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Homa organic farming reduces pest and disease infestations in okra and improves its quality and yield

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Abstract
Homa organic farming (HOF) holds significance for preventing pest and diseases in crops. A field experiment was conducted to study the impact of HOF practices on quality attributes, disease and pest incidence and yield of okra (*Abelmoschus esculentus*) in 2012. Five organic manures were assessed under soil, foliar and soil + foliar application. Results indicated a significant increase in dry matter production with homa organic manures at homa site. Maximum increase in dry matter production was obtained with soil and foliar application of Gloria Biosol (31.65%) followed by *Agnihotra* homa ash (27.74%, *P =.0.05*). The increase in dry matter content at harvest is explained to be due to a significant reduction in diseases and pest incidence and increase in ascorbic acid and phenol contents at the initial growth stage of the crop growth cycle (60 DAS). The finding is crucial for enhancing crop yields through eco-friendly management in the present climate scenario.

Keywords: Gloria Biosol, *Agnihotra* homa ash, Ascorbic acid, Total Phenol, Okra

Introduction
Okra (*Abelmoschus esculentus* L. Moench) is the choicest fruit vegetable grown extensively in the tropical, subtropical and warm area of the temperate zone. It is cultivated and valued for its delicious tender fibrous fruits or pods containing white round seeds. Okra provides an important source of vitamins, calcium, potassium and other minerals which are often lacking in the diet of developing countries [1]. It is the best source of iodine and calcium.
The diseases as well as insect and pests found on okra vary from year to year. *Erysiphe cichoracearum* and *Alternaria alternate* are two major fungal diseases in Okra that affect the crop growth and yield adversely. *Erysiphe cichoracearum* attacks the upper and lower leaf surfaces with a white coating of mycelium. Initially white superficial spots appear on leaves, but entire surface gets covered with powdery mass. The diseased parts turn brown and the affected leaves start drying. If conditions remain ideal for disease development, defoliation also takes place, which affect the plant growth and fruit development badly and yields are considerably reduced [2]. *Alternaria alternate* causes symptoms in leaves that first appear as light brown spots and later turn to concentric dark brown spots varying in size. The spots spread to cover large areas of infected leaves. In case of severe infection, infected leaves become brown and leads to death of the plants [3]. Fruit borer (*Earias vittella*) and shoot borer (*Earias insulana*) are notorious pests that cause more than 40-50 per cent losses in okra crops in various parts of India [4]. Green revolution technologies involving greater use of synthetic agrochemicals such as fertilizers and pesticides with the adoption of nutrient-responsive, high-yielding varieties of the crops have boosted the production output per hectare in most cases. However, this increase in production has slowed down and in some cases there are indications of a decline in productivity and production. Moreover, increasing consciousness about conservation of environment and 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 [5].
Many researchers have suggested ways to tackle both pests and diseases under 'Integrated Plant Disease Management (IPDM)' approach, which are less expensive and easy to adopt. However, most of the growers are unaware of these measures. Homa organic farming is one

such technique that can handle these pests and diseases. HOF is a system of agriculture that can be added to any organic farming practice. Homa is a technical term from the *Vedic* science of bio-energy denoting the process of removing the toxic conditions of the atmosphere through the agency of fire. This farming technique is used to treat the atmosphere, the soil, plants, pests and disease problems and promises an increase in crop yields with minimal input costs.

Keeping in view, the central idea of Homa therapy on 'you heal the atmosphere and the healed atmosphere heals you', the present study was taken up with an aim to assess the impact of HOF practices on quality attributes, disease pest incidence and yield of okra (*Abelmoschus esculentus*). The objectives of the study were (i) To study the impact of HOF on ascorbic acid and total free phenol contents, (ii) To study the effect of HOF on percent disease index (PDI), pest infestation and yield, (iii) To study the correlation between percent disease index and quality parameters.

