THE EFFECT OF ORGANIC MANAGEMENT TREATMENTS ON THE PRODUCTIVITY AND QUALITY OF LEMON GRASS *(CYMBOPOGON CITRATUS)*

P. Punam*, Rameshwar Kumar, Sheetal Sharma & D. Atul

*Department of Organic Agriculture, College of Agriculture,
CSK Himachal Pradesh Agricultural University, Palampur, HP, India
Email: profpunam@gmail.com

Abstract

An experiment was conducted at the Model Organic Farm of CSK Himachal Pradesh Agricultural University, Palampur (31º54' N and 76º17' E), Himachal Pradesh, India, to evaluate the effect of various organic management treatments on the productivity and quality of lemon grass (*Cymbopogon citratus*). Organic inputs (viz. farm yard manure (FYM); vermicompost; agnihotra ash; and neem powder) were added at the time of planting, while Bt + Himbio and the biodynamic preparation BD 500 were sprayed regularly at one month intervals. Crops were sown on dates matching moon and non moon position according to the Biodynamic Planting Calendar. Addition of agnihotra ash along with sowing as per moon position resulted in a higher yield of lemon grass (+124%, +99%) and a higher oil per cent (+155%, +144%) over the control, in both the years of study. Sowing as per moon position may have improved germination rate, water absorption and metabolism of the plants, whereas addition of agnihotra ash may have stabilized the nutrients present in soil.

Key Words: lemongrass, integrated organic management, yield, oil percent, moon position, agnihotra ash, biodynamic agriculture.

Introduction

Lemon grass is a perennial herb widely cultivated in the tropics and subtropics. The reported adaptation zone for lemon grass is: temperature 18 to 29ºC with an annual precipitation of 0.7 to 4.1 meters and a soil pH of 5.0 to 5.8. Since the plants rarely flower or set seed, propagation is by root or plant division. The plants are harvested mechanically or manually about four times each year with the productive life span between four and eight years.

Lemon grass is used in herbal teas, other non-alcoholic beverages, and in confections. Oil from lemon grass is widely used for fragrance in perfumes and cosmetics, such as soaps and creams. Essential oil isolated from C. flexuosus (citral-type), is reported to contain citral-b from 14% to 35% and citral-a from 23% to 56%, while geraniol type is reported to contain geraniol from 17% to 88 % (Verma et al. 1987). Citral, extracted from the oil, is used in flavoring soft drinks, in scenting soaps and detergents, as a fragrance in perfumes and cosmetics and as a mask for disagreeable odors in several industrial

 ISSN 1177-4258

products. Citral is also used in the synthesis of ionones used in perfumes and cosmetics. As a medicinal plant, lemon grass has been considered a carminative and insect repellent. Lemon grass is generally recognized as safe for human consumption as plant extract/essential oil.

In the case of medicinal plants such as lemon grass, the type and amount of compound and hence the quality along with the quantity is an important aspect considered in its production. Quality and safety are of concern to all. The understanding of food quality has been expanded beyond the mere definition by chemical content, to technical characteristics for processing and storage, appearance and taste. Organic farming is gaining momentum especially in the cultivation of medicinal plants owing to reputed improvements in the quality of the produce under organic systems of farming as well as the price premiums for certified produce. Organic production systems are based on specific and precise standards of production which aim at achieving agro-ecosystems which are socially and ecologically sustainable. Organic agriculture is based on minimizing the use of external inputs and avoiding the use of synthetic fertilizers and pesticides. Particularly in organic agriculture, but not exclusively so, other considerations like ethical values and production principles (environmental impact such as energy efficiency, non-pollution, animal welfare, aim for sustainability and social impact) are gaining weight as integral product values. There is a growing demand for organic foods driven primarily by consumers' perceptions of the quality and safety of these foods and to the favourable environmental impact of organic agriculture practices.

