Journal of Phytology 2009, 1(4): 206–212
ISSN: 2075-6240
Available Online: www.journal-phytology.com

REGULAR ARTICLE

APPLICATION OF FARMYARD MANURE AND VERMI-COMPOST ON VEGETATIVE AND GENERATIVE CHARACTERISTICS OF *JATROPHA CURCAS*

Ashwani Kumar[a], Satyawati Sharma*[a], Saroj Mishra[b]

[a]*Centre for Rural Development and Technology, Indian Institute of Technology Delhi, Hauz Khas New Delhi-110016, India*

[b]*Department of Biochemical Engineering and Biotechnology, Indian Institute of Technology Delhi, Hauz Khas New Delhi-110016. India*

SUMMARY

This study was conducted to investigate the effect of FYM and Vermi-compost on: i) biomass yield of vegetatively propagated *Jatropha curcas* and ii) physical characteristics of *Jatropha* seeds. Various vegetative and generative characteristics of *Jatropha* (survival %, shoot length, shoot diameter, number of branches, seed yield and oil content) in response to the treatments were evaluated under field conditions. The results showed that addition of vermicompost significantly increased plant survival, plant height, stem diameter, number of branches/plant, number of seeds/plant and oil content (6.76% & 19.21%) over FYM and control. Vermicompost also played an important role in increasing oil content by improving physical characteristics of *Jatropha* seeds. We conclude *Jatropha* raised through cuttings on vermicompost performed better with respect to biomass yield over FYM and untreated soil.

Keywords: Farm yard manure, Vermicompost, Days after planting, Month after planting, Biodiesel.

Ashwani Kumar et. al. Application of farmyard manure and vermi-compost on vegetative and generative characteristics of *Jatropha curcas*. J Phytol 1 (2009) 206-212
***Corresponding Author**

1. Introduction

The renewed interest, in fuels of biological origin particularly bio-diesel, to ensure energy security, cleaner environment and sustainable development has drawn research attention on non-edible oils along with other sources. One of such feedstock is the non-edible oil of *Jatropha curcas*. It is a multipurpose large shrub or small tree of Latin American origin which has got adjusted throughout arid and semiarid tropical region of the world [1]. Exploitation of *Jatropha* for various purposes is described several workers [1-5].

The recent interest in the plantation of *Jatropha* is gaining momentum for bio-diesel production on wastelands. However, there is a concern for increasing its productivity in some ways, which at the same time will take care of soil ecology too. Plant propagated by means of stem cuttings will help in rapid multiplication of superior phenotype/genotype that ensures highest seed and oil yield. Tropical regions face a shortage of fertilizer inputs mainly nitrogen, which is a crucial nutrient for maximum yields of most crops [6]. Much attention has been paid in recent years on the use of different organic over chemical fertilizers in enhancing the yield of plants. The advantages of organic farming are that it reduces pollution levels and hence preserves ecological balance, enhances productivity and ensures sustainable agriculture by keeping the soil fertile [7].

Organic manure helps in soil maintenance by improving soil aeration, water holding capacity [8-9] and stimulates microorganisms in the soil that make plant nutrients readily available leading to higher yield and better quality of plants [10]. Moreover, organic matter plays an important role in the chemical behavior of several metals in soils throughout its active groups (flavonic and humic acids) which have the ability to retain the metals in complex and chelate forms. Organic manure play a direct role in plant growth as a source of all necessary macro and micronutrients in available forms during mineralization, improving the physical and physiological properties of soils.

Review of the literature revealed that not much work has been done on the application of FYM and vermicompost for increasing biomass yield of *Jatropha*. In this work, we have also tested the effects of FYM and vermicompost on physical characteristics of *Jatropha* seeds.

2. Materials and Methods

Procurement of stock (cuttings) material and experimental design

The experiment was initiated during 2006-2008 at Micromodel complex, an experimental site at IIT Delhi, India (28.38 N, 77.12 E). The climate of the experimental site is semi-arid subtropical, with high variation between summer and winter temperature. The average annual rainfall is approximately 714 mm (28.1 inches), most of which is during the monsoons in July and August. Healthy and uniform stem cuttings (15 inches in size and 2-3 cm thickness) of *Jatropha* were obtained from the branches of 2–3 years old Jatropha stock maintained at the Herbal garden of IIT Delhi.

