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IMPROVING GROWTH AND PRODUCTIVITY OF *EUPHORBIA ANTISYPHILITICA:* A BIOFUEL PLANT FOR SEMI-ARID REGIONS

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ABSTRACT

Photosynthetic organisms use solar energy to generate reducing equivalents and incorporate atmospheric CO_2 into organic molecules. Worldwide production of biodiesel increased by 60% in 2005, and ethanol by 19% over the previous year's production, as per World watch Institute, USA. Countries like Thailand are aiming for a 10% renewable mix in the next five years; India 20% by 2020. Sweden has stated that it aims to become 100% energy independent by 2020; most of this independence will come through its own nuclear power, but renewable fuels will likely make up the balance. However there is considerable concern for competition between food and fuel if food crops are used for biodiesel production. *Euphorbia antisyphilitica* grows well in semi arid regions of the world and could be ideal for biofuel production. During present investigations edaphic conditions promoting biofuel production were studied and improvement in biofuel production is reported.

Key words: Bioufel*, Euphorbia antisyphilitica*, Hydrocarbon yielding plant.

INTRODUCTION

The biomass accounts for 43 per cent of the total energy supply in the developing countries as compared to only 1 per cent in the developed countries (Hall, 1982). Tropical forests in the world are estimated to be vanishing at an annual rate of about 7 million hectares while the corresponding rate for woodlands in the semi-arid zones is 4 million hectares (Tebicke, 1985). Use of biomass for energy and industry allows a significant quantity of hydrocarbons to be consumed without increasing the CO_2 content of the atmosphere and thus makes a positive contribution to the Greenhouse effect and to the problems of "global change" as occurs in both industrialized and developing countries (Kumar, 2008, Kumar 2011). During previous investigations (Kumar 1984, 1990, 1994, 1995, 1996, 2001; Kumar et al 1995) agro technology for raising hydrocarbon yielding biofuel plants in semi arid regions was presented. Production of such plants is influenced by soil conditions. Edaphic factors significantly influence the plant growth and development. Rajasthan has light textured aggraded plains having mostly a pale brown to brown soils (Dhir and Jain, 1982). About 12 percent of geographical area of the country constitutes arid zone. Core regions of aridity are restricted to Rajasthan and neighbouring states. Soils of these areas are extremely sandy. Arid zone of peninsular India has red soils. These soils are comparatively more open in consistency, light in texture being loamy to sandy, deficient in organic matter. Sandy soil is the dominant soil type in arid regions of Rajasthan. Coarse type sand and gravel also occur in large areas in western Rajasthan. A large number of plants belonging to family Euphorbiaceae, Asclepiadaceae are able to grow well under such edaphic conditions. The sandy soils have been reported to promote the growth of *E. lathyris* (Garg and Kumar, 1987). Present study has been undertaken with an object to determine optimum soil type for the growth and yield of *E. antisyphilitica*.

MATERIALS AND METHODS

Soil types were – Red, Sand and Gravel. These were taken singly as well as in combinations. In all, seven combinations were employed – Red, Sand, Gravel, Red+Sand, Red+Gravel, Sand+Gravel, Red+Sand+Gravel. In each pot 4.0 kg soil was filled. Mixing of two or these three types was done in equal proportion (w/w). Sand was obtained at a depth of 1-2 m, red and gravel were obtained from the local quarries. Two-month old plants of uniform size were transferred to the pots. Plants were watered at weekly intervals. Ten replicates were taken for each set of experiment. Plants were harvested after six months. Analysis of soil was done before setting the experiment.

RESULTS

Effect of Different Soil Types

Different soil types resulted in significant increase in growth and biomass of aboveground as well as underground parts. Maximum increases in fresh and dry weights along with percent dry weights of both aboveground and underground parts were obtained in red (loam) soil application (Table-1). Besides, percent hexane extractables and sugar contents were also maximum in red soil which was rich in nitrate, sodium, potassium and phosphorus pentoxide (Table-2).

Table 1
Effect of different soil types on plant growth, hexane extractables, sugar and chlorophyll contents of E. antisyphilitica.

