Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Vol 6 Special issue [3] 2017: 27-33

Online ISSN 2277-1808
Journal's URL:http://www.bepls.com
CODEN: BEPLAD
Global Impact Factor 0.533
Universal Impact Factor 0.9804
NAAS Rating 4.95

FULL LENGTH ARTICLE **OPEN ACCESS**

Effect Of Different Levels Of Fly Ash And Vermicompost On Herb Yield, Oil Content And Oil Composition Of Lemongrass (*Cymbopogon flexuosus* Nees)

Srinivas P[1*], Vijaya Padma S S[2*], Pandu Sastry K[3*]and Venugopal S[4*]
[1*& 2*] Dept. of Plantation Spices Medicinal and Aromatic Crops COH, Rajendranagar-30, Dr.Y.S.R.H.U, India.
[3*] CSIR-Central Institute of Medicinal and Aromatic Plants (CSIR-CIMAP), Research Centre, Boduppal,
[4*] Dept of Spices and Plantation Crops, Faculty of Horticulture, Bidhanchandra Krishi Viswavidyalaya, Mohanpur, Nadia- 741252, West Bengal.
Corresponding author: seenu.puli1988@gmail.com

ABSTRACT
The investigation was undertaken to study the effect of different levels of fly ash and vermicompost on content and composition of essential oil of lemongrass (Cymbopogon flexuosus Nees) during the year 2014-2015 at Central Institute of Medicinal and Aromatic Plants (CIMAP), Boduppal, Hyderabad. The experiment was carried out in Randomized Block Design with three replications. Highest herb yield was recorded in the treatment T_7 with 6t flyash and 4t vermicompost. Non significant differences were observed for essential oil content and composition. T_7 (FA 6 t/ha + VC 4 t/ha) can be recommended where the cost of inputs can be compensated with high herb yield and in turn essential oil yield.
Key words: *Flyash , Vermicompost, Oil content, Oil composition, Herb yield and Lemongrass.*

Received 23.07.2017 Revised 10.08.2017 Accepted 29.08. 2017

INTRODUCTION

Lemongrass(*cymbopogon flexuosus* nees) is a perennial multi cut aromatic grass belonging to the family Poaceae. Its oil is in great demand in the country and is also exported in large quantity. Lemongrass is grown in states of Kerala, Karnataka, U.P and Assam. The oil is a good source of citral and is used in perfumery industry, cosmetics, synthesis of Vitamin A, flavoring herbal teas and other non alcoholic beverages, confectionaries, scenting of soaps, detergents and insect repellent preparations. The oil also has germicidal, medicinal and flavoring properties.

Lemongrass is known to be very hardy plant that can grow in soil types ranging from rich loam to poor laterite but with a preference to well drained and nutrient rich soils. The plant is also known for its tolerance to soil salinity and alkalinity to a higher level than other crops. The annual world production of lemongrass oil is around 1000 tonnes. In some far Eastern countries like Java, Japan, China and India the leaves are used for flavouring foods, drinks and tea and for scenting bathwater.

Lemon grass is generally recognized as safe for human consumption as plant extract/essential oil. In the case of aromatic plants such as lemon grass, the quality and the quantity of essential oil are important aspects. Organic farming is gaining momentum especially in the cultivation of medicinal and aromatic 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. Fly ash is a by-product of pulverized coal fired thermal power stations. Fly ash contains several essential nutrients like K, P, Ca, Mg, S, B, Fe, Cu, Zn, Mn and Mo which are beneficial for plant growth. Fly ash improves the fertility status of soil, structure, texture and physical properties and improves crop yield. It optimizes pH value, improves soil aeration and reduces crust formation. The research done so far in agricultural and horticultural crops indicates that the fly ash could be a better option to replace the chemical fertilizers in developing countries. The best alternative of the present day's environmental degradation is to make proper use of the available unutilized organic biodegradable wastes in order to convert them into compost within a short period.

