UTILIZATION OF LOCAL ALTERNATIVE MATERIALS IN COW HORN MANURE (BD 500) PREPARATIONS: A CASE STUDY ON BIODYNAMIC VEGETABLE CULTIVATION

K. PERUMAL & T.M. VATSALA
Shri A.M.M. Murugappa Chettiar Research Centre
Tharamani, Chennai, 600 113, India
Email: energy1@vsnl.com

ABSTRACT

At the Shri AMM Murugappa Chettiar Research Centre apart from organic farming practices, biodynamic agriculture practices were undertaken between 1977-1980 by following the combination of French Intensive Gardening Techniques and biodynamic principles in a village near Chennai. The experimental results were quite promising and well appreciated.

The studies on biodynamic agricultural practices with scientific observation, identification of microbial diversity and its interaction in soil with different vegetable crop cultivation was undertaken in a model farm at Sevapur.

Three different vegetable crops such as carrot, onion and okra were cultivated in soil amended with different manures such as organic and biodynamic .The vegetables cultivated in the experimental plots with organic and biodynamic manures produced comparable yield, less pest and disease attack, improved soil physical-chemical and microbiological properties.

The studies on biodynamic preparations such as BD500, CPP and biodynamic compost were periodically evaluated for its compost/ manure maturity. Chromatographic techniques, microbial identification-enumeration and its physiochemical properties like pH, moisture and the available NPK were critically evaluated on these preparations. Further the possibilities of developing indigenous techniques to the local needs by identifying and characterizing locally available plant materials were evaluated.

In general BD500 is prepared by using a lactating cow horn. In India, the availability of cow horn is becoming an issue. According to Rudolf Stainer the

clay is the mediator between calcium and silica process. The clay soil can therefore be used as one of the source materials in Biodynamics. Instead of using cow horn for BD500 preparation, the horn shaped mould was fabricated with clay soil. These mud horns were buried along with cow dung in the same way and at the same time as the horn cow dung.

The quantity and quality of mud horn manure was evaluated critically. The alternative plant material such as flowers from compositae such as *Tridex procumbens, Ageratum conzyzoides* and leaves of *Casuarina sp.* were explored for its potentials in biodynamics. The results of these studies will be elaborated at the time of presentation.

INTRODUCTION

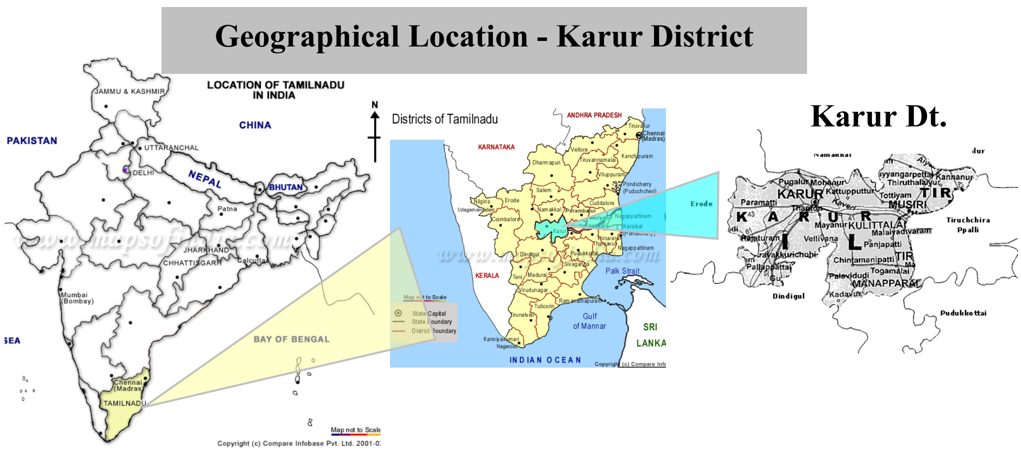
BIODYNAMIC agriculture is an advanced organic farming system developed out of eight lectures on agriculture given by Rudolf Steiner[1] in 1924 at the request of German farmers. This agricultural system is considered to be the oldest organized agriculture movement in the world. Like organic farming, biodynamic farming needs no synthetic pesticides, fertilizers. It emphasizes building up the soil with biodynamic compost, animal and green manures, crop rotations and live stocks. The important difference is that the biodynamic farmers use eight specific preparation such as cow horn manure (BD 500), cow horn silica (BD 501) and herbal preparations BD 502- 507 to their soil, compost, special foliar sprays and peppering for pest control to the crops which could enhance food quality, quantity and soil health.