Soil Type	Length (cm)		Fresh Wt. (g)		Dry Wt. (g)		Dry Wt. (%)		HE	Sugars	Chlorophylls (mg/g)		
	AG	UG	AG	UG	AG	UG	AG	UG	(%)	(mg/g)	a	b	Total
Sand	41.7	25.3	42.8	14.3	4.75	2.55	11.10	17.83	7.0	58.0	0.344	0.571	0.915
Red	37.1	22.5	52.2	15.74	5.95	3.14	11.40	19.95	9.0	182.0	0.525	0.309	0.834
Gravel	36.4	24.1	36.9	9.96	3.57	1.62	9.67	16.27	9.0	114.5	0.514	0.297	0.811
R+S	31.9	20.4	24.06	6.82	2.41	1.60	10.02	23.46	7.19	79.7	0.515	0.079	0.594
R+G	35.3	23.2	34.4	11.55	3.31	1.85	9.62	16.02	8.3	141.5	0.541	0.298	0.839
S+G	39.0	24.9	40.9	10.22	3.94	1.90	9.63	18.59	8.06	99.5	0.451	0.278	0.729
R+S+G	37.6	21.2	44.6	12.63	4.83	2.10	10.83	16.63	7.5	97.5	0.428	0.307	0.735
SEm	±6.60	±1.00	±0.70	±0.25	±4.21	±1.24							
CD at 5%	13.75	2.85	1.46	0.53	8.79	2.59							
CD at 1%	18.76	2.09	2.00	1.50	11.98	3.53							

R = Red ***AG = Aboveground***
S = Sand ***UG = Underground***
G = Gravel ***HE = Hexane extractables***

However, gravel also supported percent latex yield to the same maximum level as red soil. Calcium and magnesium contents were maximum in gravel as compared to red and sand. A favourable influence of sand on plant height and underground length could be seen. Hexane extractables and sugars were minimum in this soil type although, it was rich in phosphate and chloride contents. Plants grown in sandy soil were tall, and relatively less branching was observed. Plants grown in red soil branched more instead of increasing much in height. Chlorophyll contents were maximum in sand followed by red and gravel but sugar contents were maximum in red followed by gravel and sand.

Effect of Combination of Soil Types

Plant height was best in sand+gravel and biomass productivity occurred maximum in red+sand+gravel treatment. Latter combination (red+sand+gravel) also tended to increase percent dry matter yield of aboveground parts (Table-1).

Table 2
Analysis of different soil types for their nutrients

Nutrients in soil mg/100 g												
Soil type	**Distri-bution**	**K**	**Na**	**Mg**	**Ca**	**NH_4**	**Cl**	**SO_4**	**PO_4**	**NO_3**	**P_2O_5**	**K_2O**
Sand	a	0.36	1.88	1.63	4.50	0.15	4.80	0.44	-	-	-	-
	b	0.22	0.61	1.00	6.20	0.20	3.10	0.25	-	-	-	-
	c	0.49	0.39	1.31	10.52	0.45	1.30	0.23	1.31	-	-	-
Total		1.07	2.88	3.94	21.22	0.80	9.20	0.92	1.31	-	3.50	3.46
Red	a	0.33	1.72	1.60	4.33	0.12	2.55	0.29	0.17	0.28	-	-
	b	0.27	0.66	0.88	6.39	0.18	2.43	0.26	0.12	0.07	-	-
	c	0.89	0.54	0.85	11.90	0.86	3.10	0.68	0.71	0.19	-	-
Total		1.57	2.92	3.33	22.62	1.16	8.08	1.23	1.00	0.54	4.71	8.00
Gravel	a	-	1.11	1.22	4.79	0.10	1.60	-	-	-	-	-
	b	0.05	0.48	1.27	11.00	0.06	1.38	0.22	-	-	-	-
	c	0.06	0.65	1.83	30.90	0.20	2.39	0.24	-	-	-	-
Total		0.11	2.24	4.32	46.60	0.36	5.37	0.45	-	-	3.73	2.01

a = Soil solution
b = Absorbed ions
c = Fixed in colloids

A combination of sand-gravel also favoured maximum increase in underground length. A combination of red+sand favoured percent dry matter yield of underground parts to maximum extent. However, increased levels of percent hexane extractables and sugars were noted in red+gravel treatment. Maximum chlorophylls were recorded in red+gravel combination. Chlorophyll contents were minimum in red+sand. Chlorophylls and sugars did not vary much between sand+gravel and red+sand+gravel.