Vermicompost is found to effectively enhance the root formation, elongation of stem and production of biomass in agricultural and horticultural plants. Vermicompost has higher level of available nutrients like nitrate or ammonium nitrogen, exchangeable phosphorous and soluble potassium, calcium derived from the wastes. Vermicompost stimulates the growth of a wide range of plant species of different horticultural crops due to several direct and indirect beneficial effects as in pepper (Arancon *et al*., 2005). Vermicompost has also been found to have positive effects on some aromatic and medicinal plants (Anwar *et al*., 2005). It exerts a positive effect on vegetative growth, stimulating shoot and root development (Edwards *et al*., 2004). Hence the experiment was conducted with the object to find out the combine effect of flyash and verimicompost on growth of lemongrass.

Material and methods

The variety selected for the present experiment was Krishna which was released by CIMAP, Lucknow for cultivation in South India. The experiment was laid out in Randomized Block Design with twelve treatments replicated thrice. Gross plot size : 3.9 × 3.9 m and net plot size of : 3.6×3.6 m. A spacing of 60 cm between the rows and 60 cm between the plants and within the rows was adopted for all the treatments.

The treatments included T_1 : (F_0 + V_{10}) Fly ash(0 t/ha) + Vermicompost (10 t/ha), T_2 : (F_1 + V_9) Fly ash (1 t/ha) + Vermicompost (9 t/ha), T_3 (F_2 + V_8) : Fly ash (2 t/ha) + Vermicompost (8 t/ha), T_4 :(F_3 + V_7) Fly ash (3 t/ha) + Vermicompost (7 t/ha), T_5 : (F_4 + V_6) Fly ash (4 t/ha) + Vermicompost (6 t/ha), T_6 : (F_5 + V_5) Fly ash (5 t/ha) + Vermicompost (5 t/ha), T_7 :(F_6 + V_4) Fly ash (6 t/ha) + Vermicompost (4 t/ha), T_8: (F_7 + V_3) Fly ash (7 t/ha) + Vermicompost (3 t/ha), T_9 : (F_8 + V_2) Fly ash (8 t/ha) + Vermicompost (2 t/ha), T_{10} : (F_9 + V_1) Fly ash (9 t/ha) + Vermicompost (1 t/ha), T_{11} : (F_{10} + V_0) Fly ash (10 t/ha) + Vermicompost (0 t/ha), T_{12} : Normal dose of chemical fertilizer (100:40:40 kg/ha), T_{13} : Zero fertilizer (control).

Treatments were imposed on the standing crop after first harvest. The experimental area was kept weed free. Weeding was done at 30 days interval. The first irrigation was given immediately after planting. The subsequent irrigations were given as and when required depending upon soil moisture and weather conditions. Twenty five irrigations were given to the crop in 6 months duration. Lemongrass is a multi harvest perennial crop. The first harvest of the crop is taken 90 days and second harvest was taken at 180 days.

Essential oil content estimation methodology (% v/w)

The aerial parts of lemongrass were collected from five random plants in each treatment. From the total of these five plants, 200 g of sample was separated. For the extraction of essential oils herbage was subjected to hydro-distillation using a Clevenger apparatus. The oil content was noted down. The essential oil collected was dried over anhydrous sodium sulphate and stored at 4 °C until the GC analysis was carried out. Essential oil was computed for 100 g.

Essential oil composition estimation methodology(%)

The oil samples obtained from different treatments were compared by chemical profiling of the oil using a GC apparatus at 30, 60 and 90 DAT. GC analysis was carried out using Varian CP-3800 with Galaxy chromatography data system fitted with Flame Ionization Detector (FID) and an electronic integrator. Separation of the compounds was achieved employing a Varian CP-Sil 5CB capillary column (ID: 50 m X 0.25 mm; film thickness 0.25 µm) with 5% Gypsum dimethyl polysiloxane. Nitrogen was the carrier gas at 0.5 ml/min constant flow rate. The column temperature program was: 120°C (2 min) to 240°C (6 min) at 8°C/min ramp rate. The injector and detector temperature were 250°C and 300°C respectively. Samples (0.2 µL) were injected with a 20:80:20 split ratio. Retention indices were generated with a standard solution of n-alkanes (C6-C19). Peak areas and retention times were measured by an electronic integrator. The relative amounts of individual compounds were computed from GC peak areas without FID response factor correction. The work was carried out at CIMAP laboratory, Boduppal, Hyderabad. The work was carried out at CIMAP laboratory, Boduppal, Hyderabad.

