



The Effects of Organic Fertilizer and Planting Type on Growth and Yield of *Curcuma aromatica*

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ABSTRACT

Background: *Curcuma aromatica* Salisb is an important medicinal herb in Vietnam. It is exploited naturally, so its production is limited and in danger of extinction. Studying an organic farming model is a necessary orientation to exploit, conserve and provide quality raw materials.

Methods: The present study was conducted to investigate the effect of surface coating types (A1: without coating, A2: straw coating and A3: polymer coating) and organic fertilizer amount (B1: 0; B1: 15, B2: 20, B3: 25 and B4: 30 ton ha⁻¹) on growth and yield of *Curcuma aromatica* Salisb. The experiment was designed in a factorial randomized complete block design (RCBD) with three replications. The traits studied were: survival plant's rate (%), leaf area (cm²), plant height (cm), number of leaves, fresh weight (g/plant), Dry weight (g/plant), phenolic content/area (mg/20 m²), curcuminol content/area (mg/20 m²).

Result: The results of the experiment revealed that surface coating types and organic fertilization and their interaction were significant in growth and yield of *Curcuma aromatica* Salisb.

Key words: *Curcuma aromatica* Salisb., Curcuminol, Surface coating.

INTRODUCTION

Kasthuri turmeric (*Curcuma aromatica* Salisb.) belonging to the family Zingiberaceae is a medicinal and aromatic plant with multiple uses. Kasthuri turmeric has been used in Vietnam as a medicinal plant, with used Chest tightness, abdominal distention, Vomiting blood, nosebleeds, hematuria, chronic hepatitis, liver pain, jaundice, irregular menstruation, dysmenorrhea, epilepsy.

Kasthuri turmeric was used as medicine in South East Asia, where have a lot species of curcuma genus. It is cultivated most extensively in India, followed by Bangladesh, China, Thailand, Cambodia, Malaysia, Indonesia, Vietnam and Philippines. Kasthuri turmeric was used in cosmetic productions. Skin care is the major domain of application of this aromatic plant. Kasthuri turmeric is having anti-inflammatory, hypocholestraemic, choleratic, anti-microbial, insect repellent, anti-rheumatic, anti-fibrotic, anti-venomous, anti-diabetic, anti-viral, anti-hepatotoxic as well as anti-cancer properties in day to day domestic use as a folklore medicine from time immemorial. Kasthuri turmeric oil is used as aromatherapy and in the perfume industry. Many different active ingredients in the essential oil of kasthuri turmeric have been identified in the phenolic group: α -Pinene, β -Pinene, Limonene, 1,8-Cineole; p-Cymene, 2-Heptanol, Linalool oxide, 2-Nonanol, Camphor, Linalool, 4-Terpineol, β -Elemene, Caryophyllene, α -Humulene, α -Terpineol, α -Selinene, β -Selinene, δ -Cadinene, Caryophyllene oxide, Humulene oxide, ar-Turmerone, Curcuminol, Dodecanoic acid (Kojima *et al.*, 1998; Guo *et al.*, 1980; Tsai *et al.*, 2011). In which, the main components are curcuminol (35.77%) and 1,8-cineole (12.22%) (Tsai *et al.*, 2011). Curcuminol is active against human lung cancer cells by arresting the G(2)/M phase, causing nuclear

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fragmentation and a rapid transfer of Bax from the cytosol into the mitochondria. While, caspases are not involved in curcuminol-induced apoptosis (Tang *et al.*, 2015). In addition, Curcuminol is also beneficial for rheumatoid arthritis by inhibiting fibroblast-like synoviocyte (FLS) cell division and PDGF-BB (platelet-derived growth factor)-stimulated DNA synthesis. -BB) through the depletion of Jak2 phosphorylation and downregulatory activities that bind STAT1 and STAT3 to DNA (Wang *et al.*, 2012).

Considering the world demand for organic food, the improvement of soil health and productivity and the availability of local resources, the organic farming practice can be encouraged. Use of bio-fertilizers for crop production is gaining momentum as they are environmentally safe when compared to chemical fertilizers. Organic manures have beneficial effects on soil health and crop through of supporting microbial enhancing use fertilizer efficiently, soil

fertility status and thus help in improving the yield and quality of crops. Therefore, Vietnam is also oriented to develop agricultural products cultivated according to organic methods.

