themselves.

The Gloria Biosol treatments T₁₀ (4.58) and T₁₁ (5.69) differed significantly from T₃ and T₁ but did not differ among themselves.

The lowest damage by head borer was registered in T₁₀ (4.58) followed by T₁₁ (5.69) which were on par with each other. Other homa treatments showed significant reduction in the incidence of head borer (T₄ - T₉) as compared to T₁, T₂ and T₁₂.

4.9.2 Diamond back moth larvae

It is evident from the Table 16 and Fig. 16 that the number of Diamond back moth larvae per plant on cabbage differed significantly when T₁ (5.30) was compared with T₁₂ (8.42).

The treatment T₂ (5.74) did not differ significantly from treatment T₁₃ (6.31) and T₁ (5.30) and T₃ (5.32) did not differ significantly from the treatment T₁ (5.30).

The Non-homa ash treatments T₄ (4.75) and T₅ (4.94) did not differ significantly from T₃ (5.32) and T₁ (5.30) but T₄ and T₅ were on par with each other.

The Agnihotra homa ash treatments T₆ (2.29) and T₇ (2.35) differed significantly from T₃ (5.32) and T₁ (5.30) but did not differ significantly among themselves.

Table 16. Incidence of pest and diseases and insect attack in cabbage crop (Var. Saint) as influenced by different treatments at crop harvest stage

Treatment details	Black rot incidence (%)	Black spot of leaf incidence (%)	Head borer damage (%)	No. of diamond back moth larvae / plant	Spodoptera larvae / plant
T ₁ - Recommended dose of organics equivalent to RDF without seedling treatment (Organic control) in homa atmosphere	9.14	15.22	14.72	5.30	6.34
T ₂ - No organic manures and no seedling treatment (Absolute control) in homa atmosphere	9.88	24.82	18.08	5.74	6.52
T ₃ - Seedlings dipped in fresh cow urine and cow dung	8.79	20.98	16.96	5.32	5.86
T ₄ - Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Non-homa ash at 30 and 60 DAP	7.12	10.91	11.98	4.75	4.78
T ₅ - Seedlings dipped in fresh cow urine and cow dung with foliar application of Non-homa ash at 30 and 60 DAP	8.32	12.52	13.59	4.94	4.95
T ₆ - Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Agnihotra homa ash at 30 and 60 DAP	5.24	7.17	6.42	2.29	3.00
T ₇ - Seedlings dipped in fresh cow urine and cow dung with foliar application of Agnihotra homa ash at 30 and 60 DAP	5.98	8.89	7.54	2.35	3.14
T ₈ - Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Om Tryambakam homa ash at 30 and 60 DAP	6.00	8.02	8.75	2.42	3.25
T ₉ - Seedlings dipped in fresh cow urine and cow dung with foliar application of Om Tryambakam homa ash at 30 and 60 DAP	6.35	9.57	10.63	2.62	3.90
T ₁₀ - Seedlings dipped in fresh cow urine and cow dung with soil and foliar application of Gloria Biosol at 30 and 60 DAP	4.50	4.88	4.58	3.43	3.86
T ₁₁ - Seedlings dipped in fresh cow urine and cow dung with foliar application of Gloria Biosol at 30 and 60 DAP	4.84	5.21	5.69	3.89	3.27
T ₁₂ - Recommended package of practices (Non-homa / Non-organic) at G - block of UAS, Dharwad (Conventional control)	11.34	19.29	15.95	8.42	9.88
T ₁₃ - Organics equivalent to RDF without seedling treatment (G- block) in Non-homa atmosphere	10.06	17.97	14.59	6.31	7.96
SEm ±	0.55	0.62	0.78	0.27	0.26
CD at 5%	1.61	1.83	2.28	0.80	0.78

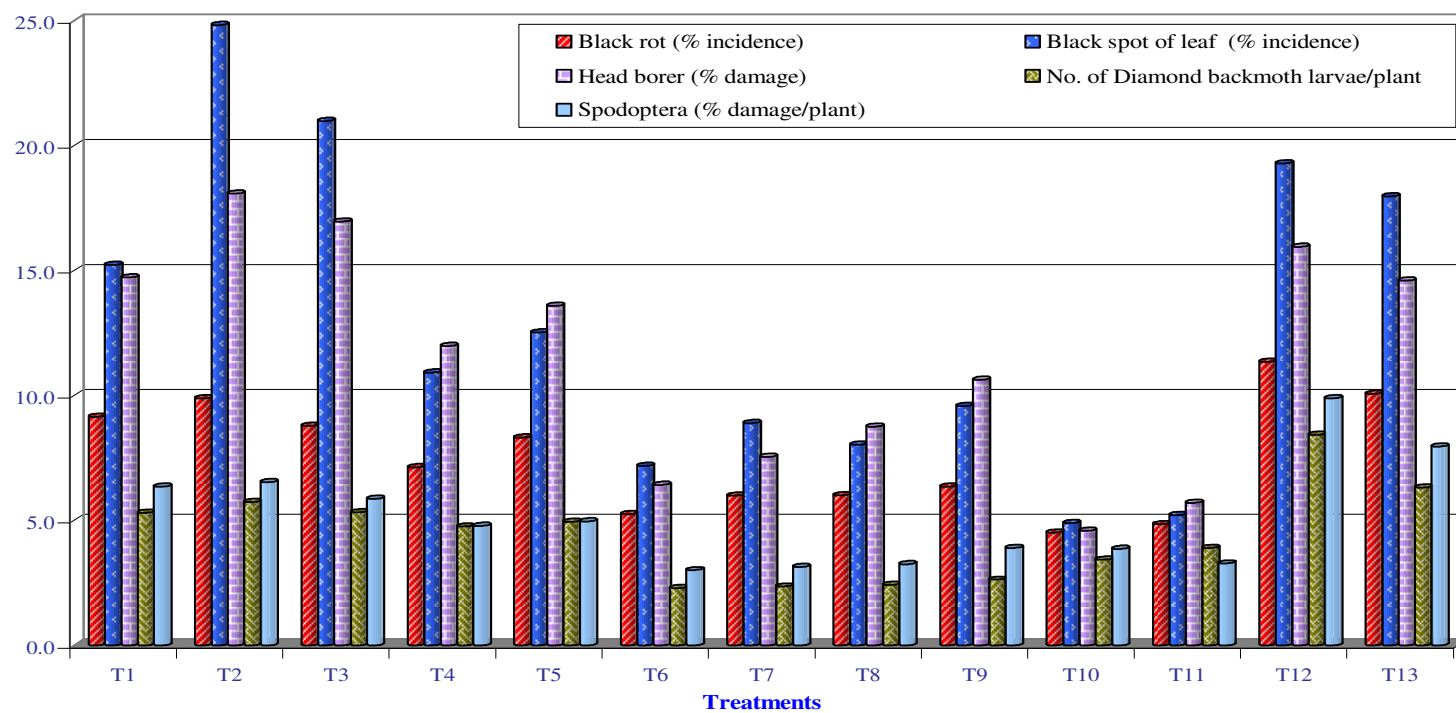


Fig. 16. Incidence of pest and diseases and insect attack in cabbage (Var. Saint) as influenced by different treatments at crop harvest stage

Fig. 16. Incidence of pest and diseases and insect attack in cabbage (Var. Saint) as influenced by different treatments at crop harvest stage

The Om Tryambakam homa ash treatments T_8 (2.42) and T_9 (2.62) differed significantly from T_3 (5.32) and T_1 (5.30) but did not differ significantly among themselves.

The Gloria Biosol treatments T_{10} (3.43) and T_{11} (3.89) differed significantly from T_3 (5.32) and T_1 (5.30) but were on par with each other.

The lowest score of Diamond back moth larvae per plant was registered by T_6 (2.29) followed by T_7 (2.35) which were on par with each other. Other treatments showed significant reduction in the incidence of larvae (T_8 - T_{11}) as compared to T_1 , T_2 and T_{12} .

4.9.3 Spodoptera larvae per plant

It is evident from the Table 16 and Fig. 16 that spodoptera larvae per cabbage plant differed significantly when T_1 (6.34) was compared with T_{12} (9.88).

The treatment T_2 (6.52) differed significantly from treatment T_{13} (7.96) but T_2 did not differ significantly from T_1 (6.34) and also T_3 (5.86) did not differ significantly from the treatment T_1 (6.34).

The Non-homa ash treatments T_4 (4.78) and T_5 (4.95) differed significantly from T_3 (5.86) and T_1 (6.34) but did not differ significantly among themselves.

The Agnihotra homa ash treatments T_6 (3.00) and T_7 (3.14) differed significantly from T_3 (5.86) and T_1 (6.34) but were on par with each other.

The Om Tryambakam homa ash treatments T_8 (3.25) and T_9 (3.90) differed significantly from T_3 (5.86) and T_1 (6.34) but did not differ significantly among themselves.

The Gloria Biosol treatments T_{10} (3.86) and T_{11} (3.27) differed significantly from T_3 (5.86) and T_1 (6.34) but were on par with each other.

The lowest score of spodoptera larvae per plant was registered by T_6 (3.00) followed by T_7 (3.14) and T_{11} (3.27) which were on par with each other. Other treatments also showed significant decrease in the pest attack by spodoptera (T_8 and T_9) as compared to T_1 , T_2 and T_{12} .

