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EFFECT OF DIFFERENT PALM OIL MILL WASTE COMPOSTS ON PHYSIOLOGICAL AND BIOCHEMICAL CHARACTERS OF RED GINGER (*ALPINIA PURPURATA*)

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ABSTRACT

A study was carried out to determine the effect of palm oil mill wastes on physiological and biochemical parameters of red ginger (*Alpinia pupurata*). The results revealed that T_5 recorded maximum photosynthetic rate (5.72 µmolm^{-2} s^{-1}), transpiration rate (2.16 mmolm^{-2} s^{-1}), stomatal conductance (90.64 mmolm^{-2} s^{-1}), intercellular CO_2 (433.91 ppm), chlorophyll-a (2.37 mg/g), chlorophyll-b (0.70 mg/g), carotenoid content (1.05 mg/g), total chlorophyll content in leaves (3.07 mg/g) and chlorophyll a/b ratio (4.23). Palm oil mill wastes showed high rates in physiological and biochemical characters.

Key words : Red ginger (*Alpinia pupurata*), Palm oil mill wastes, Physiological and Biochemical parameters.

Introduction

Sustainable land use has been identified as one way of tackling challenges related to climate change, population expansion, food crisis and environmental pollution. Disposal of oil palm solid wastes is becoming a challenge with an increased demand and production of palm oil. Palm oil is produced by processing oil palm fresh fruit bunch (FFB), which leads to the generation of FFB solid wastes. These processes lead to new products including biochar, ash and compost, which are valuable resources that can be used for soil improvement (Anyaoha *et al*., 2018). All the waste products are ligno-cellulosic in nature (Vakili *et al*., 2015). Treated POME sludge (TPS) is one of the organic fertilizers that originate from POME sludge, which is a waste extracted from crude palm oil in mills.

Oil palm (*Elaeis guineensis* Jacq.) is commonly cultivated in tropical regions, specifically in Southeast Asia, in countries such as Malaysia, Indonesia and Thailand. It requires about 40 per cent area for its optimum growth and yield and rest of the area (60%) remains vacant, which offers scope for better utilization of natural resources like space, light and aerial environment through inter cropping. Ornamental red ginger *Alpinia purpurata* (Vieillard) K. Schumann, is a shade loving crop, comes up well even in dense shade of 70 - 80% (Kepler, 1989).

Materials and Methods

The present investigation was carried out at ICAR-Indian Institute of Oil Palm Research (IIOPR), Pedavegi, which is situated in West Godavari District of Andhra Pradesh. The experimental site (Pedavegi) is located at 16^0 43'N and 81^0 09'E with a mean sea level of 13.41m. The climate of the site is hot and humid and average annual minimum and maximum temperature ranges from 22.6^{0}C to 34.6^{0}C, average annual relative humidity is 66.5% and annual average rainfall is 1074mm. The experiment was laid out in randomized block design with seven treatments and three replications. Treatments included T_1 (RDN through empty fruit bunch fibre compost), T_2 (RDN through decanter cake), T_3 (RDN through palm oil mill effluent sludge), T_4 (RDN through palm oil mill effluent), T_5 (RDN through combination of mill wastes), T_6 (RDN through farm yard manure) and T_7 (Recommended dose of fertilizers). Large sized rhizomes were selected and neatly dressed using secateurs and used for planting with a spacing of 2.89m × 2m in oil palm interspaces with two rows in triangular manner. Observations recorded at one year after planting and data analyzed by using WASP 2.0 software. Reading was recorded from morning 9 am to 11 am with a PAR above 900 nm to ensure the maximum light is available.

Physiological parameters

Gas-exchange measurements like net photosynthetic rate (Pn), transpiration rate (E), stomatal conductance (C) and inter cellular CO_2 concentration ($IntCO_2$) were recorded by using a CI -340 Handheld Photosynthesis System (CID Biosciences, Washington, USA) connected to a wide rectangular (65mm × 10mm) leaf chamber. With the chamber attached to the CI-340 and the IR Temperature sensor and PAR sensor inserted, the leaf chamber is ready to use. Place the sample between the seals of the chamber. Now gently close the chamber, locking it into place on the sample. Measurements were made on fully opened, matured and healthy leaf (3^{rd} leaf from the top of the canopy) under bright sunlight between 9-11 AM.