Results and discussion

Effect of fly ash and vermicompost on herb yield (t/ha)

Significant differences were observed in herb yield among the treatments in two harvests. The treatment T_7 (FA 6 t/ha + VC 4 t/ha) has recorded maximum herb yield (17.8 t/ha) which remained on par with the treatments T_6 (FA 5 t/ha + VC 5 t/ha) , T_8 (FA 7 t/ha + VC 3 t/ha), T_9 (FA 8 t/ha + VC 2 t/ha) , T_{10} (FA 9 t/ha + VC 1 t/ha) and T_{11} (FA 10 t/ha + VC 0 t/ha) in both the harvests.

The treatment T_{12} that received RDF has recorded herb yield of 6.85 t/ha which was on par with the treatment T_1 (FA 0 t/ha + VC 10 t/ha) (6.73 t/ha). The minimum herb yield (2.70 t/ha) was recorded by the treatment T_{13} (Zero fertilizer).

During the second crop, it was observed that the herb yield was reduced due to low temperatures of winter season during December to January.

Herb yield was maximum with treatment T_7 (FA 6 t/ha + VC 4 t/ha) during first and second seasons. The yield increased at increasing level up to T_7 and beyond 7 t/ha of fly ash the differences among the treatments were non significant for herb yield. Vermicompost beyond 5 t/ha also did not increase the yield.

The maximum herb yield was recorded by the treatment T_7 (FA 6 t/ha + VC 4 t/ha) due to application of fly ash and vermicompost. The increase may be due to the presence of many chemical constituents of fly ash which may have beneficial effect on physical properties of soil. These improved physical properties might have reflected in the form of increased herb yield. It also might be due to better supply of nutrients through higher doses of fly ash that created the most favourable condition for vigorous vegetative growth and flowering.

The results are supported by Neelima *et al*. (1995) who observed high yield of aromatic grasses particularly palmarosa and citronella in presence of different fly ash-soil combinations attributing to increased availability of major plant nutrients. Khan and Khan (1996) reported enhanced yield in tomato with 40-80% fly ash application. Significantly highest yield of grain and straw in green gram was observed with increasing levels of fly ash up to 10 t/ha (Bhaisare *et al*., 2000). Addition of fly ash at 20 and 40 t/ha along with manures recorded substantial increases in grain and straw yield over the treatments without fly ash (Selvakumari *et al*., 2000). Highest results of rice and ground nut with 40 t/ha of fly ash, 5 t/ha of vermicompost and 50% recommended dose of NPK (Pradhan *et al*., 2004). The fly ash when applied in combination with vermicompost and NPK improved the crop yield of wheat (Yavarzadeh and Shamsadini, 2012).

Maximum yield in geranium was reported by Munnu singh (2011) with 5 t/ha of vermicompost and 50% recommended fertilizer. Khalesro *et al*. (2012) found that vermicompost application improved yield in anise. Sekar *et al*. (2013) reported an increase in the yield of chilli on application of vermicompost (5 t/ha). Vermicompost improved the yield of cauliflower at statistically significant level (Tavali *et al*., 2013). Choudhary *et al*. (2014) reported that application of 4 t/ha vermicompost with 75% recommended level of fly ash gave significantly higher grain yield. The application of 75% N + 2 t vermicompost in the integrated mode gave the highest values of yield attributes (Diwakar *et al*., 2014).

The increased herb yield is due to increased plant height, number of tillers, number of leaves and leaf area in both first and second crops. The results are in conformity with Pandu Sastry *et al*. (2014) in citronella and Pandu Sastry *et al*. (2015) in palmarosa who reported increased herb and oil yield favoured with increase in plant growth characters.