5. DISCUSSION

Vegetables constitute a substantial part of human diet supplying vitamins and minerals. Among large number of vegetables, cabbage is one of the important vegetables grown throughout the world because of its health improving constituents like minerals and vitamins. It is consumed in fresh, cooked or processed form. For the past three decades, with greed to get higher yields, there has been a tendency for indiscriminate use of synthetic fertilisers, pesticides, herbicides *etc.*, in its production system. Besides, there is also a growing threat to the soil health, environmental safety and crop productivity. This could be minimised through organic farming system which involves combined use of different organic sources, bio-fertilisers and biological management of pest and diseases. The organic culture is more relevant in vegetable crops in general and cabbage in particular, as the produce is consumed fresh and within a short period after harvest leaving little scope for degradation of health hazardous pesticides.

The health hazards due to agrochemicals could be minimized through home organic farming (HOF) system which involves combined use of organic sources, home ash and biological management of pests and diseases for better quality of the produce. The home organic culture leaves little scope for the use of hazardous pesticides and insecticides. The present investigation therefore was undertaken with a view to study the effect of HOF on growth, quality and yield of cabbage as well as on the health of the soil and environment. The results obtained in the present study are discussed hereunder.

Age-old practices in agriculture have undergone sweeping changes with the introduction of latest scientific techniques involving machineries and variety of chemicals including poisonous ones to get maximum yield from the available land. Organic farming practices avoid use of agrochemicals ensuring health of the soil and the produce. The HOF technique requires organic farming as a base and hence, in the present study, no chemical fertilizers, pesticides and insecticides and genetically modified seeds were used. Further, Agnihotra and Om Tryambakam homa (yajnya) were performed in the organic field and ash obtained was used as one of the organic inputs in an agricultural field. For conducting homa, dung from cows and bullocks of Indian origin was used in the preparation of dried dung cakes and ghee prepared from Gir (Gujarat) cows' milk was used. In addition to these items, organically grown and unpolished, uncooked full rice grains were used.

5.1 Effect of home organic farming practices on growth and yield of cabbage

Crop yield is a complex phenomenon and is manifested through several growth and yield contributing crop or plant characters. In the present investigation, the cabbage plants in general, were vigorous in growth in terms of increased plant height, number of outer leaves per plant, leaf area, dry matter production per plant, dry matter production per head, number of inner leaves per head, diameter of cabbage head, surface area of cabbage head, days taken for initiation of cabbage head formation and days taken for maturity of cabbage head. These parameters were significantly influenced by Gloria Biosol treatments and were highest at 30 and 60 DAP and crop harvest stages and lowest in absolute control (T_2), wherein only organic manures without seedling treatment were supplied to the plants (Tables 1 to 7).

The observed increase in the growth and yield parameters of cabbage may be due to solubilization effect of plant nutrients by FYM and vermi compost used, seedling treatment with a mixture of fresh cow dung and cow urine given which might have increased uptake of N, P and K and also due to its favourable effect on several physical properties of the soil as observed by Subbaih *et al.* (1983). They ascribed the improvement in the plant growth parameters under the treatment with *azotobacter*, cow dung, rock phosphate and phosphate solubilizing bacteria to cow dung that influenced the physical, chemical and biological properties of soil by supplying macro and micro nutrients leading to better plant growth and development. Studies by Meelu (1996), Patidar and Mali (2004) and Sing *et al.* (2009) reveal that organic manures increase the growth attributes of rice, sorghum, ginger and other crops and thus extend support to the findings of this investigation on growth attributes.

It may be recalled here that the cabbage yield expressed in tones per hectare (Table 7) due to soil and foliar application of Gloria Biosol (T_{10}) was on par with all the other homa treatments (T_4 to T_{11}) but recorded significantly higher yield of cabbage head as compared to Non-homa ash (T_5) by over 8 per cent (3.26 t/ha increase) and over organic control treatment exposed to homa atmosphere (T_1) by over 13 per cent (4.14 t/ha increase). The Gloria Biosol also recorded about 15 per cent increase in the yield each over conventional control (4.91 t/ha increase) and organic Non-homa control (4.78 t/ha increase). The yields obtained from homa organic control (T_1) and from non-homa organic control (T_{13}) were on par with each other indicating thereby that only creating homa atmosphere was not sufficient to boost the production of cabbage significantly in an organic field. The better nutrient availability and nutrient uptake due to HOF practices might have increased the growth and yield of cabbage as noticed by earlier workers with organic sources of nutrients in cabbage (Smith and Hadley, 1988; Subhan, 1988; Farooque and Islam, 1989; Bharadwaj *et al.*, 2000; Lodhe, 2002; Yadav and Yadav, 2002; Chitrakar, 2004 and Ghuge *et al.*, 2007). This clearly indicates that comparable yields may be obtained when the plants are supplied with organic sources as compared with conventional practices. In other words, the entire nutrient requirement of the plants could be met exclusively through organics without impairing their productivity whenever organic sources are available in abundance at low cost or they could be integrated with inorganic sources whenever their availability is limited.

It may be noted here that Gloria Biosol used in this study is a homa bio-digester recommended by Fivefold Path Mission (FFPM), Dhule, Maharashtra for farming operations (Weir, 2009) used successfully in tomato by Brunda (2011). It may be noted that Gloria Biosol contains 750 g of Agnihotra ash in 200 liters of water along fresh cow dung, vermi compost, cow urine and a copper Shree Yantram (Appendix-I). It may be appropriate to mention here that Agnihotra homa ash contains 97 per cent P_2O_5 (Potdar, 1992). This additional homa ash present in Gloria Biosol treatment along with its other natural ingredients might have produced better results in this investigation.

In case of cabbage head weight per plant, Agnihotra homa ash registered an upper hand (Table 4). The results on the head weight and yield per hectare reveal that Agnihotra homa ash had better effect over Om Tryambakam homa ash and Non-homa ash.

Mondkar (1982) had reported beneficial effects of Agnihotra atmosphere (smoke) in reducing aerial microbial population. Fernandes (1985) had also reported the beneficial effects of Agnihotra homa smoke on the yield of Canadeal Barba Negra variety of wheat. The seeds of this variety were planted very close to the place where daily Agnihotra was performed. The wheat crop received no ash but only smoke from the Agnihotra fire which enabled wheat to grow very high and yield was double. Heschl (2009) reported the beneficial effects of Agnihotra smoke on soybean crop. At Indore in Madhya Pradesh, Agnihotra was performed daily in the farm of Prestige Feed Mills. The neighbouring farms which did not perform Agnihotra but received only smoke from the daily performance of Agnihotra at the farm of the Mills got the best yield of soybean varying from 700 kg to 1200 kg per ha as against their own best of 350 kg per ha in the previous year.

These reports indicate efficacy of homa smoke over conventional practices in agriculture.

5.2 Effect of homa organic farming practices on soil macro and micro nutrient status

Agnihotra homa ash has been reported to be useful in releasing P from the soil (Tung Ming, 1987). Although the investigation on the presence of P solubilizing bacteria in the Gloria Biosol (Table 13) was not carried out in this investigation, its efficacy in releasing increased amount of Cu (16%), Zn (18%), Mn (35%) and Fe (15%) from the soil (Table 12) and increase in the activities of enzymes related to soil fertility like soil dehydrogenase by over 51 per cent and that of soil phosphatase by over 13 per cent (Table 14) at crop harvest stage as compared to organic control exposed to homa atmosphere can not be overlooked. Increase in the content of soil Zn, Fe, Cu and Mn on incorporation of organic manure (Appavu *et al.*, 2000; Jadhav *et al.*, 2001 and Prakash *et al.*, 2002) and increase in the activity of soil dehydrogenase (Kamalesh *et al.*, 1991; Chiltesh, 2005; Nandani, 2006 and Suma, 2007) on receiving FYM treatment matches well with the efficacy shown by Gloria Biosol treatment.

It may be noted that Zn has been identified as an essential cofactor in over 300 enzymes and is the most common Lewis acid in the bioinorganic chemistry (Williams and de Silva, 2000). In enzymatic sites, Zn generally forms complexes with coordination numbers less than 6 and typically a tetrahedral geometry is observed. In the tetrahedral environment, the metal is usually ligated by any three nitrogen, oxygen or sulphur donors of His, Glu, Asp and Cys.

Water is always a ligand at the catalytically active site (Auld, 2001). The Zn-dependent enzymes include alcohol dehydrogenases, carbonic anhydrases and metalloproteinases (Cox and Phillips, 2007). The dehydrogenase activity has been reported to be involved in the respiratory chain of micro organisms and has often been used as a parameter to evaluate the overall microbial activity of soil (Serra-Wittling *et al.*, 1995). Similarly, vermi compost from biological sludge was incorporated into clay soil and soil biochemical activity was assessed (Masciandaro *et al.*, 1997). It was found to stimulate the activity of dehydrogenase, protease and phosphatase. Although the enzymes studied in the present investigation namely, dehydrogenase and phosphatase showed increased activities in the soil treated with homa amendments (Table 14), it is difficult to point out the exact role played by them in the light of complexity of enzymatic reactions in the soil and the roles of different metals involved. It may be appropriate to study in future the enzymes related to Cu, Zn, Mn and Fe taking in to consideration their increased status observed in the present study on receiving homa treatments.