Biochemical parameters

The following biochemical parameters were estimated during the crop period of red ginger.

Chlorophylls (mgg^{-1})

The chlorophyll content (chlorophyll *a*, *b* and total chlorophyll) of leaves was estimated by using the method of Hiscox and Israelstam (1979).

Procedure

Third leaf from the top of the plant was chosen as an experimental sample and midrib removed for chlorophyll estimation. Taken 0.02mg of the sample from middle of the leaf and it was chopped into fine pieces. Then, the sample was immersed in 10ml of AR grade dimethyl sulphoxide (DMSO) and it was incubated in dark chamber over night. After that, the sample was taken out and read in a UV-VIS Spectrophotometer (Simadzu UV-1800) at 645nm and 663nm using pure DMSO as a blank. Finally, chlorophyll *a*, chlorophyll *b* and total chlorophyll were calculated as per the following formulae:

Chlorophyll *a* ($mg\ g^{-1}$) = (12.7×OD663) - (2.69×OD645) × [V/(WX1000)]

Chlorophyll *b* ($mg\ g^{-1}$) = (22.9×OD645) - (4.68×OD663) × [V/(WX1000)]

Total chlorophyll ($mg\ g^{-1}$) = (20.20×OD645) + (8.02× OD663) × [V/(WX1000)]

Where,

V = Volume of DMSO

W = Weight of the leaf sample

Total carotenoids content (mgg^{-1})

Third leaf from the top of the plant was chosen as an experimental sample and midrib removed for carotenoid estimation. Taken 0.02mg of the sample from middle of the leaf and it was chopped into fine pieces. Then, the sample was immersed in 10ml of AR grade dimethyl sulphoxide (DMSO) and it was incubated in dark chamber over night. After that, the sample was taken out and read in a UV-VIS Spectrophotometer (Simadzu UV-1800) at 480nm using pure DMSO as a blank. Finally, carotenoid content was calculated as per the following formulae:

$$\text{Total carotenoids (mg/g)} = \frac{(1000A480 - 1.29C_a - 53.78C_b)}{220}$$

Where, C_a = Chlorophyll A, C_b = Chlorophyll B

Results and Discussion

Photosynthetic rate

Data concerning to photosynthetic rate in various treatments are presented in Table 1. The differences with regard to photosynthetic rate among various treatments differed significantly from one other. Treatment T_5 exhibited the highest photosynthetic rate at 5.72 $\mu molm^{-2}\ s^{-1}$ followed by T_3 4.88$\mu molm^{-2}\ s^{-1}$ show casing its efficacy in enhancing photosynthetic activity. Following closely behind, treatment T_7 recorded lowest photosynthetic rate 3.61$\mu molm^{-2}\ s^{-1}$, indicating its comparatively weaker influence on photosynthetic activity.

Photosynthesis rate and plant chlorophyll content were directly proportional related; photosynthesis rate will get higher when chlorophyll content was high. The same result also obtained from Arancon *et al.* (2003) that revealed the use of vermicompost with appropriate dosage of inorganic fertilizer significantly increased the crop yield. This might happen due to the vermicompost contribution that promotes better soil microbial growth and behaviour, resulting in plant nutrients availability thus, increasing the soil fertility and quality (Varghese and Prabha, 2014).

Transpiration rate

The average transpiration rate of the plant as influenced by the different growing media is furnished in Table 1. A glance of data indicates that the transpiration rate of the plant was influenced significantly by the

Table 1 : Effect of palm oil mill wastes on physiological parameters of red ginger.