However in the second crop, the plant growth and herb yield were affected by low temperatures of winter season. The result is supported by Pandu Sastry *et al*. (2014) in citronella and Pandu Sastry *et al*. (2015) in palmarosa where they reported effect of weather parameters on growth and yield of palmarosa and citronella. They observed that the growth and herb yield are more in the crop raised during October-December when compared to January-March. This is due to the fact that the plant growth was favoured by the moderate temperature throughout the crop period October-December which is correlating with the weather parameters of present investigation.

Table 1: Effect of fly ash and vermicompost on herb yield (t/ha)

	Treatments	**DAP**	
		90	**180**
T_1	Fly ash (0t/ha) + Vermicompost (10t/ha)	13.6	10.7
T_2	Fly ash (1t/ha) + Vermicompost (9t/ha)	14.2	11.3
T_3	Fly ash (2t/ha) + Vermicompost (8t/ha)	14.8	11.6
T_4	Fly ash (3t/ha) + Vermicompost (7t/ha)	15.4	12.5

T_5	Fly ash (4t/ha) + Vermicompost (6t/ha)	16.4	12.8
T_6	Fly ash (5t/ha) + Vermicompost (5t/ha)	17.3	13.3
T_7	Fly ash (6t/ha) + Vermicompost (4t/ha)	17.8	13.7
T_8	Fly ash (7t/ha) + Vermicompost (3t/ha)	16.6	12.8
T_9	Fly ash (8t/ha) + Vermicompost (2t/ha)	17.2	13.1
T_{10}	Fly ash (9t/ha) + Vermicompost (1t/ha)	15.8	12.1
T_{11}	Fly ash (10t/ha) + Vermicompost (0t/ha)	16.3	12.8
T_{12}	Recommended dose of fertilizer	13.2	10.3
T_{13}	Zero fertilizer (control)	10.3	6.4
	SEm±	0.893	0.861
	CD (0.05)	2.623	2.528

Effect of fly ash and vermicompost on Essential oil content (%)

The essential oil content differed non significantly for the treatments at all stages. A mean maximum essential oil content of 1.01 % at 30 days, 1.03% at 60 days and 1.07% at harvest was recorded. Among the treatments T_7 (FA 6 t/ha + VC 4 t/ha) has recorded highest essential oil content (1.07 %) at 90 days interval which remained on par with the treatments T_6 (1.02) (FA 5 t/ha + VC 5 t/ha), T_8 (1.06)(FA 7 t/ha + VC 3 t/ha), T_9 (1.09)(FA 8 t/ha + VC 2 t/ha), T_{10} (1.05)(FA 9 t/ha + VC 1 t/ha) and T_{11} (1.07)(FA 10 t/ha + VC 0 t/ha). The treatment T_{13} (Zero fertilizer) has recorded 0.95 % of essential oil content which was least. The treatment T_{12} (RDF) has recorded 0.98 % essential oil content which was on par with T_1 (FA 0 t/ha + VC 10 t/ha) (0.99 %). Significant differences were observed among the treatments for essential oil content during second crop. Maximum essential oil content of 0.91% at 105, 0.96 % at 160 and 1.01 at 180 days recorded respectively.

Treatment T_7 (1.01)(FA 6 t/ha + VC 4 t/ha) has recorded significant maximum essential oil content among the treatments at 180 days. The treatment was on par with T_6 (FA 5 t/ha + VC 5 t/ha) , T_8 (FA 7 t/ha + VC 3 t/ha), T_9 (FA 8 t/ha + VC 2 t/ha) , T_{10} (FA 9 t/ha + VC 1 t/ha) and T_{11} (FA 10 t/ha + VC 0 t/ha) which also recorded 0.97 %, 0.99 %, 1.02 %, 0.99 % and 1.02 % of essential oil content respectively. The treatment T_{12} (RDF) has recorded 0.91 % essential oil content which was on par with T_1 (FA 0 t/ha + VC 10 t/ha) (0.92%). The minimum essential oil content was recorded by the treatment T_{13} (0.87 %) (Zero fertilizer).