The increase in microbial population (Table 15) of bacteria (36%), fungi (47%) and actinomycetes (33%) at crop harvest stage as compared with organic control exposed to homa atmosphere derives support from the observations on application of vermicompost and organic amendments effective micro organisms of Masciandaro *et al.* (2000), Xu and Xu (2000), Chiltesh (2005), Nandani (2006) and Suma (2007). The results of HOF workers also lend support the observations of this investigation that the rejuvenation of soil occurs due to different homa treatments (Johnson and Heschl, 2009; Naik, 2009; Mutalikdesai, 2009; Kumari Namrata, 2010 and Brunda, 2011). The observed increase in the availability of soil N in this study (Table 13) may be attributed to improved soil properties and nodulation due to homa treatments which might have enhanced N-fixation and mineralization of organic nitrogen by minimizing nitrogen loss. Lowest N content observed in absolute control treatment (T_2) at harvest stage (153 kg/ha) may be due to no addition of organic nutrients and no seedling treatment. The observation that soil and foliar application of homa ashes (T_6 and T_8) recorded higher content of available K receives support from the studies of Balaji (1994) and that of Chaudhary (2003), Chithesh (2005) and Suma (2007) in increasing available N due to different homa treatments in this study.

Kumari Namrata (2010) during *kharif* observed 3-151 per cent increase in soil Zn content in her soybean experiment with HOF on soil and foliar application of Biosol and 50-430 per cent increase in the soil dehydrogenase activity when compared with organic control exposed to homa atmosphere and 7-278 per cent due to conventional practices as compared with different homa treatments including Biosol treatment. She also observed excellent root nodulation as compared to control exposed to homa atmosphere. As compared to other liquid bio-digesters like Panchgavya (Palekar, 2006), Gloria Biosol used in the present investigation becomes a very easily preparable, low cost bio-fertilizer, eco-friendly and non-hazardous liquid manure within the reach of even poor farmers. Soil application of Biosol (Guzman, 2006) in combination with different homa ashes was reported by Kumari Namrata (2010) to be more effective than its foliar application alone with respect to soil dehydrogenase activity, whereas its foliar application was superior in controlling rust and insect attack. It may be noted here that Gloria Biosol used in this investigation (Appendix-I) differed from Biosol (Guzman, 2006) used by Kumari Namrata (2010) in its Agnihotra ash, cow dung and vermi compost composition. The Gloria Biosol contains 750 mg of Agnihotra ash as against 5 kg used in Biosol prepared by Kumari Namrata. It also does not contain compost from plant residues (Appendix-I). It is compensated by increasing the amount of vermi compost and fresh cow dung from 75 kg each in Biosol to 80 kg each in Gloria Biosol.

The application of homa ash plays a major role in dissolution of native phosphorus compounds and makes them available to the plants besides mineralization as they contain appreciable amount of phosphorus (Potdar, 1992).

Gardner *et al.*, (1988) observed that incorporation of organic matter in the soil increases availability of soil phosphate due to chelation of Fe and Al by metabolites of microbial decomposition responsible for the phosphate fixation in soil and organic acids during decomposition of organic manure and convert insoluble form of phosphorus to soluble form. Similar possibility due to application of Gloria Biosol and homa ashes can not be ruled out. The available P in soil (Table 13) was highest in Gloria Biosol treatment followed by Agnihotra homa ash and Om Tryambakam homa ash treatments as compared to organic control exposed to homa atmosphere and also other non homa treatments. The observed improvement in available soil P due to homa treatments may be attributed to the production of organic acids by P solubilisers during decomposition of added organic manures which, in turn, might have converted fixed P in to available P in the soil (Gardner *et al.*, 1988).

Stevenson (1982) also reported increased availability of P in organically amended soil. It is also possible that the chelating effect of organic manures might have lowered the fixation rate of Al-P and Fe-P in the soil as observed by Saravanapandian (1998).

It may be remembered that the P_2O_5 content of Agnihotra ash has been reported to be 97 per cent which includes rice ash with 54 per cent H_3PO_4 (Potdar, 1992). Tung Ming (1987) reported that Agnihotra homa ash effectively released P from the soil. The Gloria Biosol treatment recorded highest available soil P (357 kg/ha) in this study which may be due to the organic and inorganic acids produced during decomposition of organic manures helping the release of mineral-bound insoluble P (Bhanushalini *et al.*, 2002 and Prasad and Rokima, 1991).

Micronutrients are essential for enzyme and metabolic activities and for the oxidation and reduction reactions in the plant kingdom. Organic manures are rich in micro nutrients (Katyal, 1986; Venkatesh *et al.*, 1998 and Jadhav *et al.*, 2001). This fact has been reflected in the increased micro nutrient content in the soils as observed in the treatments wherever homa treatments were imposed in the present investigation. It may be recalled that the highest values for available Cu, Zn, Mn and Fe were recorded in Gloria Biosol treatment followed by Agnihotra homa ash treatment (Table 12).

Gardner *et al.* (1988) reported that copper is found in primary and secondary minerals but occurs primarily in organic complexes. It plays an important role in photosynthesis as a part of chloroplast enzyme plastocyanin in the electron transport system. It also helps in the conversion of ferrous ions to ferric ions. Copper is part of several oxidases such as ascorbic acid and polyphenol oxidases. Species and cultivars differ in tolerance to copper. Use of copper semi-pyramid and Shree Yantram in the field during performance of homa and in the preparation of Biosol, respectively has important roles to play in HOF. In addition to these properties, electric and heat conduction by copper and its spermicidal/bactericidal activities are well known. Increase in the copper content of soil (16%) in homa atmosphere with Gloria Biosol treatment as compared to organic control exposed to homa atmosphere control (T_1) in this study indicates the role of copper in HOF.

It may be noted that nearly 70 per cent of zinc and copper in soils occur in organic form (Katyal, 2000). Association of organic matter and availability of these nutrients has been confirmed by high values of coefficients of correlation between these soil attributes through a range of studies (Lal and Kang, 1982). Stevenson (1982) also listed organic matter as the most influential factor modulating nutrient availability across diverse soils.

Bhujbal (1982) observed that the Agnihotra treatments act in two ways; one by rejuvenating the soil micro flora and other by reducing the pest and insect attack. Increase in soil micro flora (Table 15) observed due to homa atmosphere, homa ash and Gloria Biosol application in this study, therefore, receives support from Bhujbal's study.

The healthy soils have been reported to be beneficial for the good health of the plants (Rameshwar *et al.*, 2009). The use of 7-10 day old cattle urine (1:1) at the rate of 50 ml per plant in vegetable crops for the control of diseases like powdery mildew on broad leaf mustard was studied by Budhathoki (1993). Combining cabbage crop with mustard lowered the incidence of diamond back moth on cabbage crop and recorded 75 per cent higher yield of marketable cabbage heads than the untreated ones (Pawar and Lawande, 1995).

Although such a combination of cabbage with mustard was not attempted in the present investigation and cow urine was used in the preparation of Gloria Biosol and for the seedling treatment ($T_4 - T_{11}$), it is felt worthwhile to make attempts in this direction for getting higher and healthy yields.

In this investigation, an attempt was made to create healthy soil and environment for the cabbage crop through performance of homa of two different types. The performance of the cabbage crop studied scored over conventional control and also over organic controls, with and without homa. It may, therefore be inferred that performance of homa in the field was not to kill, but to strengthen the health of the plants, enabling them to resist the attack by poisonous chemicals through soil, water and the environment. The atmosphere is made more nutritious and fragrant by homa, plants get protective coating, pest and diseases do not thrive. The capacity of the plants to breath increases and the toxic effect of choking to death due to atmospheric toxins is eliminated as observed by Johnson and Heschl (2009).

It may be noted that cow of Indian origin is recommended in HOF, but people prefer hybrid cow in view of higher milk produced by the later. It may be worthwhile to study the dung and urine of hybrid cows, bullocks and even buffaloes in future experiments of HOF since the main focus of HOF is to improve the soil fertility and environmental health by utilising what is available in the farm. Ours is an agro based economy since ancient times and cow has been an integral part of our agriculture. The data is now available to prove the necessity of existence of cow to guarantee a peaceful sustainable life on earth *i.e.* to maintain a natural life cycle with minimum pollution and health hazards. Though cow dung and urine have been considered as waste, the tremendous potential in them has not been fully utilised in modern agriculture. It may be noted that two US patents for cow urine distillate (US Pat. No.6410059 and 6896907) for its antimicrobial, antibacterial, antifungal and anticancer properties have been awarded. It also has lot of antioxidants and immunomodulatory compounds. Another US Patent (No. 7097830) is related to the strains obtained from Sahiwal cow milk for plant growth promotory phytopathogenic fungi controlling activity, abiotic stress tolerating capability and phosphate solubilisation capability. It has been also reported that one dropping of a cow supplies microbial load sufficient for 2.5 acres of land (Mansinghka, 2007).

In India, there is no derth of farm animals, their droppings can maintain soil fertility. However, use of tractor and other implements for the field operations is prevalent these days which can, no doubt do the field operations perfectly but can not provide microbial load required to maintain the fertility of the soil. The homa practices are both cheap and affordable by all types of farmers, rich and poor. The enrichment of soil by homa amendmets and increase in the soil microbial population (Table 15) observed in this study (Bacteria-36%, fungi-47% and actinomycetes-33%) against organic control exposed to homa atmosphere provides an opportunity to the farmer to improve his soil health and get rich and healthy produce. The 'Homa therapy' may thus provide equal opportunities to big landlords and even farmers with small land holdings by providing an excellent opportunity to replace macro and micro nutrients in the field with cheap and easily accessible homa products.