Forty years of investigation conducted by comparing biodynamic and conventional farms or research plots in different countries indicated that the biodynamic farming system generally have better soil quality, crop yield and equal or high net returns per hectare than the conventional farming practices[2]. In India studies on organic management with and without addition of biodynamic preparations showed improved biological soil properties and increased crop root growth[3]. Recently there has been increasing interest in biodynamic farming and new gardening system derived from the teaching of Rudolf Steiner and by subsequent practitioners. In India the biodynamic farming go hand in hand with organic farming practices which were followed from ancient times. Many of the practices incorporated in biodynamic farming are the traditions of India. By the introduction of green revolution in India, most of the Indian traditional agricultural practices were taken over by chemical fertilizer crop production. Even then, India has achieved self-sufficiency and good degree of stability in food production. However, self-sufficiency can be achieved only when the population is assured of a balanced quality diet. These balanced diets for the individuals in country could be achieved only through a qualitative and quantitative sustainable cropping system by adapting to organic and biodynamic sustainable agriculture in India. The varied agro-climatic conditions in India make it possible to grow a wide variety of crops and vegetables. In India vegetables are grown in 20% of the total cropped area of which 50% is consumed locally and, being the second largest producer of vegetables in the world could contribute quality balanced diet to the consumers. Among the vegetables cultivated in India, the root vegetable carrot is an important contributor of vitamins, minerals and amino acids to the consumers. This crop requires an optimum temperature of 15-23°C for their growth in soils amended with rich decomposed organic matter.

The present study was conducted to know the efficacy of biodynamic management of carrot, okra and onion cultivation in the plain where the temperature remains above 28°C. Further to test the quality of vegetables grown biodynamically and compare it with commercially grown vegetables, by biodynamic circular paper chromatographic technique.

MATERIALS AND METHODS

The present research activities were undertaken at the field laboratory of Shri AMM Murugappa Chettiar Research Centre (Extension), Sevapur, Karur District, Tamil Nadu during August 2000 – July 2002. The climate of the site, in general is sub tropical characterized by hot summer and mild winter. The temperature during the cultivation remained at 35 – 28 ± 2°C during day and night respectively.



Biodynamic compost preparation & alternatives

The vermicompost was prepared as per the instruction outlined in the "Organic composting training manual" published by Shri AMM Murugappa Chettiar Research centre, Chennai (1999). The biodynamic compost, cow horn manure (BD 500), and cow pat pit (CPP) were made and applied to the soil by following the instruction laid down by Proctor [3].

The mud mould horn manure: The clay soil was used to prepare a cow horn shaped mould. Instead of using cow horn for BD500 preparation, the horn shaped mould was fabricated with clay soil. These mud horns were filled in with lactating cow dung and buried along with regular BD 500 in the same way and at the same time as the horn cow dung. A time scale studies were carried out to determine the quantitative and qualitative changes occurring during manure maturity.

The flowers *of Peltophorum ferrugineum* were used along with lactating cow dung. The following 3 combinations such as flower, flower & cow dung 1:1 W/W) and cow dung were made, filled in the cow horns individually, buried and periodically evaluated for its physiochemical and microbiological properties.

The above mentioned manures such as vermicompost, biodynamic compost, Cow horn manure (BD500) and CPP were further used for the following studies on vegetable cultivation.

Vegetable cultivation

Seeds: The seeds of okra (*Abelmochus esculantus*), onion (*Alium cepa*) and carrot (*Daucus carrota L)* were purchased from the Department of Agriculture, Tamil Nadu.

Plot Design: The vegetables okra, onion were cultivated in a randomized block design with three replicates each with 1.5 cent plot area. The carrot was cultivated in the experimental plot size of 1m X 1m of well drained, slightly alkaline (pH

8.0), silt loam and having the available nitrogen (N), phosphorus (P) and potash (K) at 73, 6, 89 kg/ha respectively were selected.