It is evident from the data that high essential oil content was recorded by the treatment T_7 (FA 6 t/ha + VC 4 t/ha) at 90 and 180 days. Slight increase occurs in oil content from 105 days to 180 days. In second

season oil content is decreased due to low temperatures during the period of December to January as per the annexure-1.

The results are in conformity with the findings of Pradhan *et al*. (2004). They reported highest oil content in rice with 40 t/ha of fly ash, 5 t/ha of vermicompost and 50% recommended dose of NPK. Application of coir pith, fly ash was found to be quite effective in increasing the total oil content in palmarosa plant (Mukherjee *et al*., 2002). Application of 60 t/ha of fly ash led to significantly highest oil content in seeds of sunflower (Bhoyar *et al*., 2007).

Highest essential oil content with the application of 4 t/ha of vermicompost in seed was reported by Darzi *et al*. (2012). Vermicompost application improved essential oil content in anise (Khalesro *et al*., 2012). Highest essential oil content in dragon head by applying vermicompost at 30% of pot volume was reported by (Mafakheri *et al*., 2013).

Effect of fly ash and vermicompost on oil content (%)

	Treatments	Days after planting					
		First crop			Second crop		
		30	60	90	120	150	180
T1	Fly ash (0t/ha) + Vermicompost (10t/ha)	0.91	0.98	0.99	0.82	0.89	0.92
T2	Fly ash (1t/ha) + Vermicompost (9t/ha)	0.93	1.01	1.04	0.86	0.91	0.95
T3	Fly ash (2t/ha) + Vermicompost (8t/ha)	0.92	0.97	1.01	0.84	0.93	0.93
T4	Fly ash (3t/ha) + Vermicompost (7t/ha)	0.94	1.02	1.06	0.87	0.92	0.96
T5	Fly ash (4t/ha) + Vermicompost (6t/ha)	0.93	1.02	1.05	0.89	0.94	0.94
T6	Fly ash (5t/ha) + Vermicompost (5t/ha)	0.96	0.99	1.02	0.88	0.94	0.97
T7	Fly ash (6t/ha) + Vermicompost (4t/ha)	1.01	1.03	1.07	0.91	0.96	1.01
T8	Fly ash (7t/ha) + Vermicompost (3t/ha)	0.97	1.01	1.06	0.85	0.97	0.99
T9	Fly ash (8t/ha) + Vermicompost (2t/ha)	1.02	1.04	1.09	0.92	0.95	1.02
T10	Fly ash (9t/ha) + Vermicompost (1t/ha)	0.95	0.99	1.05	0.89	0.97	0.99
T11	Fly ash (10t/ha) + Vermicompost (0t/ha)	0.98	1.01	1.07	0.87	0.93	1.02
T12	Recommended dose of fertilizer	0.93	0.91	0.98	0.81	0.91	0.91
T13	Zero fertilizer (control)	0.88	0.88	0.95	0.77	0.85	0.87
	SEm±	0.017	0.012	0.016	0.011	0.013	0.014
	CD (0.05)	N.S	N.S	N.S	N.S	N.S	N.S

Effect of fly ash and vermicompost on Essential oil composition (%)

The essential oil composition had no significant differences at 30, 60, 90, 120, 150 and 180 days. The essential oil composition was not influenced significantly by the treatments with different combinations of fly ash and vermicompost.

Table 2: Effect of fly ash and vermicompost on oil composition (Citral)(%)

	Treatments	Days after planting					
		First crop			Second crop		
		30	60	90	120	150	180
T1	Fly ash (0t/ha) + Vermicompost (10t/ha)	83.27	88.24	84.77	87.57	85.24	83.66
T2	Fly ash (1t/ha) + Vermicompost (9t/ha)	84.83	88.24	86.26	87.31	85.26	85.86
T3	Fly ash (2t/ha) + Vermicompost (8t/ha)	85.17	88.14	86.33	88.30	86.1	85.41
T4	Fly ash (3t/ha) + Vermicompost (7t/ha)	85.18	90.02	87.32	89.31	87.43	85.43