Biodynamic farming and Homa farming are two important practices within the family of organic production systems. Biodynamic agriculture is an organic farming system that arose out of a philosophical movement Anthroposophy (Steiner, 1924; Paull, 2011). Rudolf Steiner indicated that the Moon, especially in its synodic cycle, was of great importance for the growth of crops. Lili Kolisko (1936) reported the positive results of her experiments following Steiner’s indications. In 1956, Thun developed a procedure of sowing according to the position of the Moon relative to the twelve zodiacal constellations. These constellations were classified into four groups according to the element (Earth, Water, Air and Fire) astrologically associated with them. Root, leaf, flower and fruit crops were found to show increased yields if sown when the Moon stood before Earth, Water, Air and Fire constellations, respectively. Thun’s philosophy of sowing by this sidereal rhythm has become a major component of biodynamic planting calendars. In 1962, the Thun theory became embodied into a biodynamic gardening calendar which has appeared annually ever since (e.g. Thun 2001) and is presently translated into 21 languages. This calendar incorporates various lunar cycles and events. Crop yield experiments were conducted by Thun in collaboration with the statistician Heinze over the eight years 1964–71, mainly with potatoes, but also with carrots and radishes, and beans as a seed-crop (Thun & Heinze 1979). In these experiments, twelve rows of a crop were sown over one sidereal month, one row per 2–3 days, while the Moon traversed a particular constellation. Final crop yield weights were compared, measuring the total yield per row of potatoes or of beans. The weight ratio of the crop/total plant was also evaluated. There is evidence that parameters such as germination rate (Maw 1967), water absorption (Brown & Chow 1973) and metabolism (Brown 1960) respond to this cycle.

Biodynamic methods of farming are distinct in that they make use of several unique fermented substances, called preparations, as field sprays and compost inoculants (Koepf et al. 1976). Biodynamic preparations numbered 502 to 507 are used as compost additives, Biodynamic 500 (BD 500) is called cow horn manure, and is made from fresh lactating cow dung packed into cow horns, buried over the winter for fermentation in the earth (Perumal & Vatsala 2002; Pfeiffer 2006)

Homa farming is an Indian holistic concept of growing plants in a healthy atmosphere and maintaining an ecological balance by performing agnihotra (*Yajna*) in the middle of the farm and using the Yajna-ash as a fertilizer. Homa or *Yajna* ia a pyramid fire technique passed down from the ancient Atharva Vedas. The technical term *Yajna* denotes a process of removing the toxic conditions of the atmosphere through the agency of fire. The thereby healed and purified atmosphere is said to have beneficial effects on man, animals and plants (Paranjpe 1989). The basic Homa called Agnihotra (Sanskrit: agni=fire, hotra=healing), is performed at sunrise and sunset. A small fire is prepared from dried cow dung and clarified butter (ghee) in a copper pyramid. Some grains of unbroken whole brown rice, mingled with clarified butter (ghee) are put into the fire accompanied by the chanting of a mantra. The ash produced by the fire is credited with having healing properties and it is said to have fertilizing as well as plant protecting quality. Reports from India, Peru, Venezuela, the United States of America, and Austria, give accounts of the beneficial effects of Homa farming on plant germination, development, health and pest resistance, as well as on yield and product quality, and with regard to soil quality, an improved water holding capacity, an increase in amount and solubility (plant availability) of macro nutrients and trace elements (Bhujbal 1981; Paranjpe 1989; Perales et al. 2000; Mutalikdesai 2000; Schinagl 2004; Atul et al. 2006 and Kratz and Schung 2007).

Biodynamic and Homa Farming practices were incorporated with other components of organic farming in the present study to investigate the best combination of different organic practices for increasing the productivity and quality of lemon grass.

Materials and Methods

The experiment was conducted in the experimental fields of Model Organic farm, CSK HP Agricultural University, Palampur (31º54' N and 76º17' E), Himachal Pradesh, India. Before laying the experiment, the initial status of soil fertility was examined. Composite soil samples collected from 0-15 cm depth before start of the experiment were run for chemical analysis. On the basis of chemical analysis, the soil was categorized as acidic (pH 5.3), medium in organic carbon (1.35%), available nitrogen (330 kg ha^{-1}), low in phosphorus (6 kg ha^{-1}) and high in available potassium (395 kg ha^{-1}).

The experiment was laid out in a randomized block design replicated thrice with twelve treatments consisting of all the combinations of organics and time of sowing as per moon position and non moon position (Table 1). Lemon grass was transplanted as per the Biodynamic Planting Calendar of the year during which the study was conducted. The calendar was obtained from the Bio-Dynamic Association of India <www.biodynamics.in>. The calendar describes various lunar cycles and events. In this calendar, separate dates are prescribed for the planting of different crops (seeds/fruits, tubers/roots, flowers or leaves end product crops). In the present study planting as per moon position refers to the day prescribed by the calendar for leaf end product. The non moon position adopted

 ISSN 1177-4258

in the study was the day prior to the moon position day as prescribed by the calendar for planting. The calendar also specifies dates for other biodynamic agricultural practices such as the use of the preparations, and where applicable the recommendations of the calendar were followed.

