BIODYNAMIC PRACTICES IN CHILLI

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DECLARATION

I hereby declare that this thesis entitled "**Biodynamic practices in chilli**" is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award of any degree, diploma, associateship, fellowship or other similar title, of any other university or society.

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CERTIFICATE

Certified that this thesis entitled "**Biodynamic practices in chilli**" is a record of research work done independently by Ms. Jayasree, P. (2003-11-01) under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to her.

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LIST OF ABBREVIATIONS

%	–	Per cent
°C	–	Degree Celsius
°E	–	Degree East
°N	–	Degree North
@	–	At the rate of
BCR	–	Benefit-cost ratio
BD 501	–	Biodynamic preparations 501
BD-500	–	Biodynamic preparations 500
Ca	–	Calcium
CD	–	Critical difference
cm	–	Centimetre
cm^2	–	Square centimetre
CO_2	–	Carbon dioxide
DAT	–	Days after transplanting
et al.	–	And others
Fig.	–	Figure
g	–	Gram
K	–	Potassium
K_2O	–	Potash
kg	–	Kilogram
kg ha^{-1}	–	Kilogram per hectare
LAI	–	Leaf area index
m	–	Metre
mg	–	Milligram
Mg	–	Magnesium
MOP	–	Muriate of potash
N	–	Nitrogen
P	–	Phosphorus
P_2O_5	–	Phosphate
POP of KAU	–	Package of Practices Recommendations of Kerala Agricultural University
RH	–	Relative humidity
Rs	–	Rupees
t ha^{-1}		Tonnes per hectare

Introduction

1. INTRODUCTION

Green revolution technologies involving greater use of synthetic agrochemicals such as fertilizers and pesticides with adoption of nutrient-responsive, high yielding varieties of crops have boosted the productivity in most cases. However, this increase in production has slowed down and in some cases there are indications of decline in productivity and production (Ramesh *et al.*, 2005). Moreover, the success of industrial agriculture and the green revolution in recent decades has often masked significant externalities, affecting natural resources and human health as well as agriculture itself (Rao, 1999).

Increasing consciousness about conservation of environment as well as health hazards caused by agrochemicals has brought a major shift in consumer preference towards food quality, particularly in the developed countries. Global consumers are increasingly looking forward to organic food that is considered safe and hazard-free. The global market for organic food is expected to touch 29 to 31 billion dollars by 2005. The demand for organic food is steadily increasing both in developed and developing countries, with annual average growth rate of 20-25 per cent. Worldwide, over 130 countries produce certified organic products in commercial quantities (Olesen, 2000).

There is nothing mystical about organic farming. It is simply a method of working with nature by recycling the natural material to maintain fertility and looking at natural pest and disease control. Organic matter used up has to be replaced and the soil has to be revitalized. In achieving this end, biodynamic (BD) farming has emerged as an alternative in the global scene.

Biodynamic agriculture was the first ecological farming system to arise in response to commercial fertilizers and specialized agriculture after the turn of the century. The terminology 'biodynamic' simply means 'bios' – life and 'dynamics' – energy. Biodynamics can be understood as a combination of biological and dynamic agricultural practices. 'Biological' practices include a series of well-known organic farming techniques that improve soil health. "Dynamic" practices are intended to influence biological as well as metaphysical aspects of the farm (such as increasing vital life force) or to adapt the farm to natural rhythms (such as planting seeds during certain lunar phases) (Steiner, 1996)

A basic principle of biodynamics is to conceive the farm as an organism, a self-contained entity. A distinguishing feature of BD farming is the use of nine biodynamic preparations for the purpose of enhancing soil health and stimulating plant life. The preparations are used in homoeopathic quantities so that they produce an effect in extremely diluted amounts. BD preparations provide a culturing media for the proliferation of microbes, which can be spread over the land to multiply further. BD farming is oriented at having these microbes in the farm itself in a relatively cheap way (Lorand, 1996).

Biodynamic agriculture relates to cosmic influences on earth and thus on plants, to bring the cosmic rhythms into plant forms. Lunar and astrological cycles play a key role in the timing of biodynamic practices such as making biodynamic preparations and when to plant and cultivate. Biodynamic calendars are designed to express the monthly and daily astrological details like suggested times of planting, flowering and fruiting of crops (Wildfeuer, 1995). But the aspects of biodynamic farming have not yet been experimentally proved under Kerala conditions.

Vegetables are major source of bioactive compounds in human diet whose health protecting properties are universally accepted. The globalization of trade under World Trade Organization and opening of market to international players has thrown new challenges to Indian vegetable farmers. Although India is the second largest producer of vegetables in the world, their quality is below the world standard due to the residue of various chemicals and lower keeping quality. To rectify this defect, the only option is organic farming (Channabasavanna, 2003). A fundamental tenet of biodynamic agriculture is that food raised biodynamically is nutritionally superior and tastes better than foods produced by conventional methods.

Chilli or red pepper is an important vegetable cum spice crop grown throughout India due to its unlimited utility and today India is the best producer. There is good demand for Indian chillies abroad and India export about 35,000 tonnes of chillies and earn about Rs. 80 crores foreign exchange every year (Tiwari *et al.*, 2005). Different varieties are grown for vegetables, spices, condiments, sauces and pickles. It is also used both raw and ripened for colouring properties and pungency. Chilli also find use in pharmaceuticals, cosmetics and beverages and it is rich in vitamin A, B and C in its fresh state. Neuhoff *et al.*, (1999) observed enhancement in yield in solanaceous crops due to the application of biodynamic preparations. Being a member of the solanaceae family, chilli is taken as the test crop for the present study.

Keeping these views under consideration, the present investigation entitled 'Biodynamic practices in chilli' was carried out with the following objectives:

1. To study the influence of biodynamic practices in fruit yield and quality.
2. To evaluate the influence of biodynamic practices on soil quality.
3. To assess the economics of the different treatments.

Review of Literature

2. REVIEW OF LITERATURE

The increasing consciousness about health hazards on account of contamination of farm produce due to excessive use of chemical fertilizers and pesticides have provided a thrust to organic farming. Deterioration of soil health, stagnation in productivity, insecurity of quality food and other environmental hazards has come before the scientific community as a big challenge necessitating new research awareness. In this chapter an attempt has been made to review the available literature on effect of fertilizers, organic manures and biodynamic preparations on vegetables with particular reference to chilli.

2.1 EFFECT OF FERTILIZERS IN CHILLI

2.1.1 Effect on Growth Characters

Joseph (1982) from his experiments in chilli for two seasons concluded that incremental doses of nitrogen and phosphorus increased plant height and number of branches at all stages of growth whereas potassium had no significant influence on these characters except plant height at the time of final harvest.

Prabhakar *et al.* (1987) noticed that nitrogen application at the rate of 90 kg ha^{-1} recorded maximum plant height in chilli. It was also observed that plant height was not influenced by phosphorus application. Similar effects of nitrogen and phosphorus in chilli was noticed by Shukla *et al.* (1987).

John (1989) observed that plant height and number of branches increased with increased dose of nitrogen and phosphorus, but potassium had no significant influence on these characters.

Sherly (1996) noted significant increase in plant height and number of branches in chilli at higher levels of N and K. Anu (2003) observed that plant height and number of branches increased significantly with increased levels of NPK fertilizers (125% of recommended dose) at all stages of growth.

2.1.2 Effect on Yield and Yield Attributes

Combined application of NPK recorded higher fruit yield and number of fruits plant^{-1} (Das and Mishra, 1972). Choughule and Mahajan (1979) reported that significant improvement in yield and yield attributes in chilli was observed due to the application of P (90 kg ha^{-1}).

Joseph (1982) observed significant increase in number of fruits, fruit weight and fruit yield with increased levels of N, P and K. Subbiah *et al.*, (1982) reported highest fruit yield of chilli with the combined application of NPK fertilizers.

Highest dry fruit yield in chilli under rainfed condition was observed by the application of 112.50 : 60 : 30 kg NPK ha^{-1} (Joseph and Pillai,1985). Green chilli yield increased with levels of N upto 90 kg ha^{-1} and P upto 30 kg ha^{-1} (Prabhakar *et al.*, 1987).

Shukla *et al.* (1987) reported that number of fruits plant^{-1} was significantly influenced by varying levels of nitrogen. Similar results were noted by Singh and Srivastava (1988), John (1989), Natarajan (1990), Ahmed and Tanki (1991) and Lata and Singh (1993).

Rao *et al.* (1988) reported that highest economic yield of dry chilli pods was obtained with 120 kg N in combination with 50 kg K_2O. Application of increased dose of nitrogen increased the fruit weight (Goyal *et al.*, 1989 and John, 1989).

Highest fruit yield of 2.6 t ha^{-1} was obtained by application of 120 : 90 : 90 kg ha^{-1} (Nasreen and Islam, 1989). Increase in NPK rates increased the yield in chilli (Surlekov and Rankov, 1989; Subbani *et al.*, 1990; Thyagarajan, 1990; Jayaraman and Balasubramanian, 1991;

Kaminwar and Rajagopal, 1993; Subbiah, 1994). Sherly (1996) also observed increased fruit yield with increase in N and K levels.

Anu (2003) found that highest fruit length was observed with highest level (125% of recommended dose) of NPK. Fruit yield plant^{-1}, fruit weight and yield ha^{-1} were not influenced by various levels of NPK.

2.1.3 Effect on Quality Attributes

Joseph (1982) observed that incremental doses of nitrogen increased the ascorbic acid content of fruits whereas potassium had no significant influence. Thomas and Leong (1984) reported profound effects of nitrogen fertilizers on ascorbic acid content of fruits.

Singh *et al.* (1986) showed that vitamin C content increased with increased level of nitrogen and the response was linear upto 90 kg ha^{-1}. Application of 87.5 kg nitrogen ha^{-1} recorded maximum ascorbic acid content (Amritalingam, 1988).

Mary and Balakrishnan (1990) stated that increase in nitrogen application increased the ascorbic acid content of chilli due to enhancement of enzymatic activities for aminoacid synthesis.

Uddin and Begum (1990) found that nitrogen alone or in combination had negative effect on ascorbic acid content in chilli while phosphorus had positive effect. According to Kaminwar and Rajagopal (1993) application of NPK at the rate of 100 : 75 : 100 kg ha^{-1} recorded the highest ascorbic acid content in chilli. Anu (2003) noted that there was no increase in ascorbic acid content with increased levels of NPK.

Saga (1973) noted that, the capsaicin content of chilli was very low in plots without P. Favourable effect of P on capsaicin content was shown by several workers (Subbiah *et al.*, 1980; Niranjana and Devi, 1990; Murugan *et al.*, 2002; Satyaseelan, 2004). Sreeja (2003) observed that plants treated with 2:1 NK ratio and *Azospirillum* was found to be significantly superior in capsaicin content.

2.1.4 Effect on Soil Properties

Sherly (1996) reported that available soil nitrogen increased progressively with increase in nutrient level. Plots treated with medium and higher levels of nutrients recorded more soil phosphorus than those treated with lower levels of nutrients.

Among the various levels of NPK fertilizers tested, plants treated with higher level of inorganic nutrients (125% of recommended dose) had significantly higher NPK content in soil (Anu, 2003).

2.2 EFFECT OF ORGANIC MANURES

Not much work has been done on the effect of organic manures on chilli, thus literature on other crops are also included with special emphasis to vegetables.

2.2.1 Effect on Growth Characters

Farmyard manure serve as a buffer against fluctuations in moisture availability and promoted better root growth (Tandon, 1994). Thamburaj (1994) found that organically grown tomato plants are taller with more number of branches.

In a trial in bhindi, Isacc (1995) found the highest root spread of 44.05 cm obtained with the application of 6 t ha^{-1} of FYM along with inorganic fertilizers. The beneficial effect of organic amendments in increasing the growth parameters was reported by Pushpa (1996) in tomato and Anitha (1997) in chilli.

Joseph (1998) noted that in snakegourd, growth characters *viz.*, weight of roots $plant^{-1}$ and dry matter production ha^{-1} were highest in FYM treated plants as compared to poultry manure or vermicompost treated plants.

Raj (1999) found that all organic nitrogen sources (neem cake, green leaf, poultry manure and enriched vermicompost) except FYM showed superior response in growth characters like plant height and LAI than POP recommendation. According to Arunkumar (2000), farmyard manure application induced better plant height, root biomass production and leaf area index in amaranthus.

Sharu (2000) reported that integrated use of chemical fertilizer and poultry manure in 3:1 ratio recorded maximum number of branches plant^{-1}, shoot-root ratio and LAI in chilli.

2.2.2 Effect on Yield and Yield Attributes

Farmyard manure serves as a good source of almost all plant nutrients. The results of the permanent manurial experiment conducted at Coimbatore since 1909 revealed that the effect of FYM on first 36 crops was inferior to that of complete mineral fertilizers (NPK) whereas the yields from the 37th crop onwards indicated a relatively better performance of FYM. The same situation in favour of FYM over NPK existed till the 82nd crop (Krishnamoorthy and Ravikumar, 1973).

Subbiah *et al.* (1983) reported that the yield of brinjal was significantly influenced by levels of FYM (0, 12.5, 25 and 37.5 kg ha^{-1}) but not by the levels of fertilizer (0, 50, 100 and 150 per cent of recommended dose). Application of 12.5 t ha^{-1} of FYM recorded highest yield of 54.28 t ha^{-1}.

Increase in yield of chilli, bhindi, tomato and brinjal by organic manure application was reported by Gaur *et al.* (1984). In the long-term field experiment for seven years at Jalandhar, Sharma *et al.* (1988) revealed that FYM was more effective in increasing tuber yield of potato than green manuring with daincha.

Damke *et al.* (1988) observed highest yield of chilli with application of FYM @ 9 t ha^{-1} along with 50 kg ha^{-1} each of N, P and K. Similarly Surlekov and Rankov, 1989) reported significantly higher yield of chilli with application of FYM along with chemical fertilizers when compared with control.

From studies at different places it was found that application of FYM to supply 100 kg P_2O_5 ha^{-1} about 30 kg K_2O ha^{-1} not only met P and K needs of the crop but also kept the potato yield level at a higher level than the combined use of P and K fertilizers (Sud and Grewal, 1990).

Natarajan (1990) and Meena and Peter (1990) recorded the highest fruit number, fruit weight $plant^{-1}$ and yield of chilli ha^{-1} with combined application of organic and inorganic sources and concluded that only organic or inorganic fertilizers will not increase the yield of chilli.

Thamburaj (1994) found that organically grown tomato plants yielded 28.18 t ha^{-1} which was on par with the recommended dose of FYM and NPK (20 : 100 : 100). Chavan *et al.* (1997) reported that combined application of nitrogen through FYM and urea was more beneficial to fertilizer alone in order to increase yield and quality of chilli.

Joseph (1998) observed that in snakegourd yield attributing characters *viz.*, length, weight and number of fruits $plant^{-1}$ were highest in FYM applied plants as compared to poultry manure or vermicompost applied plants. In Bhindi, all organic nitrogen sources (neem cake, green leaf, poultry manure and enriched compost) except FYM showed superior yield attributes like fruit number $plant^{-1}$, fruit weight, fruit length and fruit yield in organic manure treated plants (Raj, 1999).

Shashidhara (2000) reported that combined application of recommended dose of fertilizers and FYM resulted increased yield and yield attributes in chilli. Vermicompost, poultry manure and FYM treatments increased yield in amaranthus (Arunkumar, 2000). Sharu (2000) found that vitamin C content was highest for highest dose of organic manure along with chemical fertilizer.

2.2.3 Effect on Quality Aspects

In oriental pickling melon the organic form of manures showed definite advantage over inorganic fertilizers in respect of storability, while the degree of rotting increased in treatment, which received inorganic form of NPK (KAU, 1987). Meier and Lehri (1989) studied the quality of tomato plants grown with compost from biogenic waste, NPK fertilizers, composted FYM and commercial organic manures used for comparison. They found that storage quality was improved in compost treatments.

Shanmugavelu (1989) pointed out that the application of combination of FYM and inorganic mixture was best for firmness, storage life and keeping quality of tomatoes for a long time. Montegu and Gosh (1990) found that fruit colour of tomato was significantly increased as a result of application of organic manures of animal origin.

Increase in ascorbic acid content in tomato, pyruvic acid in onion and minerals in guards were reported by the application of organic manures (Rani *et al.*, 1997). Ascorbic acid of chilli was increased when nitrogen was applied through FYM and urea compared to fertilizer applied alone (Chavan *et al.*, 1997). Joseph (1998) reported that shelf life of snakegourd grown with organic residue was much higher as compared to that gown with fertilizers.

Raj (1999) reported that plants treated with organic manures produced fruits with higher protein and ascorbic acid content and lower crude fibre content in bhindi when compared to that of POP recommendation. Keeping quality of fruits was highest in FYM + neem cake treated plots, closely followed by FYM + enriched compost.

Sharu (2000) found that poultry manure application registered maximum keeping quality of fruits in chilli. According to Arunkumar (2000) quality of amaranthus like vitamin C, fibre and protein content improved with various organic manures. Shashidhara (2000) found that the combined application of both organics and inorganics with 100 per cent recommended dose of fertilizers significantly increase the ascorbic acid content as compared to fertilizers alone.

Nandakumar and Veeraraghavathatham (2001) recorded significantly higher ascorbic acid content over control due to application of crop residues. Bhadoria *et al.* (2002) reported that protein and total mineral content of okra fruit was highest, when it was treated with FYM.