When the effect of homa on the macro and micro nutrients was studied due to application of Om Tryambakam Homa ash, positive results emerged out (Tables 12 and 13). It may be observed that the seedlings dipped in fresh cow dung, cow urine with soil and foliar application of Om Tryambakam homa ash (T_8) were equally effective when compared with soil and foliar application of Gloria Biosol treatment in which seedlings were dipped in fresh cow dung and cow urine (T_{10}) in registering highest amount of Cu as compared to absolute control (T_2). These observations receive support from the results of Kumari Namrata (2010) and Brunda (2011) who established the efficacy of Om Tryambakam homa ash in combination with Biosol in soybean and tomato crops, respectively. It may be noted that Om Tryambakam homa ash has not been recommended by FFPM, Dhule, Maharashtra for farm operations. It is recommended to use its ash in compost masking only. It has only recommended use of Agnihotra homa ash and Gloria Biosol in agriculture and horticulture.

Shendye (2009) reported that Agnihotra pot produces copper oxides and Far Infra Red (FIR) bio-energy which is especially produced by all the transition elements including copper. It may be noted that Agnihotra homa pot is made up of copper and has a semi-pyramid shape. Pyramid is a coin word for pyre means fire and amid means in the midst *i.e.* fire in the center. Fire is a special state of matter beyond solid, liquid and gas. The semi-pyramid used while performing homa, releases lots of bio-energy which heals the

atmosphere. The magical power of pyramids in preserving dead bodies in the pyramids of Egypt is well known. It may be recalled here that dried fresh cow dung cakes were burnt in the copper semi-pyramid for performing Agnihotra homa fire twice a day at sun rise and sun set. A similar copper semi-pyramid was used for the performance of Om Tryambakam homa (healing fire) for almost for 3-4 h a day during experimental period.

In the present investigation soil content of Cu, Mn, Zn and Fe registered higher values due to different homa treatments (Table 12). It has been reported that these micro nutrients are essential for various biological functions (Cox and Phillips, 2007). The role of Cu and Fe in oxidative metabolism and in the electron transport chain of all living beings needs no special mention. Further studies are, therefore required to understand the role of these micronutrients in soils treated with homa products and their mode of action. It may be recalled here that effectiveness of Agnihotra homa ash was established in increasing the soil Zn, Fe and P content of cabbage heads (T_6) in this study as compared to organic control exposed to homa atmosphere (Tables 12 and 13).

5.3 Effect of homa organic farming practices on soil biological properties

All chemical reactions in the soil involve enzymes present in soil microbes which contribute to soil biological properties and fertility of the soil.

Sreenivasa *et al.* (2010) reported that the application of organic liquid manures were effective in significantly increasing microbial population and enzyme activity in chilli as compared to the application of RDF alone. The dehydrogenase activity has been reported to be involved in the respiratory chain of micro organisms and has often been used as a parameter to evaluate the overall microbial activity of soil (Serra-Wittling *et al.*, 1995). The fact that various biochemical processes associated with nutrient recycling are mediated through soil enzymes which are derived from soil microbes and plant roots is again confirmed in this investigation (Tables 14 and 15). The activity of soil enzymes is an important indicator of biological health of soil environment as well as the reactions including nutrient transformation in the soil which are enzyme mediated. Significant increase in soil bacteria (36%) and fungi (47%) as compared to organic control observed in this investigation (Table 15) and count of actinomycetes (33%) correlates well with the increase in the activities of soil dehydrogenase (51%) and phosphatase (13%). The studies of Gunadi *et al.* (1999), Masciandaro *et al.* (2000), Chithesh (2005), Nandani (2006) and Suma (2007) on different soil enzymes like dehydrogenase, phosphatase, urease, protease, cellulase and amylase lend support to the findings of this study on the increased activities of soil dehydrogenase and phosphatase receiving homa treatments.

Soil microbial count is a labile fraction of soil organic matter and at times it acts as source and sink for many plant nutrients. On addition of different combinations of homa ashes and organic material in to the soil, the microbial count was found to increase in this study at crop harvest stage (Table 15). Such an increase in soil microbial count was also reported by Gaur (1990) in a study on phosphate solubilising micro organisms as bio-fertilisers. This observation may be attributed to increased availability of nutrients all round the crop growth period due to addition of homa inputs.

It may be appropriate to mention here that Potdar (1992) reported 97 per cent P_2O_5 contribution from Agnihotra homa ash, whereas Katyal (2000) valued phosphorus contribution of organic manures in the range of 60 to 80 per cent.

Although the beneficial role of bacteria present in Gloria Biosol has become evident in this investigation, it was not possible to isolate and study specific beneficial bacteria from the Gloria Biosol preparation as reported by Sreenivasa *et al.* (2009) in other organic liquid manures. It may, therefore be worthwhile to study the type and characteristics of the micro flora available in Gloria Biosol in future studies looking into excellent performance shown by Gloria Biosol in this study.

Significant increase in the activity of soil dehydrogenase was observed due to addition of organic manure and homa ashes in different combinations as compared with control and conventional practices (Table 14). Kumari Namrata (2010) observed that dehydrogenase activity was one of the useful indicators of biological activity in the soil which

was proved in this study in the treatment where Agnihotra ash was used for seedling treatment with soil and foliar application of Biosol. This clearly indicates that dehydrogenase activity is directly related to the viability of the intact cells. These findings are in consonance with the results of Schaffer (1993) who observed increase in the activity of dehydrogenase with addition of organic matter when compared with control.

Zinc in its cationic form (Zn^{++}) has been reported to be an essential component of nearly 100 enzymes. A few among them are NAD^+ and $NADP^+$ linked dehydrogenases, alcohol dehydrogenases, DNA and RNA polymerases, carbonic anhydrase and peptidase. Several DNA-binding motifs have been described, one among them Zinc finger. In Zinc finger, about 30 amino acid residues form an elongated loop held together at the base by a single Zn^{++} ion which lends stability to DNA molecule (Nelson and Cox, 2005).

It may, therefore, be presumed that addition of organic matter rich in macro and micro nutrients and homa ashes might have increased the quantity of microbially decomposable humic matter in the soil through different enzymes which has a direct bearing on microbial environment and its fertility in the present study.

In the present investigation, four different homa products were used. Homa smoke alone was not found to be very effective alone but was effective in combination with other homa products. Non-homa ash also did not attract any special attention as compared to Agnihotra homa ash and Om Tryambakam homa ash. Gloria Biosol, a bio-digester specially prepared for this study has Agnihotra ash as one of its components. Due to soil and foliar application of Gloria Biosol, the fungal population in soil increased by 47 per cent and that of actinomycetes by 33 per cent as against organic control exposed to homa atmosphere (Table 15). It performed very well when used as soil applicant on the growth and yield parameters and in the control of black spot, leaf black rot and head borer when used as foliar spray (T_{10}) as compared with homa ashes.

5.4 Effect of homa organic farming practices on quality of cabbage

The novelty of organic sources lies in possessing other essential nutrients like Zn, Mn, Cu, Fe *etc.*, apart from major nutrients N, P and K. This has been reflected in the quality of cabbage in terms of total soluble solids, ascorbic acid, total free phenols, nitrogen, crude protein, potassium, phosphorous, sulphur and micronutrients like Cu, Zn, Fe and Mn (Tables 8 to 11). The Gloria Biosol treatment (T_{10}) was top ranking in all these quality parameters. The next best treatment with respect to quality parameters of cabbage was the application of Agnihotra homa ash (T_6), except phenols. It may be recalled here that Kolhe and Ruikar (1987) reported significant increase in the chlorophyll a and b, ascorbic acid, protein content and yield of cabbage when graded levels of N and bio-fertilisers were applied to the soil.

Bhujbal (1981) reported that agnihotra atmosphere (only smoke) helped in raisin making from grapes. He observed that drying of grape bunches was completed in 21 days as against 300 days taken by normal practice and development of good taste took only 35 days in Agnihotra atmosphere. Increase in the quality parameters observed in this investigation may be due to increased availability of major as well as minor nutrients due to application of Gloria Biosol and homa ashes to the soil (Tables 12 and 13).

Phenolic compounds have been found to play an important role in determining resistance or susceptibility of a host to parasitic infection. A resistant variety may contain more phenolic compounds than a susceptible variety. For the realization of their protective action, phenolic compounds must be liberated from inactive forms, since it is precisely in the free state that polyphenols manifest the higher fungi and cytotoxicity (Friend, 1979).

In the present investigation, highest content of ascorbic acid (9%), total free phenols (17%), TSS (38%), nitrogen (13%), crude protein (15%), potassium (17%), phosphorous (18%) and sulphur (60%) and micronutrients Cu, Zn, Mn and Fe (11%, 8%, 8% and 4%, respectively) were observed in harvested cabbage on soil and foliar application of Gloria Biosol as compared to organic control exposed to homa atmosphere (Tables 8 to 11).

