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Effect of growing condition and mulching management for enhancing yield and quality of *Plectranthus vettiveroides* (K. C. Jacob) N. P. Singh and B. D. Sharma

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ABSTRACT

Experiments were carried out during May - September 2019 and 2020, to assess the effect of growing condition and mulching on root yield and quality of Plectranthus vettiveroides. Experimental design was split plot with three main plots (open, 25 per cent shade and 50 per cent shade) and three sub plots (no mulching, organic mulching with paddy straw and black polythene mulching). Higher bio mass yields were recorded under open and 25 per cent shaded condition (9763 and 9576 kg ha^{-1} respectively), which were statistically on par. Among sub plot treatments, mulching with the black polythene sheet was the best with respect to fresh biomass yield followed by organic mulching. Root yield and essential oil content also showed a same trend of biomass yield with higher root yield and oil content under 25 per cent shaded condition (1370 kg ha^{-1} and 1.84 per cent) followed by open condition (1285 kg ha^{-1} and 1.80 per cent), which were on par.

***Keywords**:* Growing condition, mulching, *Plectranthus vettiveroides*, light intensity, shade levels

Medicinal plants are utilized extensively for health care throughout the world. The demand for natural plant based medicines, pharmaceuticals, health products, food supplements and cosmetics are rising day by day in the national and world markets. One of the main difficulties faced by the industries and entrepreneurs is the availability of sufficient quantities of good quality raw materials for internal consumption as well as for export. *Plectranthus* is an extensive genus, belonging to the family Lamiaceae with a multitude of medicinal uses. The genus consists of about 300 species found in Tropical Africa, Asia and Australia. *Plectranthus vettiveroides* (K. C. Jacob) N. P. Singh and B. D. Sharma, which was earlier known as *Coleus vettiveroides* is an important species among them. It is a small profusely branched succulent plant which has deep straw coloured roots. Even though roots are the major economic part, the stem without leaf is also traded. The plant is used against skin diseases, bronchitis, rheumatism and allergies. It also has stimulant and carminative potential. It is most commonly used against infirmities such as fever, diarrhoea, vomiting, leucoderma, liver diseases *etc*. It is used against indigestion and urinal disorders and is a chief ingredient of many ayurvedic preparations like *Iruvelikashayam*, *devashtagandha*, *snanachoornam etc*. (Warrier *et al*.,1995). The important chemical constituents include essential oils, diterpenoids, triterpenoids, fatty acids and flavones. The essential oil is bright orange red in colour, highly viscous and has pleasant odour. About 40 herbal drugs which contain *Plectranthus vettiveroides* solely or as an ingredient are currently available in the global/local markets. About 50 tonnes of the plant biomass is required annually for ayurvedic preparations.

In the global scenario, the cultivation of *Plectranthus vettiveroides* is limited to tropical India (Lukhoba *et al*., 2006). *Plectranthus vettiveroides* is extinct in wild and thus cannot be found in natural habitats (Shivananda *et al*., 2007).

With the apprehension that some of the medicinal plants are highly exploited, many organizations are endorsing to bring medicinal plants under large scale cultivation (Lambert *et al*., 1997; Schippmann *et al*., 2002). To meet uninterrupted market requirements for quality raw materials without depleting the natural resource base, increasing the number of medicinal plants under cultivation seems to be a better option (Hassan *et al.*, 2010). While bringing a medicinal plant under cultivation, both the quality and quantity of raw drug are equally important and it can be achieved only by cultivating them under a micro climate similar to its niche original. In this background studies were conducted at AICRP on Medicinal, aromatic plants and betel vine, College of Agriculture, Kerala Agricultural University to assess the influence of growing condition and mulching on biomass, root yield and oil content of *Plectranthus vettiveroides* (K. C. Jacob) N. P. Singh and B. D. Sharma.

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MATERIALS AND METHODS

The study was conducted during May-September 2019 and 2020 at AICRP on Medicinal aromatic plants and betelvine, College of Agriculture, Kerala Agricultural University, Vellanikkara, Thrissur. The experimental site was situated at 13^0 32'N latitude and 76^0 26'E longitude, at an altitude of 40 m above mean sea level (MSL). The texture of the soil was sandy clay loam with p^H 5.34 (strongly acidic), organic carbon content 0.60 % (low), available N content 234.40 kg ha^{-1} (low), available P content 26.15 kg ha^{-1} (high) and available K content 252.60 kg ha^{-1} (medium).