2.2.4 Effect on Soil Properties

2.2.4.1 Effect on Available Nitrogen, Phosphorus and Potassium Content in Soil

Aravind (1987) recorded increased availability of potassium due to the combined application of FYM with 100 per cent recommended quantity of NPK in long term fertilizer experiment. Dhargawe *et al.* (1991) observed a significant increase in P availability in soil following the application of FYM. Higher efficiency of FYM in producing higher yield and improving chemical properties of soil compared to caster oil cake and urea was reported by Gomes *et al.* (1993).

Dhanokar *et al.* (1994) found that continuous use of FYM raised the available K content of soil by 1.3 to 5.4 folds over control. Humus by virtue of its chelating properties increases the availability of N, P, S and other nutrients to plants growing in humus rich soil. The humus substance increases P availability as they have very high exchange capacity (Gaur, 1994). Bharadwaj (1995) reported the most significant role of organic matter in supplying K.

The results of study on releasing pattern and availability of P from different soil types of Andhra Pradesh showed that increasing levels of FYM and applied P increased the available P in all types of soils (Saravanapandian, 1998).

Hedge *et al.* (1998) reported that the nutrient content (P, K, Mg and Ca) and organic carbon content of rhizosphere soil almost doubled when it was supplied with FYM or vermicompost for over two seasons.

Sharu (2000) reported that neem cake application at its highest level together with chemical fertilizers gave highest soil K. Highest level of poultry manure recorded highest level of soil N. Soil P status was significantly influenced by equal proportion of poultry manure and chemical fertilizer.

Addition of FYM or decomposed rice straw improved the NPK status of soil (Bandyopadhyay and Puste, 2002). According to Patidar and Mali (2002) application of FYM in sorghum field increased available nutrient content in soil.

2.2.4.2 Effect on Microbial Population

Many workers reported that application of organic manures usually increases the soil microbial biomass (Sakamoto and Oba, 1991; Goyal *et al.*, 1993). Manna *et al.* (1996) studied the effect of different levels of FYM on soil microbial biomass and an increased microbial biomass was observed at 4 t ha^{-1} of FYM. But further increase in FYM caused reduction in biomass turn over.

Fliessbach *et al.* (2000) reported that, the activity of soil microorganisms was higher in organic systems, which helped to recycle nutrients faster and improve soil structure. It was suggested that organic crops profit from root symbiosis and are better able to exploit the soil.

Singh (2003) reported that organic manures have the capacity to fulfil nutrient demand of crops adequately and promote the activity of beneficial macro and microflora in soil. Application of inorganic nutrients reduced population of soil organisms whereas application of organic manures resulted in the increased number of soil biota (Chhonkar, 2003).

Soil microorganisms require specific physical and chemical soil conditions for optimal growth. Organic matter availability is the main limiting factor for microbial population (Kanojira and Kanawjia, 2004).

2.2.4.3 Effect on Earthworm Population

Earthworms can be called as biological indicators of soil health. Application of organic manures increased the population of earthworms, which supports healthy populations of bacteria, fungi, actinomycetes and large number of other organisms that are essential for sustaining a healthy soil (Ismail, 1997).

Fliessbach (2000) reported that organic soil management improved soil structure by increasing soil microbial activity, thus improving the growing conditions of the crop. Chhonkar (2003) reported that application of organic nutrients resulted in increased number of earthworms, a sign of improved soil health and its fertility.

2.3 EFFECT ON PEST AND DISEASE INCIDENCE

Various amendments like composted cattle manure, poultry manure, sewage sludge and composted wool waste were found to suppress the club root disease caused by *Plasmodiophora brassicae* in field grown Chinese cabbage (Kinoshita *et al.*, 1984). Mutitu *et al.* (1988) observed that the Fusarium yellow caused by *Fusarium oxysporum* f. sp. *phaseoli* on bean can be reduced by the application of FYM.

Dayakar *et al.* (1995) reported that when FYM was applied along with 50: 50 NP fertilizer, the population of pigeon pea pod borer was lower than under the use of straight inorganic fertilizers alone. Bruggen (1995) reported that there was successful control of root diseases in organic farming system

Aguilar and Barea (1996) observed that increased levels of soil microbial activity leading to increased competition and antagonism in the rhizosphere, the presence of beneficial root colonizing bacterial and increased levels of vesicular-arbuscular mycorrhizal colonization of roots have all been identified as contributing factors in the control of root diseases in organic farms.

Lotter *et al.* (1999) reported that organic crops were more tolerant as well as resistant to insect attack. A study on integrated nutrient management in chilli by Sharu (2000) revealed lowest incidence of bacterial wilt when chemical fertilizers and neem cake were applied in the ratio 3 : 1 whereas highest incidence was noted in plots where package of practices recommendations of Kerala Agricultural University was followed.

2.4 EFFECT OF PANCHAGAVYAM ON GROWTH, YIELD AND QUALITY OF CROPS

Somasundaram *et al.* (2003) found that panchagavyam was superior to carbendazim in reducing the disease index and increased the vigour of plants and fruit yield of tomato.

Soil drenched with Maha panchagavya stock slurry @ 10% prepared using cow products like ghee, curd, milk, urin and dung along with common salt and backers yeast successfully controlled the wilt of tomato (Mishra, 2002). Dilute solutions of panchagavya can act as a growth promoter and immunity booster (Bindumol and Thomas, 2004).

Somasundaram and Sankaran (2004) reported that three percent of panchagavyam at critical stages were effective on maize, sunflower and greengram crops grown on sequence in terms of growth, yield and quality of produce than recommended inorganics. The positive influence of panchagavyam foliar spray was more pronounced on the number of grains per cob (4.9 – 18.6 %) and nitrogen uptake (12.3 – 16.6 %)in maize, test grain weight (9.7 to 16.6 %), crude protein content (1.6 to 4.8 %) and nitrogen uptake (11 to 35.2 %) in sunflower. Presence of growth regulatory substances such as IAA, GA and cytokinin, essential plant nutrients, naturally occurring beneficial microorganisms detected in panchagavyam can be attributed to its efficacy in organic foliar nutrition.

Sundararaman (2004) observed that natural preparations like panchagavyam will be of much help in the conversion from chemical farming to organic farming. Application of panchagavyam through irrigation water promoted growth of beneficial soil microorganisms and plant health. This acts 75 per cent as manure and 25 per cent as pest controller. Panchagavyam stimulates plant growth, rectify micronutrient deficiency, act as pest repellant and it help plants to develop resistance against diseases.

Reddy (2004) noted that promoting the use of panchagavyam and its use as a nutrient and a hormone can help in better yields at very cheap cost. Panchagavyam, an organic preparation was evaluated as foliar spray and soil drenching in cultivation of safed musli. The results revealed that the foliar spraying and soil drenching of three per cent panchagavyam improved the growth and yield of safed musli (Manjunatha *et al.*, 2004).

2.5 EFFECT OF BIODYNAMIC PRACTICES

2.5.1 Effect of Biodynamic Practices on Yield and Quality of Crops

An experiment conducted by Swedish biodynamic farmers showed higher relative content of protein, higher ascorbic acid, lesser darkening and better preservation of taste in potato (Raupp, 1998).

Pfeiffer (1984) reported that Biodynamics uses scientifically sound organic farming practices that build and sustain soil productivity as well as plant health and animal health. Application of BD-500 and BD-501 more than once during growth stages positively influenced product quality.

Compared with conventional farming systems, yield losses of 50 per cent for winter wheat was recorded shortly after conversion to biodynamic method (Buchner, 1993). Menon and Karnamarkar (1994) observed that BD- 500 enhanced crop growth and yield. Significant increase in yield of wheat grains was achieved over four years in biodynamic system than conventional system.

Hoffman *et al.* (1997) reported that biodynamically managed soil exhibited balanced development of grass in spring and a stimulation of grass growth in autumn after the application of BD-500 and BD-501.He also observed that in strawberry rich setting of fruits, good aroma, fungus free fruit, 30 per cent increase in yield and 8-10 days earlier harvest when BD-501 was applied.

Gardner (1997) noted that application BD-500 and BD- 501 created conditions for sound arrangement for life processes in an ecosystem. Application of both preparations lead to more integrated development of crop plants to reach full potential and corresponding quality improvements.

Fritz *et al,* (1997) reported that in dwarf beans and lettuce an inhibitory effect was observed on young vegetative growth by the application of horn silica (BD-501) whereas late application caused delay in plant senescence. In beans germination rate was significantly increased in horn silica treatment to the mother crop

The influence of biodynamic preparations and increased manure application on potato yield and quality was investigated in a three-year field study. Results showed that yield was slightly higher in biodynamic farming than in organic farming plots (Neuhoff *et al.*, 1999).

A survey of biodynamic carrot growers in Germany investigated variety choice, nutrient management and yields. Mean yield level in 1996 was 48 t ha^{-1} and was highest in loam soils (Fleck *et al.*, 2000).

Fliessbach *et al.* (2000) reported that biodynamically grown crops yielded an average 20 per cent less than conventionally grown crops given chemical fertilizers. Several research projects carried out in Germany and

Sweden had shown that the use of biodynamic spray increase the yield of sugar beet by 8-14 per cent, stimulating the growth of leaves by 8-26 per cent.

Devarajan *et al.* (2001) found that potato yield was higher in biodynamic treatment than conventional treatment. Kemp (2002) reported that biodynamic practices diligently do work in tropical Southern India. Field spray preparations positively influence soil processes such as leveling the pH and optimizing mineralisation. He also found that horn silica application improved the ripening, shelf life and aroma of apple and treated plants were less susceptible to pests and diseases.

Use of biodynamic sprays stimulate and retains soil fertility and increase the beneficial microflora. It has been proved in experiments carried out in Germany, America and Sweden that the biodynamic organic spray preparations have several positive effects with increase in yield in a number of crops like carrot and beetroot. There is also increase in quality parameters like percentage of carbohydrate, protein, nitrate, soluble amino acids and vitamins. The use of biodynamic preparations showed an improvement in the keeping quality of carrots. The biodynamic sprays applied during the growth reduce the losses during storage. These reduced the production of CO_2 enzyme activity and the number of epiphytic bacteria (Sharma, 2004).

Mathew (2004) reported that application of biodynamic preparations in vanilla resulted in vigorous growth and better yield. He also noted that application of BD-501 will increase the growth of young seedlings and foliar spray will enhance the photosynthetic process in plants and also hastens the maturity of seeds.

2.5.2 Effect of Biodynamic Practices on Soil Properties

Long term experiment conducted by Buchner (1993) showed that humus content, soil pH and the activity of microorganisms had increased while P and K content had slightly decreased in biodynamic farm.

Reganold (1995) compared soil quality and farm profitability on biodynamic and conventional farming systems. These studies indicated that the biodynamic farming systems generally had better soil quality than their conventional counterparts and were just as economically viable on a hectare^{-1} basis.

Penfold *et al.* (1995) studied productivity, profitability and environmental sustainability of organic, biodynamic, integrated and conventional farming systems on attributes of environmental sustainability. After six years, significant difference between systems is apparent on economic returns and soil available P levels. The biodynamic treatment had the highest gross margins, followed by conventional, organic and integrated farming systems.

Fliessbach *et al,* (2000) in a long term experiment found that highest soil pH, organic carbon content and total N content were found in biodynamic treatment, while the lowest values were found in the treatments given inorganic fertilizers.

Ryan (1999) observed that total soil microbial biomass and biomass of many specific groups of soil organisms will reflect the level of soil organic matter, which will inturn, be largely determined by the volume of recent organic matter inputs. Devarajan *et al.* (2001) observed that nematode number was reduced in biodynamic treatment when compared to conventional treatment.

Condron *et al.* (2002) reported that soil organic matter content and biological activity are generally higher under biodynamic system. He also found that biodynamically managed soil had greater capacity to support heterotrophic micro flora activity, higher soil microorganisms activity and different types of soil microorganisms than conventionally managed soils (*i.e.*, treated with mineral fertilizer and pesticides.

A field experiment conducted by biodynamic institute in Germany over a period of 40 years showed that biodynamically treated organic plots showed improvement in organic matter content and bulk density of subsoil and also it encouraged the activities of earthworms (Sharma, 2004). Alternative agricultural systems like biodynamic farming consider soil health as their pre-requisite (Reddy, 2004).

2.6 EFFECT OF BIODYNAMIC PLANTING CALENDAR

In ancient India, success in agricultural operations was determined from the position and movement heavenly phenomena at that time of commencement of particular practices. The beneficial influences were mostly valued at the time of ploughing or sowing of seeds (Raychaudhari *et al.*, 1964).

Cosmic influences play a role in biodynamic agriculture. The position of sun, moon and nearer planets *viz.*, Mercury, Venus, Mars, Jupiter and Saturn in the zodiac have relevance in terms of the influence of the elements. The rhythms of moon *viz.*, vaxing and waning, ascending and descending, perigee and apogee and ascending and descending nodes have significant role with the movement in the zodiacs (Steiner, 1996).

Menon and Karnamarkar (1994) reported a link between planetary rhythm and constellation with fertilizer use efficiency. The recommendation is to apply fertilizers with the ascendance of moon or in full moon night to derive maximum benefit.

A krishi panchang may be defined as a basic astro agricultural guide book/calendar published annually giving calendrical information on various aspects of agricultural and allied activities, basically suggesting region wise, season wise and crop wise strategies based on astro-meteorologicl predictions, giving auspicious or inauspicious time for undertaking or avoiding various farm related operations along with a list for performing religious rites etc. and some non astrological agricultural guidance, primarily useful for farming communities and persons interested in agricultural development (Tripathi, 1996).

In India, the classical Hindu almanc is known as 'Panchang'. It is a very important book published for farmers and it is an astrological guide to start any farming activity. Hence it is a fundamental book which is referred to by a large section of people in this country for various purpose (Mishra, 2002).

Krishi Parashara Panchanga, an almanc for the benefit of farmers in India, is prepared strictly in conformity with the ancient agricultural Sanskrit text 'Krishi Parashara' (Sadhale, 1996 and Ayyangaraya, 2003).

When moon and Saturn are in opposite direction it is better to sow seeds and BD-501 applications in garden (Mathew, 2004). Sundararaman (2004) reported that growth regulators like panchagavya should be applied two days before full moon or full moon day or four or five days after new moon for activating the growth of plants.

Reddy (2004) observed that plants absorb more foliar sprays during 1-3 days before full moon day. The moon does ascending and descending in 15 days each. The ascending days are related to the upward movement of life forces and vice-versa. Activities like application of BD-501, sowing of seeds, harvesting of fruit and flower crops are better on the ascend. Tilling, putting dung in the cow horn, application of BD-500, transplanting of seedlings, planting and harvesting of root crops in the descend.

While the biodynamic calendar follows the moon, Kerala's traditional system is based on the movement of sun (Njattuvela). Pepper vines are planted only during 'Thiruvathira Njattuvela' that falls for 14 days from last week of June to first week of July (Jacob *et al*, 2004).

Materials and Methods

3. MATERIALS AND METHODS

The present investigation was undertaken to study the feasibility of biodynamic practices in chilli cv. Jwalasakhi. The experiment was laid out at Instructional Farm, College of Agriculture, Vellayani during October-February 2004-2005. The materials used and methods adopted in the experiment are detailed below.

3.1 MATERIALS

3.1.1 Experimental Site

The experiment was conducted in the garden land of the Instructional Farm, College of Agriculture, Vellayani. The farm is situated at 8° 30' N latitude and 76° 54' E longitude at an altitude of 29 m above mean sea level.

3.1.2 Soil

The soil of the experimental area was red sandy loam belonging to taxonomical order oxisol, acidic in reaction. The physico-chemical and biological properties of the experimental site are presented in Table 3.1.

Table 3.1 Soil characteristics of the experimental site

A. Physical composition

Sl. No.	Parameter	Content (%)	Methods used
1	Coarse sand	38.00	Bouyoucos Hydrometer method (Bouyoucos, 1962)
2	Fine sand	27.00	
3	Silt	12.00	
4	Clay	23.00	

Plate 1. General view of the field experiment

B. Chemical composition

Sl. No.	Parameter	Content	Rating	Methods used
1	pH	4.8	Acidic	1 : 2.5 soil solution ratio using pH meter with glass electrode (Jackson, 1973)
2	Available N (kg ha^{-1})	248.84	Medium	Alkaline potassium permanganate method (Subbiah and Asija, 1956)
3	Available P_2O_5 (kg ha^{-1})	41.36	Medium	Bray colorimetric method (Jackson, 1973)
4	Available K_2O (kg ha^{-1})	92.85	Low	Neutral normal ammonium acetate method (Jackson, 1973)
5	Organic carbon (%)	0.47	Medium	Walkley and Black rapid titration method (Jackson, 1973)

C. Biological Properties

Sl. No.	Parameter	Value	Reference
1	Rhizosphere microbial population a. Fungi b. Bacteria c. Actinomycetes	 21.45×10^4 cfu g^{-1} 28.86×10^6 cfu g^{-1} 2.15×10^8 cfu g^{-1}	Serial dilution plate method (Timonin, 1940)
2	Earthworm count	12 earthworms m^{-2}	Bano and Kale (1991)

3.1.3 Cropping History of the Field

The experimental area was under bulk crop of bhindi before the experiment.

3.1.4 Climate and Season

The experimental area enjoys a humid tropical climate. The field experiment was conducted during the period from 19-10-2004 to 25-02-2005.

3.1.5 Meteorological Parameters

The data on meteorological parameters *viz.*, rainfall, minimum and maximum temperature, relative humidity and evaporation during the cropping period are furnished in Appendix I and presented graphically in Fig. 1.

3.1.6 Variety

The variety used was Jwalasakhi, a high yielding variety of vegetable chilli evolved by Kerala Agricultural University by crossing Vellanotchi, a popular local cultivar of South Kerala with Pusa Jwala. It has got high yield potential, ideal for culinary purpose and suited for high density planting.

