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Full Length Review Article

EFFECT OF ORGANIC MANURES, CONSORTIUM BIO-FERTILIZERS AND BIO-STIMULANTS ON SEED YIELD, OIL CONTENT AND SOIL NUTRIENT STATUS OFAMBRETTE (*ABELMOSCHUSMOSCHATUS*MEDIC.)

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An investigation was undertaken at the Department of Horticulture, Annamalai University, Annamalainagar during 2010-2011, to study the effect of different combination organic manures, consortium bio-fertilizers and bio-stimulants on seed yield, dry matter production, oil content and plant nutrient uptake in Ambrette (*Abelmoschusmoschatus* Medic.). The results revealed that among the treatments, the combination of vermicompost @ 7.5 t ha^{-1} + consortium bio-fertilizers @ 2 kg ha^{-1} + foliar spray of panchakavya @ 3 per cent recorded the highest number of pods per plant, pod weight per plant, pod yield per plot, seed yield per plant, seed yield per plot as compared to the control. Similar trend was observed for dry matter production, oil content of seeds and leaf chlorophyll content. As regard to plant nutrient uptake, the nitrogen, phosphorus and potassium uptake were higher in the treatment of vermicompost7.5 t ha^{-1}, consortiumbioferilizer@ 2 kg ha^{-1} and pachakavya 3 per cent as foliar spray.

Key words: Ambrette, Bio-stimulant, consortium bio-fertilizers.

INTRODUCTION

Ambrette (*Abelmoschusmoschatus*Medic.) also known as ‘Musk mallow’ is an important medicinal as well as an aromatic plant, valued for its scented seed. It is universally known as ‘Ambrette’ and the oil extracted from seed is called ‘Ambrette oil’. The seeds of ambrette are extensively used in perfumery, since their aroma is similar to that of musk and are also used to impart a musky perfume to sachets and hair powders etc. The ambrette oil of commerce blends excellently well with many other essential oils including rose, neroli and sandal wood oil. Ambrette oil in the form of extract is used in creams, lipsticks, cosmetic powder and soaps. The seeds possess several medicinal properties and are used as aphrodisiac, diuretic, constipating, antispasmodic, stomachic, stimulant, carminative and coolant.India has been exporting ambrette seeds to France, Germany, Japan, Singapore, Spain and several other countries at 140 tonnes of seeds worth of Rs. 35 lakhs (Srivastava, 1995). It is a hardy plant and two crops can be raised in a year. This crop has assumed commercial importance in recent year, however, very little research work has been done on this crop regarding agro techniques especially nutritional requirement of the crop for better yield and returns (Srivastava, 1974). The modern day agriculture largely depends upon the use of chemical fertilizers, pesticides and herbicides, which have resulted in adverse effects on soil productivity and environment. Building of soil fertility is indispensable for higher productivity of the cultivated lands. Thus, organic farming plays a vital role in soil fertility and crop productivity (Kunte*et al*., 1997).Organic manures have been known to increase crop yield and quality by activating the soil biologically, stimulating plant growth, restoring natural soil fertility and so on.

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With ever increasing cost of synthetic fertilizer, biofertilizer offers an opportunity to use this as nutrient source. Recently, a microbial consortium, containing a mixture of biofertilizer of N-fixers, P- solubilizer and plant growth promoting rhizobacteria (PGPR) has been found to promote the growth of plants better than their individual application (Piyush Pandey and Maheswari, 2007). A trial was therefore undertaken in Ambrette to study the effect of organics on seed yield, oil content, nutrient uptake and soil nutrient status.

MATEIRALS AND METHODS

The investigation was undertaken at the vegetable unit of Department of Horticulture, Faculty of Agriculture, Annamalai University during 2010-11. The analysis of the experimental soil was carried out initially and the data on the physical and chemical properties of the soil is presented in Table.1

Sources of organic manures and their preparation : Farmyard manure and vermicompost were obtained from the farm of the Department of Horticulture. Pressmud was obtained from the unit of M/s. M.R. Krishnamoorthy sugar mill, Sehtiathoppu. The consortium biofertilizer(CBF) was obtained from the Department of Microbiology, Faculty of Agriculture, Annamalai University. Panchakavya was prepared by a modified method as suggested by (Natrajan, 2002).Humic acid both in the crystal and liquid form were obtained from the M/s. Agro Science Laboratories, Shree Dhanalakshmi Industrial Garden, SanthaVellipet, Vadulur-607 303. Effectivemicroorganisms were obtained from the Auroville at Pudhucherry. Seeds of ambrette were collected from the Department of Horticulture, University of Agricultural Sciences, Dharward, Bangalore and used for the study.