The organic inputs (viz. FYM, vermicompost, agnihotra ash and neem powder) were added at the time of planting while Bt + Himbio and BD 500 were sprayed regularly at one month interval s starting from a month after planting. Neem powder was prepared by crushing the neem kernels purchased from the local market. Himbio was prepared from local strains of trichoderma and had a viable cell count of 10^8 cfu. The crop was planted in July, 2006 with a plot size of 12 m^2 and plant spacing of 60 X 45 cm. Growth parameters *i.e.,* plant height and plant spread (x and y axis) and number of off shoots, were determined from 10 sampled plants per plot at regular intervals of 30 days. The first cut of the crop was taken after 90 days of planting and the second cut was taken 150 days after planting. The crop was cut using sickles at about 15 cm above the ground. Oil from the leaves was extracted using steam distillation following the method given by the Persian physicist Avicenna (c.980-1037) for extraction of essential oils. Statistical analysis was done by the standard procedures suggested by Gomez & Gomez (1984) with correlations and critical differences (CDs) between means reported. CDs are reported at 95% significance throughout.

Table1. Details of Treatments

Treatments	Details of treatments
T_1	Organic manure (FYM @ 20 t/ha + vermicompost @ 15 t/ha) & sowing as per moon position (MP)
T_2	T_1 + Neem (0.05 %)
T_3	T_1 + Agnihotra ash (@ 33 kg ha^{-1})
T_4	T_1 + *Bacillus thuringiensis* (Bt) (0.3%) & Himbio (0.5 %)
T_5	T_1 + Biodynamic 500 (BD 500 – Cow horn manure)
T_6	Control + Sowing as per moon position (MP)
T_7	Organic manure (FYM @ 20 t/ha + vermicompost @ 15 t/ha) & Sowing as per non moon position (NMP)
T_8	T_7 + Neem (0.05 %)
T_9	T_7 + Agnihotra ash (@ 33 kg ha^{-1})
T_{10}	T_7 + *Bacillus thuringiensis* (Bt) (0.3%) & Himbio (0.5 %)
T_{11}	T_7 + Biodynamic 500 (BD 500 – Cow horn manure)
T_{12}	Control + sowing as per non moon position (NMP)

Results

Plant Growth

Growth parameters recorded after 30 days of planting of lemon grass (Table 2) reveal that there was no effect of date of sowing on plant height and plant spread. However, sowing according to moon position significantly increased the number of off shoots over the sowing as per non moon position. Addition of agnihotra ash significantly increased plant height, number of off shoots and plant spread. However, interaction between date of

sowing and addition of organics was non significant. There was no attack of insect pest on the crop and the crop was disease free.

Table 2: Effect of organics on yield attributes of lemon grass at 30 days after planting.

Sr. No	Parameters	Organic manure* (OM)	OM + Neem	OM + agnihotra ash	OM + Himbio + Bt	OM + BD 500	Control	Mean
1	**Plant height (cm)**							
	MP	41.55	42.83	44.68	42.79	42.84	38.85	42.26
	NMP	41.65	41.37	43.50	43.33	42.76	35.12	41.29
	Mean	41.6	42.10	44.09	43.06	42.80	36.99	
	CD							
	Date of sowing	NS						
	Treatments	2.39						
	Interaction	NS						
2	**Number of off shoots (No.)**							
	MP	9.67	9.00	11.00	7.67	7.00	7.00	8.56
	NMP	8.00	6.67	11.00	7.00	6.33	6.00	7.50
	Mean	8.83	7.83	11.00	7.33	6.67	6.50	
	CD							
	Date of sowing	0.78						
	Treatments	1.35						
	Interaction	NS						
3	**Plant spread (cm^2)**							
	MP	418.43	350.19	594.61	553.69	540.45	344.68	467.01
	NMP	490.72	451.18	561.62	543.94	499.22	305.93	475.44
	Mean	454.57	400.69	578.12	548.81	519.84	325.31	
	CD							
	Date of sowing	NS						
	Treatments	80.79						
	Interaction	NS						

(CD: Critical Difference, NS: not significant, MP: Moon Position Sowing, NMP: Non Moon Position sowing. OM* (Organic manure): FYM @ 20 t/ha + Vermicompost @ 15 t/ha; Himbio: Mixture of Trichoderma (JMA-4, SMA-5, DMA-8 and JMA-11); Bt; *Bacillus thuringiensis* ; BD 500: Biodynamic 500.)