The statistical design was split plot with three replications. The main plot treatments consisted of three growing conditions (open, 25 per cent shade and 50 per cent shade), and sub plots consisted of three mulching treatments (no mulching, organic mulching with paddy straw @ 5t ha^{-1} and 30 micron silver black polythene sheet mulching).

Dried farmyard manure was applied @ 15 t ha^{-1} at the time of land preparation. Rooted stem cuttings were used as planting materials. Planting was done at a spacing of 30 x 30 cm in the month of May. Hand weeding was carried out at 30 and 60 days after planting. Hose irrigation was done at 5mm depth daily in the morning. Harvesting was done with the initiation of flowering at four months after planting.

Observations on total biomass, root yield and essential oil content of roots were taken at harvest stage. The essential oil content of roots was estimated at harvest by hydro distillation method, using Clevenger apparatus as per the procedure reported by AOAC (1975).

The data generated from the experiment was analyzed using analysis of variance (ANOVA) with statistical package 'WASP 2' (Statistical package, ICAR Goa, India). Economics of cultivation was worked out based on prevailing labour rate (Rs. 600/- person) and market price of inputs.

RESULTS AND DISCUSSION

Total biomass yield

Plectranthus vettiveroides performed well in slightly shaded areas (up to 25 per cent) to fully open condition (Table 1). During the first year of the study higher biomass yield was observed under fully open condition (10327 kg ha^{-1}) followed by 25 per cent shaded condition (9534 kg ha^{-1}). However, during the second year of study biomass yields under fully open condition and 25 per cent shaded condition were at par (9208 kg ha^{-1} and 9619 kg ha^{-1} respectively). Pool data also showed the same trend of superior yields under open and 25 per cent shaded condition, which were statistically on par. The 50 per cent shaded condition recorded the lowest biomass yield during both the years of study. Intensity of light could affect the rate of photosynthesis, which in turn influence photosynthetic capacity and biomass production. At different light intensities, plants change their morphology and accordingly allocation of photosynthates to biomass also will change (Devkota and Jha, 2010).

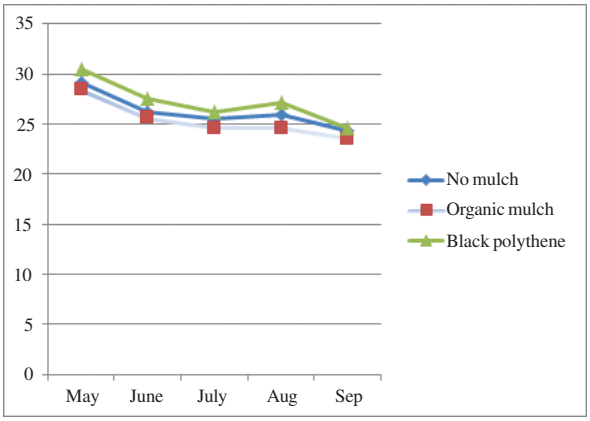
As compared to 50 per cent shaded condition, open growing condition resulted in 34.81 per cent increase in yield, whereas, yield improvement under 25 per cent shaded condition was 32.23 per cent. The biomass yield difference between open and 25 per cent shaded growing condition was only two per cent, indicating suitability of growing *Plectranthus vettiveroides* as a pure crop in the open condition and as intercrop in areas having shade level up to 25 per cent.

Among sub plot treatments, mulching with black polythene sheet was the best with respect to fresh biomass yield. Organic mulching was the next best alternative which produced 48 per cent more biomass than plants grown without mulching. As per Gunasekaran and Shakila (2014), mulching with black polythene enhanced the yield and yield attributes of medicinal coleus (*Coleus forskholli*).