The micromodel soil was mixed with FYM (procured from Katwaria sarai) and vermicompost (produced in Micromodel using cattle dung) in combination of 3:1. For vegetative propagation, total 60 plants in six rows (20 each for FYM, vermi-compost and untreated soil), ten in each row were planted. The cuttings were planted in nursery beds at a spacing of 1 m and spacing between rows was 1.5 m. The weeding and irrigation was provided twice in a week at initial stage of development and after that when required.

Analysis

The soil used in the experiment was analyzed and have following properties: Loamy soil, electrical conductivity (EC) 0.114 dS m-1, pH 7.4, organic C (%) 1.18, total N (%) 0.58, available P (11.3) and K (54.3) mg kg-1. The bulk density (BD) of soil was measured at the beginning of the experiment and after 4 months using a core sampler; mechanical analysis was done following the international pipette method [11] Table 1. Electrical conductivity (EC) was estimated by EC meter (Scientific Make, India) using a soil to water suspension of 1:5. Total organic carbon and nitrogen were determined by CHN analyzer Vario Max CN (Elementar, Hanau, Germany), P by Olsen's method [12] and K by an ammonium acetate method [13].

Table 1. Analysis of rhizospheric soil of Jatropha curcas raised on FYM, vermicompost and untreated soil.

	Control	FYM	Vermi compost
Moisture content	11.3	11.7	15.4
Bulk density (g/cm3)	1.41	1.34	1.27
PH	7.4	7.2	7.3
EC (mmhos/cm^2)	0.114	0.115	0.115

The oil was extracted from seeds by using hexane as solvent in soxhlet apparatus [14]. The solvent was evaporated under vacuum at 40–45°C in a rotary-evaporator. The oil was dried over anhydrous sodium sulfate, filtered, stored in dark brown bottles without any further purification and then kept at 5°C until analysis.

Data pertaining to effect of FYM and Vermi-compost on survival (%), length, diameter, number of branches, seed yield and oil content of *Jatropha curcas* were collected and the same was compared with control.

The effect of FYM and Vermicompost were also tested on physical properties (length, breadth, width, sphericity and surface area) of *Jatropha* seeds, in which sample was cleaned manually to remove all foreign materials such as dust, dirt, small branches and immature seeds. The arithmetic mean diameter, geometric mean diameter, sphericity, surface area, moisture content was calculated using standard formulas reported by different scientist for various plant materials [15-20]. The 1000 seed mass was determined by means of a digital electronic balance (Shimadzu Corporation, Japan, AY120) having an accuracy of 0.001 g. To evaluate the 1000 seed mass, 30 randomly selected seeds from the bulk sample were averaged.

Statistical methods

The data obtained were analyzed by analysis of variance (ANOVA) using SPSS for Windows (version 16.0). The significance of difference was determined according to Duncan's multiple range test (DMRT). P values < 0.05 are considered to be significant.

3. Results and Discussion

Effect of organic amendment on soil characteristics

The sites with organic amendment in the form of FYM and vermicompost had shown decrease in bulk density from 1.41 (untreated soil) to 1.27 (g/cm3). Changes in bulk density could be attributed to improvement in soil properties caused by the permanent vegetation, roots, bio-pores, organic matter, fauna, and other related biological processes. Several researchers like Bavaskar and Zende [21], Shanmugam and Ravi [22], Kapur et al. [23] and Bhatia and Shukla [24] verified that the addition of FYM resulted in decrease in bulk density of soil.