3.1.7 Seed

The seed was obtained from Instructional Farm, College of Agriculture, Vellayani.

3.1.8 Manures and Fertilizers

Farmyard manure (FYM) (0.56 per cent N, 0.4 per cent P_2O_5 and 0.3 per cent K_2O) was used as organic manure. Urea (46 per cent N), mussoriephos (20 per cent P_2O_5) and muriate of potash (60 per cent K_2O) were the fertilizes used for the experiment. The biodynamic preparations BD-500, BD-501 and panchagavyam were used for the experiment.

3.2 METHODS

3.2.1 Design and Layout

The experiment was laid out as Factorial Randomized Block Design. The layout of the experiment is given in Fig. 2.

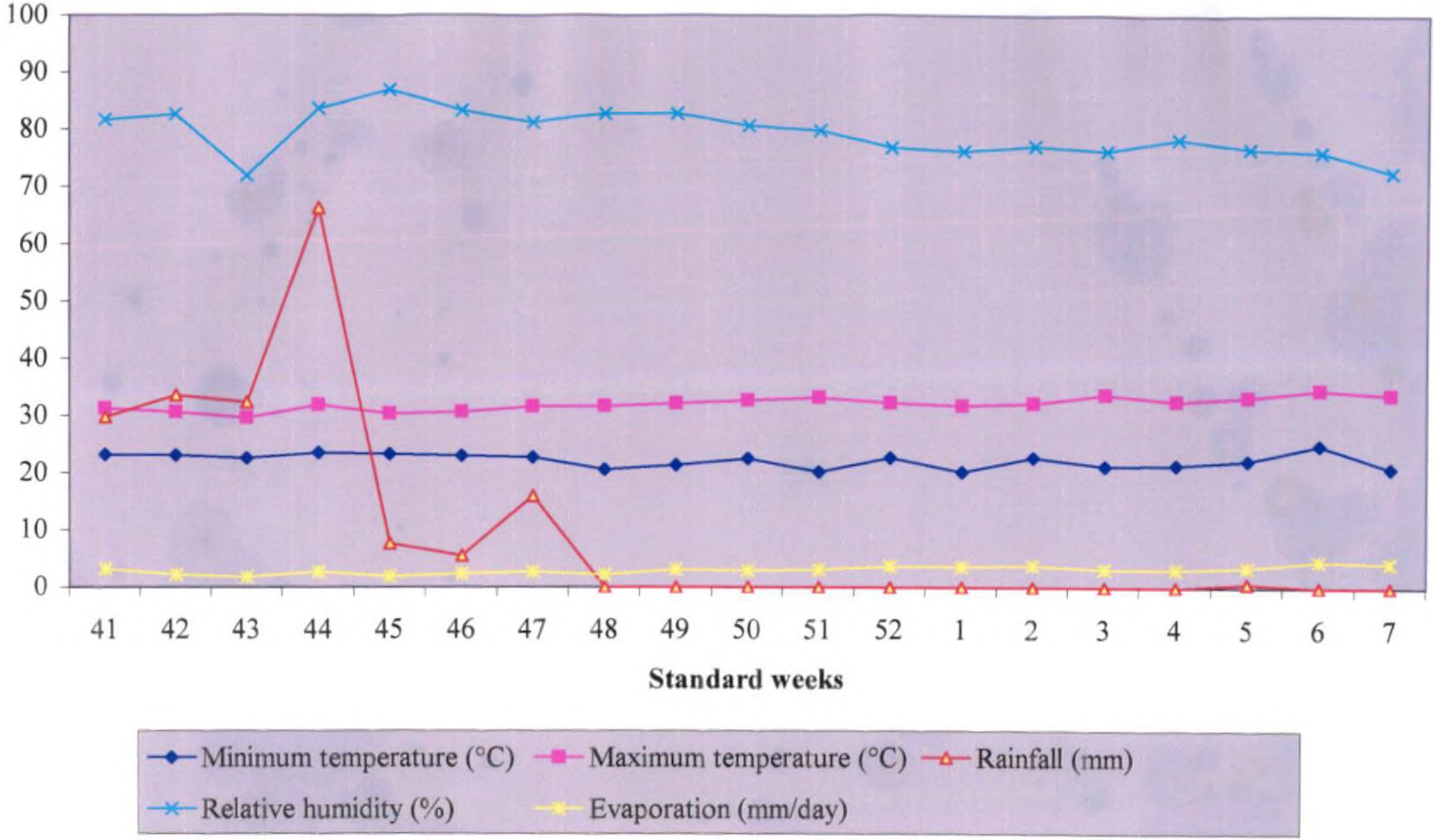

Fig. 1. Weather data for the cropping period (October 2004 to February 2005)

Details of layout are given below:

Number of treatment combinations	:	12
Number of replications	:	3
Total number of plots	:	36
Gross plot size	:	4.5 x 4.5 m
Net plot size	:	4.05 x 4.05 m
Spacing	:	45 x 45 cm
Duration	:	120 days

3.2.2 Treatments

The treatments consisted of combinations of biodynamic calendar (Factor A) and manurial schedule (Factor B).

1. Factor A

A_1 – Cultivation practices based on biodynamic calendar

A_2 – Cultivation practices without considering biodynamic calendar

2. Factor B

B_1 – Biodynamic preparation 500 (BD-500) + organic manures on nutrient equivalent basis

B_2 – Biodynamic preparation 501 (BD-501) + organic manures on nutrient equivalent basis

B_3 – B_1 + B_2 + organic manures on nutrient equivalent basis

B_4 – Panchagavyam + organic manures on nutrient equivalent basis

B_5 – Organic manures alone on nutrient equivalent basis

B_6 – Package of practice recommendations of KAU (FYM 20 t ha^{-1}, 75 : 40 : 25 kg NPK ha^{-1})

Note: FYM @13.39 t ha^{-1} was applied to satisfy the nutrient requirement of 75 : 40 : 25 kg NPK ha^{-1} in each treatment.

R_1	R_2	R_3
A_1B_2	A_2B_2	A_1B_5
A_1B_1	A_2B_1	A_1B_1
A_1B_4	A_1B_6	A_2B_2
A_2B_5	A_1B_4	A_2B_1
A_2B_2	A_1B_5	A_1B_6
A_2B_6	A_2B_4	A_2B_6
A_2B_1	A_2B_6	A_1B_3
A_1B_5	A_2B_5	A_2B_3
A_1B_3	A_2B_3	A_2B_4
A_1B_6	A_1B_3	A_1B_2
A_2B_3	A_1B_1	A_1B_4
A_2B_4	A_1B_2	A_2B_5

Fig. 2. Layout of the experiment

The treatment combinations were as follows:

1) A_1B_1	7) A_2B_1
2) A_1B_2	8) A_2B_2
3) A_1B_3	9) A_2B_3
4) A_1B_4	10) A_2B_4
5) A_1B_5	11) A_2B_5
6) A_1B_6	12) A_2B_6

3.2.3 Biodynamic Calendar

Cosmic influences play a dominant role in biodynamic agriculture. On the basis of such influences of Moon, Earth and other planets, 'Biodynamic planting calendar' has been prepared for agricultural operations during different timings of the year (Appendix II). The moon does ascending and descending in 15 days each. Activities like application of BD-501, sowing, harvesting of fruit and flower crops etc. are better on the ascend and tilling, application of BD-500, transplanting of seedlings, planting and harvesting of root crops in the descend. The day when moon and Saturn are in opposition is special for germination, transplanting and application of BD-501. Application of liquid manures will be most effective on full moon days.

3.2.4 Cultural Operations

3.2.4.1 Nursery

Two separate nurseries were prepared. 50 g seeds were sown in each well-prepared nursery beds of 1.2 m width and 15 cm height with channels around them to facilitate drainage. In the first nursery bed, seeds were sown on 19-10-2004 according to biodynamic calendar (*i.e.*, 48 hours before moon opposite to Saturn). The second nursery bed was sown on 25-10-2004 (*i.e.*, without considering the biodynamic calendar). The seedlings were irrigated everyday. Hand weeding and plant protection measures were undertaken periodically.

3.2.4.2 Field Culture

The main field was ploughed, clods broken, cleared off stubbles and plots were laid out with bunds of 30 cm width all around. Individual plots were again dug and perfectly levelled. Ridges and furrows were formed 45 cm apart. Well-decomposed FYM was applied at the time of land preparation and mixed with the soil.

3.2.4.3 Application of Manures and Fertilizers

FYM was applied in the experiment area at the time of preparatory cultivation as per the treatment schedule. N, P_2O_5 and K_2O were applied in the form of urea, mussoriephos and muriate of potash as per the treatment schedule. Half of nitrogen and half of potash were given as basal. The entire dose of phosphorus (40 kg ha^{-1}) was given as basal. One fourth of nitrogen and half of potash were applied to the soil at 25 days after transplanting (DAT). The remaining quantity of nitrogen was applied one month after the first top dressing.

3.2.4.4 Application of biodynamic preparations

3.2.4.4.1 Horn Manure (BD-500)

For the preparation of BD-500 spray solution, 62.5 g of the material was dissolved in 40 litres of warm (40°C) water. This preparation was potentized using homoeopathic principles before application. Water mixed with BD-500 was stirred in clock-wise direction followed by anti-clock wise direction and continued the homoeopathic potentizing process for an hour without a break. The liquid mixture was sprinkled as big droplets in soil in the evening one day prior to transplanting. For the factor A_1 (practices based on biodynamic calendar) the BD-500 was applied on 16-11-2004, *i.e.*, during the descending period. For the factor

A_2 (cultivation practices without considering biodynamic calendar), the BD- 500 was applied on 24-11-2004.

3.2.4.4.2 Horn Silica (BD-501)

For the preparation of BD-501 spray solution, 2.5 g of the material was dissolved in 40 litres of water and potentized in a similar way as that of BD-500. Within an hour of this homoeopathic potentizing, the mixture was sprayed as a fine mist to the plants at 9.00 am. The BD-501 was applied at monthly intervals. For the factor A_1 (cultivation practices based on biodynamic calendar), it was applied on 14-12-2004 and 10-01-2005 (days when moon was opposite to Saturn in the biodynamic calendar). For the factor A_2 (cultivation practices without considering biodynamic calendar), BD-501 was applied on 30 DAT and 60 DAT.

3.2.4.5 . Application of Panchagavyam

Panchagavyam was prepared with 5 kg cowdung, 1 kg ghee, 5 litres of cow's urine, 3 litres of curd, 3 litres of milk and 5 litres of water. The above materials were mixed together and stirred daily for 15 days for fermentation. A dilution of 1:10 was used for spraying. The panchagavyam was applied on full moon days *i.e.,* on 27-11-04, 26-12-04 and 25-01-05. It was applied at monthly intervals for the factor A_2 (cultivation practices without considering biodynamic calendar).

3.2.4.6 Transplanting

For the factor A_1 (cultivation practices based on biodynamic calendar) the seedlings were transplanted on 17-11-2004 (moon opposite to Saturn in the biodynamic calendar). For the factor A_2 (cultivation practices without considering biodynamic calendar) the seedlings were transplanted on 23-11-2004. Planting was done at a spacing of 45 x 45 cm. Plants were given uniform irrigation. Necessary shade was also provided for the first four days after transplanting.

3.2.4.7 After Cultivation

Gap filling was done with healthy seedlings on the seventh day after transplanting. Regular irrigation and weeding were carried out.

3.2.4.8 Plant Protection

As a prophylactic measure against pest attack neemoil-garlic emulsion was sprayed repeatedly at 14 days interval for getting satisfactory fruit yield. *Pseudomonas* drenching was also done to prevent wilt.

3.2.4.9 Harvest

The crop was ready for first harvest 60 days after transplanting and subsequent harvests were made at an interval of 7-10 days.

3.3 OBSERVATIONS

The observations were taken from five plants selected at random in each plot after eliminating border rows. Parameters considered and methods followed are briefly stated below.

3.3.1 Growth Observations

3.3.1.1 Height of Plant

The height of plants was measured from the base to the growing tip of the plants at three stages *viz.*, 30, 60 and 90 days after transplanting. The mean plant height was worked out and expressed in cm.

3.3.1.2 Number of Branches Plant^{-1}

The total number of branches plant^{-1} at three growth stages *viz.*, 30, 60 and 90 DAT were recorded from five observational plants and mean values recorded.

3.3.1.3 Leaf Area Index (LAI)

Leaf area index was worked out at three stages *i.e.*, 30, 60 and 90 DAT and expressed in square centimeter. LAI was worked out using the equation suggested by Watson (1958).

$$\text{Leaf area index} = \frac{\text{Total leaf area}}{\text{Land area}}$$

3.3.1.4 Root Spread

Soil around the semi circular hemisphere of plant was slowly exposed at 90 DAT and spread of main root was measured in cm ignoring small root lets.

3.3.1.5 Root Length

The root length was measured from the collar region to the tip of the taproot at 90 DAT. The average was worked out and recorded in cm.

3.3.1.6 Root-Shoot Ratio

The plants were pulled out at harvest and the dry weights of shoots and roots were recorded. From this root-shoot ratio was calculated.

3.3.2 Yield Observations

3.3.2.1 Number of Fruits Plant^{-1}

The total number of fruits on the five observational plants was recorded and the average worked out.

3.3.2.2 Weight of Fruits Plant^{-1}

The weight of green fruits obtained from observational plants was recorded at each harvest. The total weight of fruits plant^{-1} from the vegetable harvests was worked out and the mean calculated.

3.2.2.3 Length of Fruits

Length of randomly selected ten fruits from the observational plants was measured and mean worked out and expressed in cm.

3.2.2.4 Mature Fruit Yield

The total weight of mature fruits obtained from the net plot area was recorded and yield in kg ha^{-1} was computed.

3.3 SOIL ANALYSIS

3.3.1 Rhizosphere Microbial Population

The total number of bacteria, fungi and actinomycetes in the pooled soil samples were determined by serial dilution plate method (Timonin, 1940) at monthly intervals. The media used for isolation of different groups of microorganisms are given in Appendix-III.

3.3.2 Chemical Analysis

Samples collected before and after the experiment were dried in shade, sieved through 2 mm sieve and analysed to determine the available N content of the soil by alkaline permanganate method (Subbiah and Asija, 1956), available P by Bray's method and available K by ammonium acetate method (Jackson, 1973).

3.3.3 Earthworm Count

One metre square wooden frame was used for marking the sampling area in each plot. Digging was done up to about 10 cm depth (Bano and Kale, 1991). The soil lumps were broken and the soil passed through fingers to sort out the worms.

3.4 QUALITY ASPECTS

3.4.1 Shelf Life

The fruits collected from different treatments were kept under ambient conditions and the days up to which quality was maintained without deterioration *i.e.*, change in colour, shrinkage, rotting etc. were recorded.

3.4.2 Ascorbic Acid Content

Ascorbic acid content of the fruits at red ripe stage was estimated by 2, 6-dichlorophenol indophenol dye method (Sadasivam and Manickam, 1992). Ascorbic acid content of the sample was calculated using the formula.

$$\text{Ascorbic acid content in mg } 100\text{ g}^{-1}\text{ fresh fruit} = \frac{\text{Titre value x dye factor x volume made up x 100}}{\text{Aliquot of extract taken x Weight of sample taken}}$$

3.4.3 Capsaicin Content

Capsaicin content was determined by Folin-Dennis method. The pungent principle reacts with Folin-Dennis reagent to give a bluish complex, which was estimated colorimetrically (Mathew *et al.*, 1971).

3.5 PEST AND DISEASE SCORING

3.5.1 Damping Off

Incidence of damping off was reckoned by visual observation. Scoring was done by computing the per cent of infection.

$$\text{Per cent of infection} = \frac{\text{Number of plants infected plot}^{-1}}{\text{Total number of plants plot}^{-1}}$$

3.5.2 Incidence of Leaf Curl

A scoring procedure with a 0-5 scale was adopted based on the extent of damage caused by chilli mite, *Polyphagotarsonemus latus* to the plants.

0 – No incidence

1 – Mild (25 per cent)

3 – Medium (50 per cent)

5 – Severe (75 per cent)

3.5.3 Incidence of Fruit Rot

$$\text{Per cent infection} = \frac{\text{Number of fruits infected plant}^{-1}}{\text{Total number of fruits plant}^{-1}}$$

3.6 ECONOMIC ANALYSIS

Economic analysis was done taking into account the cost of cultivation and prevailing market price of vegetable chilli.

3.6.1 Net Returns

Net returns were calculated using the formula:

$$\text{Net returns (Rs. ha}^{-1}\text{)} = \text{Gross income} - \text{Total expenditure}$$

3.6.2 Benefit : Cost Ratio (BCR)

Benefit : Cost ratio was worked out using the formula:

$$\text{BCR} = \frac{\text{Gross income}}{\text{Total expenditure}}$$

3.7 STATISTICAL ANALYSIS

The data generated for the characters studied under different treatments were subjected to analysis of variance (Panse and Sukhatme, 1985). Whenever the results were significant, the critical difference was worked out at five or one per cent probability.

Results

4. RESULTS

An experiment was conducted at the Instructional Farm, College of Agriculture, Vellayani during the period from October 2004 to February 2005 to assess the feasibility of biodynamic practices in chilli. The experimental data were subjected to statistical analysis and the results obtained are presented under the following sections.

4.1 GROWTH CHARACTERS

Observations on growth characters like plant height, number of branches, leaf area index, root spread, root length and root- shoot ratio were recorded and the results are presented below.