Treatment:

Carrot Cultivation:

The soil was initially amended with 7 kg of vermicompost, 7 kg of biodynamic compost and 1 kg of cow pat pit manure (CPP) which were previously prepared and thoroughly mixed. The carrot seeds were propagated on a root sign day (11th November 2001: The sun position was opposite to Libra and the moon was opposite to Leo- Virgo) at the experimental plot. Once in 3 days irrigation was done. On the 15th day after sowing thinning process (5 cm between plants) was undertaken. Forty day after sowing earthing up and top dressing were undertaken with an application of 7 kg each of vermicompost and biodynamic compost manures. Weeding was done on 20th and 40th day after sowing. On the 60th and 80th day after sowing vermicompost extract prepared by mixing 3 kg of vermicompost in 2000 ml of water. An extract of 500 ml was collected and again diluted with 500 ml of water. This extract (100 ml) was applied as foliar spray in addition to cow urine (3% V/V). On the 80th day after sowing a foliar spray of BD 501 was given and 50 grams of gypsum also applied to the soil. On the 95th day after sowing carrot crop was harvested.

Okra & Onion cultivation :

The okra (*Abelmochus esculantus*), onion (*Allium cepa*) were cultivated on fruit-root sign day during May- August 2000 at the experimental plots and a comparison was made between four farming system such as Farmers practice (**T1**- consists of farmyard manure 15 kg, Urea 1.5 kg, super phosphate 9 kg as basal and Urea 1kg, potash 0.5 kg was applied during top dressing), Biodynamic (**T2**- treatment consist of biodynamic compost each 40 kg applied during basal and top dressing), Organic (**T3** treatment consists of farmyard manure and vermicompost each 20 kg were applied during basal and top dressing), and inorganic practice (**T4-** treatment consists of urea 2.5 kg, super phosphate and potash each at 1.5 kg respectively applied as basal and top dressing to the soil.) were under taken.

During the 25th and 50th Day after planting, plant protection measures were followed for okra and onion and the details are given below:

Treatment	5th Day (ml spray)	50th Day (ml spray)
T1	Endosulphan (25)	Monocil (10)
T2	BD 501,CPP	Cow urine (300) & Datura extract (1000)
T3	Cow urine (300)	Datura extract (1000)
T4	Endosulphan (25)	Monocil (10)

BIOMETRICAL ANALYSIS

The okra's biometric analysis such as plant height (shoot& root length), No of flowers/ plant, No. of fruit/ plant, No. of seeds/ fruit, fruit yield and stack yield were recorded at 10 days interval. The onion biometric analysis such as plant height, dry matter production, No of bulbs/ plant, weight of bulb/plant, bulb yield (Fresh & dried) and stack yield were recorded The observation on the carrot growth parameters like plant height, root length, root girth, dry biomass, and total root yield were recorded at every 10 days interval upto the 90^{th} DAS (at the time of harvesting). At each observation 20 plants were randomly selected and recorded.

Soil physicochemical analysis

The soil from various treatments such as initial, pre harvested or manure applied and post harvested soil were analysed for physicochemical properties such as pH, EC, N, P, K and OC (organic carbon) by following standard soil & manure analysis methods as described by Muthuvel and Udayasoorian[4] .

Microbial analysis

The microbial analysis of soils (such as initial, manure applied and post harvested) were done by using standard dilution plate count techniques[5]. The media such as nutrient agar, yeast extract manitol agar, *Azospirillum* isolation medium, *Azotobacto*r isolation agar medium and rose Bengal nutrient agar medium were used for the enumeration of the total bacteria, *Rhizobium, Azospirillum* , *Azotobactor* and fungi respectively. All the experimental analyses were carried out in triplicates and the average value was used in these studies.

Biodynamic circular paper chromatographic analysis

Samples of one gram each of soils from initial, manure applied and post harvested areas and 2.5 gram of carrots (biodynamic, commercial) were individually analysed for qualitative differences by biodynamic circular paper chromatographic techniques[6].

Circular Whatman No1. Filter paper 15 cm in diameter was taken and at the centre a hole about 1/16 inch diameter was made. A wick was prepared with Whatman No.1 filter paper by cutting ¾ inch square and rolled them tightly into a cylinder. The wick was placed in the centre hole, protruding on either side of the disc. A pencil mark was made at 3 cm and 6 cm distances from the centre of the circular filter paper. Silver nitrate (0.1%) solution was prepared and stored in brown bottle. Two ml of 0.1% silver nitrate was poured into the Petri dish and the filter paper was placed in the Petri dish. The solution of silver nitrate by capillarity moves over the filter paper, and radiates in all direction and was allowed upto the 3 cm pencil mark. The paper was removed immediately from the Petri dish and the wick removed at once. The paper was then placed on another Petri dish for drying in a dark room or compartment for complete drying. Test samples of biodynamically and commercially grown carrot each of 2.5 grams were ground in to a fine paste by using mortar and pestle and individually placed into 250 ml Erlenmeyer flasks each containing fifty ml of 0.5% sodium hydroxide solution, mixed thoroughly and kept on an orbital shaker (100 rpm) for 3 hrs. Five ml of sample extract was placed into a Petri dish then put the prepared filter paper with a new wick over the solution in the Petri dish. The wick must touch the bottom of the Petri dish. The solution was allowed to spread upto 6 cm pencil mark. Removed the disc and wick and placed the disc again on a Petri dish for complete drying in a shade/ dark compartment. After complete drying the disc was exposed to a diffused day light in order to develop pattern and colour. The differences in distance (Rf value), colour, pattern and shape of the carrot chromatograms were analysed.

