Metabolism of Jatropha : A Biodiesel Plant in Relation to Four Major Types of Indian Soils as Growing Medium

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ABSTRACT

Various types of soils are found in India that differs widely in their physico-chemical characteristics. Their response towards plants varies for the growth and development for example, in the Jatropha plant which is an important biodiesel plant. Experiments were carried in clay pots to study the effects of four types of soils (as growing medium) viz. Alluvial, Mountain, Desert and Red on certain metabolic parameters in Jatropha curcus plant.

Lot of variations with regard to certain metabolic parameters such as concentrations of chlorophyll, carotenoid and protein along with the activities of two iron enzymes i.e. catalase and peroxidase were recorded. These are discussed in the light of metabolic activity with important results being discussed.

Key words: soil types: Alluvial, Mountain, Desert and Red, Jatropha curcus, Catalase, Peroxidase, Chlorophyll,

1. INTRODUCTION

Most life on earth depends upon the soil as a direct or indirect source of food. Plants rely on soil to grow, as it is the natural medium for their growth. Soil is formed from the weathering of rocks and minerals. The surface rocks break down into smaller pieces through a process of weathering and are then mixed with biomass etc. to give it some characteristic properties.

The content of soil varies in different locations and is constantly changing. Soils differ among themselves in some or all the properties depending on the differences in the genetic and environmental factors. Thus, some soils are red, some are black, some are deep and others are shallow and so on. Thus, there may be many types of soils. Each has certain characteristics including some specific colour and composition. Different kind of soils support the growth of different types of plants and also determine how well the plant life grows.

Jatropha curcus plant grows in tropical and subtropical regions. The plant can grow in waste lands and grows on almost any terrain even on gravelly, sandy or saline soil.

Fig.1. Thirteen Months' old Plants of Jatropha Curcus Sown in Alluvial Soil

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Fig.2. Thirteen Months' Old Plants of Jatropha Curcus Sown in Mountain Soil

Fig.3. Thirteen Months' Old Plants of Jatropha Curcus Sown in Desert Soil

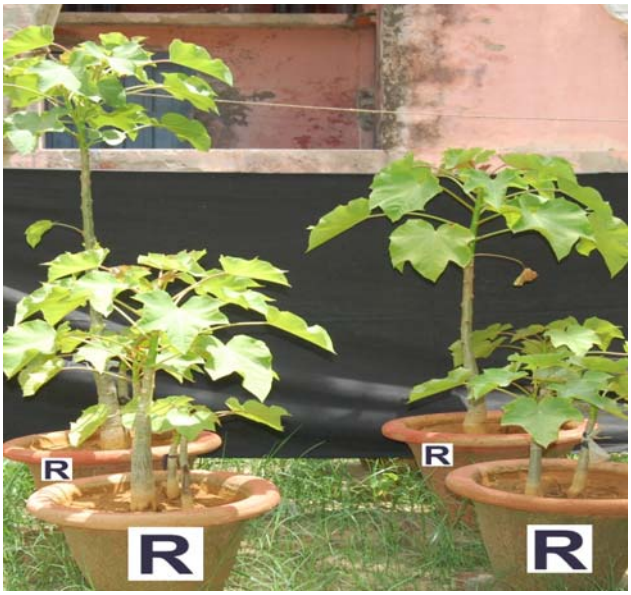

Fig.4. Thirteen Months' Old Plants of Jatropha Curcus Sown in Desert Soil

This plant has been identified for India as the most suitable tree for the production of biodiesel and also due to its wide presence throughout the country. The seed contains 19%oil, 4.7% polyphenol, 3.9% hydrocarbon. This semi drying oil could be an efficient substitute for diesel fuel. Presently in some Indian villages, farmers are extracting oil from Jatropha curcus and after setting and decanting it which are mixed with filtered oil and diesel fuel. Production of biodiesel from Jatropha curcus may lead to the upliftment of the rural population resulting in increased revenues and over all prosperity. In the near future, Jatropha curcus plant may promise energy independence to India.

In the light of above facts, the present investigations were carried out in order to find out the effects of Alluvial, Mountain, Desert and Red soils having different characteristics on certain biochemical and physiological parameters of Jatropha curcus plants.

2. MATERIALS AND METHODS

Experiments were conducted in pot culture under the natural environmental conditions in replicates. The plant Jatropha curcus was grown in earthen pots having different types of soils namely, Alluvial, Mountain, Desert and Red.