Experimental Design/ Treatments: The experiment was conducted in a randomized block design with 3 replications with a plot size of 2 x 2 m and with 13 treatment combinations viz., FYM alone @ 37.5 tonnes + CBF 2 kg (T_1), vermicompost alone @ 7.5 tonnes + CBF 2 kg (T_2), pressmud alone @ 37.5 tonnes + CBF 2 kg (T_3), FYM @ 37.5 tonnes + CBF 2 kg + PK 3% (T_4), FYM @ 37.5 tonnes + CBF 2 kg + HA 0.2% (T_5), FYM @ 37.5 tonnes + CBF 2 kg + EMI (1:1000 dilution) (T_6), vermicompost alone @ 7.5 tonnes + CBF 2 kg + Panchakavya 3% (T_7), vermicompost alone @ 7.5 tonnes + CBF 2 kg + HA 0.2% (T_8), vermicompost alone @ 7.5 tonnes + CBF 2 kg + EM (1:1000 dilution) (T_9), pressmud @ 37.5 tonnes + CBF 2 kg + Panchakavya 3% (T_{10}), pressmud @ 37.5 tonnes + CBF 2 kg + HA 0.2% (T_{11}), pressmud @ 37.5 tonnes + CBF 2 kg + EMI (1:1000 dilution) (T_{12}) and absolute control (T_{13}).

Table 1. Physical and chemical properties of the soil

Mechanical analysis (International pipette method)	Content
Coarse sand (%)	14.10
Fine sand (%)	34.02
Silt (%)	16.33
Clay (%)	36.17
B. Soil type	
Textural class	Clay loam
C. Chemical analysis	
pH	7.45
EC(dSm^{-1})	0.40
Organic matter (%)	0.70
Available nitrogen (kg ha^{-1})	179.42
Available phosphorus (kg ha^{-1})	19.53
Available potassium (kg ha^{-1})	294.18

Seeds were soaked in water for 12 hours before sowing. Two to three seeds per hill were sown at a depth of 1 cm with a spacing of 60 x 60 cm and covered with sand. The plots were immediatly irrigated. The required quantity of organic manures *viz*., farmyard manure,vermicompost and pressmud were incorporated at the time of last ploughing as per the treatment schedule.The consortium biofertilizer(CBF) @ 2 kg ha^{-1} was applied ten days after the incorporation of organic manures. The bio-stimulants *viz*., panchakavya (3%), humic acid (0.2%) and effective microorganisms (1: 1000 dilution) were applied as per treatment schedule in three sprays at fortnightly intervals.

Observations Recorded: Observations were recorded on pod yield per plant (g), pod yield per plot (g), seed yield per plant (g), seed yield per plot (g) and estimated seed yield per hectare (kg). Dry matter production (g plant^{-1}) was assessedin the uprooted plants after drying in hot air oven at a temperature of 65ºC to constant dry weight and recorded in grams. The chlorophyll content of leaves (%) was assessed at 150 DAS by using the standard procedure of Mahadevan and Sridhar (1986) and expressed in percentage. The oil content of seeds was estimated by the Soxhlet extraction apparatus as suggested by Sadasivam and Manickam (1992) and represented in percentage. The oil content as percentage was calculated using the following formula

$$\text{Oil content } (\gamma) = \frac{w_2 - w_1}{\text{Weight of sample}} \times 100$$

Analysis of Plant Samples: Five plants at random were pulled at the time of harvest without damaging the roots, washed free of soil and shade dried for one day followed by drying in a hot air oven at 80ºC. The dried plants were ground in a wiley mill having stainless steel sieves and used for analysis.

Nitrogen uptake (kg ha^{-1}): The plant samples were analysed for N content by microkejeldhal method suggested by Yoshida *et al*. (1972) and expressed in kg ha^{-1}.

Phosphorus uptake (kg ha^{-1}): The total phosphorus content of the plant sample was analysed calorimetrically from triple acid extract (Jackson, 1973) and expressed in kg ha^{-1}.