The present research was conducted to evaluate the significance and combined effect of different surface coating types and Organic fertilizer amount on kashthuri turmeric towards the growth, yield and economic improvement of it.

MATERIALS AND METHODS

Site description

The experiment was conducted during the 2018/2019 growing season in Cau Ngang, Tra Vinh, Viet Nam (9°48' 10" N 106°26' 54" E). Cau Ngang experiences two seasons- rainy and dry. The rainy season runs from April through October, with temperature ranges from 22.6 to 34.6 °C and rainfall that ranges from 66.8 to 96.6 mm in 2019. The dry season extends from November through March. The soil is classified as aerosols with height P (200 to 224 mg kg⁻¹ soil). Agriculture in the area is intensified high inorganic fertilizer input. PH values ranging from 6.2 to 7.0. The *C. aromatica* Salisb. cultivar used was micropropagated and domesticated in a greenhouse for 4 months before planting.

Fertilizers used

Organic fertilizers were made up of composts produced from cow dung manures. The composting procedure as described by Ngakou *et al.* (2008) consisted of superposing wastes in layers to build piles comprising dry straws, manures and inoculum (waste degrading microorganisms). All piles not lower than 1.5 m in height were monitored by aerating or turning after every 2 weeks until all substrates within the pile were completely degraded to yield mature compost. The chemical components of organic fertilizers are presented in Cow compost (N: C: K= 0.442: 5.47: 5.40%; P: 206.5 µg/g).

Experimental design and treatments

Trials were performed following a randomized complete block (RCB) design; comprising fourteen treatments and twelve replicates formulated as follows:

The treatments consisted of four equidistant spacing between rows and between plants: 0.5x0.5 m; corresponding to densities of 40,000 plants ha⁻¹, respectively. Each plot consisted of two rows with eight plants per row, totaling 80 plants per plot.

The experiment was designed in a factorial randomized complete block design (RCBD) with three replications. Each replication consists of six experimental units and the total number of experimental units was 18. The area of each experimental unit (plate size) was 4 × 5 = 20 m² and while the distance between the blocks was 1.5 m, the distance between the experimental unit was 1 m.

The study included two factors: 1- surface coating types (A) 2- Organic fertilizer amount (B). There are three surface coating types (without coating, straw coating and polymer coating) (A1, A2 and A3, respectively) for *C. aromatica*

Salisb. and five different levels of organic fertilizer (0;15, 20, 25 and 30 ton ha⁻¹) (B1; B2, B3 and B4, respectively).

Plants from the central two rows of each plot were harvested and measured. Some vegetative growth traits of *C. aromatica* Salisb. and yield were determined as: Survival plant's rate (%), leaf area (cm²), plant height (cm), number of leaves, fresh weight (g/plant), dry weight (g/plant) after 6 months and phenolic (mg/gDW), curcuminol (mg/g DW) after 9 months planting. The data were processed using ANOVA. The statistical tests were carried out using SPSS Statistics program. The significance level was set at P≤0.05. Differences between trait means were assessed using Duncan's Multiple Range Test at P≤0.05 levels and T-test was used at P≤0.05 to compare between the mean data of organic fertilizer application and plant density.

- The survival rate of plants was assessed by recording dead and alive plants after every 6 months and 9 months.

The percentage of surviving plants were calculated using the formula:

$$\text{Surviving plant's rate} = \frac{\text{Number of surviving plants}}{\text{Number of plants growing}} \times 100$$

- The plant biomass were measured at 6 and 9 months after planting after drying of plants in an oven at 105° for 24 h.

- Leaf area was identified by Model CI-202 (CID- USA).

Analytical methods conducted at the Institute of Tropical Biology, Vietnam Academy of Science and Technology.