The soils collected from different places were dried, powdered and further purified with the help of sieve. A drainage hole was made in these containers for leaching purpose and covered with inverted piece of watch glass. Optimum quantities of soils were filled in pots. The ordinary tap water was supplied a couple of times in a week to the plants as per the requirement.

Fresh leaf tissues were taken from experimental plants. The leaf tissue was then ground with sand in ice chilled pestle mortar kept in an ice bath. 1 gm. of leaf tissue was extracted in 10ml of glass distilled water. The homogenate was filtered through two fold muslin cloth with the help of Buchner funnel and stored

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at freezing temperature in refrigerator. Leaf extract was used for estimation of various biochemical parameters.

(a) Concentration of Chlorophyll and Protein were measured by the method of Petering (1940) and Lowery et al (1951) respectively.

(b) Activities of antioxidative enzymes Catalase and) Peroxidasewere measured by the modified methods of Bisht (1972) and Luck (1963) respectively.

3. RESULTS AND DISCUSSION

3.1 Chlorophyll and Carotenoid Concentrations

Maximum mean concentration of chlorophyll-a (Table-1) was observed in the leaves of plants grown in red soil while mean value was obtained in those grown in alluvial soil. However, analysis of variance revealed no statistically significant differences among different groups of plants grown in four types of soils implying that chlorophyll a levels remain unaffected by type of soil.

Table-1: Comparison of Chlorophyll-a Concentration in Different Groups

S. No.	Group	No. of Observations	Mean	SD	Min.	Max.
1.	Alluvial	4	0.686	0.408	0.304	1.180
2.	Mountain	4	0.741	0.475	0.300	1.301
3.	Desert	4	0.794	0.232	0.548	1.082
4.	Red	4	1.166	0.253	0.863	1.456

Analysis of Variance

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	0.567	3	0.189	1.481	0.269
Within Groups	1.531	12	0.128	--------	--------
Total	2.098	15	----------	---------	--------

Maximum mean concentration of Chlorophyll-b (Table-2) was again found in plants of Red soil (while minimum was seen for Mountain soil)

Table -2 : Comparison of Chlorophyll- b Concentration in Different Groups

S. No	Group	No. of Observations	Mean	SD	Min.	Max.
1.	Alluvial	4	0.856	0.701	0.244	1.705
2.	Mountain	4	0.807	0.510	0.352	1.279
3.	Desert	4	0.928	0.535	0.431	1.547
4.	Red	4	1.495	0.203	1.200	1.664

Analysis of Variance

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	1.225	3	0.408	1.514	0.261
Within Groups	3.237	12	0.270	--------	---------
Total	4.462	15	--------	---------	---------

Carotenoid Concentration was also found to be maximum and minimum in leaves of plants grown in red and alluvial soil respectively.

3.2 Mean Protein Concentration

It was found to be maximum and minimum in the leaves of plant grown in Mountain and Desert soil respectively. Analysis of variance revealed statistically significant differences in this parameter in plants grown in four groups of soil.

3.3 Catalase Activity

The mean Catalase activity was found to be maximum in plant leaf grown in Desert soil (Table-3) followed by Red soil, Alluvial soil and Mountain soil respectively. Maximum variability was seen with minimum value to be 3.00 and maximum value to be 245.00

Table - 3: Catalase Activities
(μ moles H_2O_2 split/100mg fresh wt.)

S. No.	Group	No. of Observations	Mean	SD	Min.	Max.
1.	Alluvial	4	112.000	117.058	3.000	245.000
2.	Mountain	4	72.500	23.979	50.000	105.000
3.	Desert	4	158.750	36.372	125.000	205.000
4.	Red	4	141.250	52.658	80.000	190.000

Analysis of Variance

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	17073.250	3	5691.083	1.239	0.339
Within Groups	55120.500	12	4593.375	--------	--------
Total	72193.750	15	----------	--------	--------

3.4 Peroxidase Activity

The mean value of Peroxidase activity was maximum in Red soil and minimum in Desert soil. However, the minimum peroxidase activity was found in Mountain soil.

It was found that chlorophyll content increased in plants where soils were having high concentration of Fe and Mn. Chlorophyll content gets reduced due to decreased Fe and Mn concentration in leaves and thus iron and manganese metabolism also gets disturbed due to reduced transport of iron from root to shoot. The biosynthesis of chlorophyll was checked as Fe is associated with chlorophyll biosynthesis. In some cases, the shape of chloroplast gets deformed and dilation of thylakoid membrane was observed (Li and Shi, 1999) which might be a major contributor in developing chlorotic symptoms in plants. Findings of the present study are in conformity with the findings of some earlier workers. (Stobart et al., 1985; Keshan Mukerji, 1992 and Gallego et al., 1996) Protein is the most important structural unit of a plant body. It was found to be variously affected by different groups of soils in Jatropha curcus plants.