Potassium uptake (kg ha^{-1}): From the triple acid extract, the total potassium content was estimated by using flame photo meter (Jackson, 1973) and expressed in kg ha^{-1}. Soil samples were also collected twice from the experimental plots, one before the incorporation of the treatments and another after the harvest and estimated available nitrogen (Subbaiah and Asija, 1956), available phosphorus(Olsen *et al*., 1954), available potassium (Stanford and English, 1949). The data were statistically analyse and critical differences were worked out at 5 per cent level to draw statistical conclusion (Panse and Sukhatme, 1978).

RESULTS AND DISCUSSION

Ambrette (*Abelmoschusmoschatus*) is an emerging medicinal crop, which has gained importance in medicine and cosmetic industries. The cultivation of this crop on a commercial basis has gained momentum in recent years. Besides, organic cultivation has been adjudged as a recent trend of cultivation to overcome the adverse effects of organic inputs in agriculture. A study conducted with organics in 'Ambrette' has given useful results which are discussed hereunder. In the present study, the treatment with different organic manures were found to exert marked influence on yield and its attributes. The treatment receiving vermicompost @7.5 ha^{-1} + consortium biofertilizer 2 kg ha^{-1} + foliar spray of panchakavya @ 3 per cent recorded the highest number and weight of pods per plant, seed yield per plant and yield per ha (Table 2). This may be attributed to increased nutrient availability from the vermicompost which in turn may have increased various endogenous hormonal levels in the plant tissue, which ultimately increased the pod characters resulting in higher yield as suggested by Balaguru (2006) in ambrette.

Higher yield due to the application of organic inputs may also be attributed to the favourable effects in improving the physical condition of the soil, besides supplying adequate major and minor nutrients which might have enhanced the absorption, translocation and assimilation of nutrients resulting in higher yield as suggested by Dange*et al.* (2002) in chilli and Sivakumar (2004) in black night shade. The beneficial role of panchakavya as an yield enhancer may be due to the sustained availability of N throughout the growing phase and also due to enhanced carbohydrate synthesis and its translocation. The pronounced increase in pod and seed yield with panchakavya might also be due to the sustained availability of N throughout the growing phase and also due to enhanced carbohydrate synthesis and effective translocation of photosynthates to the developing sink. The proportion and activity of beneficial microbes would have been at higher rates in panchakavya, which helps in the synthesis of growth

Table 2. Influence of organic manures, biofertilizers and biostimulants on pod and seed yield in ambrette

Treatments		No. of pods $plant^{-1}$	Pod yield per plant (g)	Pod yield per plot (g)	Seed yield per plant (g)	Seed yield per plot (g)	Seed yield per hectare (kg)
T_1	FYM 37.5 t + CBF 2 kg	37.49	45.74	26.62	292.82	739	503.14
T_2	VC 7.5 t + CBF 2 kg	38.71	49.54	30.58	336.38	849	544.94
T_3	PM 37.5 t + CBF 2 kg	36.16	41.95	22.42	246.62	622	461.45
T_4	FYM + CBF 2kg + PK 3%	46.11	71.01	52.57	578.27	1460	781.11
T_5	FYM + CBF 2kg + HA 0.2%	44.23	64.13	46.88	515.68	1302	705.43
T_6	FYM + CBF 2kg + EM 1: 1000 dilution	40.48	55.05	36.43	400.73	1011	605.55
T_7	VC + CBF 2 kg + PK 3%	48.77	81.45	63.88	702.68	1774	895.95
T_8	VC + CBF 2 kg + HA 0.2%	47.55	76.08	58.49	643.39	1624	836.88
T_9	VC + CBF 2 kg + EM 1: 1000 dilution	43.46	62.14	45.20	497.20	1255	683.54
T_{10}	PM + CBF 2 kg + PK 3%	42.58	59.61	43.01	473.11	1194	655.71
T_{11}	PM + CBF 2 kg + HA 0.2%	41.36	55.83	38.46	423.06	1068	614.13
T_{12}	PM + CBF 2 kg + EM 1: 1000 dilution	39.82	53.36	34.64	381.04	962	586.96
T_{13}	Control	24.49	19.59	12.97	142.77	396	269.39
SEd		0.50	1.33	15.18	1.11	12.56	24.20
	CD(P=0.05)	1.01	2.66	30.36	2.22	25.12	48.40

Table 3. Influence of organic manures, biofertilizers and biostimulants on chlorophyll content and dry matter production inambrette