T5	Fly ash (4t/ha) + Vermicompost (6t/ha)	85.52	90.55	87.29	89.24	87.05	86.58
T6	Fly ash (5t/ha) + Vermicompost (5t/ha)	86.41	90.40	87.39	90.34	87.73	88.35
T7	Fly ash (6t/ha) + Vermicompost (4t/ha)	87.31	90.49	88.42	90.76	87.43	88.84
T8	Fly ash (7t/ha) + Vermicompost (3t/ha)	86.42	89.57	87.03	89.52	86.23	87.49
T9	Fly ash (8t/ha) + Vermicompost (2t/ha)	85.18	89.40	88.3	88.68	87.22	86.64
T10	Fly ash (9t/ha) + Vermicompost (1t/ha)	83.49	88.06	87.57	87.58	85.28	88.47
T11	Fly ash (10t/ha) + Vermicompost (0t/ha)	82.13	88.70	86.41	89.37	86.63	87.54
T12	Recommended dose of fertilizer	82.3	83.6	82.3	84.1	85.6	83.9
T13	Zero fertilizer (control)	80.1	81.2	80.7	82.3	81.3	80.3
	SEm±	0.852	0.658	0.672	0.729	0.762	0.744
	CD (0.05)	N.S	N.S	N.S	N.S	N.S	N.S

Table 3: Effect of fly ash and vermicompost on oil composition (Geraniol)(%)

	Treatments	Days after planting					
		First crop			Second crop		
		30	60	90	120	150	180
T1	Fly ash (0t/ha) + Vermicompost (10t/ha)	1.07	0.33	2.31	2.08	1.86	1.25
T2	Fly ash (1t/ha) + Vermicompost (9t/ha)	1.96	0.59	2.22	2.06	1.02	0.72
T3	Fly ash (2t/ha) + Vermicompost (8t/ha)	1.90	0.93	1.80	2.33	0.43	0.69
T4	Fly ash (3t/ha) + Vermicompost (7t/ha)	2.82	1.98	1.62	1.99	0.83	0.70
T5	Fly ash (4t/ha) + Vermicompost (6t/ha)	1.67	0.48	1.77	2.44	0.64	0.72
T6	Fly ash (5t/ha) + Vermicompost (5t/ha)	1.80	1.70	1.80	2.54	1.02	0.91
T7	Fly ash (6t/ha) + Vermicompost (4t/ha)	1.57	1.89	1.36	4.78	0.84	0.82
T8	Fly ash (7t/ha) + Vermicompost (3t/ha)	1.19	0.84	2.03	2.14	1.16	1.06
T9	Fly ash (8t/ha) + Vermicompost (2t/ha)	1.12	0.95	1.51	1.35	1.04	3.64
T10	Fly ash (9t/ha) + Vermicompost (1t/ha)	1.97	0.85	2.16	2.43	2.40	0.60
T11	Fly ash (10t/ha) + Vermicompost (0t/ha)	2.62	1.03	1.43	1.73	0.72	0.36
T12	Recommended dose of fertilizer	3.24	0.61	2.74	1.06	0.76	0.68
T13	Zero fertilizer (control)	2.31	1.17	1.88	2.57	0.57	0.75
	SEm±	0.009	0.006	0.009	0.008	0.008	0.007
	CD (0.05)	N.S	N.S	N.S	N.S	N.S	N.S

Table 4: Effect of fly ash and vermicompost on oil composition (Geranyl acetate)(%)