4.1.1 Height of Plant

The data on mean height of plants at 30 DAT, 60 DAT and 90 DAT are presented in Table 1.

Biodynamic calendar (A) did not show any significant effect on plant height.

Main effect of manurial schedule (B) was significant in influencing the plant height at all stages of growth *viz*., 30, 60 and 90 DAT. At 30 DAT, maximum plant height of 29.14 cm was recorded by B_6 (POP recommendations of Kerala Agricultural University) and was significantly superior to all other treatments. Similarly at 60 DAT and at 90DAT B_6 was significantly superior to others and recorded the maximum plant height of 39.74 and 45.07 cm respectively.

The interaction of A and B was also not significant in influencing the plant height at any of the growth stages.

Table 1 Effect of biodynamic calendar and manurial schedule on plant height at 30, 60 and 90 DAT, cm

Treatments	30 DAT	60 DAT	90 DAT
Biodynamic calendar (A)			
A_1	24.62	35.04	39.46
A_2	24.33	35.50	39.24
$F_{(1, 22)}$	0.600^{NS}	2.00^{NS}	0.629^{NS}
SE	0.267	0.228	0.192
CD	-	-	-
Manurial schedule (B)			
B_1	23.17	33.19	38.50
B_2	23.37	34.64	37.65
B_3	23.16	33.70	37.68
B_4	24.02	35.51	38.85
B_5	23.99	34.83	38.36
B_6	29.14	39.74	45.07
$F_{(5,22)}$	25.01**	35.06**	72.90**
SE	0.463	0.395	0.332
CD	1.360	1.159	0.976

**Significant at 1 per cent level
NS – Not significant

4.1.2 Number of Branches Plant^{-1}

The mean number of branches plant^{-1} at 30 DAT, 60 DAT and 90 DAT are shown in Table 2.

There was no significant variation in number of branches in treatments due to biodynamic calendar (A) at any stage of growth.

Manurial schedule significantly influenced number of branches at all stages of growth *viz.*, 30, 60 and 90 DAT. At 30 DAT, B_6 (POP recommendations of Kerala Agricultural University) recorded the highest number of branches (14.14) and was significantly superior to other treatments. At 60 and 90 DAT also the same trend was observed with the highest values of 30.86 and 50.62 respectively in the treatment B_6 (package of practices recommendations of KAU).

A x B interaction was not significant.

4.1.3 Leaf Area Index

Table 3 depicts the leaf area index (LAI) at 30, 60 and 90 DAT as influenced by biodynamic calendar and manurial schedule.

The cultivation practices without considering biodynamic calendar (A_2) had a profound impact on LAI at all growth stages except at 30 DAT. At 60 DAT and 90 DAT, A_2 (cultivation practices without considering biodynamic calendar) was found to be significantly superior to A_1 (cultivation practices based on biodynamic calendar) and recorded the maximum values of 0.649 and 0.685 cm^2 respectively.

With regard to manurial schedule, significant difference among different treatments was noted in all growth stages. Maximum LAI values of 0.200, 0.740 and 0.761 cm^2 were observed for the treatment B_6 (package of practices recommendations of KAU) at 30, 60 and 90 DAT respectively and were significantly superior to other treatments.

Table 2 Effect of biodynamic calendar and manurial schedule on number of branches plant^{-1} at 30, 60 and 90 DAT

Treatments	30 DAT	60 DAT	90 DAT
Biodynamic calendar (A)			
A_1	10.46	24.94	43.38
A_2	10.00	25.38	43.31
$F_{(1, 22)}$	1.575^{NS}	0.611^{NS}	0.013^{NS}
SE	0.258	0.392	0.435
CD	-	-	-
Manurial schedule (B)			-
B_1	9.39	23.51	41.42
B_2	9.31	23.79	41.67
B_3	8.87	23.63	41.69
B_4	10.05	24.61	42.69
B_5	9.61	24.57	42.00
B_6	14.14	30.86	50.62
$F_{(5,22)}$	19.10**	17.34**	22.68**
SE	0.447	0.679	0.753
CD	1.311	1.992	2.210

**Significant at 1 per cent level
NS – Not significant

Table 3 Effect of biodynamic calendar and manurial schedule on LAI at 30, 60 and 90 DAT in chilli, cm^2

Treatments	30 DAT	60 DAT	90 DAT
Biodynamic calendar (A)			
A_1	0.144	0.629	0.666
A_2	0.150	0.649	0.685
$F_{(1, 22)}$	0.927^{NS}	15.80**	12.82**
SE	0.003	0.003	0.003
CD	-	0.010	0.010
Manurial schedule (B)			
B_1	0.127	0.603	0.645
B_2	0.145	0.624	0.669
B_3	0.130	0.615	0.658
B_4	0.139	0.605	0.661
B_5	0.141	0.625	0.657
B_6	0.200	0.740	0.761
$F_{(5,22)}$	15.24**	65.01**	43.50**
SE	0.006	0.006	0.006
CD	0.020	0.018	0.018

**Significant at 1 per cent level
NS – Not significant

There was no significant difference in the LAI due to A x B interaction.

4.1.4 Root Length

Biodynamic calendar did not significantly affect the root length, but the maximum value of 11.80 cm was noted for the treatment A_2 (cultivation practices without considering biodynamic calendar).

Table 4 shows superiority of the treatment B_6 (package of practices recommendations of KAU) among the manurial schedule in increasing the root length of chilli. B_6 (package of practices recommendations of KAU) recorded a maximum value of 14.67cm, which was significantly superior to all other treatments. The lowest root length of 11.03 cm was recorded when the plants were given the treatment B_3 (BD 500+ BD 501 + organic manures on nutrient equivalent basis)

A x B interaction was not significant

4.1.5 Root Spread

Root spread as influenced by biodynamic calendar (A) and manurial schedule (B) are presented in table 5

There was no significant influence of biodynamic calendar on root spread.

Significant difference was observed for root spread among the factor B. B_6 (package of practices recommendations of KAU) recorded significantly higher root spread (30.11 cm) while the treatment B_4 (panchagavyam + organic manures on nutrient equivalent basis) registered the minimum value (22.42 cm).

Interaction effect of biodynamic calendar and manurial schedule failed to produce any significant effect on root spread.

Table 4 Effect of biodynamic calendar and manurial schedule on root spread, root length and root-shoot ratio

Treatments	Root length (cm)	Root spread (cm)	Root-shoot ratio
Biodynamic calendar (A)			
A_1	11.70	23.97	0.114
A_2	11.80	24.10	0.112
$F_{(1, 22)}$	0.047^{NS}	0.041^{NS}	0.810^{NS}
SE	0.322	0.579	0.002
CD	-	-	-
Manurial schedule (B)			
B_1	11.23	22.92	0.121
B_2	11.51	22.73	0.117
B_3	11.03	22.75	0.117
B_4	11.23	22.42	0.118
B_5	11.85	23.20	0.117
B_6	14.67	30.11	0.088
$F_{(5,22)}$	6.69**	8.89**	11.12**
SE	1.638	2.944	0.003
CD	0.558	1.003	0.010

**Significant at 1 per cent level
NS – Not significant

4.1.6 Root-Shoot Ratio

The mean data on root-shoot ratio are presented in Table 4.

Biodynamic calendar (A) failed to influence the root- shoot ratio.

Root-shoot ratio was significantly influenced by manurial schedule. Maximum value for root shoot-ratio was noticed for the treatment B_1 (BD 500 + organic manures on nutrient equivalent basis). B_6 (Package of practices recommendations of KAU) recorded the lowest value of 0.088 and was significantly inferior to other treatments.

A x B interaction failed to produce significant influence on the root-shoot ratio.

4.2 YIELD CHARACTERS

4.2.1 Number of Fruits Plant^{-1}

The data on number of fruits plant^{-1} is given in Table 5.

Biodynamic calendar (A) did not have any significant influence on number of fruits plant^{-1}

The influence of manurial schedule on number of fruits plant^{-1} was found to be statistically significant (Table 5). Treatment B_6 (Package of practices recommendations of Kerala Agricultural University) recorded the maximum number of fruits plant^{-1} (60.55) and was significantly superior to other treatments. The lowest value of number of fruits plant^{-1} (43.48) was recorded by the treatment B_2 (BD 501 + organic manures on nutrient equivalent basis).

The treatment interaction due to biodynamic calendar and manurial schedule were not significant in influencing the number of fruits plant^{-1}.

Table 5 Effect of biodynamic calendar and manurial schedule on number of fruits plant^{-1}, weight of fruits plant^{-1} and fruit length

Treatments	Number of fruits plant^{-1}	Weight of fruits plant^{-1}	Fruit length (cm)
Biodynamic calendar (A)			
A_1	46.58	141.65	7.69
A_2	46.90	144.89	7.88
$F_{(1, 22)}$	0.258^{NS}	0.194^{NS}	9.35**
SE	0.448	5.188	4.367
CD	-	-	0.128
Manurial schedule (B)			
B_1	43.49	140.53	7.42
B_2	43.48	139.80	7.35
B_3	43.61	139.29	7.56
B_4	45.00	119.82	7.72
B_5	44.32	141.09	7.66
B_6	60.55	179.29	9.00
$F_{(5,22)}$	72.29**	4.69**	65.11**
SE	0.777	8.986	7.564
CD	2.279	26.357	0.221

**Significant at 1 per cent level
NS – Not significant

4.2.2 Weight of Fruits plant^{-1}

Weight of fruits plant^{-1} as influenced by biodynamic calendar and manurial schedule is presented in Table 5.

Biodynamic calendar (A) did not show any significant effect on weight of fruits plant^{-1}.

The results revealed that significant influence of manurial schedule on weight of fruits plant^{-1}. Treatment B_6 (Package of practices recommendations of Kerala Agricultural University) recorded the highest weight of fruit plant^{-1} (179.29 g) and was significantly superior to all other treatments.

Treatment interactions (A x B) did not have any significant influence on weight of fruits plant^{-1}

4.2.3 Fruit Length

The data pertaining to the mean values of fruit length as influenced by different treatment are presented in Table 5.

Biodynamic calendar (A) significantly influenced the fruit length. Cultivation practices without considering biodynamic calendar increased the fruit length from 7.69 to 7.88 cm.

Manurial schedule (B) had significant influence on fruit length. Treatment B_6 (Package of practices recommendations of Kerala Agricultural University) recorded the maximum length of 9.00 cm which was significantly superior to all other treatments. The lowest value of 7.35 cm was recorded by treatment B_2 (BD 500 + BD 501 + organic manures on nutrient equivalent basis).

Treatment interaction (A x B) was not significant.

Table 6 Effect of biodynamic calendar and manurial schedule on mature fruit yield of chilli

Treatments	Yield (t ha^{-1})
Biodynamic calendar (A)	
A_1	7.49
A_2	7.30
$F_{(1, 22)}$	0.563^{NS}
SE	0.182
CD	-
Manurial schedule (B)	
B_1	7.43
B_2	6.87
B_3	6.85
B_4	6.96
B_5	7.46
B_6	8.82
$F_{(5,22)}$	5.56**
SE	0.316
CD	0.928

**Significant at 1 per cent level
NS – Not significant

4.2.4 Mature Fruit Yield

Mature fruit yield ha^{-1} as influenced by different treatments are presented in Table 6.

No significant influence was observed in mature fruit yield with biodynamic calendar (A).

The mature fruit yield ha^{-1} was significantly influenced by manurial schedule. The highest mature fruit yield of 8.82 t ha^{-1} was recorded by the treatment B_6 (Package of practices recommendations of Kerala Agricultural University). Treatment B_3 (BD 500 + BD 501 + organic manures on nutrient equivalent basis) recorded the lowest value of 6.85 t ha^{-1}.

A x B interaction was not significant.

4.3 SOIL ANALYSIS

4.3.1 Rhizosphere Microbial Population

Different treatments significantly influenced the rhizosphere microbial population and are presented in Tables 7 to 9.

4.3.1.1 Fungal Population

The rhizosphere fungal population as influenced by biodynamic calendar and manurial schedule is presented in Table 7.

The main effect of biodynamic calendar was not significant.

The results revealed that the effect of manurial schedule did not show any significant variation at 30 DAT and 90 DAT. However, rhizosphere fungal population at 60 DAT showed significant variation among the different levels of factor B. Treatment B_5 (organic manures alone on nutrient equivalent basis) recorded the highest value of 25.40 cfug^{-1} x10^4 and was on par with B_1, B_2, B_3 and B_4. Lowest value of (18.23 cfu g^{-1} x 10^4) was recorded with the treatment B_6 (Package of

Table 7 Influence of biodynamic calendar and manurial schedule on rhizosphere fungal population (cfu g^{-1} x 10^4)

Treatments	30 DAT	60 DAT	90 DAT
Biodynamic calendar (A)			
A_1	26.52	23.26	13.62
A_2	24.49	23.04	12.97
$F_{(1, 22)}$	0.369^{NS}	0.45^{NS}	0.524^{NS}
SE	2.356	0.725	0.634
CD	-	-	-
Manurial schedule (B)			
B_1	30.82	23.27	14.51
B_2	28.62	24.63	13.92
B_3	22.98	22.93	13.87
B_4	21.34	24.42	13.57
B_5	30.80	25.40	13.33
B_6	18.46	18.23	10.60
$F_{(5,22)}$	1.672^{NS}	4.186**	1.574^{NS}
SE	4.081	1.257	1.099
CD	-	3.687	-

**Significant at 1 per cent level
NS – Not significant

practices recommendations of Kerala Agricultural University) and was significantly inferior to other treatments.

Treatment interaction (A x B) did not have any significant influence on rhizosphere fungal population.

4.3.1.2 Bacterial Population

The bacterial population of rhizosphere as influenced by biodynamic calendar and manurial schedule is given in Table 8.

The results revealed that biodynamic calendar, manurial schedule and their interaction had no significant influence on rhizosphere bacterial population at 30, 60 and 90 DAT. However, B_6 (POP recommendations of KAU) showed a decline in the rhizosphere bacterial population when compared to other organic manurial schedule (B)

4.3.1.3 Actinomycetes Population

The data on actinomycetes population in the rhizosphere at 30, 60 and 90 DAT are given in Table 9.

The results indicate that biodynamic calendar, manurial schedule and their interaction did not show any significant influence on actinomycetes population. Though manurial schedule (B) had no significant influence in the actinomycetes population, highest value of 3.22 was recorded in B_1 (BD 500 + organic manures on nutrient equivalent basis).

4.3.2 NPK Content in Soil

4.3.2.1 Available Nitrogen in Soil

The available nitrogen in soil after the experiment as influenced by different treatments is presented in Table 10.

The main effect of biodynamic calendar (A) failed to produce any significant influence on available nitrogen in soil

Table 8 Effect of biodynamic calendar and manurial schedule on rhizosphere bacterial population (cfu g^{-1} x 10^6)

Treatments	30 DAT	60 DAT	90 DAT
Biodynamic calendar (A)			
A_1	42.44	31.55	21.30
A_2	42.11	31.52	20.76
$F_{(1, 22)}$	0.141^{NS}	0.048^{NS}	0.335^{NS}
SE	0.615	0.671	0.653
CD	-	-	-
Manurial schedule (B)			
B_1	42.40	31.54	20.14
B_2	43.40	31.43	21.42
B_3	41.57	31.70	21.60
B_4	42.80	31.87	21.03
B_5	42.86	31.63	21.72
B_6	40.66	30.04	20.26
$F_{(5,22)}$	0.881^{NS}	0.527^{NS}	0.362^{NS}
SE	1.066	1.162	1.132
CD	-	-	-

NS – Not significant

Table 9 Effect of biodynamic calendar and manurial schedule on actinomycete population in the rhizosphere (cfu g^{-1} x 10^{8})

Treatments	30 DAT	60 DAT	90 DAT
Biodynamic calendar (A)			
A_1	2.53	3.10	2.55
A_2	2.21	3.36	2.45
$F_{(1, 22)}$	0.979^{NS}	5.570^{NS}	0.099^{NS}
SE	0.225	0.211	0.218
CD	-	-	-
Manurial schedule (B)			
B_1	2.45	3.22	2.64
B_2	2.71	2.62	2.12
B_3	2.83	2.74	2.83
B_4	2.12	2.71	2.99
B_5	2.59	2.96	2.69
B_6	1.51	2.14	1.73
$F_{(5,22)}$	1.552^{NS}	0.890^{NS}	1.587^{NS}
SE	0.390	0.383	0.379
CD	-	-	-

NS – Not significant

The effect of manurial schedule (B) on available nitrogen content of soil was found to be significant. The highest value of 281.62 kg ha^{-1} was registered by B_4 (panchagavyam + organic manures on nutrient equivalent basis) and was on par with B_1, B_2, $B_3$and B_5. The lowest available nitrogen content of 265.32 kg ha^{-1} was observed in the treatment B_6 (POP of Kerala Agricultural University) and was significantly inferior to all other treatments.

A x B interaction was not significant in influence in available nitrogen content of soil.

4.3.2.2 ***Available Phosphorus in Soil***

Available phosphorus in soil after the experiment as influenced by biodynamic calendar and manurial schedule is furnished in Table 10.

Biodynamic calendar did not have a significant influence on available phosphorus.

The main effect of manurial schedule (B) significantly influenced the available phosphorus in soil. The highest value for available phosphorus in soil (64.09 kg ha^{-1}) was recorded by the treatment B_4 (panchagavyam + organic manures on nutrient equivalent basis) which was on par with B_1, B_2, B_3 and B_5.

Treatment interactions (A x B) did not have any significant influence on available phosphorus content in soil.

4.3.2.3 ***Available Potassium in Soil***

Available potassium in soil after the experiment as influenced by different treatments are presented in Table 10.