Notable among these observations is the increase in sulphur content of cabbage (Table 10). It may be noted that different homa treatments (both the homa ashes and Gloria Biosol) when compared with organic control exposed to homa atmosphere (T_1) increased it by 45 – 60 per cent, by 54 – 85 per cent as compared to conventional control (T_{12}) and 43 – 71 per cent when compared with Non-homa organic control (T_{13}). Sulphur, one of the macronutrients, is normally present in soil as an anion (SO_4^{2-}) and a higher plant obtain sulphur principally by uptake of sulphate ion through roots and has many biological roles. It is a component of lipoic acid, coenzyme A, glutathione and biotin, cysteine, cystine, methionine and thus proteins. It is also a component of adenosine-5'-phosphosulphate formed by the reaction of sulphate ion with ATP catalyzed by an enzyme ATP-sulfurylase (Blancher *et al.*, 1965). Increase in the amount of sulphur in cabbage head due to different homa treatments is a new research finding and thus needs further exploration into its possible role in obtaining better growth and development exhibited by the crops raised organically employing homa technique.

Mapson (1970) proposed a model for the enzymatic formation of ethylene from methionine involving enzymes like transaminase, glucose oxidase and peroxidase with sulfinic acid and phenolics as cofactors. The role of ethylene in the growth and development of cabbage can not be ruled out due to observed increase in the sulphur content between 45-60 per cent in the present investigation. This increased sulphur content might have been incorporated into L-methionine leading to ethylene formation. Such possibility was studied by Patil (1984) in mango. It may, therefore, be appropriate to study in future the status of sulphur containing amino acid like L-cysteine and L-methionine in ethylene production in cabbage in future.

Increase in the quality parameters of cabbage observed in this investigation may be due to increased availability of major as well as minor nutrients, because major nutrients especially nitrogen and potassium play a vital role in enhancing the quality of crops by entering the protoplasm leading to enhancement of the quality attributes (Barooh and Ahmed, 1964).

5.5 Effect of homa organic farming practices on pest and diseases

The food choice of insects or pathogens is associated with a set of phytochemicals available in the plants. It seems that the cabbage plants in homa ash and Gloria Biosol treated plots had physiological and biochemical reactions that might have resulted in production of phytochemicals affecting the proliferation of insects, pests and thereby reducing the disease incidence. This could be evidenced from the fact that the incidence of black rot, black spot of leaf and head borer of cabbage was low in Gloria Biosol treated plants (51%, 68% and 69%, respectively) as compared to organic control exposed to homa atmosphere. The number of diamond back moth larvae and *Spodoptera litura* larvae per plant was found to be reduced maximally (57% and 53%, respectively) by the application of Agnihotra homa ash. These are new findings in cabbage crop raised under HOF and a very useful outcome of the present investigation.

It has been reported that application of higher levels of synthetic fertilisers and pesticides increase susceptibility of crops to pest but organic crops show tolerance to insect attack (Lotter *et al.*, 1999). The results of the present investigation confirm the ineffectiveness of conventional treatment in controlling the pest and diseases as compared to homa ash and Gloria Biosol treatments.

Mondkar (1982) reported beneficial effects of Agnihotra atmosphere in reducing aerial microbial population. Fernandes (1985) also reported the beneficial effects of Agnihotra homa smoke on Canadeal Barba Negra variety of wheat. The seeds of this variety were planted very close to the place where daily Agnihotra was performed. No ash was used. The wheat crop received only smoke from the Agnihotra fire which enabled wheat to grow very high and yield was double. Heschl (2009) reported the beneficial effects of Agnihotra homa smoke on soybean at Indore in Madhya Pradesh where Agnihotra homa was performed daily in the Prestige Feed Mill's farm.

Selvaraj *et al.* (2009) reported that Agnihotra homa brought down the incidence of pests and diseases like powdery mildew in Rose by 34 per cent, leaf spot in Carnation, Gerbera and Cabbage by 20, 44 and 40 per cent, respectively, *Fusarium* wilt in Carnation by 32 per cent, in Gerbera by 63 per cent and late blight in potato by 75 per cent. These observations clearly indicate that Agnihotra homa provides higher disease resistance to plants. Kumari Namrata (2010) had observed decrease in the rust incidence (30%), insect attack (26%) and *Spodoptera litura* larvae per row meter (31%) due to foliar application of Biosol as compared with control exposed to homa atmosphere. She inferred that furrow application of homa ash was more effective in increasing organic C and available P as compared to control without homa. The foliar application of Biosol was more effective in control of rust, pod borer and caterpillar, whereas its soil application was more effective in increasing the nodule count, nodule weight, number of pods, straw and grain yield in her study.

Paranjpe (1989) postulated that when homa is performed in a garden or in a field, smoke goes to leaves and acts as a catalyst for the generation of chlorophyll in terms of biochemical reactions. Homa atmosphere acts as catalyst on the plant metabolism causing the plant to reach for nutrients it needs, necessitating in strength and yielding the nutrients, giving the plant health and allowing it to blend efficiently more with the ecological balance of the things. Performance of homa helps in carrying the nutrients equally throughout the plants by vascular system.

Flanagan (1989) also gave a physical explanation of de-polluting effect of Agnihotra. He stated that colloidal molecules of cow ghee and cow manure could chelatingly attract and grab pollutants in the air, the way water is purified by being flocculated. The seized molecules settle on the ground and make the soil alkaline and when in contact with plant, stick to the leaves and act as time-released foliar nutrient. Moreover, due to use of ghee and manure, smoke is electrically charged.

The positive effects of 'Homa therapy' in agriculture, both in India and other countries have been well demonstrated by Bhujbal (1982), Davis (1983), Tung Ming (1987), Mishra (1987) and in 2009 by Bizberg, Garcia, Heschl, Hernandez and Macan Ringma and Ringma, Johnson and Heschl, Mutalikdesai and Naik from Karnataka Rameshwar and co-workers from CSK Himachal Pradesh Krishi Vishwavidyalaya, Palampur, Selvaraj and co-workers of Tamil Nadu Agricultural University (TNAU), Coimbatore and Kumari Namrata (2010) and Brunda (2011) of the University of Agricultural Sciences, Dharwad. It may be noted that the best results in 'Homa therapy' are obtained when the fields are organically maintained is the observation of all the workers mentioned above. It is, therefore stated that organic farming forms the basis of HOF practices.

It may be noted that organically grown fields also receive threats from the pest and diseases. Although the natural predators take care of such threats, the organic farmer feels helpless and dejected when heavy infestation is air-borne. The HOF provides a solution to atmospheric pollution and air borne diseases since homa in Vedic literature is considered as a process in the technology of Yajnya to heal the atmosphere, soil and water. Agnihotra is the basic homa in Vedic practices and Om Tryambakam homa (healing homa) is an additive yajnya.

The excessive use of chemical fertilisers and pesticides in agriculture has received severe criticism from the environmentally conscious people who opined that increase in agricultural production was achieved at the cost of soil health (Cooke, 1982). The environmental degradation due to faulty agricultural practices has made several experts to focus their attention on ecologically sound, viable and sustainable farming system. There have been a series of scientific and policy conferences on this issue (Venkataraman, 1991) on developing such a system that will help to overcome problems of soil erosion and environmental pollution through organic farming which aims at cooperating rather than confronting with nature. Fukuoka of Japan, popularly known as father of natural farming, opined that organic farming is the only answer to bring sustainability in agriculture in future (Fukuoka, 1988). On the similar lines, Gunjal (1991) expressed necessity of more comprehensive and analytical approach based on large volume of on-farm trial to examine the comparative feasibility of organic farming versus modern farming.

The observations of Biju (2001) has sent a right signal to all the concerned that the total reliance on insecticides for insect-pest control in most of the developing countries has resulted in certain ecological and economic imbalances with grave consequences to crop production, human health and environmental quality. He cautions against a common practice among the farmers to increase the application of insecticides, if the desired control of a target pest is not achieved. When the control becomes still inadequate, they switch over to another insecticide. This leads to resurgence of target pests. He opined that the widespread development of these man-made or entomologenic pest outbreaks is one of the most serious indictments of our present day pest control technology.

It may be noted here that Fivefold Path Mission (FFPM), Dhule in Maharashtra, India has come out with a modified version of Biosol (Guzman, 2006) known as Gloria Biosol (Weir, 2009). Its efficacy needs to be tested on different crops in view of the encouraging results obtained using Biosol in soybean crop (Kumari Namrata, 2010) and Gloria Biosol in tomato crop by Brunda (2011). The FFPM insists on storing Agnihotra homa ash and Om Tryambakam homa ash separately. It further insists that only Agnihotra homa ash should be used in agriculture. According to them, Om Tryambakam homa ash may be added to the compost (Johnson and Heschl, 2009). Contrary to this belief, Om Tryambakam homa ash was found to be equally effective in earlier studies from this laboratory in soybean (Kumari Namrata, 2010) and tomato (Brunda, 2011) and cabbage cultivation in the present investigation. Major studies on Homa farming have been seen to concentrate on the effect of Agnihotra homa ash on soil and water. In the present study Gloria Biosol was found to very effective in controlling pest and diseases. It is evident from Table 16 that the Gloria Biosol treatment reduced black rot and black spot of leaf incidence by about 54 and 80 per cent, respectively and Agnihotra homa ash reduced damage caused by head borer, number of diamond back moth larvae per plant and spodoptera by about 75, 40 and 53.98 per cent, respectively when compared with the absolute control, T₂.

Although Agnihotra finds a reference in Vruksha Ayurveda for family property (Johnson and Heschl, 2009), Vedic literature is silent on the usefulness and its utility of Agnihotra in agriculture. It, therefore, needs generation of data on the effect of 'Homa therapy' in agriculture, which is in progress at present in more than 75 countries of the world.