Treatments		Chlorophyll content (%)	Dry matter production (g) $plant^{-1}$
T_1	FYM 37.5 t + CBF 2 kg	222.08	0.54
T_2	VC 7.5 t + CBF 2 kg	226.23	0.59
T_3	PM 37.5 t + CBF 2 kg	219.74	0.48
T_4	FYM + CBF 2kg + PK 3%	242.25	0.96
T_5	FYM + CBF 2kg + HA 0.2%	239.11	0.86
T_6	FYM + CBF 2kg + EM 1: 1000 dilution	231.43	0.59
T_7	VC + CBF 2 kg + PK 3%	248.62	1.11
T_8	VC + CBF 2 kg + HA 0.2%	245.50	1.03
T_9	VC + CBF 2 kg + EM 1: 1000 dilution	237.86	0.82
T_{10}	PM + CBF 2 kg + PK 3%	236.30	0.81
T_{11}	PM + CBF 2 kg + HA 0.2%	232.85	0.79
T_{12}	PM + CBF 2 kg + EM 1: 1000 dilution	229.71	0.69
T_{13}	Control	186.62	0.41
SEd		0.02	0.98
CD(P=0.05)		0.04	1.96

Table 4. Influence of organic manures, biofertilizers and biostimulants on essential oil content (%) in ambrette

Treatments		Essential Oil content (%)
T_1	FYM 37.5 t + CBF 2 kg	16.65
T_2	VC 7.5 t + CBF 2 kg	17.02
T_3	PM 37.5 t + CBF 2 kg	16.22
T_4	FYM + CBF 2kg + PK 3%	18.99
T_5	FYM + CBF 2kg + HA 0.2%	18.56
T_6	FYM + CBF 2kg + EM 1: 1000 dilution	17.66
T_7	VC + CBF 2 kg + PK 3%	19.90
T_8	VC + CBF 2 kg + HA 0.2%	19.43
T_9	VC + CBF 2 kg + EM 1: 1000 dilution	18.16
T_{10}	PM + CBF 2 kg + PK 3%	17.99
T_{11}	PM + CBF 2 kg + HA 0.2%	17.81
T_{12}	PM + CBF 2 kg + EM 1: 1000 dilution	17.51
T_{13}	Control	14.80
SEd		0.12
CD(P=0.05)		0.25

Table 5. Influence of organic manures, biofertilizers and biostimulants on major nutrient uptake (kg ha^{-1}) in ambrette

Treatments		N	P	K
T_1	FYM 37.5 t + CBF 2 kg	68.64	25.26	69.91
T_2	VC 7.5 t + CBF 2 kg	69.53	26.09	70.29
T_3	PM 37.5 t + CBF 2 kg	67.76	24.51	69.49
T_4	FYM + CBF 2kg + PK 3%	74.78	29.46	71.52
T_5	FYM + CBF 2kg + HA 0.2%	73.83	28.71	71.09
T_6	FYM + CBF 2kg + EM 1: 1000 dilution	71.40	27.68	70.74
T_7	VC + CBF 2 kg + PK 3%	76.64	30.46	72.25
T_8	VC + CBF 2 kg + HA 0.2%	75.76	29.91	71.90
T_9	VC + CBF 2 kg + EM 1: 1000 dilution	73.40	28.55	71.00
T_{10}	PM + CBF 2 kg + PK 3%	72.82	28.42	70.92
T_{11}	PM + CBF 2 kg + HA 0.2%	71.85	27.84	70.83
T_{12}	PM + CBF 2 kg + EM 1: 1000 dilution	70.51	26.93	70.65
T_{13}	Control	66.79	23.62	69.00
SEd		0.32	0.08	0.07
CD(P=0.05)		0.65	0.16	0.15

Table 6. Influence of organic manures, biofertilizers and biostimulants on available soil major nutrient status (kg ha^{-1})

Treatments		N	P	K
T_1	FYM 37.5 t + CBF 2 kg	147.41	12.62	154.34
T_2	VC 7.5 t + CBF 2 kg	136.02	9.49	151.01
T_3	PM 37.5 t + CBF 2 kg	138.28	10.38	151.79
T_4	FYM + CBF 2kg + PK 3%	158.85	16.19	158.08
T_5	FYM + CBF 2kg + HA 0.2%	151.00	13.97	155.62
T_6	FYM + CBF 2kg + EM 1: 1000 dilution	161.95	17.19	159.97
T_7	VC + CBF 2 kg + PK 3%	155.26	15.30	156.97
T_8	VC + CBF 2 kg + HA 0.2%	152.44	14.32	153.02
T_9	VC + CPF 2 kg + EM 1: 1000 dilution	165.50	18.30	161.92
T_{10}	PM + CBF 2 kg + PK 3%	145.86	12.30	153.96
T_{11}	PM + CBF 2 kg + HA 0.2%	144.64	12.05	153.61
T_{12}	PM + CBF 2 kg + EM 1: 1000 dilution	141.50	11.24	152.66
T_{13}	Control	149.67	13.59	155.23
SEd		0.62	0.28	0.31
CD(P=0.05)		1.24	0.57	0.63