Total phenolic content

The total phenolic content of the extract was determined by the Folin-Ciocalteu method (Kaur and Kapoor, 2002). Briefly, 200 µL of crude extract (1 mg/ml) were made up to 3 ml with distilled water, mixed thoroughly with 0.5 ml of Folin-Ciocalteu reagent for 3 min, followed by the addition of 2 ml of 20% (w/v) sodium carbonate. The mixture was allowed to stand for a further 60 min in the dark and absorbance was measured at 650 nm. The total phenolic content was calculated from the calibration curve and the results were expressed as mg of Gallic acid equivalent per g dry weight.

Curcuminol content

Curcuminol was identified by HPLC system consisted of a Agilent TC ODS column (4.6 mm×15 cm, 5 µm) and DAD detector at 210 nm, the flow rate was 1.0 mL/min and the mobile phase was composed of mobile phase A: acetonitrile-methanol-water-phosphoric acid (550:225:225:1) and mobile phase B: methanol as gradient mode (Cao *et al.*, 2007) (Fig 1).

RESULTS AND DISCUSSION

In general, the results showed that the traits were significantly influenced by the interaction between factors (the interaction between surface coating types and organic fertilizer) on all traits of Kashthuri turmeric. Results of plant growth after 6 and 9 months of planting (Fig 2), recorded: there is a difference between the treatments with different fertilizer content and different growing patterns: Increase

Table 1: Growth and development criteria of *C. aromatica* after 6 months of planting.

Treatment	Survival plants rate (%)	Leaf area (cm ²)	Plant height (cm)	No. of leaves	Fresh weight (g/plant)	Dry weight (g/plant)
0	84.33 ^c	164.48 ^j	38.90 ^e	10.00 ^a	143.87 ^f	13.70 ^e
A1B1	84.33 ^c	182.25 ⁱ	40.90 ^{de}	11.00 ^a	164.80 ^e	15.43 ^{de}
A2B1	87.33 ^{abc}	184.83 ^{hi}	42.10 ^{bcd}	10.33 ^a	175.67 ^{cde}	16.80 ^{cd}
A3B1	85.33 ^{bc}	184.40 ^{hi}	41.57 ^{cde}	10.00 ^a	173.87 ^{de}	16.53 ^{cd}
A1B2	85.67 ^{abc}	201.83 ^{gh}	43.07 ^{bcd}	11.00 ^a	182.03 ^{cde}	17.37 ^{cd}
A2B2	89.67 ^{abc}	207.00 ^{fg}	43.40 ^{bcd}	10.33 ^a	195.17 ^c	18.47 ^c
A3B2	92.00 ^{ab}	220.67 ^{ef}	43.53 ^{bcd}	10.67 ^a	190.40 ^{cd}	18.10 ^c
A1B3	89.67 ^{abc}	237.47 ^{de}	44.00 ^{abcd}	10.33 ^a	225.00 ^b	21.33 ^b
A2B3	92.33 ^a	253.33 ^{cd}	44.87 ^{abc}	10.67 ^a	230.03 ^b	21.57 ^b
A3B3	89.00 ^{abc}	259.93 ^c	45.53 ^{ab}	10.33 ^a	231.90 ^b	22.07 ^b
A1B4	86.67 ^{abc}	305.67 ^b	45.67 ^{ab}	10.33 ^a	244.03 ^{ab}	23.30 ^{ab}
A2B4	85.00 ^{abc}	332.40 ^a	47.67 ^a	11.00 ^a	258.03 ^a	24.60 ^a
A3B4	87.67 ^{abc}	327.67 ^b	47.33 ^a	10.67 ^a	262.43 ^a	24.93 ^a
CV	3.95	4.28	4.56	7.77	5.30	5.64
MSD (Minimum Significant Difference)	5.80	16.92	3.35	1.37	18.32	1.85



A



B

Fig 1: *C. aromatica* were experimentally planted after 6 (A) and 9 (B) months of planting.

the amount of fertilizer to cover growth criteria (leaf area, fresh weight, dry weight) increased with (Table 1, 2) and get the highest value in condition A2B4 (straw coating - additions organic fertilizer 30 ton ha⁻¹): plant height 333.00 cm², fresh weight: 295 g/plant, dry weight: 27.40 g/plant.