Materials and Methods

Experimental site

The experiment was conducted at the University of Agricultural Sciences (UAS), Dharwad, India, located at15°48' 90.85''N, 74°98' 42.64''E and 735 m above sea level. Maximum temperature ranging from 35 °C to 39 °C, which occurs during April and minimum temperature ranges from 12 °C to 15 °C which occurs during December. The total rainfall of the region ranges from 619 to 1303 mm with an average of 750 to 800 mm. Most of the rainfall (about 84%) is received through south west monsoon from June to October and July is the peak rainfall month. The experimental site had mixed red and black soil. The soil of the experimental and control Site was homogenous.

A field experiment was conducted to study the influence of Homa organic farming practices on the quality parameters and its impact on disease and pest as well as yield of okra (var. Arka Anamika) during kharif 2012 at C-block Farm, Institute of Organic Farming, University of Agricultural Sciences, Dharwad. The control plot (non Homa site) was at D-block Farm, University of Agricultural Sciences, Dharwad, which was 1 km away from the C-block to avoid the effect of Homa. Five organic manures were taken for the study and their composition is given in Table 1. The experiment was laid out in randomized block design replicated thrice with 18 treatments as given in Table 2.

Preparation of homa organic manures

Five homa organic manures, three liquid and two solid manures were taken up for study. Gloria biosol, (a liquid organic manure)was prepared by mixing vermicompost (80 kg), fresh cow dung (80 kg), fresh cow urine (10L), *Agnihotra* homa ash (250 g), *Shree yantra* made of copper (1 unit) and water (200 L) and was incubated for 30 days in an air-tight plastic tank [6]. *Panchagavya* (a liquid organic manure) was prepared by mixing of fresh cow dung (7 kg), cow urine (3 L), jaggery (250 g), ghee (1 kg), curd (2 L), yeast (100g), coconut water (2 L), ripened banana (12 piece) and water (10 L). However, another liquid organic manure *Jeevamrutha* was prepared by mixing cow dung (10 kg), cow urine (10 L), Jaggery (2 kg), coconut water (2 L), legume flour (2 kg) and water (200 L). Two organic ashes, non-homa ash and *Agnihotra* homa ash were taken up for study.

The non homa ash was collected by burning the crop debris and residues in field. *Agnihotra* homa ash was collected from the homa hut [7]. The hut was constructed in the centre of the 45 acre farm at C- Block. The size of the hut was 3 m x 4 m and longer side was aligned with east/west axis with an opening from the west. Two pinches of rice grains were smeared in cow's ghee and put in fire lit on dried cow dung cake in a copper semi-pyramid (size 14.5 cm x 14.5 cm at the top, 5.25 cm x 5.25 cm at the bottom and 6.5 cm in height) and *Agnihotra* mantra was chanted at sun rise and sun set till harvest of the crop daily. The mantras chanted were as follows.

At sun rise

1. Suryaya swaha, suryaya idam namama |
2. Prajapataye swaha, prajapataye idam namama ||

At sun set

1. Agnaye swaha, agnaye idam na mama |
2. Prajapataye swaha, prajapataye idam na mama ||

Agnihotra mantras are known to create vibrations that positively manipulate the atmosphere [8]. The composition of the homa organic manures is given in Table 1.

Crop Culture

Okra variety *Arka Anamika* was sown on 2nd June, 2012 with a seed rate of 12 kg ha^{-1} as line sowing in 45 cm × 30 cm spacing. The fertilization of the crop was done according to the treatments and the crop was grown with the standard package of practices for the region.