Results & Discussion

The fundamental concept of biodynamic agriculture is to raise a qualitatively or nutritionally superior food by incorporating biodynamic preparation and BD manures to the soil to ensure sustainable soil health. The soil health can be improved by advocating biodynamic compost, BD 500 and CPP to the soil. In our research activities we prepared different compost such as BD compost, CPP, and BD 500. The cattle dung were subjected to physio chemical and microbiological analysis (Table 1&2).

Table 1. Microbial analysis in various dung

Dung	TVC*	Rhizobium*	Azospirillum*	Azotobactor*	Fungi
Lactating Cow	144	Nil	Nil	Nil	$11X10^5$
Carrying cow	29	Nil	Nil	Nil	9
Bull	137	Nil	Nil	Nil	12
Buffalo	129	Nil	Nil	Nil	21

TVC= Total Viable Count, * = $X10^6$

Table 2. Physio-Chemical Analysis of Different Dung

Dung	Ph	EC	N	P	K	OC	Moisture	C:N
Carrying	7.5	0.33	0.84	0.62	1.08	58.23	90.13	33.60
Lactating	7.7	0.34	0.79	0.60	1.15	59.8	89.13	37.72
Bull	8.2	0.37	0.82	0.64	1.19	60.3	87.30	36.74
Buffalo	7.6	0.37	0.87	0.68	1.20	60.13	86.4	34.63

N,P,K, OC (%) , EC = m.mohs

Table 3.Chemical analysis of Cow horn

Cow horn	Total Nitrogen (%)	Protein (%)	Major Amino acids (%)
Raw	14	87.5	-
Steamed	13.5	84.5	-
Hydrolyzed	12	75	Cysteine 1, Lysine 2.35 Methionine 0.47

Authentic cow horn manure was received from Kurinji biodynamic farms, Batlagundu, Tamil Nadu, India and comparison was made. A fresh cow horn and cow dung from a lactating cow were individually analysed. The fresh cow horn contains 14% of total nitrogen and 87% of protein. The hydrolyzed cow horn contain amino acids like cysteine (1%), lysine (2.35%) and methionine (0.47%) (Table 3). The microbiological analysis of different dung is presented in Table 1, and is recorded that the absence of *Rhizobium, Azotobactor* and *Azospirillum*. The physiochemical properties of different dung are also reported in Table 2.

The presence of different beneficial microbes such as bacteria and fungi recorded in the cow horn manure maturation was assessed over a period of 90 days is an important contributor to the soil when it is applied at low concentration (25g/ acre) (Table 4a& 4B).

Table 4A. Time Scale studies on microbial analysis of cow horn manure (BD 500)

Days	TVC*	Rhizobium*	Azospirillum*	Azotobactor*	Fungi
0	144	Nil	Nil	Nil	11X10^5
30	27 X10^6	9 X10^3	23 X10^5	42 X10^4	9 X10^3
60	131 X10^6	26 X10^6	45 X10^6	29 X10^6	11 X10^4
90	138 X10^6	80 X10^6	96 X10^6	45 X 10^6	21 X10^6
120	242 X10^6	128 X10^6	178 X10^6	98 X10^6	45 X10^6

TVC = Total Viable count, * = X 10^6

Table 4B.Time Scale Studies on Physicochemical Analysis of Cow-Horn Manure (BD 500)

Days	PH	EC	N	P	K	OC (%)
0	7.2	0.25	0.84	0.62	0.08	58.33
30	6.4	0.28	1.22	0.87	1.47	53.37
60	6.9	0.33	1.02	0.53	1.09	36.75
90	7.2	0.25	1.53	1.0	1.72	35.0
120	7.6	0.25	1.62	1.10	2.50	24.50