Decreased order of protein concentration in different soil was as follows:

Mountain > Red > Alluvial >Desert

Thus, it appears that contents of Mountain soil favorably affects nitrogen metabolism of plants which in turn enhances protein biosynthesis.

The activities of anti-oxidative enzymes express variable trends during present investigation. It was already reported that Jatropha seedlings could adjust themselves to higher concentrations of Cu and sand culture (Gao et al., 2008, 2009) Role of ROS-Scavenging enzymes in the protection against harmful oxidative reaction resulting from Zn stress has also been reported (Prasad et al., 1999, Bonnet et al., 2000, Khud Sar et al., 2004, Mc Geer et al., 2005). These findings suggest that these plants try to counteract high concentrations of oxygen species produced under Zinc toxicity through a co-ordinated increase in the activities of enzymes involved in their detoxication.

REFERENCES

[1] Bisht, S.S. Ph.D. Thesis, University of Lucknow, Lucknow. 1972.

[2] Bonnet, M.,O.Camaras and P.Veisseire. Effects of Zinc and influence of *Acremonium lolii* on growth parameters, chlorophyll florescence and antioxidant enzyme activities of ryegrass (*Lolium perenne* L. cv Apollo). *J. Exp. Bot*; 42:1-10, 2000.

[3] Euler H.Von and Josephson K. Uber Catalase. I. Leibigs Ann 452; 158-184, 1927.

[4] Gallego, S.M., Benavides, M.P., Tomaro, M. L. Effects of heavy metal in excess on Sunflower leaves: evidence for involvement of oxidative stress: *Plant Science* (Limerick), 121(2), 151-159, 1996.

[5] Gao, S., R.Yan, M.Cao, W. Yang, S. Wang and F. Chen. Effects of Copper on growth, antioxidant enzymes and phenylalanine ammonialyase activities in *Jatropha curcus* L. seedling. *Plant Soil Environment*. 54: 117-122, 2008.

[6] Gao, S, Q. Li, C. Ou-Yang, L. Chen, S. Wang and F. Chen. Lead toxicity induced antioxidant enzymes and phenylalanine ammonialyase activities in *Jatropha curcus* L. radicles. *Fresenius Environ. Bull.*, 5: 811-815, 2009.

[7] Keshan, U. and Mukerji, S. (1992). Effect of Cd toxicity on chlorophyll content, Hill activity and chlorophyll activity in Vigna radiate. *Indian Journal of plant physiol*.35, 225-230.

[8] Khudsar, T., Mahmooduzzafar, M. Iqbal and R.K. Sairam. Zinc induced changes in morpho-physiological and biochemical parameters of Artemission annua. *Bot. Plant*, 48: 225-260, 2004.

[9] Li, D. H., Shi, G. X. Effects of Cd+2 or Hg+2 water pollution on the ultra structure of nuclei and chloroplasts in somatic cells of *Trapa bicornis*. *Osbeck. J. Plant Res. Environ.*, 8:43-48, 1999.

[10] Lowery, O.H., Rosbrough, N.J. Farr, A.L. and Randall R.J. Protein measurement with Folin Phenol reagent. *J. Biol. Chem.* 193:265-275, 1951.

[11] Luck, H. In Peroxidase method of enzymatic analysis (Ed.V Berg mayer) *Academic Press. Inc.* New York 895-897, 1963.

[12] McGeer, J. C., C. Szebedinszky, P.G. McDonald and C. M. Wood. Effects of chronic sublethal exposure to waterborne Cu, Cd or Zn in rainbow trout. 1; lono-regulatory disturbance and metabolic costs. *Aqua Toxicol*., 50:231-243,2005

[13] Petering H.H.., Wolman, K and Hibbard, R.P. Determination of Chlorophyll and carotene in plant tissue. Ind. Eng. Chem. Annual. 12:148-151, 1940.

[14] Prasad, K.V.S.K, P. Paradha Saradhi and P. Sharmila. Concentrated action of antioxidant enzymes and curtailed growth under zinc toxicity in *Brassica juncea*. *Environ. Exp. Bot.*, 42:1-10, 1999

[15] Stobart A.K., Trever Griffith W, Ameen- Bukhari I, Brahmin and P. Sherwood Robert. The Effect of Cd on biosynthesis of chlorophyll in leaves of barley. Physiologia Planatarum, 63, 293-298, 1985.

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