Biochemical Analysis and Dry Matter Estimations

The quality parameters recorded were ascorbic acid and total free phenol. Five grams of fresh okra fruits were crushed with oxalic acid (4%) and filtered through muslin cloth to get a clear solution. Ascorbic acid content was estimated by titrimetric method using 2, 6-dichlorophenol indophenol dye as per the modified procedure of AOAC [9] and expressed as mg of ascorbic acid per 100 g on fresh weight basis. Total free phenol content of okra fruit (mg/100 g) was determined as described by Singleton [10]. To 1 ml of okra extract in distilled water exactly, 1 ml of Folin-Ciocalteu reagent (FCR) was added. After mixing well, 2 ml of 2 per cent sodium carbonate in 0.1 N sodium hydroxide solution was added and the samples were placed in a boiling water bath for exactly 1 min and cooled. The final volume was made up to 10 ml with distilled water and the absorbance was measured at 650 nm in a spectrophotometer and the concentration of total free phenols was determined using standard catechol. From the standard curve, the concentration of phenols in the test sample was found out and expressed as mg of total free phenols per 100 g sample.

Three randomly selected plants were uprooted from each plot at 30 DAS and at crop harvest. Uprooted plants were washed in water, air dried and separated in to leaf, stem and head and chopped in to small pieces. They were oven dried at 65-70 ºC to constant weight and expressed as g per plant.

Table 1: Composition of liquid manures, non homa and homa organic ashes

S. No	Organic manures	N	P	K	Cu	Zn	Mn	Fe	Bacteria* (cfu x 10^5 /g)	Fungi* (cfu x 10^4/g)	*Actinomycetes** (cfu x 10^4 /g)	P-solubiliser (cfu x 10^2 /g)	Total diazotrophs (cfu x 10^2/g)
Liquid organic manure													
1	Panchagavya	0.05	0.04	0.06	0.23	0.26	0.23	0.86	26.10	18.00	4.20	6.3	3.25
2	Jeevamrutha	0.03	0.03	0.04	0.21	0.23	0.19	0.79	19.70	13.40	3.50	4.5	5.0
3	Gloria Biosol	0.02	0.01	0.02	0.17	0.19	0.15	0.82	23.10	11.23	2.80	29.0**	22.0**
	SEm ± CD at 5 %	0.002 0.005	0.002 0.006	0.003 0.007	0.003 0.006	0.005 0.011	0.003 0.007	0.006 0.013	0.19 0.41	0.13 0.29	0.042 0.024	-	-
Organic Ashes													
1	Non-homa ash	0.015	0.053	0.26	70	233	0.41	0.84	-	-	-	-	-
2	*Agnihotra* homa ash	0.021	0.059	0.29	78	238	0.49	0.89	-	-	-	-	-
3	Om Tryambakam homa ash	0.023	0.062	0.25	73	236	0.43	0.82	-	-	-	-	-
	SEm ± CD at 5 %	0.00006 0.00010	0.00008 0.00010	0.0010 0.0030	0.270 0.580	0.200 0.440	0.002 0.004	0.002 0.004					