At 60 days of planting (Table 3), the treatments where organic manure alone was added and where organic manure was added in conjunction with biopesticide were at par with each other. Sowing as per moon position significantly increased plant height, number of off shoots and plant spread over the non moon position sowing. There was a significant improvement in these parameters in the treatments where organics were added over the control. Highest plant height and plant spread was observed in treatment T_3 followed by

 ISSN 1177-4258

T_9 treatment. There was no attack of insect pest on the crop and the crop was disease free.

Table 3: Effect of organics on yield attributes of lemon grass at 60 days after planting.

Sr. No	Parameters	Organic manure* (OM)	OM + Neem	OM + agnihotra ash	OM + Himbio + Bt	OM + BD 500	Control	Mean
1	**Plant height (cm)**							
	MP	54.93	55.18	84.33	75.22	62.36	52.48	64.09
	NMP	53.24	53.00	75.35	65.41	58.27	48.97	59.04
	Mean	54.08	54.09	79.84	70.32	60.32	50.72	
	CD							
	Date of sowing	1.58						
	Treatments	2.73						
	Interaction	3.87						
2	**Number of off shoots (No.)**							
	MP	32.00	33.00	71.00	60.00	48.00	16.00	43.33
	NMP	25.00	23.00	65.00	53.00	43.00	11.33	36.72
	Mean	28.50	28.00	68.00	56.50	45.50	13.67	
	CD							
	Date of sowing	1.56						
	Treatments	2.70						
	Interaction	NS						
3	**Plant spread (cm^2)**							
	MP	1,290.84	1,194.20	6,413.67	5,302.89	3,824.91	1,506.93	3,255.57
	NMP	1,349.16	1,273.04	6,069.47	4,470.77	3,204.90	401.56	2,794.82
	Mean	1,320.00	1,233.62	6,241.57	4,886.83	3,514.91	954.24	
	CD							
	Date of sowing	181.08						
	Treatments	313.63						
	Interaction	443.54						

(CD: Critical Difference, NS: not significant, MP: Moon Position Sowing, NMP: Non Moon Position sowing. OM* (Organic manure): FYM @ 20 t/ha + Vermicompost @ 15 t/ha; Himbio: Mixture of Trichoderma (JMA-4, SMA-5, DMA-8 and JMA-11); Bt; *Bacillus thuringiensis* ; BD 500: Biodynamic 500.)

Plant height and number of off shoots at harvest

Perusal of data reveals that there was a significant effect of date of sowing and addition of different organics on plant height and number of off shoots in the first and second year (Tables 4 & 5). Sowing as per moon position resulted in a significant increase in plant height and number of off shoots over the sowing as per non moon position. Treatments where organic manure was added alone and where organic manure was added in

conjunction with bio-pesticide, were at par with each other. However, in both the years the interaction between date of sowing and addition of different organic manures was non significant for both the parameters.

Table 4: Effect of date of sowing and addition of organics on plant height of lemon grass at harvest.

Organics	Plant height (cm)					
	First year			Second year		
	MP	NMP	Mean	MP	NMP	Mean
Organic manure* (OM)	68.85	67.54	68.20	63.0	58.6	60.80
OM + Neem	69.65	67.26	68.45	65.04	61.24	63.14
OM + Agnihotra ash	98.59	92.41	95.50	80.97	72.86	76.92
OM + Himbio + Bt	87.58	79.67	83.63	75.55	65.91	70.73
OM + BD 500	76.62	72.53	74.58	74.61	64.5	69.56
Control	64.74	61.01	62.88	57.78	53.07	55.43
Mean	77.67	73.40		69.49	62.70	
CD						
Date of sowing	1.27			2.56		
Organics	2.02			4.43		
Interaction	NS			NS		

(CD: Critical Difference, NS: not significant, MP: Moon Position Sowing, NMP: Non Moon Position sowing. OM* (Organic manure): FYM @ 20 t/ha + Vermicompost @ 15 t/ha; Himbio: Mixture of Trichoderma (JMA-4, SMA-5, DMA-8 and JMA-11); Bt; *Bacillus thuringiensis* ; BD 500: Biodynamic 500.)