	Treatments	Days after planting					
		First crop			Second crop		
		30	60	90	120	150	180
T1	Fly ash (0t/ha) + Vermicompost (10t/ha)	0.46	0.14	1.51	0.72	0.32	0.85
T2	Fly ash (1t/ha) + Vermicompost (9t/ha)	2.24	0.06	4.11	1.52	0.63	0.17
T3	Fly ash (2t/ha) + Vermicompost (8t/ha)	2.71	0.22	1.44	2.14	0.49	0.27
T4	Fly ash (3t/ha) + Vermicompost (7t/ha)	2.54	0.20	0.96	0.70	0.06	0.16
T5	Fly ash (4t/ha) + Vermicompost (6t/ha)	2.84	0.18	1.41	1.30	0.19	0.09
T6	Fly ash (5t/ha) + Vermicompost (5t/ha)	1.54	0.22	0.86	1.69	0.39	0.33
T7	Fly ash (6t/ha) + Vermicompost (4t/ha)	2.88	0.18	0.91	2.97	0.03	0.13
T8	Fly ash (7t/ha) + Vermicompost (3t/ha)	1.04	0.20	1.31	1.77	0.78	0.49
T9	Fly ash (8t/ha) + Vermicompost (2t/ha)	0.42	0.52	1.11	0.42	0.13	1.34
T10	Fly ash (9t/ha) + Vermicompost (1t/ha)	1.45	0.33	1.46	2.33	0.19	0.07
T11	Fly ash (10t/ha) + Vermicompost (0t/ha)	2.79	0.07	1.07	0.98	0.25	0.32
T12	Recommended dose of fertilizer	3.95	0.11	1.41	0.29	0.19	0.34
T13	Zero fertilizer (control)	2.25	0.13	1.41	1.20	0.32	0.94
	SEm±	0.007	0.006	0.007	0.093	5.125	0.004
	CD (0.05)	N.S	N.S	N.S	N.S	N.S	N.S

CONCLUSION

As the organic farming gaining momentum for growing of crops this study will be helpful to grow the lemongrass by using the combination of flyash and vermicompost in efficient way. In this experiment the observations were recorded on herb yield, oil content and oil composition. Highest herb yield was recorded in the treatment T_7 with 6t flyash and 4t vermicompost and non significant values are recorded in oil content and oil composition. In this regard also, T_7 (FA 6 t/ha + VC 4 t/ha) can be recommended

where the cost of inputs can be compensated with high herb yield and in turn essential oil yield though the non significant values are recorded in oil content and oil composition.