The main effect of biodynamic calendar was not significant.

Manurial schedule (B) significantly influenced available potassium in soil. The highest value of available potassium was observed (122.91 kg ha^{-1}) in plots treated with panchagavyam + organic manures on nutrient equivalent

Table 10 Effect of biodynamic calendar and manurial schedule on available N, P and K content of soil after the experiment

Treatments	Available N (kg ha^{-1})	Available P (kg ha^{-1})	Available K (kg ha^{-1})
Biodynamic calendar (A)			
A_1	277.49	62.08	120.39
A_2	278.17	62.21	120.71
$F_{(1, 22)}$	1.184^{NS}	0.039^{NS}	0.422^{NS}
SE	0.788	0.467	0.362
CD	-	-	-
Manurial schedule (B)			
B_1	280.48	63.10	122.72
B_2	281.23	62.51	122.57
B_3	279.65	62.96	122.56
B_4	281.62	64.09	122.91
B_5	280.32	63.13	120.95
B_6	265.32	57.05	111.61
$F_{(5,22)}$	21.29**	9.92**	49.84**
SE	1.365	0.809	0.628
CD	4.004	2.373	1.842

**Significant at 1 per cent level
NS – Not significant

basis (B_4) and the lowest available potassium was observed when the plants were treated with POP of Kerala Agricultural University (111.61 kg ha^{-1}).

A x B interactions did not have any significant influence on available potassium content in soil.

4.3.3 Earthworm Count

The mean values of earthworm count are presented in Table 11.

No significant influence was exerted by biodynamic calendar, manurial schedule (B) and their interaction on earthworm count. But a slight increase in earthworm count (1.0 earthworm m^{-2}) was observed in B_5 where organic manure alone on nutrient equivalent basis was given.

4.4 QUALITY ASPECTS

4.4.1 Shelf Life

Table 12 shows the effect of biodynamic calendar (A) and manurial schedule (B) on shelf life of chilli.

Among the different levels of manurial schedule treatments B_4 (panchagavyam + organic manures on nutrient equivalent basis) produced the highest shelf life (4.88 days) and was on par with other organic manurial practices. B_6 (POP recommendations of Kerala Agricultural University) produced the lowest shelf life (3.29days) and was significantly inferior to other treatments.

Interaction effect of biodynamic calendar (A) and manurial schedule (B) was not significant.

4.4.2 Ascorbic Acid Content

The data presented in Table 12 indicates the ascorbic acid content of chilli.

The results revealed that ascorbic acid content of fruits varied significantly due to manurial schedule. Among the different treatments of

Table 11 Effect of biodynamic calendar and manurial schedule on earthworm count (Number of earthworms m^{-2})

Treatments	Earthworm count
Biodynamic calendar (A)	
A_1	0.778
A_2	0.611
$F_{(1, 22)}$	0.295^{NS}
SE	2.167
CD	-
Manurial schedule (B)	
B_1	0.667
B_2	0.500
B_3	0.833
B_4	0.833
B_5	1.00
B_6	0.33
$F_{(5,22)}$	0.426^{NS}
SE	0.375
CD	-

NS – Not significant

Table 12 Effect of shelf life, ascorbic acid content and capsaicin content as influenced of biodynamic calendar and manurial schedule

Treatments	Shelf life (days)	Ascorbic acid content (mg 100 g^{-1})	Capsaicin content (%)
Biodynamic calendar (A)			
A_1	4.54	97.35	0.580
A_2	4.38	97.15	0.587
$F_{(1, 22)}$	2.480^{NS}	0.444^{NS}	0.324^{NS}
SE	6.908	0.216	8.950
CD	-	-	-
Manurial schedule (B)			
B_1	4.73	97.59	0.565
B_2	4.52	97.45	0.570
B_3	4.81	97.48	0.568
B_4	4.88	97.64	0.570
B_5	4.53	97.85	0.573
B_6	3.29	95.48	0.655
$F_{(5,22)}$	24.54**	5.49**	5.19**
SE	0.119	0.375	0.150
CD	0.350	1.099	0.045

**Significant at 1 per cent level
NS – Not significant

the factor B, highest ascorbic acid content of 97.85 mg 100 g^{-1} was recorded in B_5 (organic manures alone on nutrient equivalent basis), which was on par with B_1, B_2, B_3 and B_4. B_6 (POP of Kerala Agricultural University) recorded the least ascorbic acid content (95.48 mg 100 g^{-1}) and was significantly inferior to all other treatments.

Both biodynamic calendar (A) and A x B interaction failed to produce any significant effect on ascorbic acid content.

4.4.3 Capsaicin Content

Table 12 shows the main effect of biodynamic calendar (A) and manurial schedule (B) on capsaicin content of chilli.

The effect of biodynamic calendar (A) was no significant.

Capsaicin content was significantly influenced by manurial schedule. B_6 (POP recommendations of Kerala Agricultural University) recorded higher capsaicin content (0.655 per cent) which was significantly superior to all other treatments. Treatment B_5 (organic manures alone on nutrient equivalent basis) recorded the lowest capsaicin content (0.573 per cent) which was on par with B_1, B_2, B_3 and B_4.

Treatment interaction A x B failed to produce any significant influence on capsaicin content.

4.5 PEST AND DISEASE INCIDENCE

4.5.1 Damping off

The influence of biodynamic calendar and manurial schedule on damping off incidence is presented in Table 13.

The main effect of biodynamic calendar was not significant.

Results revealed that manurial schedule significantly influenced the incidence of damping off. Among the different treatments under manurial schedule, treatment B_6 (POP recommendations of Kerala Agricultural University) recorded the lowest incidence of damping off (5.66 per cent)

Table 13 Effect of biodynamic calendar and manurial schedule on damping off, leaf curl and fruit rot of chilli

Treatments	Damping off (%)	Leaf curl	Fruit rot (%)
Biodynamic calendar (A)			
A_1	23.44	1.96	15.58
A_2	21.33	1.85	15.90
$F_{(1, 22)}$	4.65*	0.806^{NS}	0.188^{NS}
SE	0.691	0.091	0.511
CD	2.02	-	-
Manurial schedule (B)			
B_1	25.83	1.90	15.86
B_2	25.50	1.99	15.13
B_3	24.33	1.75	15.53
B_4	26.16	1.73	13.74
B_5	26.33	1.78	15.44
B_6	5.66	2.30	18.74
$F_{(5,22)}$	46.91**	1.856^{NS}	3.44*
SE	1.198	0.158	0.885
CD	3.515	-	2.597

**Significant at 1 per cent level
*Significant at 5 per cent level
NS – Not significant

and was significantly superior to other treatments. Highest disease incidence of 26.33 per cent was recorded by the treatment B_4 (panchagavyam + organic manures on nutrient equivalent basis) and was on par with B_1, B_2, B_3 and B_5.

A x B interaction was not significant.

4.5.2 Leaf Curl

Data presented in Table 13 indicated that biodynamic calendar, manurial schedule and their interaction failed to produce any significant influence on incidence of leaf curl.

4.5.3 Fruit Rot

Table 13 indicates the main effect of biodynamic calendar (A) and manurial schedule (B) on incidence of fruit rot.

The effect of manurial schedule was significant in the incidence of fruit rot. Maxium incidence of fruit rot (18.74) was observed in the treatment B_6 (POP recommendations of Kerala Agricultural University) while the treatment B_4 (Panchagavyam +organic manures on nutrient equivalent basis) registered the lowest (13.74) incidence.

Both biodynamic calendar and treatment interaction did not significantly influence the incidence of fruit rot.

4.6 ECONOMICS OF CULTIVATION

4.6.1 Net Returns

Data presented in Table 13 revealed that manurial schedule (B) had significant influence on net returns. B_6 (POP recommendations of Kerala Agricultural University) recorded the highest net returns (49,266.33 Rs ha^{-1}) which was significantly superior to all other treatments. Treatment B_3 (B_1 + B_2 + organic manures on nutrient equivalent basis) recorded the lowest value (22,475.09 Rs ha^{-1}).

Table 14 Effect of biodynamic calendar and manurial schedule on net returns and B:C ratio

Treatments	Net returns (Rs ha^{-1})	Benefit cost ratio
Biodynamic calendar (A)		
A_1	28265.95	1.37
A_2	26824.60	1.32
$F_{(1, 22)}$	3.84 ^{NS}	5.10
SE	924.91	0.017*
CD	-	0.049
Manurial schedule (B)		
B_1	25545.87	1.29
B_2	22844.75	1.33
B_3	22475.09	1.27
B_4	23992.25	1.29
B_5	24147.34	1.29
B_6	49266.33	1.58
$F_{(5,22)}$	42.57**	15.40**
SE	1601.992	0.030
CD	4698.78	0.089

**Significant at 1 per cent level
NS – Not significant

Table 15. Cost of cultivation

Treatments	Cost of cultivation (Rs ha^{-1})
B_1	80420.00
B_2	80340.00
B_3	80470.00
B_4	80540.00
B_5	80290.00
B_6	83130.00

Both biodynamic calendar and treatment interactions did not significantly influence the net returns.

4.6.2 Benefit-Cost Ratio

The effect of various treatments on benefit-cost ratio is given in Table 14.

Main effect of biodynamic calendar and manurial schedule showed significant difference. Among the factor A, maximum benefit-cost ratio of 1.37 was recorded by the treatment A_1 (cultivation practices based on biodynamic calendar). Treatment B_6 (POP recommendations of Kerala Agricultural University) registered the highest benefit-cost ratio of 1.58 which was significantly superior among the various treatments under manurial schedule. Treatment B_3 (B_1 + B_2 + organic manures on nutrient equivalent basis) recorded the lowest value (1.27).

Interaction effect due to biodynamic calendar and manurial schedule was not significant.

Discussion

5. DISCUSSION

Indian agricultural traditions are based on certain key percepts such as living in harmony with nature. Due to the indiscriminate use of chemical fertilizers and plant protection chemicals the environmental pollution and degradation of natural resource base is increasing drastically. So the need of the hour is to rediscover our past heritage of sustainable agriculture and blend useful practices with modern agriculture. In this context comes the importance of alternative agricultural systems like biodynamic farming, which is gaining popularity in the name of environmental safety, healthy soil, healthy crop, healthy food and feed.

In the present investigation entitled 'Biodynamic practices in chilli', an attempt has been made to ascertain the effect of biodynamic practices in chilli. The results of the investigation are briefly discussed below taking into consideration the previous information available in this subject and the data generated from the study. A critical analysis has been done to elicit possible trends and to draw definite conclusions.

5.1 GROWTH CHARACTERS

The results of the experiment showed that various growth characters of chilli were significantly influenced by different treatments.

Plant height and number of branches plant^{-1} progressively increased upto 90 DAT. Among the different treatments under manurial schedule, plants receiving package of practice recommendations of Kerala Agricultural University (FYM 20 t ha^{-1} + 75 : 40 : 25 kg N: P_2O_5 : K_2O ha^{-1}) registered significantly higher values in all growth stages.

In package of practice recommendation, besides the readily available nutrients present in chemical fertilizers, a part is also supplied through FYM. Increased availability of N, P and K increased photosynthetic surface area, resulting in more production, translocation

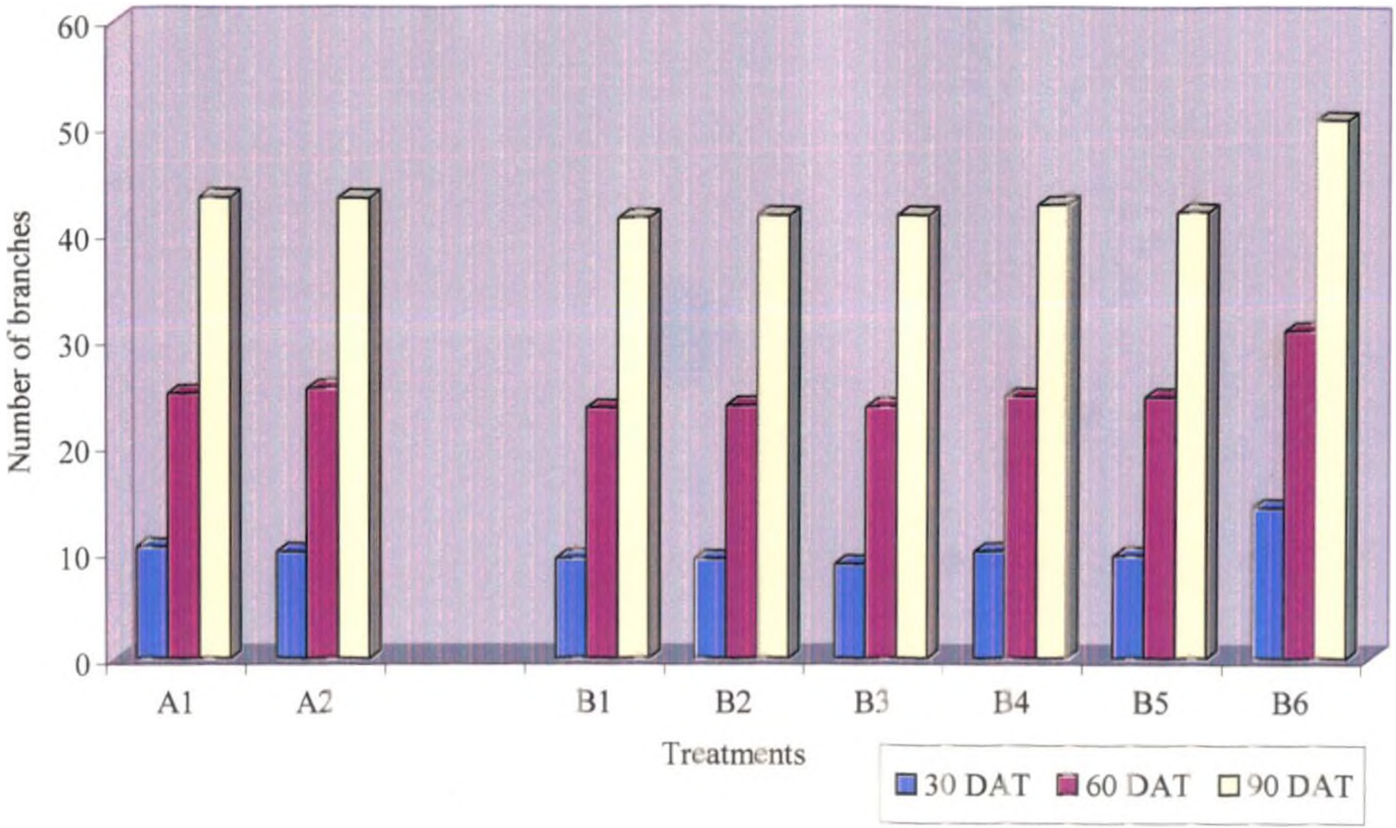

Fig. 3. Effect of biodynamic calendar and manurial schedule on number of branches plant^{-1} at 30, 60 and 90 DAT

and assimilation of photosynthates, which inturn increased plant height and number of branches. This is in conformity with the results obtained by John (1989), Sherly (1996) and Anu (2003).

Leaf area index (LAI) also increased progressively upto 90 DAT. Right from the beginning, LAI was significantly influenced by the manurial schedule and was highest in POP of KAU. The result is a reflection of the statement of Russel (1973) who reported that as the nitrogen supply increases, the extra protein produced allows the plant leaves to grow larger and hence to have more surface area available for photosynthesis. Similar increase in LAI with higher levels of nutrients was reported by John (1989), Joseph (1982), Sherly (1996) and Sreeja (2003).

The results revealed that root length and root spread were significantly influenced by manurial schedule. Maximum root length and root spread were observed in treatments receiving both organic and chemical fertilizers (POP of KAU). This may be attributed to good and steady supply of phosphorus from both nutrient sources. High phosphorus concentration causes initiation and prolific development of both first and second order lateral roots. (Tisdale *et al*, 2002).

Though root length and root spread were higher for treatment receiving POP of KAU, the root-shoot ratio was lowest for the treatment. This is a clear indication of the production of better shoot system by this treatment compared to treatment receiving organic manures alone and in combinations with BD preparations and panchagavyam. The easily available nutrients present in the POP recommendations of KAU might have led to such a performance. Similar results were observed by Sreeja (2003).