N,P,K (%) , EC = m.mohs

The physiochemical, microbiological and chromatographical properties of cow horn manure (BD 500), cow dung mixed with flower paste and flower alone stuffed into the lactating cow horns and buried as per the procedures and all these manures were periodically evaluated for its physio- chemical and microbiological properties (Table 5A, 5B, 6A and 6B)

Table 5A. Time Scale on Physicochemical Analysis of BD 500 - Combination Manure (Cow horn + Cow dung + Flower manure)

Days	PH	EC	N	P	K	OC
0	7.7	0.34	0.79	0.50	0.80	69.8
30	7.4	0.30	0.91	0.52	0.98	64.17
60	7.6	0.30	1.03	0.54	1.38	52.31
90	6.2	0.26	1.32	1.02	1.42	29.56

N,P,K, OC (%) , EC = m.mohs

Table 5B. Time Scale on microbiological analysis of BD 500 - Combination manure (Cow horn + Cow dung + Flower manure)

Days	TVC*	Rhizobium*	Azospirillum*	Azotobacter*	Fungi*
0	144	Nil	Nil	Nil	11
30	71	17	156	56	13
60	77	12	119	41	24
90	223	166	121	133	21

TVC = Total Viable count, * = X 10^6

Table 6A. Time Scale on physicochemical analysis of BD 500 - Combination manure (Cow horn + Flower manure)

Days	PH	EC	N	P	K	OC
0	7.7	0.34	0.79	0.50	0.80	69.8
30	6.75	0.26	0.73	0.53	1.12	65.13
60	6.06	0.25	0.81	0.61	1.26	59.3
90	6.30	0.28	1.23	0.91	1.27	26.14

N,P,K, OC (%) , EC = m.mohs

Table 6B. Time Scale on microbiological analysis of BD 500 - Combination manure (Cow horn Flower manure)

Days	TVC*	Rhizobium*	Azospirillum*	Azotobacter*	Fungi*
0	5	Nil	Nil	Nil	Nil
30	36	17 $X10^5$	36 $X10^4$	36 $X10^4$	10
60	121	14	43	47	7
90	87	3	9	16	11

TVC = Total Viable count, * = X 10^6

The mud horn manure (equivalent to BD 500) were equally comparable and reported to be the same quality (Table 6C & 6D). The application to the soil have to be studied for its effect and the influence of cosmic on the crop productivity and soil health.

Table 6C. Time Scale studies on physicochemical analysis of Mud horn BD 500

Days	PH	EC	N	P	K	OC
0	7.7	0.34	0.79	0.6	1.15	59.8
30	7.0	0.31	0.68	0.53	1.23	63.28
60	7.9	0.31	1.06	0.83	1.41	26.52
90	7.9	0.36	1.23	1.34	1.58	21.25

N,P,K, OC (%) , EC = m.mohs

Table 6D. Time Scale studies on microbiological analysis of Mud horn BD 500

Days	TVC*	Rhizobium*	Azospirillum*	Azotobactor*	Fungi*
0	144	Nil	Nil	Nil	11 X10^5
30	95	20	31	36	11
60	197	110	90	170	120
90	239	250	89	178	147

Table 6. Consolidated Microbial & physio- chemical analysis of different BD manures (90^{th} Day)

BD manure	TVC*	Rhizo*	Azos*	Azoto*	Fungi	pH	EC	N	P	K	OC	Moisture	C:N
BD 500	138	80	96	45	21	6.7	0.28	1.09	0.78	1.38	30.1	52.0	27.64
MD 500	239	250	89	178	147	7.9	0.31	1.06	0.83	1.41	28.1	55.0	26.52
F+ horn	87	3	9	16	11	6.3	0.28	1.23	0.91	1.27	16.14	58.0	21.25
F+ horn+ dung	223	166	121	133	21	6.2	0.26	1.32	1.02	1.42	29.56	58.0	22.3
Initial Dung	29	Nil	Nil	Nil	9	7.5	0.33	0.84	0.62	1.08	58.23	90.13	33.60

TVC = Total viable count, Rhizo* = Rhizobium, Azos* = Azospirillum and Azoto* = Azotobactor, * = x10^6

The regular BD 500, BD compost and CPP prepared by us were incorporated to the experimental plots to cultivate vegetables. The other BD herbal preparations (BD 502- 507) used in our studies were purchased from Kurinji.