REFERENCES

1. Anwar, M. Patra, D.D. Chand, S. Kumar, A. Naqvi, A.A. and Khanuja, S.P.S. 2005. Effect of organic manures and inorganic fertilizer on growth, herb and oil yield, nutrient accumulation, and oil quality of French basil. *Communications in soil science and plant analysis.* 36(1-14): 1737-1746.
2. Arancon, N.Q, Edwards, C.A, Bierman, P , Welch, C , Metzger, J.D. 2004. Influences of vermicomposts on field strawberries: 1. Effects on growth and yields. *Bioresource Technology*. 93 (2004) 145–153.
3. Bhaisare, B. Matte, D.B. Badole, W.P. and Deshmukh, A. 2000. Effect of flyash on yield, uptake of nutrients and quality of green gram grown on vertisol. *Journal of Soils and Crops*. 10(1): 122-124.
4. Bhoyar, S.M. Deshmukh, A.H. Deshmukh, P.R. Bhople, B.S. and Rathod, P.K. 2007. Effect of graded levels of fly ash application on growth, nutrient uptake and yield of sunflower in black soil. *Annals of Plant Physiology*. 21(2): 217-221.
5. Choudhary, R. Yadav, L.R. and Parihar, S. 2014. Studies on the interactive effect between vermicompost and fertility levels on pearl millet (Pennisetum glaucum L.) *Annals of Agri-Bio Research*. 19(3): 430-433.
6. Darzi, M.T. Hadi, M.H.S. and Rejali, F. 2012. Effects of the application of vermicompost and nitrogen fixing bacteria on quantity and quality of the essential oil in dill (*Anethum graveolens*). *Journal of Medicinal Plants Research*. 6(21): 3793-3799.
7. Diwakar, J.K. Kumar, M. Prasad, K.M. Nath, P. Kumar, P. and Bind, H. 2014. Effect of FYM, vermicompost and time of nitrogen application on growth, yield and nutrient uptake of basmati rice. *Annals of Agri Bio Research.* 19(4): 697-702.
8. Edwards, C.A. Dominguez, J. and Arancon, N.Q. 2004. The influence of vermicomposts on plant growth and pest incidence. S.H Shakir and W.Z.A. Mikhail (eds). *Soil Zoology for Sustainable Development in the 21st century*, Cairo, 397-420.
9. Khalesro, S. Ghalavand, A. Sefidkon, F. and Asgharzadeh, A. 2012. The effect of biological and organic inputs on quantity and quality of essential oil and some elements content of anise (*Pimpinella anisum* L.). *Iranian Journal of Medicinal and Aromatic Plants*. 27(4): 551-560.
10. Mafakheri, S. Omidbaigi, R. Sefidkon, F. and Rejali, F. 2013. Effect of biofertilizers, vermicompost, *Azotobacter* and biophosphate on the growth, nutrient uptake and essential oil content of dragonhead (*Dracocephalum moldavica* L.). *Acta Horticulture*. 1013: 395-401.
11. Mukherjee, P.S. Gumaste, J.L. and Nanda, B.2002. Effect of fly ash and coir Pith in oil Yield of palmarosa plant (*Cymbopogon martini*). *Proceedings of the National Conference on Utilization of Bioresources.*
12. Munnu, S.2011. Effect of integrated nutrient management through vermicompost and inorganic fertilizers on growth, yield, nutrient uptake and oil quality of geranium grown on alfisol. *Journal of Spices and Aromatic Crops* 20(2).
13. Neelima, M.R. Khandual, S. Tripathy, A. Sahu, R.K.1995. *Proceedings of workshop on fly ash management in the state of Orissa, April 11, 1995, RRL, Bhubhaneshwar*, *India,* pp. 76-89.
14. Pandu Sastry, K. Srinivas, K.V.N.S. Kumar, J.K. Kumar, A.N. Dharmendra, K.R. and Maheswara Sarma, V.U. 2014. Variation in the essential oil content and composition of citronella (*Cymbopogon winterianus* Jowitt.) in relation to time of harvest and weather conditions. *Industrial Crops and Products*. 61: 240-248.
15. Pandu Sastry, K. Srinivas, K.V.N.S. Kumar, J.K. Kumar, A.N. Dharmendra, K.R. and Anubala, A.S. 2015. Changes in the essential oil content and composition of palmarosa (*Cymbopogon martini*) harvested at different stages and short intervals in two different seasons. *Industrial Crops and Products*. 69: 348-354.
16. Pradhan, K.C. Sahu, S.K. and Samanta, P.K. 2004. Effects of fly ash on rice-groundnut cropping system in lateritic soil. *International Arachis Newsletter*.24:49-50.
17. Sekar, J. Jayanthi, L. and Parthasarathi, K. 2013. Efficiency of vermicompost supplementation with inorganic fertilizers on growth and yield in chilli (*Capsicum annuum* L.). *Review of Research Journal*. 3(3): 1-6.
18. Selvakumari, G. Baskar, M. Jayanthi, D and Mathan, K.K. 2000. Effect of integration of fly ash with fertilizers and organic manures on nutrient availability, yield and nutrient uptake of rice in alfisols. *Journal of the Indian Society of Soil Science.* 48(2): 268-278.
19. Tavali, I.E. Maltas, A.S. Uz, I. and Kaplan, M. 2013. The effect of vermicompost on yield, quality and nutritional status of cauliflower (*Brassica oleracea* var. *botrytis*). *Akdeniz university journal of the faculty of agriculture*. 26(2): 115-120.
20. Yavarzadeh, M.R. and Shamsadini, H.2012. Safe Environment by Using Flyash and Vermicompost on wheat. *International Conference on Transport, Environment Civil Engineering,* ICTECE' 2012, Kuala Lumpur, Malaysia, August 25-26.

CITATION OF THIS ARTICLE

Srinivas P, Vijaya Padma S S, Pandu Sastry K and Venugopal S. Effect Of Different Levels Of Fly Ash And Vermicompost On Herb Yield, Oil Content And Oil Composition Of Lemongrass (*Cymbopogon flexuosus* Nees). Bull. Env. Pharmacol. Life Sci., Vol 6 Special issue [3] 2017: 27-33