There is a difference in the content of phenolic and curcuminol when changing the growing type and amount of organic fertilizers after 9 months of planting. The highest value was recorded in treatments 25-R (25 tons/ ha⁻¹ straw cabinet) showed the highest efficiency respectively: 2,63 (mg/20 m²) và 0,046 (mg/20 m²) (Table 2).

The organic fertilizer has significant effects on the all traits. Increasing of organic fertilizer led to the increase of all traits. Organic fertilizers are the sources of organic matter in the soil and important alternative to chemical fertilizers because they provide nutrients to the plant for a longer period, as well as increase soil productiveness by increasing the activity of soil microorganisms. These results are in accordance with the results of Belay *et al.* (2001), Murray and Anderson (2004) and Marlina *et al.* (2017). Application of organic fertilizers increased the growing of plant recorded by Gadelrab and ELAmin (2013) in *Allium cepa* L. The highest number of leaves per plant was obtained by

compost Elshomokh in week 15 in the first season (12 leaves per plant). Compost Elshomokh was followed by compost Alkhaseeb, compost Elkhayat, Osarat Eltabya and the control respectively. The results on number of leaves per plant in the second season indicated that highest number of leaves per plant was obtained by compost Elshomokh (11 leaves per plant) in week 13, followed by compost Elkhayat, compost Alkhaseeb, Osarat Eltabya and control respectively (Gadelrab and ELAmin, 2013).

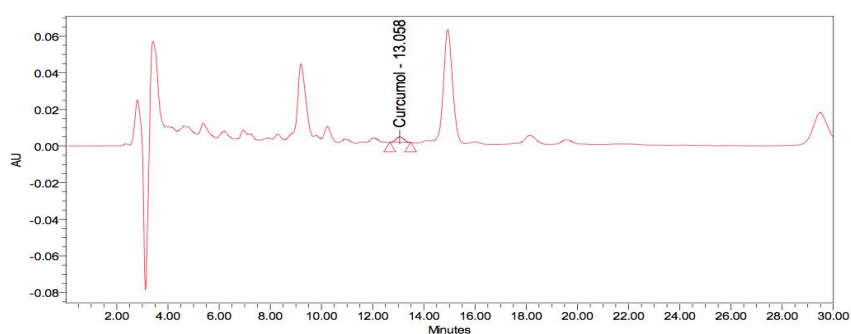
Organic manure can serve as an alternative practice to mineral fertilizers (Wong *et al.* 1999; Naeem *et al.* 2006) for improving soil structure (Dauda *et al.* 2008) and microbial biomass (Suresh *et al.* 2004). Therefore, the utilization of locally produced manures by vegetable production operations may increase crop yields with less use of chemical fertilizer. The use of chemical fertilizers alone to sustain high crop yield has not been quite successful due to the enhancement of soil acidity, nutrient leaching, degradation of soil physical properties and organic matter status (Nottidge *et al.* 2005).

The analysis of variance showed that fertilizer content has significant effect caused by the increase of some growth traits except plant height and yield. The organic fertilizer

Table 2: Growth and development criteria of *C. aromatica* after 9 months of planting.