The root vegetable carrot (D*aucus carrota L.,)* was also cultivated in the plain with biodynamic agriculture techniques where the temperature remained at 35- 28° C. There was no occurrence of pest and diseases during carrot cultivation. The yield of 18.938 tons per of carrot hectare was achieved by these practices. The soil health condition during and after carrot cultivation improved tremendously by the addition of biodynamic compost, vermicompost, cow pat pit and cow horn manure to the soil and cow horn silica to the crop as foliar spray. The quality of carrot grown biodynamically which was subjected to chromatographic analysis revealed differences in colour , pattern and the spikes which are the indicators of active substances.

The germination of carrot seeds were noticed during 6th to 8th DAS. There was no occurrence of pest and diseases till the harvest. The carrot yield and its yield attributes such as biomass, girth and shoot- root lengths were recorded as fresh weight basis and are tabulated in Table.7.

Table 7. Yield attribute of carrot grown biodynamically

Biomass (leaves)	4285 kg/ ha
Total Root yield	18,928 kg/ha
Average Root length	8.5 cm
Average Root girth	12 cm

Table 8. Physicochemical properties of carrot grown soil

Soil	pH	EC	N (Kg/ha)	P (Kg/ha)	K Kg/ha)	OC (%)
Initial	8.0	0.34	73	6.3	89	0.28
Manure applied	7.2	0.29	82	6.7	92	0.45
Post harvested	7.0	0.27	72	6.2	87	0.31

By organic and biodynamic agriculture management practices 18. 938 tonnes/ ha of carrot was harvested at the experimental plot where the temperature remained above 28°C. The carrot had deep orange colour. Generally in Hill areas where the temperature ranges from 15- 20°C and the average yield of 25-30 tonnes / ha was reported by Department of Horticulture and plantation crops, Tamil Nadu. In India carrot is cultivated in 20124 hectares with 2870007 tonnes carrot production. The average productivity was 14.26 tonnes/ ha[7]. Thus the present experimental result indicated that an increased yield of 4. 668 tonnes/ ha than the expected average yield in the plains. Further the root vegetable carrot can be grown in Sevapur area where the temperature ranges from 35-28°C during the November - February season.

The soil microflora play a vital role in plant nutrition and specially the fungi actively stimulate synthesis of amino acids, proteins and other plant nutritive factors in addition to their symbiotic benefits and nutrients specially phosphorus[8]. The present experimental result on quantitative distribution of micro flora determined in the soil, manure applied soil and the post harvested soil revealed an increased quantity of beneficial microbes such as *Rhizobium, Azospirillium* and *Azotobacter* and fungi. The physiochemical characteristics of post-harvested soil were significantly improved by its available nutrients (Table 8) and beneficial microbial activity (Table 9). By the biodynamic agriculture management on carrot cultivation, not only an increase of yield and an improvement in the soil condition are observed.

Table 9. Quantitative distribution of micro flora in carrot grown soils

Soil	TVC*	Rhizobium*	Azospirillum*	Azotobacter*	Fungi*
Initial**	10	-	-	-	12
Manure applied	207	93	150	62	125
Post harvested	280	180	128	184	182

In addition to the standard methods available to determine quantitative estimation of mineral, protein and starch components, the qualitative analysis of food / soil are highly essential and these were reviewed by Lampkin[9] in organic farming practices. These qualitative methodologies include image forming techniques such as certain types of copper chloride crystallization and chromatograms; physico-chemical techniques such as counting photon emissions from sample of food/ soil and microbiological – biochemical techniques. Of these methods, the crystallization and circular paper chromatography techniques seem to be gaining wider recognition to test the quality determination of ecologically grown foods in sustainable agriculture system[10,11] . In our studies the chromatographic images of soils indicated the improved condition of soil health. The chromatogram of soil (initial) indicated absence of the outer zone which reflected the lack of colloidal substances. The middle zone was faint, brown in colour and lack of forms that were mainly due to the availability of less organic material. The inner zone was comparatively larger and contains hardly any mineral sign (Figure 3.A).