DISCUSSION

Among the major soil groups, the dunes are a dominant formations in 36.1 percent of western Rajasthan and a sub-dominant associate in 35.5 percent area. The soils of the dunes are highly sandy (fine 63-84 percent and coarse 11-30 percent) with associated clay, silt and diffused carbonates. Peninsular India, has red soils as the largest group derived from parent rocks such as granite and gneiss. Red soil occur in areas of tropical and subtropical climate with high humidity and temperature. In present experiment red soil was found better in nitrate contents as compared to sand or gravel. Besides nitrogen, sodium and potassium contents were also high in red soil. Due to better nutrient status of soil, biomass yield was maximum in red soil. Although magnesium was highest in gravel, a fairly good amount of magnesium was present in sand and red soil also. Nevertheless, chlorophylls were maximum in sandy soil. Effects of calcium carbonate accumulation on soil chemistry and structure include decreased water penetrability and a well buffered pH range of 8.0-8.4 (Hennessy *et al*, 1983). The fixation of phosphorus by pedogenic calcium carbonate has been implicated in the lowered crop response to phosphorus fertilization (Chang, 1953). Enhancement of potassium flux has been observed in maize roots when the calcium level of bathing increased. On the contrary, Handley *et al* (1965) reported that ion uptake is not always increased by the presence of calcium and it is generally accepted that calcium exerts a dual effect, increasing the efficiency of the active uptake while decreasing the membrane permeability. Chloride and phosphate contents were maximum is sand in the present study. Sandy soil supported maximum increase in aboveground and underground length during present investigation. Because of poor water holding capacity of the sandy soil, underground length increased in search of water. Red soils were having small particle size and high water holding capacity. Due to the presence of this property, water and nutrients were available more to the plants growing in this soil which reflected on maximum production of biomass and percent dry matter yield. Soil type was found to influence growth and hexane extractables of *E. lathyris*. Addition of gravel to the soil enhanced the hexane and methanol extractables (Garg and Kumar, 1987). In *E. antisyphilitica* also gravel enhanced hexane extractables, besides red soil. In both the cases, the yield of hexane extractables was the same. One of the factors

responsible for enhanced latex yield in gravel might be higher contents of calcium in it. It was 46.69 mg/100 g in the present experiment. Calcium constitutes 7.5 percent of the dry latex weight and could be important in latex biochemistry (Nemethy *et al*, 1983). In case of red soil, a better nutrient status because of improved water holding capacity, might be responsible for increased hexane extractables. A positive correlation between calcium content and carbohydrate content, during active growth phase of peanut pods has been reported (Mizuno, 1960). Although not much difference has been observed in chlorophyll contents of red soil and gravel, a combination of red+gravel also produced chlorophylls to the same extent, as red soil. The latter soil type also supported maximum production of sugar contents. The possibility behind it might be that greater amount of chlorophyll alongwith better nutrient supply, play a positive role in the synthesis of latex components and sugars. Plant life and soil fertility are closely interrelated. In this relationship plant roots play an important role in their function in the absorption and translocation of nutrients. Fertilizers contain those nutrients such as nitrogen, phosphorus and potassium that are rapidly taken up and required in high quantities by crops. There is general agreement that of all the nutrient amendments made to soil, nitrogen fertilizer application has had the most important effects in terms of increasing crop production.

CONCLUSION

Above study clearly reveals that red+ gravel soil improved latex contents of *E. antisyphilitica* which is a promising petro crop. For large scale cultivation red and gravel soil types of wastelands are suitable to obtain maximum yield.

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