Table 2: Treatment details of the experiment

S. No	Treatment	Treatment Details	Rate of application	
			Soil application	Foliar application (DAS- Days after sowing)
1	T_1	Conventional control at non-homa site	-	-
2	T_2	Organics equivalent to RDF and seed treatment with biofertilizer - at non- homa site	Compost and vermicompost, 50% each	-
3	T_3	Organics equivalent to RDF and seed treatment with bio-fertilizers at homa site	Compost and vermicompost, 50% each	-
4	T_4	T_3+ soil application of Non-homa ash	41.5Kg/ha	-
5	T_5	T_3+ Foliar application of Non-homa ash	-	@ 1850 liters/ha at 30, 45, 60 and 75 DAS
6	T_6	T_3+ Soil application of Non-homa ash and its foliar application	41.5Kg/ha	@ 1850 L/ha at 30, 45, 60 and 75 DAS
7	T_7	T_3 + soil application of *Agnihotra* homa ash	41.5 Kg/ha	-
8	T_8	T_3+ Foliar application of *Agnihotra* homa ash	-	@ 1850 litres/ha at 30, 45, 60 and 75 DAS
9	T_9	T_3 + Soil application of *Agnihotra* homa ash and its foliar application	41.5 Kg/ha	@ 1850 litres/ha at 30, 45, 60 and 75 DAS
10	T_{10}	T_3 + Soil application of Gloria Biosol	@ 1850 liters/ha at 30, 45 and 60 DAS	-
11	T_{11}	T_3+ Foliar application of Gloria Biosol		@ 1850 litres/ha at 30, 45, 60 and 75 DAS
12	T_{12}	T_3+ Soil application of Gloria Biosol and its foliar application	@ 1850 liters/ha at 30, 45 and 60 DAS	@ 1850 litres/ha at 30, 45, 60 and 75 DAS
13	T_{13}	T_3+ Soil application of Panchagavya (5%)	@ 1850 liters/ha at 30, 45 and 60 DAS	-
14	T_{14}	T_3+ Foliar application of Panchagavya (5%)	-	@ 1850 liters/ha at 30, 45, 60 and 75 DAS
15	T_{15}	T_3+ Soil + Foliar application of Panchagavya (5%)	@ 1850 liters/ha at 30, 45 and 60 DAS	@ 1850 liters/ha at 30, 45, 60 and 75 DAS
16	T_{16}	T_3 + Soil application of Jeevamrutha	@ 1850 liters/ha at 30, 45 and 60 DAS	-
17	T_{17}	T_3 + Foliar application of Jeevamrutha	-	@ 1850 liters/ha at 30, 45, 60 and 75 DAS
18	T_{18}	T_3 + Soil + Foliar application of Jeevamrutha	@ 1850 liters/ha at 30, 45 and 60 DAS	@ 1850 liters/ha at 30, 45, 60 and 75 DAS

Incidence of Disease and Pests

At harvesting, five plants from each plot were observed for powdery mildew infestations using 0-9 scale [11]. Further, the PDI was calculated with the above scales using the formula [12].

$$PDI = \frac{\text{Sum of all individual ratings}}{\text{Total no. of leaves observed x Maximum disease grade}} \times 100$$

Scale

Score	Description
0	No symptom of powdery mildew
1	Small scattered powdery mildew specks covering 1per cent or less leaf area
3	Small powdery lesions covering 1-10 per cent of leaf area
5	Powdery lesions enlarged covering 11-25 per cent of leaf area
7	Powdery lesions coalesce to form big patches covering 26-50 per cent of leaf area
9	Big powdery patches covering 51 per cent or more of leaf area and defoliation occur.

At harvest, five plants from each plot were selected for recording *Alternaria* leaf spot using 0-9 scale[11]. Further, the PDI was calculated with the scale mentioned above using the formula [12]. At the time of harvest, total number of fruits were selected from each treatment and observed for damage by fruit borer and expressed as per cent fruit damage.

$$\% \text{ fruit damage} = \frac{\text{Number of fruits damaged}}{\text{Total number of fruits}} \times 100$$

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

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

Yield and quality attributes of okra fruits

The total yield of okra in terms of tonnes per hectare (t/ha) was calculated on the basis of total yield per net plot. One hundred okra fruits were selected randomly and weighed (kg). Five fruits were selected randomly at the time of harvest and their shelf life was recorded in days.

Statistical analysis

The data of the experiment were analyzed statistically following the procedure described by Gomez and Gomez [13]. The level of significance used in **'**F**'** and 't' test was p = 0.05. The critical difference was calculated wherever the **'**F**'** value was found to be significant.

Results

Effect of Homa Organic Farming on Quality Attributes

Ascorbic acid contents (mg/100g) in okra at 60 DAS and at harvest are is given in Table 3. Results revealed that maximum ascorbic acid content at both 60 DAS and harvest stage were found in soil and folia application of GB [T_{12}] (31.6 and 33.51 mg/100g) followed by soil and foliar application of *Agnihotra* homa ash [T_9] (31.01 and 32.87 mg/100g). However, conventional control [T_1] (22.11 and 24.92 mg/100g) at Non-homa site significantly differed with [T_{15}] which was 42.92 and 34.47% less over [T_{15}] whereas homa control at non-homa site [T_2] (24.03 and 26.35 mg/100g) was 31.5 and 27.17% less over soil and foliar application of GB at both 60 DAS and harvest stage respectively. The data on total free phenol content of okra fruit as shown in table 3 convinced that soil and foliar application of GB [T_{12}] (172.56 and 176.03 mg/100 g) recorded maximum phenolic content amongst all the treatment which was 8.37 and 7.82% more over conventional control [T_1] (159.23 and 163.26 mg/100 g) at both 60 DAS and harvest stage respectively; followed by soil and foliar application of *Agnihotra* homa ash [T_9] (172.39 and 175.32 mg/100g). However both [T_{12}] and [T_9] were at par with each other at both 60 DAS and crop harvest stage.