Treatments	Photosynthetic rate ($\mu molm^{-2} s^{-1}$)	Transpiration rate ($mmolm^{-2} s^{-1}$)	Stomatal conductance ($mmolm^{-2} s^{-1}$)	Intercellular CO_2 concentration (ppm)
T_1	3.97	1.71	55.07	312.75
T_2	4.25	2.00	56.61	428.60
T_3	4.88	1.89	83.89	391.14
T_4	4.29	1.84	53.34	325.80
T_5	5.72	2.16	90.64	433.91
T_6	4.20	1.62	37.73	384.24
T_7	3.61	1.56	30.22	365.21
CD @ 5%	0.60	0.24	14.60	28.43
SEM ±	0.37	0.03	0.13	0.05
CV (%)	7.63	7.48	14.10	4.24

application of different growing media. It is also observed that the treatments were differed statistically. Among different growing media, Treatment T_5 had the highest transpiration rate at 2.16 $mmolm^{-2} s^{-1}$, indicating efficient water uptake and transport. Treatment T_2 closely followed with a rate of 2.00$mmolm^{-2} s^{-1}$, displaying a notable but slightly lower transpiration rate compared to T_5. Treatment T_7 displayed the lowest rate at 1.56 $mmolm^{-2} s^{-1}$.

Stomatal conductance

Data pertaining to stomatal conductance in various treatments are presented in Table 1. The differences with regard to stomatal conductance among various treatments differed significantly from each other. It is evident from the data that Treatment T_5 demonstrated the highest stomatal conductance at 90.64 $mmolm^{-2} s^{-1}$, indicative of efficient gas exchange and stomatal regulation followed by T_3 (83.89 $mmolm^{-2} s^{-1}$). Treatment T_7 exhibited the lowest stomatal conductance at 30.22 $mmolm^{-2} s^{-1}$, suggesting potential limitations in gas exchange processes. Stomatal conductance was a measurement of stomatal opening rate and leaf photosynthesis discovered highly correlated with stomatal conductance (Kusumi *et al.*, 2012). Photosynthesis rate was high with the stomatal conductance.

Intercellular CO_2 concentration

A scrutiny of data indicates that the intercellular CO_2 concentration of the plant was influenced significantly by the application of different palm oil mill wastes and are presented in Table1. It is also observed that the treatments were differed statistically. Among different palm oil mill wastes, Treatment T_5 recorded the highest intercellular CO_2 concentration at 433.91 ppm, followed by T_2 (428.60 ppm) indicating efficient CO_2 uptake and utilization within the leaf. Treatment T_1 recorded the lowest concentration at 312.75 ppm.

Chlorophyll content

Chlorophyll a : Data concerning leaf chlorophyll a (mg/g) content in various treatments are presented in Table 2. The differences with regard to chlorophyll a among various treatments differed significantly from one other. It is vivid from the data that treatment T_5 exhibited the highest concentration of chlorophyll a at 2.37 mg/g, which is on par with T_3 (2.23 mg/g), Treatment T_1 exhibited the lowest chlorophyll a concentration at 1.12 mg/g.

Chlorophyll b : Data regarding on leaf chlorophyll b (mg/g) content in various treatments are presented in Table 2. The differences with regard to chlorophyll b among various treatments differed significantly from one other. It is evident from the data that treatment T_5 demonstrated the highest concentration of chlorophyll b at 0.70 mg/g which is on par with T_3 with a concentration of 0.69mg/g. Treatment T_2 displayed the lowest chlorophyll b concentration at 0.36 mg/g.

Total Chlorophyll

Data concerning to total chlorophyll (mg/g) content in various treatments are presented in Table 2. The differences with regard to total chlorophyll content among various treatments differed significantly from one other. Significantly maximum total chlorophyll content were recorded in treatment T_5 with total chlorophyll content of 3.07 mg/g, which is on par with T_3 (2.92 mg/g). Treatment T_4 exhibited the lowest total chlorophyll concentration at 1.76 mg/g.

Chlorophyll is an essential photosynthetic pigment for the plant that largely determines the capacity of the

Table 2 : Effect of palm oil mill wastes on biochemical parameters of red ginger.