Table 5: Effect of date of sowing and addition of organics on number of off shoots of lemon grass at harvest.

Organics	No. of off shoots					
	First year			Second year		
	MP	NMP	Mean	MP	NMP	Mean
Organic manure* (OM)	47.00	40.00	43.5.0	43.33	32.33	37.83
OM + Neem	48.00	38.00	43.00	44.67	35.33	40.00
OM + Agnihotra ash	86.00	80.00	83.00	56.67	52.33	54.50
OM + Himbio + Bt	75.00	68.00	71.50	49.00	40.33	44.67
OM + BD 500	63.00	58.00	60.50	47.33	37.00	42.17
Control	26.00	21.00	23.50	26.33	20.00	23.17
Mean	57.50	50.83		44.56	36.22	
CD						
Date of sowing	1.51			2.98		
Organics	2.62			5.16		
Interaction	NS			NS		

(CD: Critical Difference, NS: not significant, MP: Moon Position Sowing, NMP: Non Moon Position sowing, OM* (Organic manure): FYM @ 20 t/ha + Vermicompost @ 15 t/ha; Himbio: Mixture of Trichoderma (JMA-4, SMA-5, DMA-8 and JMA-11); Bt; *Bacillus thuringiensis* ; BD 500: Biodynamic 500.)

Effect on plant spread and yield at harvest

The highest yield was recorded (7853 kg ha^{-1} in first year and 7278 kg ha^{-1} in second year) in the treatment where lemon grass was sown as per moon position with organic manure and agnihotra ash (Table 6 & 7) while lowest yield (2833 kg ha^{-1} in first year and

 ISSN 1177-4258

3193 kg ha^{-1} in second year) was obtained in control with sowing as per non moon position.

Table 6: Effect of date of sowing and addition of organics on plant spread of lemon grass at harvest.

Organics	Plant spread (cm^2)					
	First year			Second year		
	MP	NMP	Mean	MP	NMP	Mean
Organic manure* (OM)	2,520.79	2,442.83	2,481.81	4,592.13	3,613.79	4,102.96
OM + Neem	2,244.94	2,349.95	2,297.45	4,758.34	4,448.69	4,603.52
OM + Agnihotra ash	9,191.72	8,226.35	8,709.03	6,863.55	6,174.35	6,518.95
OM + Himbio + Bt	7,425.67	6,409.59	6,917.63	5,189.57	4,578.92	4,884.25
OM + BD 500	5,572.97	4,817.07	5,195.02	4,820.03	4,558.34	4,689.19
Control	1,475.87	1,064.52	1,270.20	3,355.24	3,025.61	3,190.43
Mean	4,738.66	4,218.39		4,929.81	4,399.95	
CD						
Date of sowing	226.05			455.33		
Organics	391.54			788.65		
Interaction	553.72			NS		

(CD: Critical Difference, NS: not significant, MP: Moon Position Sowing, NMP: Non Moon Position sowing, OM* (Organic manure): FYM @ 20 t/ha + Vermicompost @ 15 t/ha; Himbio: Mixture of Trichoderma (JMA-4, SMA-5, DMA-8 and JMA-11); Bt; *Bacillus thuringiensis* ; BD 500: Biodynamic 500.)

Table 7: Effect of date of sowing and addition of organics on yield of lemon grass.

Organics	Fresh Yield (kg/ha)					
	First year			Second year		
	MP	NMP	Mean	MP	NMP	Mean
Organic manure* (OM)	4,667.00	4,083.00	4,375.00	5,137.00	3,603.00	4,370.00
OM + Neem	4,583.00	4,417.00	4,500.00	5,253.00	3,998.00	4,626.00
OM + Agnihotra ash	7,853.00	7,467.00	7,660.00	7,278.00	5,883.00	6,581.00
OM + Himbio + Bt	7,292.00	7,000.00	7,146.00	6,025.00	5,200.00	5,613.00
OM + BD 500	6,754.00	6,500.00	6,627.00	5,581.00	5,069.00	5,325.00
Control	4,000.00	2,833.00	3,417.00	3,389.00	3,193.00	3,291.00
Mean	5,858.00	5,383.00		5,444.00	4,491.00	
CD						
Date of sowing	125			407		
Organics	216			704		
Interaction	306			NS		

(CD: Critical Difference, NS: not significant, MP: Moon Position Sowing, NMP: Non Moon Position sowing. OM* (Organic manure): FYM @ 20 t/ha + Vermicompost @ 15 t/ha; Himbio: Mixture of Trichoderma (JMA-4, SMA-5, DMA-8 and JMA-11); Bt; *Bacillus thuringiensis*; BD 500: Biodynamic 500.)