From the results it is evident that the manurial schedule comprising biodynamic preparations along with organic manures and cultivation operations based on biodynamic calendar (considering the position of moon) failed to produce significant variation in growth characters like

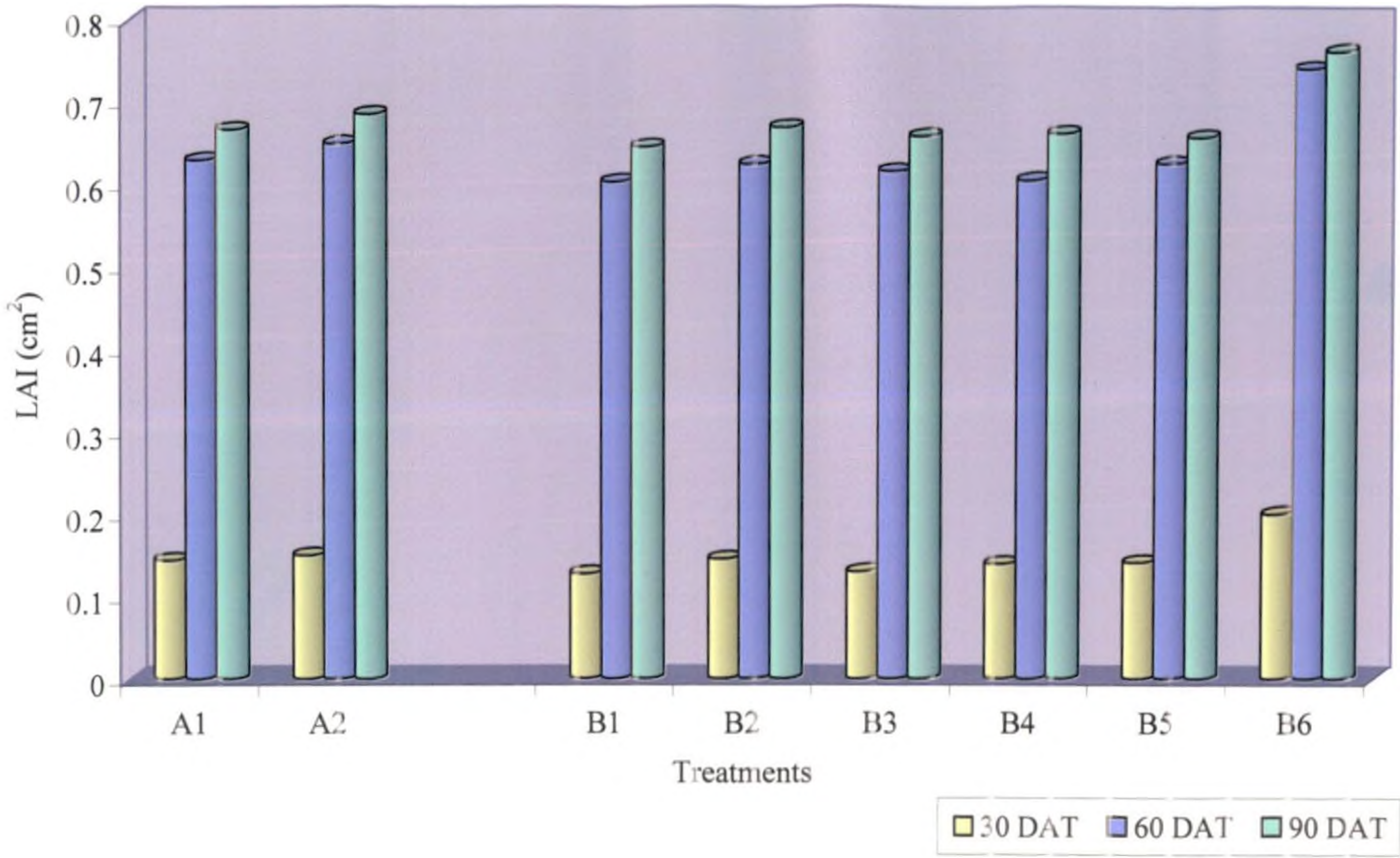

Fig. 4. Effect of biodynamic calendar and manurial schedule on LAI at 30, 60 and 90 DAT in chilli

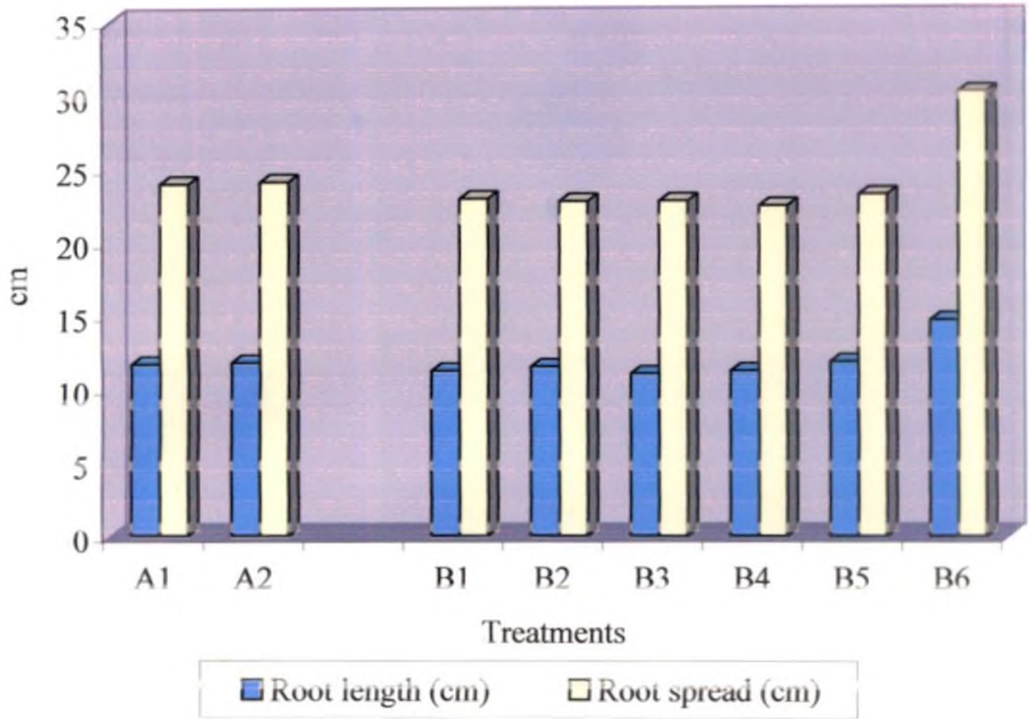

Fig. 5. Effect of biodynamic calendar and manurial schedule on root length and root spread

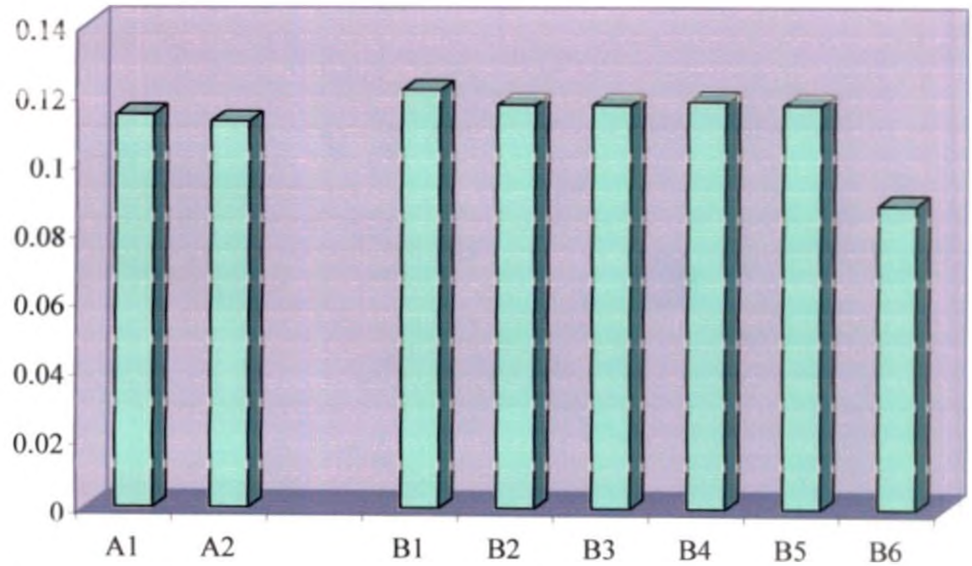

Fig. 6. Effect of biodynamic calendar and manurial schedule on root-shoot ratio

characters like plant height, number of branches, LAI, root length and root spread. A sudden shift from integrated farming system to organic probably could not express their superiority with respect to growth characters as it requires, sufficient time (conversion period) to develop into a viable and sustainable agro-ecosystem. Similar results were observed by Stanhill (1990), Wynen (1994), Halberg and Kristenson (1997).

5.2 YIELD CHARACTERS AND YIELD

Manurial schedule had profound influence on yield and yield attributing characters.

Number of fruits plant^{-1}, fruit length and mean weight of fruits plant^{-1} were significantly influenced by integrated nutrient supply system. In all these cases the maximum values were registered for POP recommendations and this might be attributed to increased availability and uptake of nutrients. Adequate supply of N, P and K early in the life of plant is important for the development of reproductive structures (Tisdale *et al.*, 2002). Increased nutrients in turn increased the production, translocation and assimilation of photosynthates to growing points thereby stimulating plants to produce more flowers plant^{-1} and subsequently more fruits plant^{-1}and fruit length. Similar results were reported by Kaminwar and Rajagopal (1993), Sherly (1996) and Anu (2003).

Mature fruit yield was significantly influenced by manurial schedule. POP recommendations of KAU registered highest mature fruit yield, which was significantly superior to other treatments. The cumulative positive influence of growth characters and yield attributes had resulted in better expression of yield. The improvement in yield and yield attributes with higher doses of NPK fertilizers may be attributed to the fact that these nutrients being important constituents of nucleotides, proteins, chlorophyll and enzymes involve in various metabolic process which have direct impact on vegetative and reproductive phases of plants (Mongel and Kirkby (1996). Similar increase in mature fruit yield with

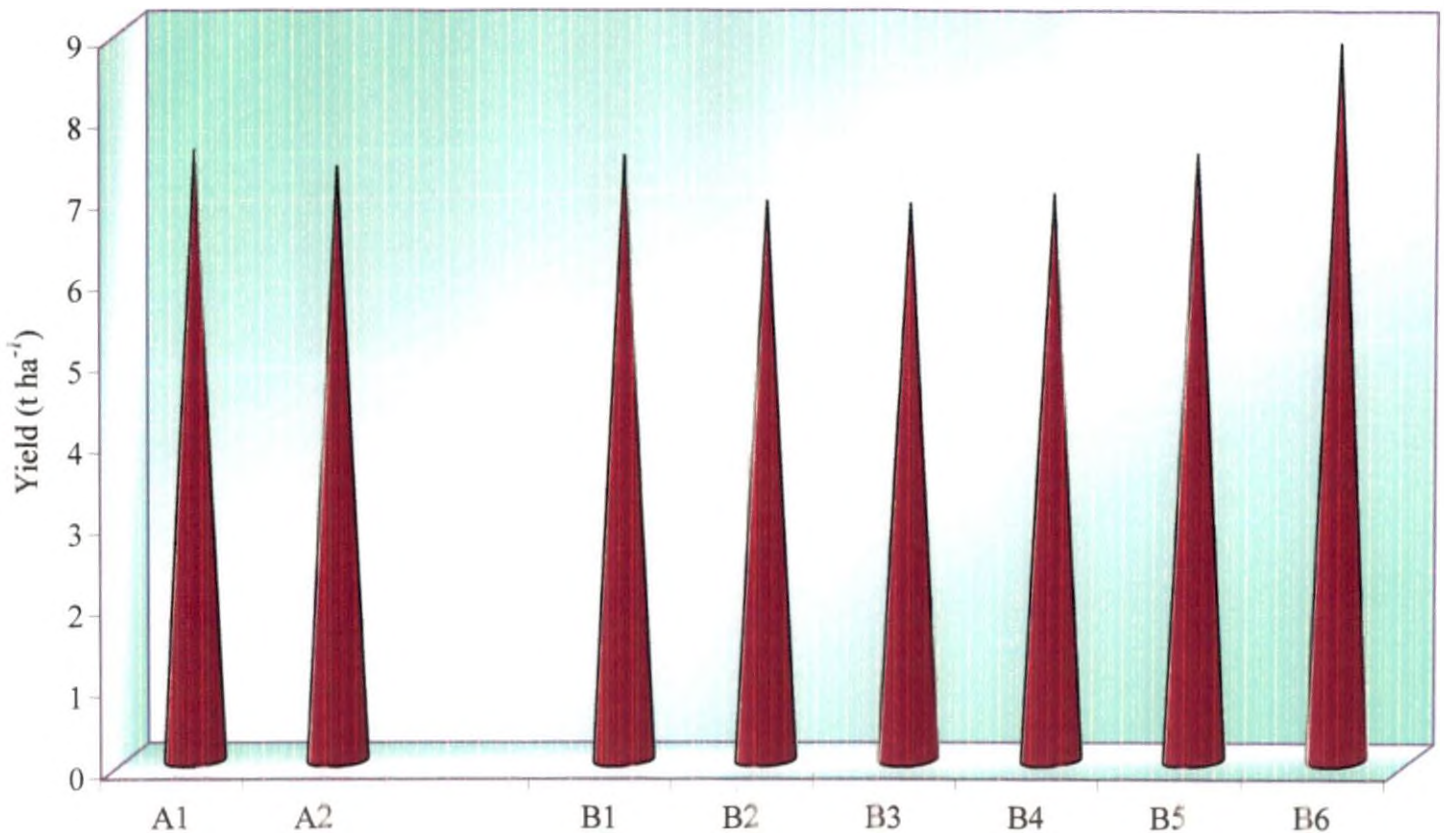

Fig. 7. Effect of biodynamic calendar and manurial schedule on mature fruit yield of chilli

increased level of fertilizers was reported by Singh and Srivastava (1988) John (1989) and Joseph (1998).

It is worth mentioning that the increased yield with POP recommendation might be due to the additional influence of organic manure component which might have resulted in improved physico-chemical condition of the rhizosphere leading to the better expression of response to applied chemical fertilizers.

As in the case of growth characters, the organic manure treatments with biodynamic preparations and panchgavyam produced the same declining trend in yield characters and yield when compared to the integrated application of chemical fertilizers and organic manures. In contrast to chemical fertilizers the availability of nutrients present in bulky organic manures such as FYM is less as only one half of N, one sixth of P_2O_5 and a little more than half of K_2O alone are readily available to plants during the first season (Thampan, 1993). Thus nutrients from FYM were not fully available to plants especially at the critical stages of crop growth and reproduction. This might have resulted in decreased crop growth and yield.

Lack of adequate response from biodynamic preparations may be due to insufficient time available for biodynamic preparations to get activated, since this investigation was taken up in field, which was fertilized mainly with chemical fertilizers. Experiments have shown that in intensive farming system, organic agriculture decreased yield and the range depends on the intensity of external input use before conversion. The organic transition effect in which a yield decline in the first 1-4 years of transition to organic agriculture, followed by a yield increase when soils have developed adequate biological activity was reported by Liebhardt *et al.* (1989) and Neera *et al.* (1999).

5.3 NUTRIENT CONTENT IN SOIL

Organic manures combined with BD preparations and Panchagavyam recorded the highest values of N, P and K content in soil after the experiment. The lowest content of N, P and K was recorded in POP recommendations. In POP treatments application of fertilizers along with organic manures resulted in faster decomposition of organic manures and resulted nutrients along with the inorganic fraction were utilized for increased growth and yield as reflected in increased branching, LAI, increased number of fruits plant^{-1}, increased fruit weight plant^{-1} and mature fruit yield. This might have resulted in the lower N, P and K content in soil treated with integrated plant nutrient supply system. The increased available nutrient content in soil in organic manure treatment may be due to the better retention of nutrients in soil due to slow mineralization and reduced losses of nutrients. Similar results of increase in available nutrient content in soil with organic manures were reported by Joseph (1998), Raj (1999) and Sharu (2000).

5.4 RHIZOSPHERE MICROBIAL POPULATION

The results revealed that the rhizosphere fungal population was not significantly influenced by various treatments on different growth stages except at 60 DAT. Fungal population in organic manure treated plots with biodynamic preparations and panchagavyam were significantly superior to plots receiving POP recommendations. Application of nutrients in the form of chemical fertilizers especially urea increased the soil pH. This higher soil pH and high osmotic potential resulted in a partial and temporary sterilization of soil within the retention zone (Tisdale *et al*, 2002). Similar results of increase in fungal population with increase in organic manure application was reported by Buchner (1993) and Manna *et al.* (1996).

Biodynamic calendar and manurial schedule showed no significant variation in bacterial as well as actinomycetes population in the

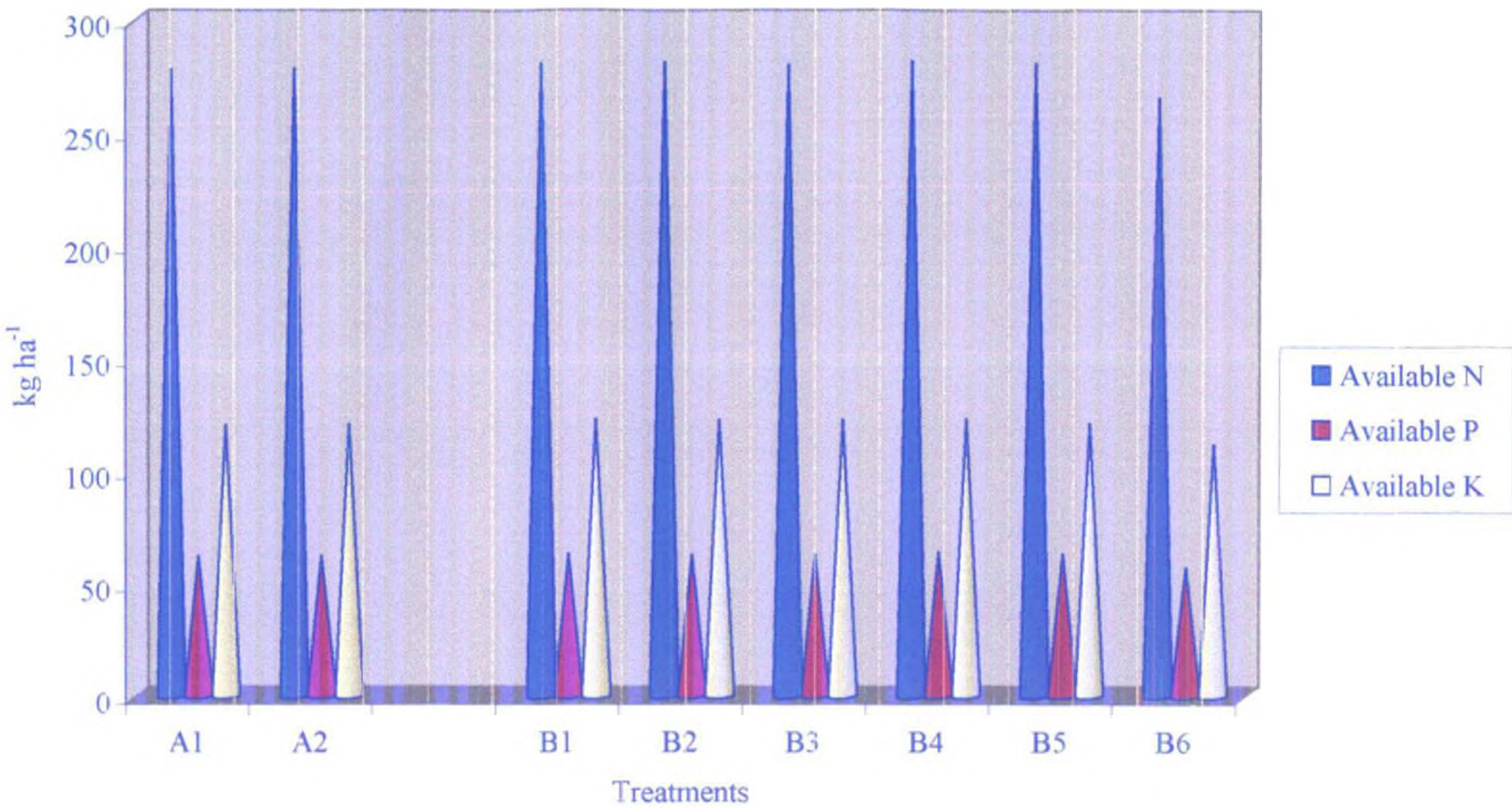

Fig. 8. Effect of biodynamic calendar and manurial schedule on available N, P and K content of soil after the experiment

rhizosphere. The actinomycetes population was found to be lower compared to bacterial and fungal populations. This may be due to competition and actinomycetes are sensitive to acidic soil conditions (Brady, 2001).