Table 3: Effect of homa organic farming on ascorbic acid and total free phenol content of okra (var.Arka Anamika)

Treatment details	Ascorbic acid (mg/100 g)		Total free Phenols (mg/100 g)	
	60 DAS	Harvest	60 DAS	Harvest
T_1	22.11	24.92	159.23	163.26
T_2	24.03	26.35	162.35	166.27
T_3	26.39	29.03	163.62	167.13
T_4	25.00	27.72	161.57	166.92
T_5	23.25	25.03	158.96	160.93
T_6	30.06	31.95	171.62	174.96
T_7	26.00	27.96	163.72	167.34
T_8	24.75	26.21	161.32	162.61
T_9	31.01	32.87	172.39	175.32
T_{10}	28.03	29.37	166.13	169.37
T_{11}	25.03	26.35	164.21	166.05
T_{12}	31.60	33.51	172.56	176.03
T_{13}	25.56	28.92	165.21	166.85
T_{14}	24.81	26.05	163.67	164.32
T_{15}	27.03	32.13	169.96	168.82
T_{16}	26.47	28.03	164.03	167.81
T_{17}	24.9	25.59	163.42	165.72
T_{18}	27	31.7	167.22	168.21
S Em ±	0.13	0.17	0.22	0.28
CD at 5%	0.45	0.64	0.73	0.94

Effect of homa organic farming on disease and pest incidence in okra

Incidence of Powdery mildew (%) are presented in Table 4. Homa organic cultural practices reduced the incidence of powdery mildew. Minimum infestation of Powdery mildew was observed in soil and foliar application of GB [T_{12}] (12.51%) followed by soil and foliar application of *Agnihotra* homa ash [T_9] (12.55%).However, conventional control [T_1] at non-homa site registered (19.50%) infestation of powdery mildew which was 35.84 and 35.64% more powdery mildew infestation over [T_{12}] and [T_9] respectively. The data on incidence of Leaf spot of *Alternaria* are presented in Table 4. The incidence of *Alternaria* leaf spot of okra leaf (%) was significantly lower under homa site. Soil and foliar application of GB [T_{15}] (8.60%) registered minimum infestation of *Alternaria* leaf spot which was 55.25% less over conventional control [T_1] (19.22) whereas soil and foliar application of *Agnihotra* homa ash [T_9] (9.80%) was the second least affected. It is evident from the Table 4 that fragrant atmosphere created by the homa drastically reduced the pest population and enhances growth as well as yield of

okra. Fruit borer damage of okra (%) in soil and foliar application of GB [T_{12}] (8.30%) which were minimum amongst all the treatment followed by soil and foliar application of *Agnihotra* homa ash [T_9] (8.60%). Reduction in fruit borer infestation under homa organic system was 20-38.51%. As shown in Table 4 *Spodoptera* larvae per okra plant were minimum in soil and foliar application of GB [T_{12}] (3.16%) followed by soil and foliar application of *Agnihotra* homa ash [T_9] (3.29). Reduction in *Spodoptera* infestation under homa organic practices was 33.96-60%.