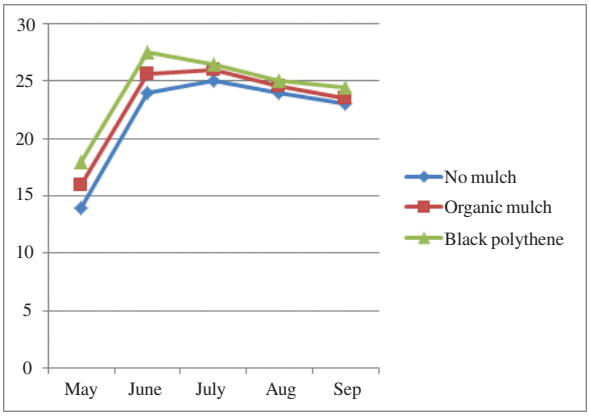
The combination effect of growing condition and mulching was statistically significant for biomass yield. The combination of open growing condition with the black polythene mulching recorded the highest biomass yield followed by mulching with the black polythene sheet under 25 per cent shaded condition and black polythene mulching under 50 per cent shaded condition.

Root yield

Root yield showed the same trend of biomass yield with higher root yield under 25 per cent shaded condition (1370 kg ha^{-1}) followed by open condition (1285 kg ha^{-1}), which were found to be statistically similar. The root yield was the lowest under 50 per cent shaded condition (996 kg ha^{-1}). Mulching significantly influenced the root formation of Plectranthus. The root yield under black polythene mulch was 154 per cent more than no mulching. The root yield difference between organic mulching and no mulching was 47 per cent, clearly indicating the positive influence of mulching on improving root yield. Many workers reported yield improvement of crops under mulching. In this study, throughout the experiment period higher soil temperature and soil moisture was observed under mulched treatments (Fig. 1). Bo *et al.* (2018) also reported the influence of mulching on modifying soil physical properties. According to them, organic mulching could



Soil temperature at 10 cm depth



Soil moisture at 10 cm depth

Fig. 1: Effect of mulching on soil temperature and soil moisture at 10 cm depth of soil (Pooled average of two years)

Table 1: Effect of growing condition and mulching on yield and essential oil content of *Plectranthus vettiveroides*

	Biomass (kg ha^{-1})			Root yield (kg ha^{-1})			Essential oil content (%)		
	First year	Second year	Pooled	First year	Second year	Pooled	First year	Second year	Pooled
Main plot (Growing conditions)									
Open	10327.00	9208.00	9763.00	1216.00	1336.00	1285.00	1.78	1.82	1.80
25 % shade	9534.00	9619.00	9576.00	1328.00	1411.00	1370.00	1.83	1.85	1.84
50 % shade	7471.00	7302.00	7242.00	985.00	1006.00	996.00	1.31	1.37	1.34
SEm(±)	**175.19**	**144.21**	**119.14**	**15.51**	**35.09**	**26.32**	**0.01**	**0.05**	**0.02**
LSD (0.05)	**687.89**	**566.23**	**378.05**	**60.88**	**137.79**	**89.92**	**0.05**	**0.14**	**0.078**
Sub plot (Mulching)									
No mulching	4347.00	4401.00	4393.00	657.00	753.00	728.00	1.43	1.49	1.46
Organic mulching (Paddy straw @5 t ha-1)	6773.00	6413.00	6502.00	1029.00	1095.00	1072.00	1.57	1.59	1.58
Black polythene mulching	16213.00	15317.00	15197.00	1843.00	1906.00	1851.00	1.91	1.95	1.93
SEm (±)	**203.60**	**154.30**	**109.51**	**26.12**	**30.30**	**22.15**	**0.01**	**0.04**	**0.02**
LSD .(0.05)	**627.35**	**475.45**	**378.06**	**80.49**	**93.35**	**63.98**	**0.04**	**0.14**	**0.06**
Growing condition x mulching									
Open x No mulching	4731.00	4872.00	4801.00	653.00	890.00	715.00	1.62	1.64	1.63
Open x Organic mulching	7261.00	7241.00	7171.00	1027.00	1140.00	1113.00	1.69	1.73	1.71
Open x Black polythene mulching	18988.00	15513.00	17345.00	1969.00	1979.00	1972.00	2.01	2.08	2.05
25 % shade x No mulching	5062.00	5033.00	5048.00	843.00	866.00	845.00	1.65	1.66	1.65
25 % shade x Organic mulching	7370.00	7301.00	7335.00	1185.00	1218.00	1202.00	1.72	1.75	1.74
25 % shade x Black polythene mulching	16169.00	16523.00	16346.00	1957.00	2150.00	2053.00	2.12	2.15	2.13
50 % shade x No mulching	3246.00	3296.00	3229.00	476.00	503.00	490.00	1.03.00	1.18	1.11
50 % shade x Organic mulching	5687.00	4696.00	4699.00	877.00	926.00	902.00	1.29	1.30	1.30
50 % shade x Black polythene mulching	13481.00	13915.00	13699.00	1603.00	1590.00	1593.00	1.60	1.62	1.61
SEm(±)	**337.04**	**261.56**	**195.40**	**36.06**	**39.54**	**40.91**	**0.02**	**0.08**	**0.03**
LSD (0.05)	**1115.5**	**1005.25**	**583.42**	**139.41**	**147.88**	**63.98**	**0.05**	**0.04**	**0.13**
CV(%)	**12.79**	**11.24**	**10.87**	**6.95**	**7.87**	**7.72**	**2.18**	**7.80**	**5.38**