Effect on oil per cent

Oil percent was significantly higher where sowing was done according to moon position as compared to that in the crop sown as per non moon position Table (8). Interaction of date of sowing and addition of organics was significant for oil percent with highest oil (0.46 %) in treatment where lemon grass was sown as per moon position with organic manure + Agnihotra ash while lowest oil (0.18 %) was obtained in control with sowing as per non moon position. There was no attack of insect pest on the crop and the crop was disease free.

Table 8: Effect of date of sowing and addition of organics on oil percent in lemon grass.

Organics	Oil percent		
	Date of sowing		
	As per moon position (MP)	As per Non moon position (NMP)	Mean
Organic manure* (OM)	0.31	0.21	0.26
OM + Neem	0.31	0.19	0.25
OM + Agnihotra ash	0.46	0.41	0.44
OM + Himbio + Bt	0.34	0.35	0.35
OM + BD 500	0.38	0.35	0.37
Control	0.18	0.18	0.18
Mean	0.33	0.28	
CD			
Date of sowing	0.014		
Organics	0.024		
Interaction	0.033		

(CD: Critical Difference, NS: not significant, OM* (Organic manure): FYM @ 20 t/ha + Vermicompost @ 15 t/ha; Himbio: Mixture of Trichoderma (JMA-4, SMA-5, DMA-8 and JMA-11); Bt; *Bacillus thuringiensis*; BD 500: Biodynamic 500.)

Correlation analysis

Correlation analysis between growth parameters, yield and oil percent showed that all the growth parameters were highly and significantly correlated to yield and oil percent with coefficient ranging from 0.904 to 0.998 in first year and 0.767 to 0.885 in the second year (Table 9). Highest correlation of yield was established with number of new slips, showing that yield increased with the increase in number of new slips.

Table 9: Correlation between different parameters, yield and oil content of lemon grass.

Parameter	Plant height		Plant spread		Fresh yield	
	1st year	2nd year	1st year	2nd year	1st year	2nd year
No. of off shoots	0.943*	0.885*	0.961*	0.827*	0.964*	0.850*
Plant height			0.960*	0.767*	0.904*	0.826*
Plant spread					0.959*	0.818*

(*Significant at 95% confidence.)

 ISSN 1177-4258

Discussion

In both the years of study, sowing as per moon position significantly increased plant height and number of off shoots (Plates 1 & 2) which may be due to better germination rate (Maw, 1967), water absorption (Brown & Chow, 1973) and metabolism in these plants (Brown, 1960). These growth parameters improved all the more with the addition of organics, contributing towards healthier chemical, physical and biological conditions of the soil. Steiner (1924) stated that the Moon especially in its synodic cycle was of great importance for the growth of crops. Brown & Chow (1973) have reported the effect of lunar cycle on the water absorption process in the plants. It may have an indirect effect on the nutrient uptake by the plants, resulting in increased growth in case of crop sown on moon position day. Brown (1960) has also confirmed the effect of this lunar phase ('synodic') cycle on metabolism of the plants. Within the Anthroposophical movement, botanical studies of plant morphology by Bockemühl have supported the view that stages of plant growth may be seen in terms of such 'formative forces' that are linked with the traditional four elements. He has related the stages of leaf, flower, and seed formation with water, air and warmth (Bockemühl, 1980). Significantly higher plant height and number of off shoots were obtained with addition of agnihotra ash, followed by addition of Himbio + Bt and BD 500.

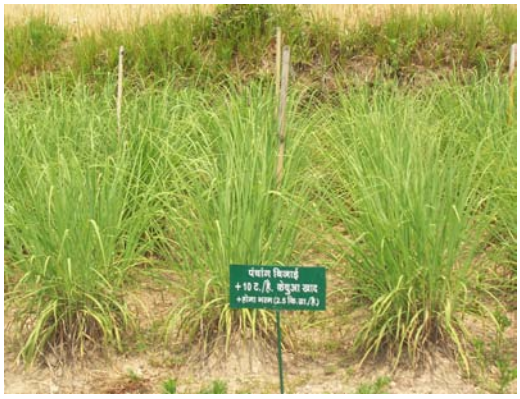

Plate 1

Plate 2

Plate 1: Lemon sown as per moon position (MP).
Plate 2: Lemon grass sown as per non moon position (NMP).