Table 4: Effect of homa organic farming on disease and pest incidence in okra (var. *Arka Anamika*)

Treatments	Powdery Mildew (% damage)	*Alternaria* leaf spot (% damage)	*E. vitella* (% damage)	*Spodoptera* larvae/plant
T_1	19.50	19.22	13.50	10.03
T_2	17.93	20.03	12.06	7.92
T_3	17.60	15.20	11.80	6.27
T_4	15.40	12.40	10.90	5.10
T_5	15.70	12.70	11.30	5.23
T_6	14.25	10.20	9.10	3.80
T_7	15.06	12.30	10.70	4.90
T_8	15.65	12.60	10.90	5.12
T_9	12.55	9.80	8.60	3.29
T_{10}	15.05	12.40	9.80	4.10
T_{11}	15.56	12.70	10.50	4.60
T_{12}	12.51	8.60	8.30	3.16
T_{13}	14.26	12.52	9.95	4.20
T_{14}	15.65	12.70	10.20	4.67
T_{15}	13.71	10.03	9.17	3.85
T_{16}	15.04	13.50	9.50	3.90
T_{17}	15.87	14.16	10.8	4.9
T_{18}	13.62	12.08	8.94	3.4
SEm±	0.04	0.023	0.09	0.36
CD at 5%	0.15	0.08	0.35	0.87

Yield Attributes

Dry matter production per plant in okra

The data on dry matter production (DMP) per plant in okra (g) are presented in Table 5. Dry matter production per plant of okra was maximum with soil and foliar application of GB [T_{12}] (15.89 and 370.16 g) which was 46.3 and 26.29% higher against conventional control [T_1] (10.86 and 293.10 g) at both 30 DAS and crop harvest stage respectively. It was followed by soil and foliar application of *Agnihotra* homa ash [T_9] (15.03 and 342.13 g).

Table 5: Effect of homa organic farming on dry matter production, yield and shelf life of okra

Treatments	Dry matter (g/plant)		Yield (t/ha)	Fruit weight of 100 fruits (kg)	Shelf life (Days)
	30 DAS	Harvest			
T_1	10.86	293.10	11.02	1.01	3
T_2	11.32	296.20	11.76	1.16	4
T_3	12.73	300.67	12.38	1.22	5
T_4	12.91	318.24	12.94	1.46	6
T_5	12.85	315.37	12.32	1.33	4
T_6	13.56	339.21	14.53	2.25	7
T_7	12.94	319.27	13.95	1.54	6
T_8	12.82	318.03	12.97	1.36	5
T_9	15.03	342.13	14.70	2.34	8
T_{10}	13.01	321.36	14.21	1.61	7
T_{11}	12.96	320.73	13.35	1.38	6
T_{12}	15.89	370.16	15.03	2.43	9
T_{13}	12.89	319.00	14.03	1.49	6
T_{14}	12.83	318.01	13.20	1.43	5
T_{15}	14.73	320.12	14.51	2.32	7
T_{16}	12.85	319.12	14.01	1.46	5
T_{17}	12.80	316.83	13.04	1.32	4
T_{18}	14.5	319.49	14.48	2.26	6
SEm±	1.25	0.45	0.12	0.10	0.15
CD at 5%	2.30	1.35	0.31	0.25	0.48

Yield per hectare

Maximum yield of okra (t/ha) were recorded in soil and foliar application of GB [T_{12}] (15.03) which was 36.38% more over conventional control [T_1](11.02, Table 5). However, soil and foliar application of *Agnihotra* homa ash [T_9] (14.70) registered 33.39% more yield over conventional control [T_1].

Hundred fruit weight and shelf life of okra

The data on hundred fruit weight of okra expressed in kg is given in Table 5. It is evident from the table that maximum weight of hundred fruit were found in soil and foliar application of GB [T_{12}] (2.43 kg) which was 140% more over

conventional control [T_1] (1.01 kg) followed by soil and foliar application of *Agnihotra* homa ash [T_9] (2.34 kg). Longest shelf life of okra was attained in soil and foliar application of GB [T_{12}] (9 Days) which was 200% more over conventional control (3 Days). However, soil and foliar application of *Agnihotra* homa ash [T_9] (8 Days) was the second best performing treatments in terms of shelf life.