Figure 2 Circular paper chromatographic images of (A) commercial carrot & (B) biodynamically grown carrot

Figure 3. Circular paper chromatographic images of (A) soil initial, (B) manure applied soil & (C) post harvested soil

The manure applied soil possessed a natural, stable humus and friable structure that contributed to soil health. Attention is drawn to the medium brown edge zone of the chromatogram with light brown spots. The middle zone protruded with spike into the outer zone. The pattern of radiating forms from the middle zone was harmonious. The inner zone was light brown in colour and has a width of 3.3 cm which indicated its quantity of available mineral (Figure 3. B). The figure 3 C and Table 10 showed quality difference of the post harvested soil where an increased amount of availability of organic carbon and proliferation of micro flora such as bacteria and fungi are apparent in each three zones.

The qualitative analysis of biodynamically grown carrot was undertaken in order to separate the different fractions in 0.1% alkali- water solutions (sodium hydroxide), which were subjected to Whatman No.1 filter paper analysis. The paper chromatographic analysis of carrot revealed a very clear difference in colour, pattern and shape of the spikes in each zone, which is propositional to the quality of carrot between biodynamic management and the conventional practices (Table 11, Figure 2 A). In the chromatograms of carrots there were three zones inner, middle and the outer reflect the presence of mineral, starch and proteins respectively. The chromatograms of biodynamically grown carrot showed a prominent inner zone (3.5 cm diameter) than that of the inner zone of commercial carrot (2 cm), which clearly indicated qualitative and quantitative differences in the availability of minerals. According to Pfeiffer (1984) the width of zones corresponds to the amount of characteristic substances available in the test sample. The spikes protruding from the middle zone towards the outer zone are caused by proteins. Another important feature in this chromatogram is the small, round bell shaped spot which is light olive in colour that appeared on each spike at the outer zone. This bell shape appeared only in biodynamically grown carrot (Figure 2B).

Table 10. Chromatographic analysis of carrots

Chromatogram Zones	*Biodynamic carrot*	*Commercial carrot*
Inner zone (Minerals)		

Width (cm)	3.5	2.0
Rf value	0.58	0.3
Colour	Deep yellow to orange	Deep yellow to greenish
Pattern & No. Spikes	Regular Spearing spike , 60	Circular thick band, 0
Middle zone (Starch)		
Width (cm)	1.0	1.0
Rf value	0.75	0.5
Colour	Dark to light brown	Light pink
Pattern & No. Spikes	Circular strong band	Light band & week spikes, 45
Outer Zone (Proteins)		
Width (cm)	1.5	2.2
Rf value	0.97	0.87
Colour	Light brown	Dark brown
Pattern & No. Spikes	50, Thick and regular spikes projected outwards	45,Thin and regular spikes projected

Table 11. Chromatographic analysis of soil

Chromatogram Zones	Initial soil	Basal manure application	Post harvest soil
Inner (Minerals)			
Width (cm)	3.4	3.3	3.5
Rf value	0.56	0.55	0.58
Colour	Light	Light brown	Light yellow

	yellowish brown		
Pattern	Ring type, No forms	Radiating spikes protruded outward	Radiating spikes protruded outward
Middle zone (Available C, N)			
Width (cm)	0.8	1.2	1.0
Rf value	0.70	0.75	0.75
Colour	Faint brown	Dark Gray	Dark yellowish Gray
Pattern	Irregular, Ring type thick band	Thick 64 radiating spikes projected outward	Thick 60 radiating spikes projected outward
Outer Zone (Water soluble Humus)			
Width (cm)	Nil	1.3	1.0
Rf value	Nil	0.95	0.98
Colour	Nil	Light Brown	Light Brown
Pattern	Nil	Light 64 radiating spikes projected inward	Regular wave like spikes are projected inward

Table 12: **Post harvest biometrical plant characters of Onion (T1- Farmer's Practice, T2- Bio-dynamic,T3- Organic &T4 – Inorganic treatments**)

Sl.No	PLANT CHARACTERS	T1	T2	T3	T4
1.	Area in Cents	1.5	1.5	1.5	1.5
2.	Date of Sowing	10.5.01	10.5.01	10.5.01	10.5.01
3.	Date of Harvest	11.8.01	11.8.01	11.8.01	11.8.01
4.	Shoot length (cm)	25.0	24.5	26.0	25.0
5.	Root length (cm)	06.3	07.6	07.5	06.6

6.	No. of bulbs/plant	7	6	6	7
7.	Weight of bulb/plant (gm)/	18	17	21	21
8.	Total stalk yield (kg)	11.7	12.5	10.8	12.3
9.	Dry matter/ Production (gm)/bulb	2.05	2.31	1.99	2.19
10.	Total bulb yield (kg)	74	78	74.5	73
11	Productivity (ton/ha)	12.17	12.82	12.25	12.0
12	No. of plants/ sq.m.	32	33	32	36