Table 2: Effect of growing condition and mulching on economics of cultivation of *Plectranthus vettiveroides*

Treatments	Cost of cultivation (Rs/ha)			Gross income (Rs/ha)			Net income (Rs/ha)			B:C ratio		
	Open	25 % shade	50 % shade	Open	25 % shade	50 % shade	Open	25 % shade	50 % shade	Open	25 % shade	50 % shade
No mulching		121300		216045	227160	145305	94745	105860	24005	1.78	1.87	1.20
Organic mulching		151300		322695	330075	211455	171395	178775	60155	2.13	2.18	1.40
Black polythene mulching		165516		780525	735570	616455	615009	570054	450939	4.72	4.44	3.72

buffer soil temperature and preserve soil moisture and increase available nutrients in the soil, which further improved soil fertility and crop growth. Also, the polythene cover could act as a physical barrier between soil and outside environment and could reduce the compaction of the soil. This influence of mulches on soil might have helped the deep penetration of roots into the soil compared to non mulched plots and thereby increased the root yield.

The combination of 25 per cent shaded condition with black polythene mulching recorded higher root yield followed by open condition with black polythene mulching. Plants grown under 50 per cent shaded condition without mulching resulted in the lowest root yield.

Essential oil

Essential oil content of roots was higher under 25 per cent shaded condition and was on par with open growing condition. The lowest content of oil was under 50 per cent shaded condition, which was 37.31 per cent less than 25 per cent shaded condition. Light is a physical factor which can influence growth, yield and the production of secondary metabolites. Many workers reported changes in essential oil content in medicinal and aromatic plants due to variations in light intensities (Figueiredo *et al*., 2008; Kong *et al*., 2016; Li *et al*., 2018).

Among sub plots, mulching with the black polythene sheet resulted in the highest oil content followed by mulching with organic mulch. The interaction effect of growing conditions and mulching on the essential oil content was significant with the highest oil content in treatment combination 25 per cent shaded condition with polythene mulching, followed by polythene mulching under open condition. The 50 per cent shaded condition without any mulching resulted in the lowest oil content. In *Rosmarinus officinalis* L., an increase of 16.2 per cent of herb yield and 24.2 per cent of essential oil yield due to mulching with lemon grass spent material was reported by Singh (2012).

Higher net income (Rs. 615009/-) and BC ratio (4.72) was observed in the treatment with black polythene sheet under open growing condition. No mulching under 50 per cent shaded condition resulted in lower net income and BC ratio.

Significant influence of the growing condition and mulching on yield and quality of *Plectranthus vettiveroides* was observed in this study. *Plectranthus vettiveroides* can be cultivated as a pure crop in the open condition or as an intercrop in areas having shade level up to 25 per cent. Mulching either with black polythene or with paddy straw @ 5 t ha^{-1} also can be recommended

as a cultural practice for improving biomass yield and quality.

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