Treatment	Survival plants rate (%)	Leaf area (cm ²)	Plant height (cm)	No. of leaves
0	84.33 ^a	166.33 ^h	42.20 ^a	10.33 ^b
A1B1	84.33 ^a	183.00 ^{gh}	43.87 ^a	11.00 ^{ab}
A2B1	86.67 ^a	184.87 ^g	45.60 ^a	10.67 ^{ab}
A3B1	85.33 ^a	193.00 ^{fg}	45.00 ^a	10.33 ^b
A1B2	85.33 ^a	203.33 ^f	46.60 ^a	11.00 ^{ab}
A2B2	89.67 ^a	222.33 ^e	47.73 ^a	11.00 ^{ab}
A3B2	90.67 ^a	221.00 ^e	48.20 ^a	11.00 ^{ab}
A1B3	89.67 ^a	248.00 ^d	47.33 ^a	11.00 ^{ab}
A2B3	91.67 ^a	277.33 ^c	49.93 ^a	11.00 ^{ab}
A3B3	88.67 ^a	274.33 ^c	48.83 ^a	10.67 ^{ab}
A1B4	85.33 ^a	306.00 ^b	49.60 ^a	11.00 ^{ab}
A2B4	85.00 ^a	333.00 ^a	50.93 ^a	11.33 ^a
A3B4	85.67 ^a	318.33 ^{ab}	50.93 ^a	11.33 ^a
CV	4.91	4.34	14.18	6.35
MSD (Minimum Significant Difference)	7.19	17.56	11.29	1.14
Treatment	Fresh weight (g/plant)	Dry weight (g/plant)	Phenolic content/area (mg/20m ²)	Curcumol content/area (mg/20m ²)
0	177.00 ^g	16.37 ^g	2.20 ^{ab}	0.036 ^b
A1B1	184.67 ^{fg}	17.33 ^{fg}	2.26 ^{ab}	0.038 ^{ab}
A2B1	206.67 ^{de}	19.57 ^{de}	2.30 ^{ab}	0.042 ^{ab}
A3B1	197.00 ^{ef}	18.50 ^{ef}	2.32 ^{ab}	0.039 ^{ab}
A1B2	218.67 ^{cd}	20.50 ^{cd}	2.38 ^{ab}	0.041 ^{ab}
A2B2	246.67 ^b	23.47 ^b	2.57 ^{ab}	0.046 ^a
A3B2	230.33 ^a	21.87 ^a	2.51 ^{ab}	0.045 ^{ab}
A1B3	281.33 ^a	26.37 ^a	2.47 ^{ab}	0.044 ^{ab}
A2B3	294.67 ^a	27.70 ^a	2.63 ^a	0.046 ^a
A3B3	288.53 ^a	27.13 ^a	2.43 ^{ab}	0.044 ^{ab}
A1B4	290.67 ^a	27.20 ^a	2.15 ^{ab}	0.040 ^{ab}
A2B4	295.00 ^a	27.40 ^a	2.13 ^b	0.042 ^{ab}
A3B4	293.00 ^a	27.33 ^a	2.17 ^{ab}	0.041 ^{ab}
CV	3.66	3.79	10.54	11.15
MSD (Minimum Significant Difference)	15.15	1.47	0.42	0.01

O: without coating- no additions organic fertilizer; A1B1: without coating- additions organic fertilizer 15 ton ha⁻¹; A2B1: straw coating - additions organic fertilizer 15 ton ha⁻¹; A3B1: straw coating - additions organic fertilizer 15 ton ha⁻¹; A1B2: without coating- additions organic fertilizer 20 ton ha⁻¹; A2B2: straw coating - additions organic fertilizer 20 ton ha⁻¹; A3B2: straw coating - additions organic fertilizer 20 ton ha⁻¹; A1B3: without coating- additions organic fertilizer 25 ton ha⁻¹; A2B3: straw coating - additions organic fertilizer 25 ton ha⁻¹; A3B3: straw coating - additions organic fertilizer 25 ton ha⁻¹; A1B4: without coating- additions organic fertilizer 30 ton ha⁻¹; A2B4: straw coating - additions organic fertilizer 30 ton ha⁻¹; A3B4: straw coating - additions organic fertilizer 30 ton ha⁻¹.

**Fig 2:** Curcumol content of *C. aromatica* root extract was identified by HPLC.

(25 ton ha⁻¹) has a positive effect on *C. aromatic* Salisb. Moreover, the effect of interaction between surface coating types and organic fertilizer led to the increase in the growth and yield of *C. aromatic* Salisb. Addition of organic fertilizer resulted in the release of more nutrients that resulted in number of leaves/plant. This agreed with the finding of Shams (2003) who found that the addition of organic manure improved vegetative growth of sweet pepper plants.

CONCLUSION

The change in natural conditions, along with unplanned forest exploitation, has led to ecological imbalance that degrades natural resources. In order to meet the increasing demand for medicinal herbs, it is necessary to develop a growing process to actively source raw materials. The study has determined the effect of organic fertilizers on the growth and quality of *C. aromatic* grown in Vietnam. Experiment results revealed that Organic fertilizers and surface coating types affect plant growth and development of *C. aromatic*. Therefore, *C. aromatic* were grown in condition straw coating - additions organic fertilizer 20 ton ha⁻¹ is the most suitable.

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