Treatments	Chlorophyll a (mgg^{-1})	Chlorophyll b (mgg^{-1})	Chlorophyll a/b	Total chlorophyll (mgg^{-1})	Carotenoid (mgg^{-1})
T_1	1.12	0.65	1.75	1.77	0.85
T_2	1.53	0.36	4.23	1.89	0.87
T_3	2.23	0.69	3.28	2.92	1.03
T_4	1.15	0.61	1.90	1.76	0.85
T_5	2.37	0.71	3.38	3.07	1.05
T_6	1.39	0.41	3.45	1.80	0.80
T_7	1.41	0.37	3.89	1.79	0.67
CD @ 5%	0.37	0.10	0.70	0.40	0.17
SEM ±	0.23	0.19	0.08	4.74	9.23
CV (%)	12.86	10.35	12.65	10.60	10.72

photosynthetic process and hence the growth of plants (Li *et al*., 2018). Thus, chlorophyll content quantity is a directly proportional relationship with the photosynthesis process; the high chlorophyll content increases the photosynthesis rate process. However, both organic amendments had improved the chlorophyll content compared to the control treatment. These results were in agreement with the data obtained by Ganeshnauth *et al*. (2018) that claimed the highest chlorophyll level in a plant with vermicompost treatment compared to other organic and inorganic fertilizer.

Carotenoid

Data concerning to total chlorophyll (mg/g) content in various treatments are presented in Table 2. It is vivid from the data that treatment T_5 exhibited the highest concentration of carotenoids at 1.05 mg/g followed by T_3 mg/g. Treatment T_7 displayed the lowest carotenoid concentration at 0.67 mg/g.

Conclusion

Results revealed T_5–combination of mill wastes recorded most promising in promoting favorable physiological responses, including heightened photosynthetic rates, transpiration rates, stomatal conductance, intercellular CO_2 concentration and biochemical responses. Improved using organic amendments together with the application of inorganic fertilizer to sustain soil health. At the same time, they provide enough nutrients for crops to grow economically. This not only conserves soil fertility but also reduces chemical or inorganic fertilizer cost up to 50%.

References

Anyaoha, K.E., Sakrabani R., Patchigolla K. and Mouazen A.M. (2018). Critical evaluation of oil palm fresh fruit bunch solid wastes as soil amendments: Prospects and challenges. *Resources, Conservation and Recycling*, **136(1)**, 399-409.

Arancon, N.Q., Edwards C.A., Bierman P., Metzger J.D., Lee S. and Welch C. (2003). Effects of vermicomposts on growth and marketable fruits of field-grown tomatoes, peppers and strawberries: *The 7th International Symposium on Earthworm Ecology, Cardiff Wales, United Kingdom*. 731–35.

Ganeshnauth, V., Jaikishun S., Ansari A.A. and Homenauth O. (2018). *Automation in agriculture-securing food supplies for future generations*. Intech. Rijeka, Croatia.

Hiscox, J.D. and Israelstam G.F. (1979). A method for the extraction of chlorophyll from leaf tissue without maceration. *Canadian J. Bot*., **57(12)**, 1332-1334.

Kepler, A.K. (1989). *Exotic tropicals of Hawaii*. Mutual Publishing Co., Honolulu.

Kusumi, K., Hirotsuka S., Kumamaru T. and Iba K. (2012). Increased leaf photosynthesis caused by elevated stomatal conductance in a rice mutant deficient in SLAC1, a guard cell anion channel protein. *J. Exp. Bot*., **63**, 5635–5644.

Vakili, M., Zwain H.M., Rafatullah M., Gholami Z. and Mohammadpour R. (2015). Potentiality of palm oil biomass with cow dung for compost production. *KSCE J. Civil Engg*., **19(1)**, 1994-1999.

Varghese, S.M. and Prabha M.L. (2014). Biochemical characterization of vermiwash and its effect on growth of *Capsicum frutescens*. *Malaya J. Biosci.*, **1**, 86–91.