It may be recalled that Moorthy and Kumar (2000) reported that 4 per cent neem seed kernel extract (NSKE) could manage insecticide resistant diamond back moth. As an alternative to this, NSKE (4%) was evaluated in field trials in Karnataka, India, in October-December 1996 and was found to be effective against diamond back moth, *Plutella xylostella* and leaf webber, *Crocidolomia binotalis*. Similarly, a mixture of extracts from Pongamia (10%), aloe (5%), NSKE (10%) and cow urine (30%) recorded highest antifeedant activity with 75.57 and 68.63 per cent reduction in larval weight of *S. litura* and *H. armigera*, respectively (Barapatre, 2001). It may be noted that Nagaraj (1991) substituted N, P, K by compost from fresh cow dung, grass and dry leaves. The cow and ox urine served as a good source of growth promoters for the control of insect and diseases in his study. Spraying 10 per cent cow urine (1:10 dilution) once in 15 days fetched him 680 kg of paddy per ha. These results indicate the effectiveness of Indian technology knowledge (ITK) and products Indian knowledge systems (IKS) products in the management of pest and diseases in the field and needs further promotion.

The mechanism by which 'Homa therapy' clears air pollution and creates healthy atmosphere is yet to be thoroughly studied through scientific experimentation. Shendye (2009) has put forth a hypothesis to explain the mechanism of homa action which needs documentary evidence. It is possible that glutathione and Phytochelatins present in micro flora and in the plants remove pollutants through phyto-remediation (Anon, 2009b). It is, however, too early to comment authentically on such a mechanism of action operating through 'Homa therapy' due to lack of scientific support.

All the species try to maintain balance in nature with each other. The so called dangerous pests are controlled by predators, the friends of the farmer which appear automatically in a balanced environment (Mutalikdesai, 2009 and Naik, 2009). It goes without saying that chemicals destroy this fine balance in nature, whereas 'Homa therapy' encourages this balance in nature. The observation of Tangaswami (1991) that organic farming yields were comparable to conventional agriculture holds good in case of HOF too when compared with conventional control studied in this investigation (Table 7).

In addition to different homa products used in this investigation, the role of Indigenous Technology Knowledge (ITK) products like butter milk (Gothi, 1996) and neem seed kernel extract, different Neemasthras, Agniasthra, Brahmastra, Panchagavya, cow urine, neem oil, garlic-chilli-kerosene extract and Biodynamic preparations have been reported to be effective against pests and diseases and as growth stimulators (Patil *et al.*, 2009). These products need to be studied in depth since they are eco-friendly and within the reach of poor farmer. Further, the centre for Indian knowledge systems (IKS), Chennai (Subhashini *et al.*, 2006) has come out with a booklet which covers variety of IKS products for the growth and development and protection of different vegetables and fruits from pests and diseases. Since their approach is organic in nature, farmers may try these small experiments to consolidate their faith in organic farming techniques. Homa technique adds to ITK and IKS, an advantage of taking care of environmental pollution.

Agnihotra homa ash has been recognised in the entire world for the purification of atmosphere and as a boon to all the live forms (Anon, 2009b). Its application in agriculture in the form of 'Homa therapy' is being tested in 75 countries all over the world. The effectiveness of different homas tried earlier have revealed that its effectiveness spreads hardly around 50 to 100 ft. (Johnson and Heschl, 2009). To extend its area of influence, a Resonance point technique (RPT) has been introduced which has been found successful in many countries including India. The RPT was tested in the present investigation with a good success rate. It may be recalled here that the HOF treatment given to the seedlings with the mixture of fresh cow dung and cow urine (T_3) before transplanting produced better results with homa treatments over Non-homa treatments.

While studying the effectiveness of RPT in the present study, 37.77 per cent increase in the TSS and 8.85 per cent increase in ascorbic acid content was observed. Although increase in the phenol content of cabbage head was found to be 17.32 per cent in this study, increase in nitrogen, crude protein, potassium, phosphorous, sulphur and also micronutrients Cu, Zn, Mn and Fe, the decrease in the incidence of black rot and black spot of leaf (50.76 and 67.93), respectively and insect attack head borer (68.88) is worth mentioning here as the soil fertility is dependent on the increase in the soil macro (N-15.47%, P-22.68% and K-19.23%) and micro (Cu-16.07 %, Zn-18.05%, Mn-35.35% and Fe-15.26%) nutrient status, increase in the activities of soil dehydrogenase (24.48-51.02%) and phosphatase (3.24-12.98%) and increase in the soil micro flora (Bacteria-36.58%, fungi - 47.36% and actinomycetes - 33.33%) over organic control. The observations on these aspects are more glaring when different homa treatments are compared with control not exposed to homa atmosphere. It may be remembered here that due to incorporation of Gloria Biosol and homa ash, these changes were observed. The results of this investigation, therefore lend support to the observations of Kumari Namarata (2010) and Brunda (2011) who worked with homa ashes and Biosol and Glorias Biosol in soybean and tomato crops, respectively at UAS, Dharwad.

Bhaskar and Ashok (1993) who shifted to natural farming because modern agriculture practices have made important observations and pointed out following defects in the conventional practices in agriculture. They are (i) dependence on external input to a great extent (ii) killing of all types of insects due to chemical spray (iii) lesser gross profits (iv) reduction in soil fertility due to use of chemical fertilizers and (v) low cost : benefit ratio.

It is clear that the homa organic farming practices are good for the health of soil, micro flora and fauna, crop growth and its health and also helpful to the farming community with the greatest advantage that the land we cultivate can be saved from the bad effects of chemicals, save money spent on chemical fertilisers and pesticides and also protect the health of the farmer and his family.

Organic farming is a ray of hope for the farmers especially after they have burnt their fingers in chemical farming over a long period of six decades. They have now realised the importance of self-reliance and dependence on nature and eco-friendly methods in agriculture. Farmers are now eager to learn more about such safe techniques which will restore their confidence in agricultural practices. Though their pace in adopting Vedic agricultural practices is slow, it is getting momentum and showing improvement day by day. It has been attracting, not only small land holders but big land lords doing chemical farming too because of its safe nature. The interest in Homa organic farming (HOF) has also been slowly catching up not only in India but in other countries too due to its advantages over organic farming (Selvaraj *et*

al., 2009). People know that no organic farmer has committed suicide. No better certification is required than this to establish the fact that organic farming has come to stay and bring health and prosperity to the farming community. Since farmers believe and follow University research, an attempt has been made here to try HOF in a hybrid variety of cabbage (Var. Saint) in the form of a small research project in the PG programme of this department. It is, in fact, third of its kind. The first one was the work on soybean (Kumari Namrata, 2010) which has been discussed earlier in this dissertation and the second one was on tomato (Var. DMT-2) by Brunda (2011). It is felt at this juncture that many aspects untouched in the present dissertation may be undertaken for further research in the field of a promising zero technological approach which is purely of Indian origin called 'Homa therapy'.

Future line of work

1. Different combinations of material from Indigenous Technology Knowledge (ITK) and Indian Knowledge System (IKS) are successful in agriculture. Use of these products with 'Homa therapy' may be initiated since integrated approach may be much more beneficial in combating various pest and diseases.
2. There is a need to study combination of different organic liquid manures like Panchagavya, Jeevamrutha, Beejamrutha and Biodigester with Agnihotra homa ash, Om Tryambakam homa ash and Gloria Biosol and their storage life, nutrient composition and effect on biological, physical and chemical properties of the crops and soil.
3. Variations in the nutrient status of the soil through incorporation of Agnihotra homa ash, Om Tryambakam homa ash and Gloria Biosol and their doses throughout the crop growth period need further exploration since promising results have been obtained in this investigation.
4. Homa organic research is in its primitive stage. It requires scientific documentation. Different types of homa ashes are useful in agriculture. However, optimization of their doses needs standardization crop-wise, since excess of homa ash may be harmful for the growth and development of any crop due to its high content of phosphorus.
5. Efficacy of Gloria Biosol has been established in this investigation. However, there is a need to study Gloria Biosol and homa ash-water spray schedule on large scale at different growth stages of cabbage and other crops to reduce incidence of various pest and diseases.
6. The characterization of different types of soil bacteria, fungi, actinomycetes and other beneficial microbes and their growth and development patterns may be studied in depth under homa treatments. Particularly, bacteria, fungi and actinomycetes in Gloria Biosol useful to different cropping systems may be studied in future.
7. The use of Indian mustard as a trap crop for the management of major lepidopterous pest and planting of mustard in cabbage has been reported to lower the incidence of diamond back moth. Such a mixed cropping pattern may be studied in future in different cole crops like knol-khol, cauliflower *etc.*

6. SUMMARY AND CONCLUSIONS

A study was conducted to find out the response of Homa organic farming (HOF) practices on cabbage (Var. Saint) during *kharif* 2010 in the C-block of Institute of Organic Farming at UAS, Dharwad. A conventional control where no homa was performed was maintained about 1 km away from Homa site in G-block. Various parameters in cabbage crop like growth, quality, yield and chemical and biochemical characteristics were studied. Soil analysis was also carried out to study macro and micro nutrient status and biological activity. The salient features of the study are as follows:

1. Homa smoke alone was moderately effective in cabbage cultivation and proved better over organic treatment. Fresh cow urine and cow dung treatment to the cabbage seedlings gave overall better results over Non-homa treatments.
2. Morphological characters like plant height, number of outer leaves per plant, leaf area, dry matter production and number of inner leaves per head and diameter of cabbage head were enhanced due to different homa treatments.
3. There were significant differences in the surface area (cm²) of cabbage head among different treatments. It increased by 85 per cent in Gloria Biosol (a special bio-digester prepared for this study) treatment, 61 per cent in Agnihotra homa ash and 46 per cent in Om Tryambakam homa ash treatments when compared with organic control without homa. However, organic control and absolute control with homa, Non-homa ash and conventional control treatments did not differ significantly from organic control without homa.
4. There were significant differences in the days taken for initiation of cabbage head formation among different treatments. It was 40 days in organic control not exposed to homa atmosphere, 30 days in Gloria Biosol treatment, 35 days in each in both homa ash treatments, 41 days in conventional control and 39 days in organic control exposed to homa atmosphere. However, only Gloria Biosol and Agnihotra homa ash differed significantly from organic control without exposure to homa.
5. There were significant differences in the days taken for maturity of cabbage head among different treatments. It was 62 days in Gloria Biosol treatment, 76 days each in conventional and organic control not exposed to homa atmosphere and 74 days in organic control exposed to homa atmosphere and 66 and 68 days in Agnihotra homa ash and Om Tryambakam homa ash treatments, respectively. However, only Gloria Biosol (18%) and Agnihotra homa ash treatments (12%) differed significantly in taking less number of days for maturity of cabbage head from organic control without exposure to homa (76 days).
6. Differential response was observed in cabbage head weight due to different treatments. It was significantly higher in the best homa treatment, Gloria Biosol (53%) followed by Agnihotra homa ash (35%) and Om Tryambakam homa ash (19%) treatments as compared to organic control not exposed to homa atmosphere. However, the organic control exposed to homa atmosphere, Non-homa ash and conventional control did not differ significantly from organic control not exposed to homa atmosphere.
7. Noteworthy was increase in cabbage yield by 4.14 t per ha due to Gloria Biosol treatment (36.84 t/ha) which was the best among homa treatments and showed 15 per cent increase over organic control not exposed to homa (32.06 t/ha) but was non significant when compared with the control exposed to homa atmosphere (32.70 t/ha). The yields from absolute control with homa, Non-homa ash, Om Tryambakam homa ash and conventional control did not differ significantly among themselves and from organic control not exposed to homa atmosphere.
8. Soil macro nutrient status registered increase (N, 9-15 %; K, 5-23 % and P, 8-50 %) over organic control exposed to homa atmosphere due to different homa treatments. However, when compared with control without homa atmosphere, only both the ashes and Gloria Biosol differed significantly.

9. Soil micro nutrient status also registered increase (Cu, 4-16%; Zn, 10-8%; Mn, 11-15% and Fe, 12-35%) as compared to organic control exposed to homa atmosphere due to different homa treatments. However, when compared with control without homa atmosphere, only both the ashes and Gloria Biosol differed by showing significant increase in all the micro nutrients but Non-homa ash treatment did so in Mn and Fe content only.
10. Significant increase in the population of bacteria (9-40%), fungi (11-55%) and actinomycetes (21-38%) in the soil was observed due to different homa treatments including Gloria Biosol as compared with control without homa treatment.
11. Significant increase in the activities of soil dehydrogenase (15-54%) and phosphatase (6-18%) were observed in different homa treatments as compared with organic control not exposed to homa treatment but organic control with homa and conventional control did not differ significantly.
12. Increase in quality parameters of cabbage like TSS (25-41%), ascorbic acid (7-11%), phenols (5-18%), nitrogen (5-16%), crude protein (5-16%), sulphur (36-71%), potassium (10-22%), phosphorus (15-22%) micronutrients like Cu, Zn, Mn and Fe (8-13%, 6-8%, 8-9% and 4%), respectively was registered due to different homa treatments as compared to organic control not exposed to homa atmosphere.
13. Decrease in the incidence of black rot (29-55%) and black spot of leaf (39-73%), head borer (18-69%), number of diamond back moth larvae per plant (25-64%) and *Spodoptera litura* larvae per plant (40-62%) were observed due to different homa treatments as compared with organic control not exposed to homa treatment but organic control with homa and conventional control did not differ significantly.
14. Notable among the observations was increase in sulphur content of cabbage head. Different homa treatments inclusive of both the homa ashes and Gloria Biosol registered very high increase when compared with organic control exposed to homa atmosphere, conventional control and non-homa organic control (45-60%, 54-85% and 43-71%), respectively.
15. Soil and foliar application of Gloria Biosol was found to be more effective than other homa treatments. Om Tryambakam homa ash was also effective like Agnihotra homa ash. Non-homa ash was found to be least effective in cabbage cultivation.
16. The present study demonstrates that Homa organic farming practices not only heal the atmosphere by lowering the incidence of pest and diseases but also take care of health of the soil, plant and its produce.

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Appendix I. Composition of Biosol and Gloria Biosol

Sl. No	Material	Biosol	Gloria Biosol
1	Vermi-compost	75 Kg	80 Kg
2	Fresh cow dung	75 Kg	80 Kg
3	Compost from plant residue	75 Kg	-
4	Fresh Cow urine	10 L	10 L
5	Agnihotra homa ash	5 Kg	250 g
6	Shree Yantram made of copper (Plate.1c)	1 unit	1 unit
7	Water	200 L	200 L

Note:

- The mixture was incubated for 30 days in an air tight plastic tank with two valves and later used for foliar spray and soil application with suitable dilutions.
- One valve, which was fitted above the biosol formulation was used to release gases accumulated during fermentation process occurring in the tank.
- The other valve of bigger size (3-4" dia) was to take out ready to use biosol.
- One liter of biosol was diluted in 15 liters of water. Four liters were used for furrow application @ 4 L per 18 sq. m. plot (3.6 m x 5 m). This was useful in case of insect attack.

Appendix II. Special terms used in 'Homa therapy'

Fivefold Path	: Five basic principles for happy living – Agnihotra (Yajnya), Daan, Tapa, Karma and Swadhyaya.
Fivefold Path Mission	: It is an NGO working on the principle of Fivefold Path in India and abroad with its HQ at Tapovan, Dhule in Maharashtra.
Homa	: It is a process in the technology of yajnya given through Vedas to heal the atmosphere, soil and water.
Yajnya	: This is a technical term from the Vedic Science of Bio-energy denoting the process of removing toxins from the atmosphere through the agency of fire.
Vyahruti Homa	: This is a yajnya which can be performed at any time of the day or night, except at the specified times of Agnihotra.
Agnihotra Homa	: This is a small fire prepared in a copper semi-pyramid attuned to the bio-rhythm of sunrise/sunset. This Ayurvedic process purifies the atmosphere, gives nutrition to the plant kingdom and eradicates diseases.
Om Tryambakam Homa	: This is a specific Homa in which one mantra is repeated continuously. At the end of the mantra, a small spoonful of cow's ghee is offered to the fire. This homa can be repeated up to 24 h by people taking turns.
Shree Yantram	: A special geometrical design made of copper that attracts healing energies of the cosmos.
Gir cow	: An indigenous cow from Rajasthan.
Ayurveda	: It is an ancient most science of medicine given through Vedas. Literally it means Science of life.
Purush Sookta	: A set of mantras denoting song of creation, which has great vibrational healing power.
Homa Pyramid	: A copper vessel of specific size used for performing all types of yajnya of yajnya in Homa Therapy. It's also called as semi-pyramid since its bottom is not sharp as that of pyramid bottom
ITK	: Indigenous technology knowledge.
IKS	: Indian knowledge system

Appendix III. Mantras used in 'Homa therapy' and their meanings

Agnihotra homa mantra

Agnihotra mantras generate relaxing and purifying effect on the mind. They create vibrations of peace and love and positively manipulate our mind and atmosphere. There are two mantras in the morning at sun rise and two mantras in the evening at sun set.

At sun rise

**Sooryaya swaha, sooryaya idam na mama |
Prajapataye swaha, prajapataye idam na mama ||**

At sun set

**Agnaye swaha, agnaye idam na mama |
Prajapataye swaha, prajapataye idam na mama ||**

These mantras in Sanskrit are ordained by the Vedas. All the alphabets of the Sanskrit language are endowed with special vibrational powers. Their utterance in esoteric combination produces unique sound waves of magnificent vibrations. These vibration sound waves are powerful beyond imagination. Agnihotra mantras are to be uttered in such rhythmically balanced tone that the sound vibrates in their entire household. It should not be harshly loud or too weak nor it should be uttered in hurry. The mantras should be chanted in clear, magnifying and scintillating voice. The words 'Soorya', 'Agni' and 'Prajapati' i.e. Brahma in the mantras are synonyms of the Almighty. The feeling of total surrender is developed through the utterance of these mantras.

Om Tryambakam homa mantra

**Om Tryambakam yajamahe | sugandhim pushti-varadhanam ||
urvarukamiva bandhanan | mrutyormukshiya mamritat ||**

It is important to understand the mantra in order to develop faith in it. The individual words of the mantra convey its nourishing quality and, even in English, they are life sustaining. They fill us with the sense that a great force of goodness is at work within us, supporting our growth, lifting us up during times of trouble and helping us recall, even in the midst of our busy lives, the higher aim of life itself.