In general, a reduction in microbial population was noticed with the advancement of crop. This might be due to the reduction in the availability of organic substrata and adequate build up organic matter is a prerequisite for proliferation of microorganism supplied through biodynamic preparations

5.5 EARTHWORM COUNT

A perusal of data on earthworm count in the soil indicates that no significant influence exerted by biodynamic calendar, manurial schedule and their interaction on earthworm count.

In all the treatments there is a drastic reduction in earthworm count after harvest compared to the initial count. This may be due to the reduced soil moisture content and higher temperature during the period of harvest. Hallett *et al.* (1992) found that moisture influenced the growth and reproduction of earthworm and the most favourable moisture content is 80 per cent. During summer months reproduction rate of earthworms are comparatively less both in exotic and indigenous earthworm species (Jiji, 1997).

5.6 QUALITY CHARACTERS

Highest shelf life was recorded in treatment which received Panchagavyam + organic manures on nutrient equivalent basis and this was on par with other organic manurial treatments. Ascorbic acid content was maximum in the treatment receiving organic manures alone on nutrient equivalent basis. Almost the same values were observed in other organic manure treatments with BD preparations and panchagavyam. The more balanced availability of macro as well as micro nutrients from organic manures might have increased the vitamin C content of fruits. The

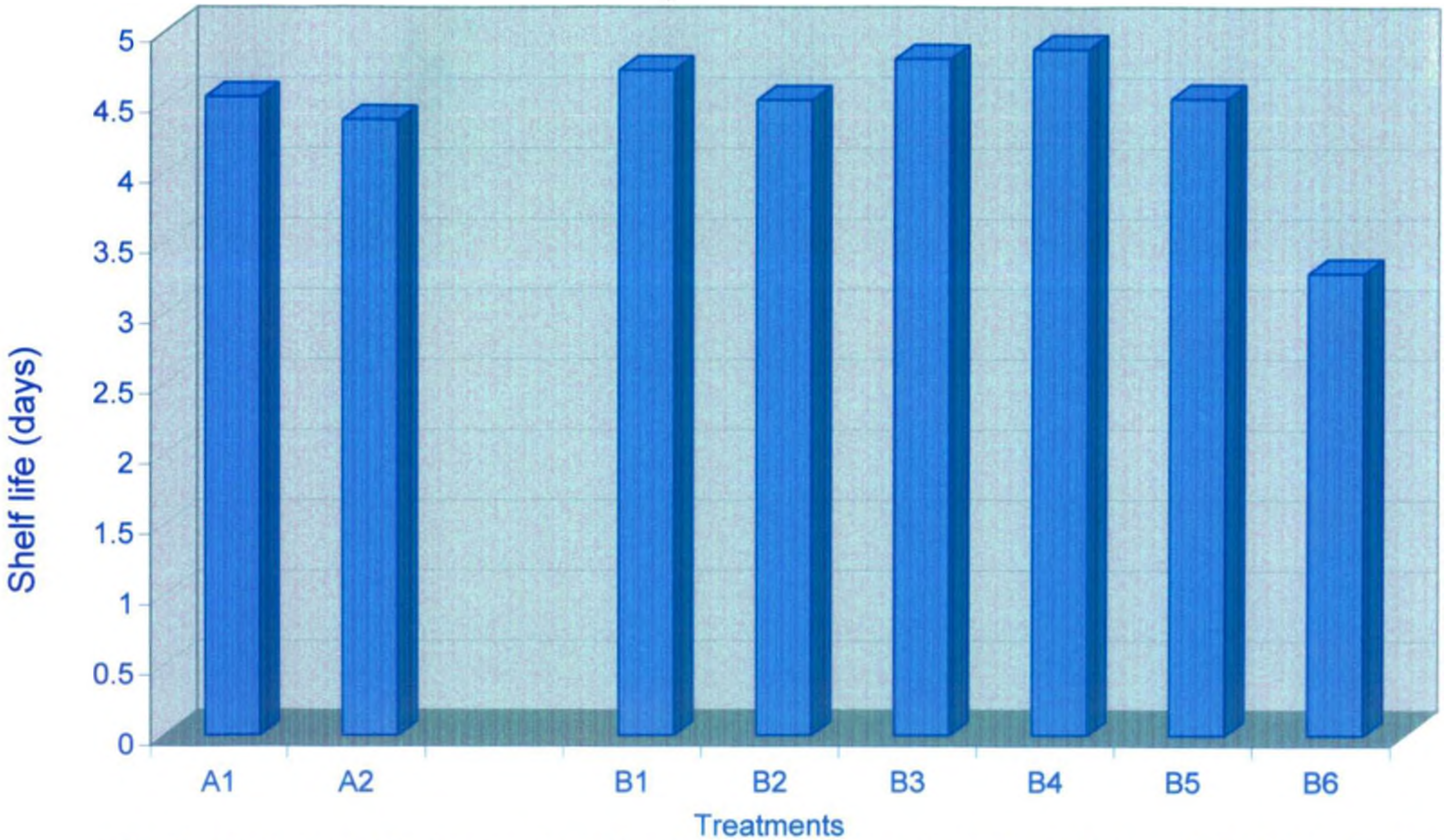

Fig.9. Effect of biodynamic calandar and manurial schedule on shelf life of chilli

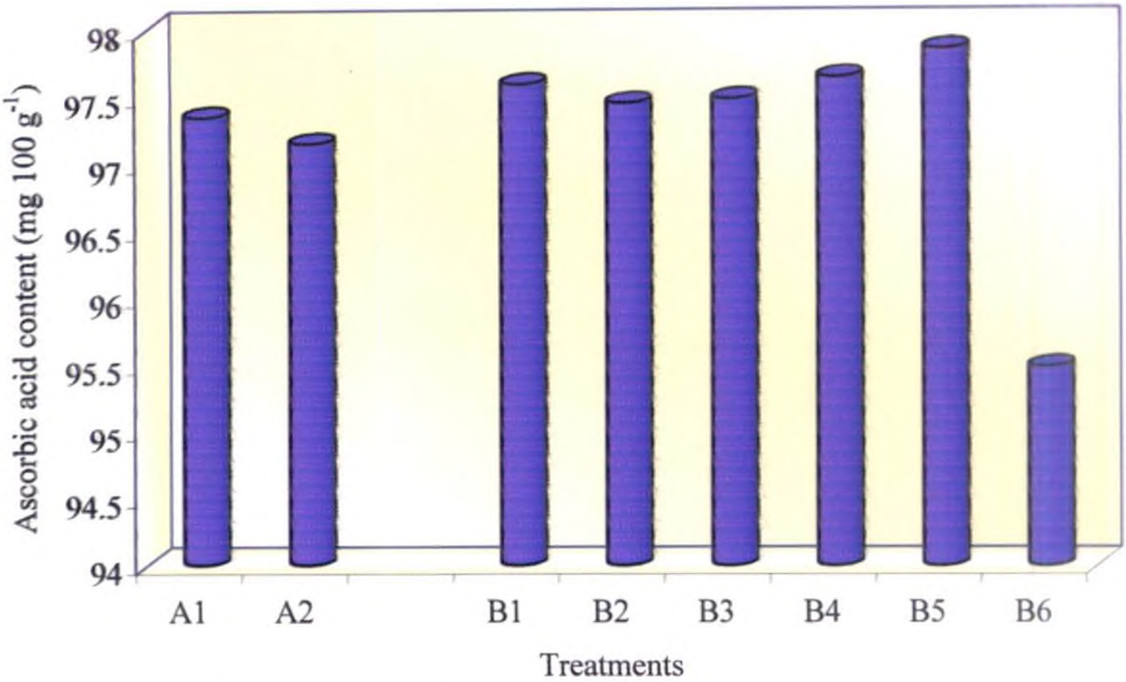

Fig. 10. Effect of biodynamic calendar and manurial schedule on ascorbic acid content

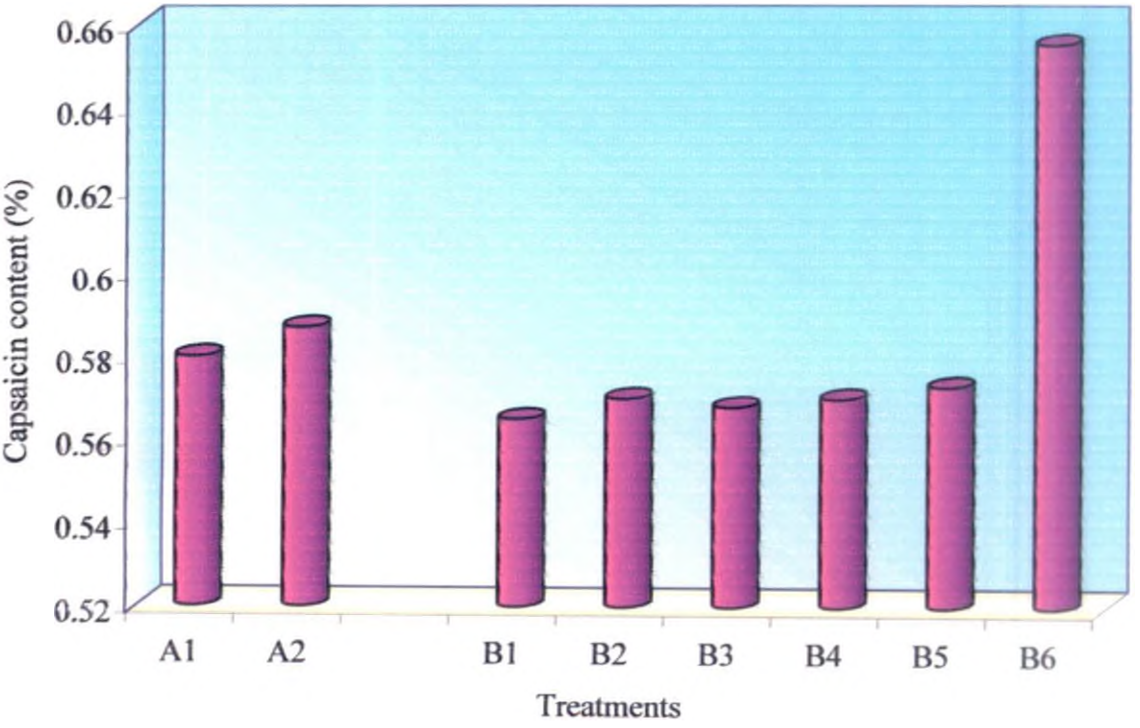

Fig. 11. Effect of biodynamic calendar and manurial schedule on capsaicin content (%)

biological function of vitamin C is based on its ability to donate electrons, which provides intra and extra cellular reducing power for a variety of biological reactions. Substantially high cellular levels of vitamin C provide antioxidant protection against photosynthetically generated free radicals (Singh *et al.*, 2004). This might have increased the shelf life of chilli fruits. Moreover application of fertilizers produced succulent fruits which might have reduced the storage life. Similar results of increase in vitamin C content and shelf life with the application of organic manures were reported by Sharu (2000) and Rani *et al.* (1997).

Significant improvement was noticed in POP recommendations of KAU on capsaicin content which was significantly superior to all other treatments. Pungency is considered as one of the most important quality trait in chilli. Capsaicin is the condensation product of 3-hydroxy, 4-methoxy benzylamine and decylenic aid. Optimum nitrogen content is considered to be essential for the production of this chemical. The favourable effect of POP in increasing the capsaicin content might be due to its beneficial role in increasing amino acid synthesis and thereby protein synthesis favoured by the increased availability of N and P. Moreover, adequate availability of high-energy compounds in the plant system under assured P nutrition might have enhanced the activity of enzymes involved in capsaicin synthesis. Similar confirmatory reports have been put forward by Niranjana and Devi (1990), Sreeja (2003) and Satyaseelan (2004).

5.7 PEST AND DISEASE INCIDENCE

Damping off, leaf curl and fruit rot incidence were observed in the experimental plot. Among these damping off and fruit rot were influenced by manurial schedule. With regard to damping off, a significant reduction was recorded in POP recommendations of KAU. Due to the rapid availability of nutrients in inorganic fertilizer treated plots, plants exhibited vigorous early growth and this might have provided better early

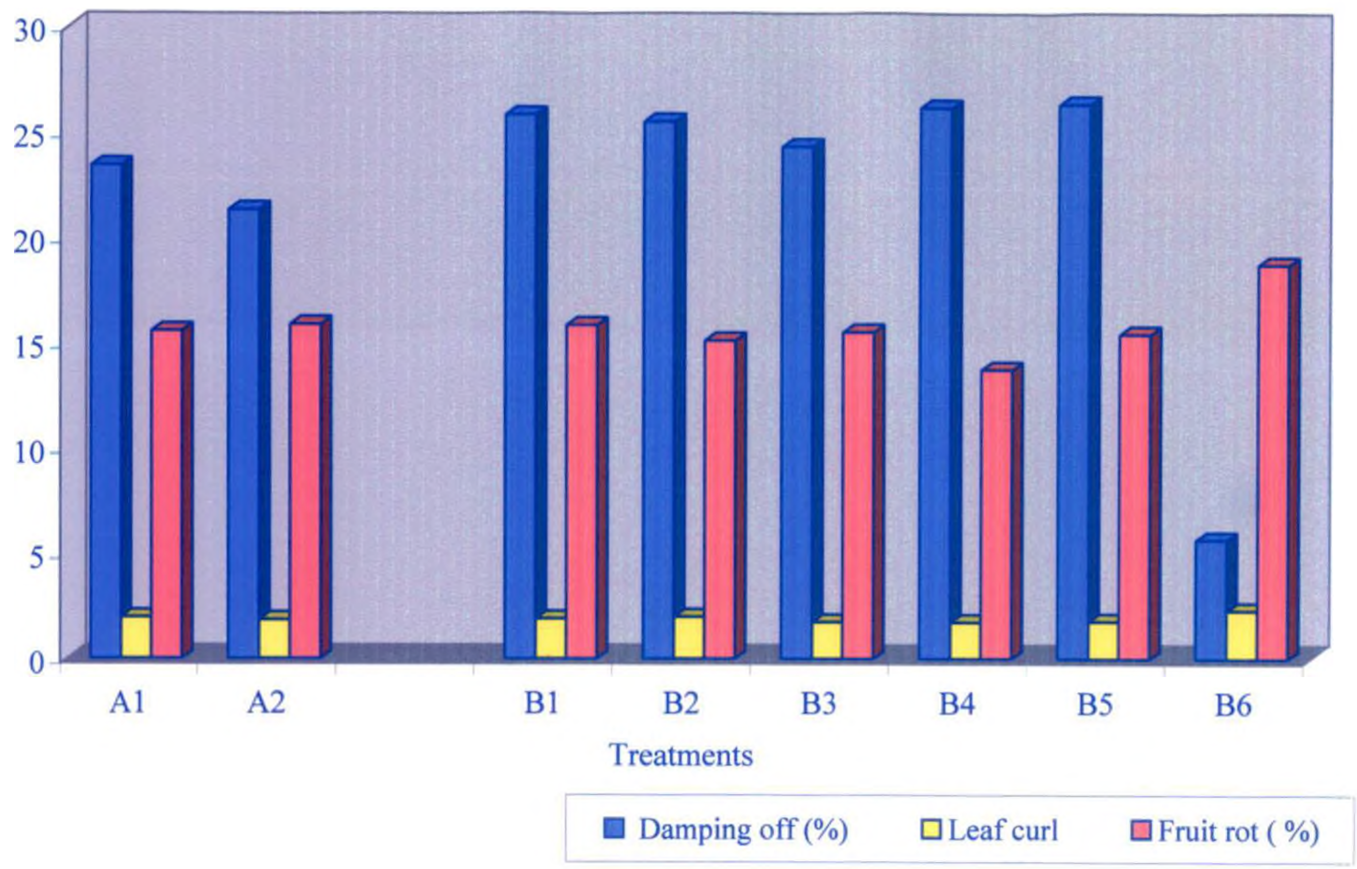

Fig. 12. Effect of biodynamic calendar and manurial schedule on damping off, leaf curl and fruit rot of chill

resistance in these plants as the disease was observed only two weeks after transplanting. Supply of sufficient quantities of nutrients keep plants in a vigorous, healthy condition to maximize competitiveness against diseases (Tisdale *et al* 2002).