Sowing according to moon position with organic manure and agnihotra ash recorded the highest yield. Results from the trial of Thun and Heinze (1979) on potato, beans and radish have also indicated that the yield maxima appeared in the, predicted 'trigon' or Moon-constellation-element of the sowing dates. Abele (1975) in his experiment on grain crops (barley and oats) and root crops (carrots and radish) showed that there was a mean yield excess of 7% in the 'fruitday' trigons and an averaged excess of 21% in the 'rootday' trigons as compared to sowings at other times. In a two year study conducted at the Model Organic Farm of CSK Himachal Pradesh Agriculture University, significantly higher maize yield has been reported (ICAR, 2007) in crop sown as per moon position (18.2%) than the crop sown as per non moon position. Kollerstron & Staudenmaier (1998) have reported the results from their trial on potatoes and showed that mean yields on 'rootday' sowings were 30 per cent in excess of sowings on other days. Bishop (1977) has also obtained yield excesses in leaf-day sowings. The increase in yield can be

attributed to the significant effect of date of sowing as per moon position on growth and development of these crops.

In association with soil microorganisms, organic manures are known to help in synthesis of certain phytohormones and vitamins which promote the growth and development of crops (Kumar, 2007). Similar results have been obtained by Sharma (1983). Organic manures are also known to increase the cation exchange capacity of soil, form chelates with micronutrient elements and consequently leaching losses are reduced considerably. Besides this, organic manures help to improve the soil structure which in turn increases the infiltration and retention of water, improves soil aeration and moderates the soil temperature (Allison, 1973).

Agnihotra ash, when put on the soil, helps stabilize the amount of nitrogen and potassium present. Trace elements in the soil change drastically (Paranjpe, 1989). Kratz & Schnug (2007) found that the addition of agnihotra ash improves the short-term solubility of soil phosphorus compounds, which then may be more readily available to plants and soil microorganisms.

Oil percent was significantly higher where sowing was done according to moon position as compared to that in the crop sown as per non moon position (Table 8). There was no attack of insect pest on the crop and the crop was disease free. Better metabolism of plants due to sowing as per moon position might have increased oil content and at the same time agnihotra ash might have stabilized the nutrient present in soil contributing in synthesis of better oil recovery in lemon grass. The present study clearly indicates that Homa farming and Biodynamic farming (Biodynamic Planting Calendar) have potential for improving the plant yield and oil content of *Cymbopogon citratus*.

Acknowledgement

The authors are thankful to the Niche Area of Excellence Programme of Indian Council of Agricultural Research (Education Division) on ‘Organic Farming in Hill Agriculture’ under which this study was carried out at the Model Organic Farm of the University.

References

Abele, U. 1975. Saatzeitversuche mit Radies. Lebendige Erde, 6: 223-225.

Allison, F.E. 1973. Soil organic matter and its role in crop production. Development in Soil Science 3. Amsterdam: Elsevier.

Atul, D., Saini, J.P., Rameshwar, R., Sood, P., Punam, P. & Sharma, N. 2006. Organic farming in hill agriculture under the plan scheme niche area of excellence – experiment 5: impact of integrated organic crop management on productivity of medicinal plant based system. Palampur, College of Agriculture, Half yearly Progress Report.

Bhujbal, B.G. 1981. Agnihotra and grapes. http://www.agnihotra. org/science.htm

Bishop, C. 1977. Moon influence in lettuce growth. The Astrological Journal, 10: 13-15.

Bockemühl, J. 1985. Elements and ethers: modes of observing the world. In Towards a Phenomenology of the Etheric World. New York: Anthroposophical Press.1-67.

Brown, F. 1960. The rhythmic nature of animals and plants. Cycles, April: 81–92.

 ISSN 1177-4258

Brown, F. & Chow, C.S. 1973. Lunar-correlated variations in water uptake by bean seeds. Biological Bulletin, 145: 265–278.

Gomez, K.A. and Gomez, A.A. 1984. Statistical Procedures for Agricultural Research (2nd), New York: John Wiley and Sons.