promoting substances that might have increased the yield. This is in line with the findings of Sarma and Anandaraj (2003).The results of the study are in conformity with the reports of Kanimozhi (2003) and Bharathi (2004) in medicinal Coleus. As suggested by Krishnamoorthy and Ravikumar (1973), higher production of dry matter by the plant could be attributed to the fact that organic manures have high amount of humus, which facilitates N-fixation by microbes, regulate the nitrogen supply to the plants and also helps in the production of plant growth promoters. The presence of humic acid in FYM may have also encouraged greater uptake of nitrogen resulting in higher total dry matter accumulation (Table 3). The oil content was significantly influenced by the application of vermicompost@ 7.5 t ha^{-1} + consortium biofertilizer@ 2 kg ha^{-1} + panchakavya@ 3 per cent (Table 4). These results are in line with the findings of Anwar *et al.* (2005) in French basil and Santana (2005) in safflower. The favourable physical condition created in the soil would have increased nutrient availability especially phosphorus and potassium and the resultant uptake might have prompted deeper and stronger root system. The higher availability and uptake of nutrients might have enhanced the higher photosynthetic activity resulting in higher amount of oil content (Mohanalakshmi and Vadivel 2008). Similar results were also reported by Maheswari *et al.* (2000) in aswaghandha and Kanimozhi (2003) in coleus.

Plant Nutrient Uptake: As regard to plant nutrient status, the nitrogen, phosphorus and potassium uptake were higher in the treatment receiving vermicompost7.5 t ha^{-1}, consortium biofertilizer 2 kg ha^{-1} and panchakavya 3 per cent foliar spray (Table 5). Organic manures when applied to the soil resulted in the breakdown of complex nitrogen compounds by the action of microorganisms and increase its availability to the soil in the form of nitrate nitrogen as observed by Balaguru (2006) in ambrette. The use of combined application of organic manures increased the potassium content, which may be ascribed to its role in improving the soil properties, leading to better penetration of roots, thereby resulting in greater uptake of potassium from native source (Budhawant, 1994). Similar findings have been reported by Paul *et al.* (2004) in tomato, Chavan *et al.* (1997) and Meera Nair and Peter (1990) in chilli. Added organic manures not only acted as a source of nutrients, but also had influenced their availability and the cumulative effect of these treatments along with panchakavya seemed to be adequate suppliers of nutrients slowly and steadily throughout the period of crop growth as observed by Santhanalakshmi (2006). The increased content of major nutrients could be due to the chemolithicautotropicnitrifiers (ammonifiers and nitrifiers) which colonize in the leaves leading to increased ammonia uptake and enhanced total N supply (Papen *et al.*, 2002). Analysis of postharvest soil nutrient status revealed that the three major plant nutrients *viz*., N, P and K were higher in the promising treatment combination of vermicompost @ 7.5 t ha^{-1} + consortium biofertilizer @ 2 kg ha^{-1}+ Effective microorganism (1:1000 dilution) as foliar spray. This might be due to the slow release of nutrients from the organics, resulting in extended availability in due course of time (Table 6). Increased nitrogen in the soil might be due to the enhanced microbial activity, which caused transformation of the substrate N into microbial protein, thereby preventing nitrogen loss as suggested by Chand *et al*. (1996). Greater availability of phosphorus under organic manures might largely be due to the organic recycling and minimum fixation of phosphorus in the soil in the presence of humic substances. The organic P is converted slowly to inorganic form as suggested by Hangarge *et al.* (2004). Combined application of FYM and vermicompost increased the nitrogen and phosphorus availability which might have triggered the potassium availability in the soil. Moreover, higher content of potassium in the soil might also be the reason for increased potassium availability. To conclude, application of vermicompost @ 7.5 t ha^{-1} + consortium biofertilizers @ 2 kg ha^{-1} + panchakavya @ 3 per cent as foliar spray at monthly intervals was adjudged to be the best treatment for maximizing yield and quality of Ambrette.

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