Discussion

Homa organic farming, an ancient Vedic farming technique, promises an increase in crop yields with minimal input costs. The practice is used to treat the atmosphere, the soil, plants, pests and disease problems. *Agnihotra* homa not only maintains an ecological balance by purifying the air but the ash from the *Agnihotra* can also be used as fertilizer [14]. Our results have suggested that homa organic treatments enhance the yield of okra through improvement in quality parameter like ascorbic acid and total free phenol, which in turn reduces the disease as well as pest infestation. A strong positive correlation existed between ascorbic acid (r^2= 0.82) and total phenol contents (r^2=0.75, Table 6). However, a strong negative correlation existed between yield and disease and pest incidence (Table 6). The uniqueness of organic sources lies in presence of other micro nutrients like Zn, Mn, Cu, Fe *etc.*, apart from macro nutrients N, P and K. This has been reflected in the quality of okra in terms of ascorbic acid and total free phenols. Both ascorbic acid and total phenol contents were highest in Gloria Biosol treatment [T_{12}] and was followed by *Agnihotra* homa ash [T_9]. Antioxidant activity and phenol content of okra fruits ranked third after red cabbage and broad beans according to their phenol content (167.70 mg gallic acid /100g) amongst 19 vegetables commonly consumed in India [15] which is at par with our experiment. Phenols have been found to play an important role in determining resistance or susceptibility of a host to parasitic infection. For the realization of their protective action, phenolic compounds must be liberated from inactive forms, since it is precisely in the combined state that polyphenols manifest the higher fungi and cytotoxicity [16]. Increase in the quality parameters of okra observed in this investigation may be due to increased availability of major as well as minor nutrients, because major nutrients especially nitrogen and potassium play a vital role in enhancing the quality of crops by entering the protoplasm leading to enhancement of the quality attributes [17]. *Agnihotra* homa atmosphere (only smoke) helped in raisin making from grapes, drying of grape bunches was completed in 21 days as against 300 days taken by normal practice and development of good taste took only 35 days in *Agnihotra* atmosphere [18]. It thus indicates that homa smoke also contributes to the quality of homa organic produce which was also found in our experiment in terms of increased shelf life. The food choice of insects or pathogens is associated with a set of phytochemicals available in the plants.

Table 6: Correlation of Homa organic farming with ascorbic acid, total phenols, DM, disease and pest incidence and yield of okra

	Dry Matter[#]	Dry matter[##]	Ascorbic acid *	Ascorbic acid **	TFPC	TFPC	PM	ALS	EV	SL	Yield
Ascorbic acid*	0.83	0.85	1.00								
Ascorbic acid**	0.85	0.70	0.91	1.00							
TFPC[$]	0.84	0.78	0.94	0.93	1.00						
TFPC[$$]	0.71	0.77	0.95	0.89	0.93	1.00					
PM	-0.92	-0.85	-0.78	-0.77	-0.79	-0.67	1.00				
ALS	-0.88	-0.85	-0.73	-0.69	-0.71	-0.58	0.92	1.00			
EV	-0.89	-0.83	-0.84	-0.81	-0.85	-0.74	0.96	0.87	1.00		
SL	-0.83	-0.76	-0.71	-0.65	-0.68	-0.55	0.94	0.91	0.94	1.00	
Yield	0.86	0.81	0.84	0.82	0.85	0.75	-0.94	-0.87	-0.97	-0.92	1

[#]30 DAS,[##] at harvest, *at 60 DAS, **at harvest, TFPC[$]: Total Free Phenol content at 60 DAS, TFPC[$$]: Total Free Phenol content at harvest, PM: Powdery mildew (%), ALS: *Alternaria* Leaf Spot, EV: *Earias vitella*: (% damage), SL: *Spodoptera* larvae/plant