ICAR. 2007. Annual Report Niche Area of Excellence program in Organic Farming in Hill agriculture. Indian Council of Agriculture Research (ICAR), CSK HPKV Palampur, HP.

Koepf, H.H., Pettersson, B.D. & Schaumann, W. 1976. Bio-dynamic Agriculture. Hudson, USA: Anthroposophic Press.

Kolisko, L. N. (1936). The Moon and the Growth of Plants (M. Pease, Trans.). London: Anthroposophical Agricultural Foundation.

Kollerstrom, N. & Staudenmaier, G. 1998. Mond-Trigon-Wirkung: eine statistiche Auswertung. Lebendige Erde, 11: 478–483.

Kratz, S. & Schnug, E. 2007. Homa Farming – a vedic fire for agriculture: Influence of Agnihotra ash on water solubility of soil P. Landbauforschung Volkenrode, 3(57): 207-211.

Kumar, J. 2007. Studies on integrated nutrient management through Vermicompost in direct seeded rice-wheat sequences. Ph.D. thesis. Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishvavidyalaya, Palampur.

Maw, M. 1967. Periodicities in the influences of air ions on the growth of garden cress. Canadian Journal of Plant Science, 47: 499–505.

Mutalikdesai, A.2000. Agricultural experience with vanilla plants. http://www.agnihotra.org/science.htm

Naguib, N.Y. 2002. Yield and quality of lemongrass plants (Cymbopogon flexuous stapf) as influenced by farm yard manure and foliar application of bread yeast. Annals of Agricultural Science, Ain Shams University, Cairo, 47(3):85874.

Paranjpe, V. V. 1989. Homa therapy - our last chance. Madison, VA: Five-fold Path.

Paull, J. (2011). Attending the First Organic Agriculture Course: Rudolf Steiner's Agriculture Course at Koberwitz, 1924. European Journal of Social Sciences, 21(1): 64-70.

Perales, J.O., Solier, L., Basurto, A., Torres, M.R. & Mendez, J.N. 2000. Project report: Homa therapy in the cultivation of cotton variety tanguis, 1999-2000 campaign. Lima, Peru, unpublished report.

Perumal, K. & Vatsala, T.M. 2002. Consolidated report on Sustainable biodynamic farming boost agricultural economy scheduled caste farmers. Department of Science and Technology, Govt. of India, New Delhi. 16-21.

Pfeiffer, E. 2006. Soil Fertility, Renewal and Preservation: Bio-Dynamic Farming and Gardening. Delhi, India: Asiatic Publishing House.

Sharma, H.L. 1983. Studies on the utilization of crop residue, FYM and N-fertilization in rice-wheat cropping system under sub-temperate climate. Ph.D Thesis. Department of Agronomy, HPKVV, Palampur.

Singh, M. 2001. Long-term studies on yield, quality and soil fertility of lemongrass (*Cymbopogon flexuosus*) in relation to nitrogen application. The Journal of Horticultural Science and Biotechnology, 76(2):180-182.

Singh, Munnu, Ganesha Rao, R. S. & Ramesh, S. 2005. Effects of nitrogen, phosphorus and potassium on herbage, oil yield, oil quality and soil fertility status of lemongrass in a semi-arid tropical region of India. The Journal of Horticultural Science and Biotechnology, 80(4): 493-497.

Staudenmaier, G. & Kollerstrom, N. 2001. Evidence for Lunar – Sidereal Rhythms in Crop Yield: A Review. Biological Agriculture and Horticulture, 19: 247-259.

Steiner, R. 1924 (1993 trans). Lectures on Agriculture, 1924. Trans. by C. Creeger & M. Gardner, Kimberton, PA: Biodynamic Farming and Gardening Association Inc.

Schinagl, H. 2004. Untersuchungen des Einflusses pflanzenstarkender Mittel auf Wachstum, Ertrag und Qualitat gartnerischer Nutzpflanzen. Wien : Univ Bodenkultur

Thun, M. 2001. Working with the Stars, a Biodynamic Sowing and Planting Calendar. 26th edn. Launceston, U.K.: Lanthorne Press.

Thun, M. & Heinze, H. 1979. Mondrhythmen im Sidetischen Umlauf und Pflanzenwachstum. Darmstadt, Germany.

Verma, V., Sobti, S.N. & Atal, C.K. 1987. Chemical composition and inheritance pattern of five Cymbopogon species. Indian Perfumer, 31: 295-305.

 ISSN 1177-4258