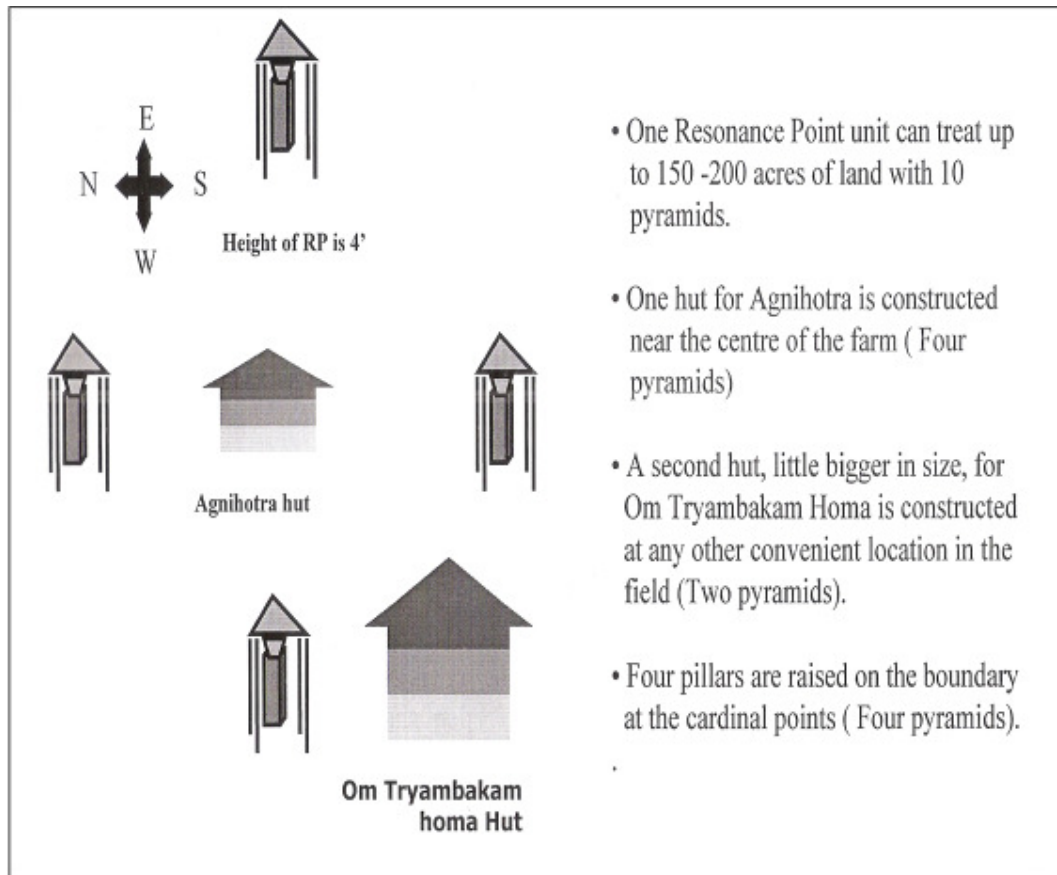
Om we worship and adore you, O three-eyed one, O Shiva, you are sweet gladness, the fragrance of life, who nourishes us, restores our health, and causes us to thrive. As, in due time, the stem of the cucumber weakens and the gourd is freed from the vine, so free us from attachment and death and do not withhold immortality.

Appendix IV. Sunrise and sun set timings, 2010

Timings/Longitude 74.984451° (10-mode)/Latitude 15.504167° (10-mode)
Time Zone = 5.500 Town /Place = AGRI. UNIV., DHARWAD

July		August		September		October		November		December		
SR	SS	SR	SS	SR	SS	SR	SS	SR	SS	SR	SS	
1.	60637	70105	61540	65702	62054	63913	62321	61607	62957	55713	64421	55333
2.	60654	70111	61555	65639	62059	63829	62327	61522	63017	55648	64454	55344
3.	60713	70116	61609	65615	62104	63745	62334	61436	63040	55625	64529	55357
4.	60730	70119	61623	65550	62109	63701	62341	61352	63103	55604	64604	55408
5.	60746	70124	61637	65524	62115	63616	62348	61308	63125	55543	64639	55424
6.	60805	70126	61651	65457	62121	63531	62357	61224	63150	55524	64713	55440
7.	60823	70128	61704	65431	62125	63444	62405	61142	63215	55506	64748	55456
8.	60840	70128	61718	65403	62130	63400	62413	61059	63238	55449	64823	55513
9.	60860	70128	61730	65333	62135	63314	62423	61018	63304	55433	64857	55534
10.	60918	70128	61743	65303	62138	63227	62432	60935	63330	55417	64933	55552
July		August		September		October		November		December		
11.	60937	70125	61756	65233	62144	63141	62441	60855	63357	55403	65006	55613
12.	60955	70121	61807	65203	62149	63055	62452	60814	63423	55352	65041	55634
13.	61012	70118	61818	65130	62152	63008	62501	60734	63451	55338	65116	55657
14.	61033	70114	61830	65058	62157	62922	62513	60655	63520	55329	65148	55722
15.	61050	70107	61839	65023	62202	62833	62525	60615	63548	55319	65221	55746
16.	61109	70102	61850	64950	62205	62747	62536	60538	63617	55310	65254	55811
17.	61127	70053	61901	64913	62210	62700	62549	60499	63646	55303	65327	55837
18.	61146	70044	61909	64839	62215	62612	62601	60424	63717	55259	65359	55905
19.	61203	70035	61920	64803	62218	62525	62615	60347	63748	55252	65431	55930
20.	61222	70025	61929	64724	62223	62437	62629	60312	63817	55249	65501	60000
July		August		September		October		November		December		
21.	61240	70013	61937	64647	62227	62350	62642	60237	63849	55249	65531	60030
22.	61256	70000	61945	64608	62231	62303	62658	60203	63921	55247	65601	60058
23.	61314	65946	61954	64529	62237	62217	62713	60130	63953	55247	65631	60128
24.	61331	65932	62001	64449	62243	62129	62729	60058	64025	55249	65700	60200
25.	61349	65916	62008	64410	62245	62043	62745	60027	64058	55251	65729	60231
26.	61405	65860	62016	64328	62251	61956	62803	55956	64130	55254	65757	60305
27.	61422	65842	62022	64246	62258	61910	62821	55926	64204	55301	65822	60337
28.	61437	65823	62029	64206	62303	61823	62838	55858	64238	55305	65849	60410
29.	61453	65805	62036	64123	62308	61737	62858	55830	64311	55314	65914	60443
30.	61510	65744	62041	64041	62315	61653	62917	55802	64346	55324	65938	60519
31.	61525	65723	62047	63957	62937	55737	70002	60552				

Appendix V. Resonance point and pillar layout



Appendix VI. Composition of media for microbial studies

Nutrient agar for enumeration of bacteria	
Glucose	5.0 g
Peptone	5.0 g
Beef extract	3.0 g
Agar	15.0 g
Distilled water	1000 ml
pH	7.2
Martin's Rose Bengal agar for enumeration of fungi	
Glucose	5.0 g
Peptone	5.0 g
Beef extract	3.0 g
Agar	15.0 g
Distilled water	1000 ml
pH	7.2
Kuster's agar for enumeration of actinomycetes	
Starch	10.00 g
Casien hydrosylate	0.30 g
Potassium nitrate	2.00 g
Dipotassium hydrogen phosphate	2.00 g
Calcium carbonate	0.20 g
Ferrous sulfate	0.01 g
Agar	18.00 g
Distilled water	1000 ml
pH	7.00

BIOCHEMICAL STUDIES ON HOMA ORGANIC FARMING PRACTICES IN CABBAGE (*Brassica oleracea* var. Saint)

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2011

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ABSTRACT

A field experiment laid out in Completely Randomised Block Design with 13 treatments replicated thrice was conducted during *kharif* 2010 to study the biochemical studies on Homa organic farming practices in cabbage (*Brassica oleracea* var. Saint). The conventional control (CC) and control without homa (CWH) were maintained almost 1 km away. The soil type was red black. All the seedlings were grown on raised beds, transplanted after one month and were given fresh cow dung and cow urine as basal treatment except absolute control, CC and CWC. The non-homa ash was collected after burning the agricultural waste. Agnihotra homa (AH) was performed at sun rise and sun set and Om Tryambakam homa (OTH) was performed for 3-4 h daily during experimental period. A special bio-digester called Gloria Biosol was prepared which contained AH ash. The non-homa ash, AH ash, OTH ash and Gloria Biosol were used for soil and foliar application. Soil and foliar application of Gloria Biosol was significantly superior over organic control in plant height, number of outer leaves per plant, leaf area, number of inner leaves per head and yield attributes, microbial population in soil, increase in the activities of soil dehydrogenase (15-54%) and soil phosphatase (6-18%), soil N, K, Cu and Mn and cabbage TSS (41%), ascorbic acid (11%), phenols (18%), crude protein (16%), N (16%), S (71%), K (22%), P (22%), Cu (13%), Zn (8%), Mn (9%) and Fe (4%) showed significant increase over organic control. Soil and foliar application of AH ash significantly increased soil P, Zn and Fe. Significant reduction was observed in the incidence of black rot (29-55%), black spot of leaf (39-73%), insect attack (head borer(18-69%), diamond back moth larvae (25-64%) and *Spodoptera litura* larvae (40-62%) per plant due to soil and foliar application of Gloria Biosol and different homa treatments.