Contradictory to damping off highest incidence of fruit rot was observed in inorganic manure treated plots. The increased succulence of chilli fruits might have resulted in increased disease incidence. A significantly low fruit rot incidence was observed in panchagyam + organic manures on nutrient equivalent basis treated plots which was on par with other organic manure plots with BD preparations. The decreased fruit rot incidence may be due to the effect of panchagavyam, which helped the plants to develop resistance against diseases (Sundararaman, 2004). Mathew (2004) reported that *Pseudomonas*, *Trichoderma* etc. will be produced in soil as result of application of BD- 500 which will protect plants from pests and diseases

Even though not significant, highest leaf curl incidence was noted in POP treatment. Plant susceptibility to insect attack has been associated with high plant N levels related to high inputs of soluble N fertilizers. Free amino acids, associated with high N application, increase pest attack (Hedin *et al.*, 1993 and Phelan, 1999).

5.8 ECONOMICS

Package of practices recommendations of KAU recorded maximum net returns and benefit : cost ratio which was significantly superior to all other treatments. This increase in net returns and BCR may be due to increased productivity compared to organic manure plots. Though the cost of cultivation of integrated plant nutrient supply system is higher than organic manure plots with BD preparations and panchagavyam, the higher fruit yield compensated for the additional cost resulting in higher net returns and BCR. Studies have shown that labour cost in organic

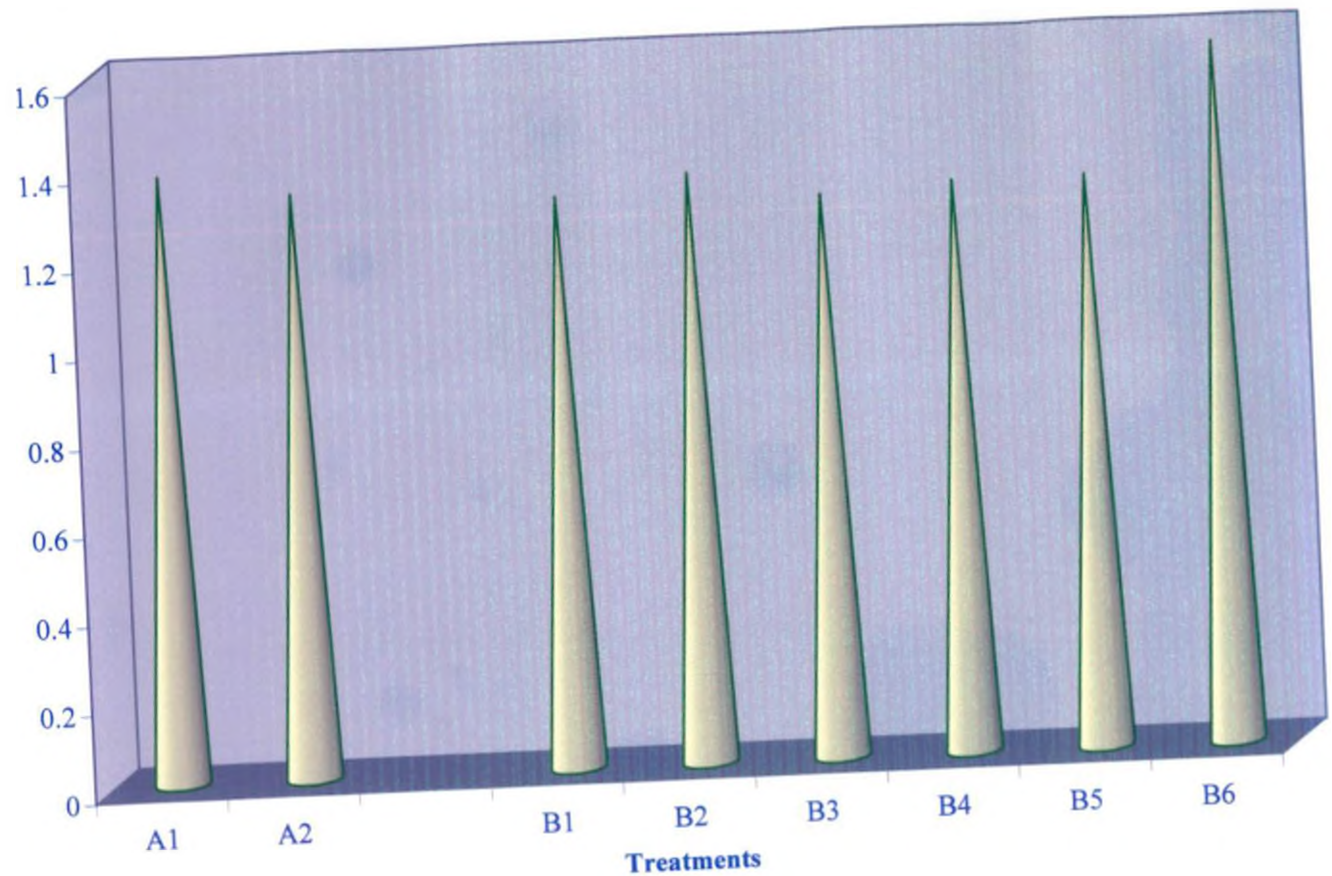

Fig. 13. Effect of biodynamic calendar and manurial schedule on B:C ratio

agriculture studies were 40-50 per cent higher than conventional agriculture (Pandel and Lampkin, 1994). Higher input costs due to the purchase of organic manures have been reported by Sellen *et al.* (1993). However it has been observed that use of farm derived resources and favourable price premiums can offset reduced yields and make organic farms equally and often more profitable than conventional farms (Hanson *et al.*, 1997; Petersen *et al.*, 1999; Reganold *et al.*, 2001).

It is evident from the results of this investigation that for chilli POP recommendations of KAU (integrated nutrient supply system) performed better in terms of yield and economics. However, from the quality point of view organic farming practices with biodynamic preparations and panchagavyam showed a positive trend. It may also be elucidated that just the use of biodynamic preparations and following biodynamic calendar for a single season might not produce any dramatic change in yield and productivity. A gradual change from chemical to integrated and then to organic with biodynamic practices would be a better preposition in terms of yield, quality and sustainability.

Summary

6. SUMMARY

A field experiment was conducted at the Instructional Farm, College of Agriculture, Vellayani from October 2004 to February 2005 to study the feasibility of biodynamic practices in organic farming with special reference to yield, fruit quality and soil health of vegetable chilli, cv. Jwalasakhi.

The experiment was laid out in factorial randomised block design with two replications. The treatment consisted of two levels of biodynamic calendar (factor A) A_1- the cultivation practices based on biodynamic calendar and A_2 - cultivation practices without considering biodynamic calendar) and six levels of manurial schedule (factor B) B_1 – BD 500 + organic manures on nutrient equivalent basis, B_2 – BD 501 + organic manures on nutrient equivalent basis, B_3 – B_1 + B_2 + organic manures on nutrient equivalent basis, B_4 – Panchagavyam + organic manures on nutrient equivalent basis, B_5 – organic manures alone on nutrient equivalent basis, B_6 – package of practices recommendations of Kerala Agricultural University (FYM 20 t ha^{-1} + 75 : 40 : 25 kg N: P_2O_5 : K_2O ha^{-1}) The salient findings of the experiment are summarized below.

1. Growth characters *viz.*, height of plant, number of branches, leaf area index, root length and root spread were highest in Package of Practices Recommendations of KAU (B_6).
2. Significantly higher root-shoot ratio was noticed in BD-500 + organic manures on nutrient equivalent basis (B_1) which was on par with other treatments which received organic manures.
3. Yield attributing characters *viz.*, number of fruits $plant^{-1}$, weight of fruits $plant^{-1}$, fruit length and mature fruit yield ha^{-1} were highest in POP of KAU (B_6).

4. Rhizosphere fungal population was not significantly influenced by different treatments except at 60 DAT. The rhizosphere bacterial population and actinomycetes population were not significant at any of the growth stages of the plant.

5. The NPK content in the soil was highest for the treatment panchagavyam + organic manures on nutrient equivalent basis (B_4) which was on par with other treatments receiving organic manures with BD preparations.

6. The organic form of manures showed a definite advantage over POP of KAU on quality of fruits. Higher shelf life was observed in treatment panchagavyam + organic manures on nutrient equivalent basis (B_4) which was on par with other treatments receiving organic manures with BD preparations.

7. Ascorbic acid content were highest in fruits obtained from organic manures alone applied plots (B_5) which was on par with organic manures with BD preparations and Panchagvyam.

8. The capsaicin content was highest in POP of KAU (B_6) applied plots and was significantly superior to other treatments, which received organic manures.

9. The damping off incidence was influenced by manurial schedule. POP of KAU (B_6) recorded the least disease incident.

10. Integrated application of FYM + chemical fertilizers (POP of KAU) increased the fruit rot incidence while the lowest incidence was noticed in panchagavyam + organic manures on nutrient equivalent basis (B_4) and was on par with other organic manure treatments with BD preparations.

11. Biodynamic calendar showed no significant variation in growth characters, yield, yield attributes and biological properties.

12. Net returns and B:C ratio were higher in POP recommendation.

It is evident from the experiment that for chilli POP of Kerala Agricultural University with integrated nutrient supply system is more effective and showed better response in terms of growth, yield and economics while shelf life, ascorbic acid content of fruits and soil health showed a positive trend in organic farming practice with BD preparations and panchagavyam.

Future line of work

1. In order to draw conclusive results on organic farming with biodynamic practices, this type of investigation need to be carried out continuously for two. to three years in different seasons and with different crops.
2. More detailed study should be conducted on microbial count and soil enzymes.

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BIODYNAMIC PRACTICES IN CHILLI

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ABSTRACT

The research project entitled 'Biodynamic practices in chilli' was conducted at the Instructional Farm, College of Agriculture, Vellayani during October 2004 to February 2005. The study was conducted on chilli cv, Jwalasakhi.

The experiment was laid out in factorial randomised block design with two replications. The treatments consisted of two levels of biodynamic calendar – factor A (A_1 is the cultivation practices based on biodynamic calendar and A_2 is cultivation practices without considering biodynamic calendar) and six levels of manurial schedule – factor B (B_1 – BD 500 + organic manures on nutrient equivalent basis, B_2 – BD 501 + organic manures on nutrient equivalent basis, B_3 – B_1 + B_2 + organic manures on nutrient equivalent basis, B_4 – Panchagavyam + organic manures on nutrient equivalent basis, B_5 – organic manures alone on nutrient equivalent basis, B_6 – package of practices recommendations of Kerala Agricultural University (FYM 20 t ha^{-1} + 75 : 40 : 25 kg N: P_2O_5 : K_2O ha^{-1})

Results of the experiment revealed that POP recommendations of Kerala Agricultural University significantly increased the growth characters like plant height, number of branches, leaf area index, root length and root spread while root-shoot ratio was higher in organic manure treatments. Similar trend was also observed for yield and yield attributing characters.

The post harvest nutrient content in soil showed a significant increase with panchagavyam + organic manures on nutrient equivalent basis which was on par with other treatments receiving biodynamic preparations and organic manures.

Quality parameters of chilli significantly improved as a result of application of biodynamic preparations and organic manures. Panchagavyam + organic manures increased the shelf life while organic manures alone on nutrient equivalent basis increased ascorbic acid content. POP of Kerala Agricultural University was found to be significantly superior in capsaicin content.

There was significant reduction in the incidence of damping off by POP of Kerala Agricultural University while the highest incidence of fruit rot was observed in the same treatment. Eventhough the cost of cultivation is higher for POP recommendations of Kerala Agricultural University, it was rated as more economic in terms of net returns and B:C ratio.

Appendices

APPENDIX – I

Weather data for the cropping period (October 2004 to February 2005)

Standard week	Temperature (°C)		Rainfall (mm)	Relative humidity (%)	Evaporation (mm/day)
	Minimum	Maximum			
41	23.25	31.28	29.8	81.74	3.27
42	23.18	30.75	33.6	82.71	2.25
43	22.63	29.7	32.4	71.92	1.82
44	23.52	31.87	66.4	83.71	2.68
45	23.38	30.43	7.63	86.92	1.92
46	23.05	30.72	5.53	83.33	2.41
47	22.70	31.65	16.0	81.34	2.76
48	20.56	31.71	0	82.83	2.23
49	21.42	32.25	0	82.83	3.18
50	22.53	32.71	0	80.71	2.93
51	20.21	33.25	0	79.91	3.15
52	22.72	32.36	0	76.87	3.76
1	20.21	31.85	0	76.25	3.67
2	22.72	32.24	0	77.14	3.81
3	21.21	33.75	0	76.35	3.28
4	21.41	32.63	0	78.41	3.09
5	22.25	33.32	0.67	76.78	3.54
6	24.95	34.63	0	76.14	4.60
7	20.91	33.85	0	72.64	4.31

APPENDIX - II

Biodynamic farming calendar 2004 (For India)

Month	Moon opposite to Saturn	Full moon	New moon	Ascending period	Descending period	Node	Suggested dates for crops based on moon/constellation position			
							Seed and fruit	Root	Flower	Leaf
Jan	20	7	22	1 to 7 21 to 31	8 to 20	29	1, 2, 11, 12, 20, 21, 28, 29, 30	4, 5, 13, 14, 22, 23, 31	6, 7, 16, 24, 25	9, 10, 18, 19, 26, 27
Feb	16	6	20	1 to 3 18 to 29	4 to 17	26	7, 8,16, 17, 25	1, 10, 11, 18 ,19, 27, 28, 29	2, 3, 4, 12, 13, 20, 21	5, 6, 14, 15, 23, 24
Mar	14	7	21	1, 2 16 to 29	3 to 15, 30, 31	24	6, 7, 14, 15, 23	18, 9, 16, 17, 26, 27	1, 2, 10, 12, 19, 20, 28, 29	3, 4, 13, 21, 22, 31
Apr	11	5	19	12 to 25	1 to 11 26 to 30	20	2, 3, 10, 11, 19, 21, 29, 30	4, 5, 13, 14, 22, 23	6, 15, 16, 24, 25, 26	1, 8, 9, 17, 18, 27, 28
May	8	5	19	9 to 23	1 to 8 25 to 31	17	8, 9, 18, 27, 28	2, 3, 10, 11, 19, 20, 29, 30	5, 12, 13, 22, 23, 31	6, 7, 14, 15, 24, 25
June	5	3	18	6 to 19	1 to 5 20 to 30	14	4, 5, 13, 23, 24	6, 7, 15, 16, 17, 25, 26	8, 9, 18, 19	2, 3, 11, 12, 20, 21, 22, 30
July	3	2	17	3 to 16 30, 31	1.2 17 to 29	11	2, 10, 20, 21, 29, 30	4, 13, 14, 23, 24, 31	6, 7, 15, 16, 17, 26	8, 9, 18, 19, 27, 28
Aug	27	30	16	1 to 12 27 to 31	13 to 26	7	8, 16, 17, 18, 25, 26	1, 9, 10, 19, 20, 27, 28	2, 11, 12, 13, 22, 30	4, 5, 14, 15, 23, 24
Sept	23	28	14	1 to 9 23 to 30	10 to 22	3	4, 13, 14, 22, 23, 30	5, 6, 7, 15, 16, 24, 25	8, 9, 18, 26, 27	1, 2, 10, 11, 12, 20, 29
Oct	21	28	14	1 to 6 20 to 31	7 to 19	15	1, 10, 11, 19, 20, 28, 29	3, 4, 12, 13, 21, 22, 30, 31	5, 6, 15, 16, 23, 24	8, 9, 17, 18, 25, 26
Nov	17	27	12	1, 2 17 to 30	3 to 16	11	6, 7, 8, 15, 16, 25	9, 10, 17, 18, 26, 27, 28	1, 2, 3, 12, 19, 20, 29, 30	4, 5, 13, 14, 22, 23
Dec	14	26	12	14 to 27	1 to 13 28 to 31	8	4, 5, 13, 22, 31	6, 7, 15, 24, 25	9, 17, 18, 26, 27	1, 22, 3, 11, 19, 20, 29, 30

(Source: Biodynamic Association of India)

APPENDIX – III

Composition of media used for isolation of microorganisms

1. Fungi – Martins Rose Bengal Agar

Glucose	–	10 g
Peptone	–	5 g
K_2HPO_4	–	1 g
$MgSO_4 . 7H_2O$	–	0.5 g
Streptomycin	–	30 mg
Agar	–	15 g
Rose Bengal	–	0.035 g
Distilled water	–	1000 ml

2. Soil Extract Agar

Glucose	–	1 g
K_2HPO_4	–	0.5 g
Agar	–	15 g
Soil extract	–	100 ml
Tap water	–	900 ml

3. Kenknight's medium

Dextrose	–	1 g
K_2HPO_4	–	0.1 g
$NaNO_3$	–	0.1 g
KCl	–	0.1 g
$MgSO_4 . 7H_2O$	–	0.1 g
Agar	–	15 g
Distilled water	–	1000 ml