Average National productivity 11.32 ton/ha

Table13: Okra post harvest biometrical plant characters (T1- Farmer's practice, T2- Bio-dynamic,T3- Organic &T4 – Chemical treatments)

Sl.No.	PLANT CHARACTERS	TREATMENTS			
		T1	T2	T3	T4
1.	Area in cents	1.5	1.5	1.5	1.5
2.	Date of sowing	05.05.01	05.05.01	05.05.01	05.05.01
3.	Date of Harvest	27.08.01	27.08.01	27.08.01	27.08.01
4.	Shoot length (cm)	61.0	60.3	60.5	74.3
5.	Root length (cm)	19.0	29.5	24.0	26.3
6.	No. of Fruits/plant	14	17	16	18
7.	No. of Branches/plant	03	03	02	05
8.	Fruit length (cm)	13.2	14.1	13.3	13.9
9.	No. of seeds/Fruit	56	58	58	53
10.	Dry matter production Per plant (gm)	72	70	82	124
11.	Stalk yield (kg)	61	58	57	68
12.	Fruit yield (kg)	52.5	64.5	60.5	69.3
13.	No. of plants/sq.m.	08	08	08	08
14	Productivity (ton/ha)	8.64	10.61	9.95	11.40

Average National productivity 6.28 ton/ha

Table 14. Physicochemical properties of soil from okra and onion experimental plots (units in %)

Soil	pH	Ec	N(Kg/ha)	P(Kg/ha)	K(Kg/ha)	OC	Zn	Fe	Mn	Cu

Inorganic (T4)	8.3	0.18	64	7	35	0.3	0.52	6.94	7.4	2.95
BD (pre harvest)	7.0	0.15	85	8.5	90	0.5	0.67	8.14	10.4	4.17
BD post harvest	6.8	0.10	78	8	48	0.5	0.6	8.0	8.4	3.27

OC =%, Zn, Fe, Mn, Cu = ppm, EC = m.mohs

Table 15. Microbial diversity in soil from okra and onion from experimental plots

Soil	TVC*	Rhizobium *	Azospirillum*	Azotobacter*	Fungi^{+}
Inorganic (T4)	21	Nil	Nil	Nil	16
BD (pre harvest)	280	148	194	162	128
BD post harvest	310	210	214	194	137

TVC = Total viable count, * (X10$^{6)}$, Fungi x 10^{5}

The average okra yield of different treatment such as T1, T2, T34, and T4 were 8.64, 10.61, 9.95 and 11.40 tonnes/ ha respectively. The chemical fertilizer applied plot (T4) showed an increased average yield of 0.79 ton/ ha than the biodynamic (T2) plot.(Table12). Though there is a marginal increase of 780 kg/ha, the soil fertility and microbial diversity in the post harvested soil was poor thus indicating the significance of biodynamic agriculture system (Table 14, 15). Over a period of continuous biodynamic crop cultivation activities proportionately increase the yield and the soil health than the chemical fertilizer applied system.

The average bulb yield of onion in the biodynamic plot (T2) was almost same as that of organic (T3), whereas a higher yield was achieved than the chemical fertilizer applied system (T4). There is a significant increase of onion productivity (12.82 ton/ha) than the expected national average productivity (11.32 ton/ha) Table 13.

In general biodynamically grown foods are nutritionally superior because such food contain higher levels of vitamin, minerals and amino acids. The future of organically grown food market is more appropriate and depends on the viability of the sustainable farming system as an alternative agriculture practice that offers effective solutions to the detrimental effects on the environmental and non sustaining aspects of chemical farming practices. The healthy foods grown on healthy soils are understood to play an underlying role in human health and further such foods contain an important life force separate from its mineral or chemical constituents. These differences in life force can be differentiated by circular paper chromatograms. In order to evaluate the economical sustainability of biodynamic agriculture management on carrot cultivation an extensive large scale field trials has to be carried out in various places in sub tropical regions. A qualitative analysis of different vegetables that may not grow in plain (potato, beet root) on different soil types are to be carried out to have a clear insight on the qualitative difference existing on different cultivation practices.

Acknowledgement

We thank the Science & Society Division, Department of Science & Technology, Government of India, New Delhi for providing financial assistance to carry out this work through a major research project (SSD/SCP/42/98).

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