It seems that the okra plants in homa ash and Gloria Biosol treated plots had physiological and biochemical reactions that might have resulted in production of phytochemicals affecting the proliferation of insects, pests and thereby reducing the disease incidence. This could be evidenced from the fact that the incidence of powdery mildew, *Alternaria* leaf spot and damage by okra fruit borer was low in GB treated plants (36%, 55% and 38%, respectively) as compared to conventional control [T_1] exposed to homa atmosphere. The number of *Spodoptera litura* larvae per plant was found to be reduced maximally (68%) by the application of GB. These are new findings in okra crop raised under HOF and area very useful outcome of the present investigation. Application of higher levels of synthetic fertilisers and pesticides increase susceptibility of crops to pest but organic crops show tolerance to insect attack [19].

The present investigation confirms the ineffectiveness of conventional treatment in controlling the pest and diseases as compared to homa ash and Gloria Biosol treatments. *Agnihotra* homa brought down the incidence of pests and diseases like powdery mildew in Rose by 34 per cent, leaf spot in Carnation, Gerbera and Cabbage by 20, 44 and 40 per cent, respectively, *Fusarium* wilt in Carnation by 32 per cent, in Gerbera by 63 per cent and late blight in potato by 75 per cent [20]. These observations clearly indicate that *Agnihotra* homa provides higher disease resistance to plants. It may be noted that organically grown fields also receive threats from the pest and diseases. Although the natural predators take care of such threats, the organic farmer feels helpless and dejected when heavy infestation is air-borne. The HOF provides a solution to atmospheric pollution and air borne diseases since homa in Vedic literature is considered as a process in the technology of Yajna to heal the atmosphere, soil and water. Total reliance on insecticides for insect-pest control in most of the developing countries has resulted in certain ecological and economic imbalances with grave consequences to crop production, human health and environmental quality which is a common practice among the farmers to increase the application of insecticides, if the desired control of a target pest is not achieve, when the control becomes still inadequate, they switch over to another insecticide this leads to resurgence of target pests [21]. Widespread development of these man-made or entomologic pest outbreaks is one of the most serious indictments of our present day pest control

technology. The observations have sent a right signal to all the concerned stakeholders to overcome the problem with sustainable approaches.

Crop yield is a multigenic trait which is governed by several growths and yield contributing crop or plant character such as fruit weight, disease and pest infestations. In the present investigation, the okra fruit were vigorous in terms of their weight and minimum percentage of fruit borer infestation and disease infestations. These parameters significantly influenced by GB, liquid organic manure and homa ash treatments. The observed increase in the yield parameters of okra may be due to use of organic manures to meet the nutrient requirement of crop whichever an inevitable practice in the years to come for sustainable agriculture since, organic manures generally improve the soil physical, chemical and biological properties along with conserving the moisture holding capacity of soil and thus resulting in enhanced crop productivity along with maintaining the quality of crop produce [22]. It may be recalled here that the okra yield expressed in tonnes per hectare due to soil and foliar application of GB [T_{12}] recorded significantly higher yield over all the other treatments. Vegetable crops such as carrot, okra and brinjal cultivated in soil amended with different manures such as organic amendments and biodynamic forms organic and biodynamic manures recorded lesser pest and disease attack and produced comparable yield [23]. Similarly in the present investigation homa organic source of nutrient not only enhance the soil fertility but it also reduces the disease and pest infestation indicating thereby that creating homa atmosphere was a positive step to boost the production of healthy okra fruits significantly in an organic field.

Conclusion

Performance of homa with the use of sacrificial fire in specific time particular to *Agnihotra* homa as prescribed by *vedic* science and ash collected from the homa along with liquid organic manures, enhanced the quality attributes of okra and provides a defensive measure and control against disease and pest which leads to significant increase in yield. Soil and foliar application of GB led to significant increase in total free phenol, ascorbic acid, disease and pest resistance. This not only led to significant increase in okra yields with homa organic farming but also sustained the environment and ecosystem. Work on impacts of homa organic farming in other crops is underway.

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Conflict of Interest

There is no conflict of interest

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