Effect of FYM and Vermicompost on vegetative and generative characteristics of *Jatropha*

The observation on development of vegetatively propagated Jatropha on control soil, FYM and Vermicompost are summarized in table 2. Data on survival percentage showed, 100% of Jatropha cuttings were fresh upto 25 DAP with all treatments, but survival percentage was significantly ($p > 0.05$) reduced in the following order; control soil (83%) < FYM (92%) < vermicompost (98%) at 45 DAP. Plant height showed insignificant increased at 4 MAP in all treatments and further it was increased significantly with FYM (13.14% & 8.29%) and vermicompost (25.13 & 17.53%) over control at 11 and 14 MAP respectively. Results pertaining to effect of FYM and Vermi-compost on stem diameter showed significant increased over control at 4 MAP, whereas at 14 MAP vermicompost performed better over FYM and control. Number of branches/plant was significant with vermicompost over FYM and control after 4 & 11 MAP. This increase in vegetative growth with FYM and Vermicompost might be due to organic amendment which improved the structure of the soil by increasing the water holding capacity, good aeration and drainage that encourage better root growth and nutrient absorption. The better role of vermicompost over FYM could be due to better mobilization and availability of plant nutrients (nitrogen, sulphur, potash, phosphorus, calcium, magnesium, etc.) and growth enhancing substances to the plants [25] in soil amended with vermicompost.

Table 2. Vegetative development of *Jatropha curcas* with FYM and Vermi-compost (D= Days after plantation, M= Months after plantation)

Treatments	Survivals (%)		Plant Height (cm) Months after plantation			Stem diameter (mm)		No. of branches /plant	
	25 D	45 D	4M	11M	14M	4M	14M	4M	14M
Untreated Soil	100	83a	82.6a	129.3a	242.4a	39.5a	72.3a	4.8a	5.2a
FYM	100	92b	91.6a	146.3b	262.5b	49.0b	84.1b	5.6ab	7.4b
Vermicompost	100	98c	95.1a	161.8c	284.9c	53.6b	94.1c	6.3b	9.8c

Different letters in each column indicate significant differences at $p<0.05$ according to DMRT. (n =5)

The results pertaining to the effect of FYM and vermicompost on generative growth parameters (number of capsule/plant, number of seeds per capsule, seed weight and percentage seed oil content) of *Jatropha* plants are summarized in table 3. The effect of vermicompost and FYM on number of capsules/plant amounted to 142.85% and 85.71% over control. Vermicompost performed better (significant, $p<.05$) over other treatments pertaining to number of seeds/plant, seed weight and oil content. However, number of seeds/capsule at par with respect to FYM and vermicompost. Percentage increase in oil content in *Jatropha* grown under vermicompost was 6.76 and 19.21 % over FYM and control respectively.

Table 3. Generative development of *Jatropha curcas* with FYM and Vermi-compost.

Treatments	Number of capsules /plant	Number of seeds/plant	Number of seeds /capsule	Seed wt. (g)	1000 seeds wt. (g)	Seed oil (%)
Untreated Soil	7	27a	1.6a	0.598a	590.8a	25.14a
FYM	13	34b	2.50b	0.663b	663.4b	28.07b
Vermicompost	17	45c	2.50b	0.711c	711.0c	29.97c

Different letters in each column indicate significant differences at $p<0.05$ according to DMRT. (n =5)

Better performance of vermicompost with respect to generative growth of *Jatropha* could be explained by the presence of more C, P and N in vermicompost [26] over FYM which probably favored metabolic and auxin activities in plant and ultimately resulted in increased number of fruits, number of seeds per plant, seed weight (kg). These results are similar to results obtained by Nanthakumar & Veeragavathatham [27] in chilli, Prabhu et al. [28] in brinjal.

The better role of vermi-compost is also experimentally verified by Kumar and Sharma [29], wherein *Jatropha* curcas raised through seeds on Vermi-compost showed better performance for all growth parameters than FYM. More recent experiments have demonstrated that vermicompost contain plant growth regulating materials, including plant growth hormones and humic acids, which are probably responsible for increased germination, growth and yields of plants [30-32].

Effect of FYM and vermicompost on physical properties of *Jatropha*

Average values of the three principal dimensions of *Jatropha* seed, viz., length, width and thickness measured in this study are presented in Table 4. Data showed that application of vermicompost improved seed length, breadth and thickness as compared to FYM and control, which directly influence oil content of seeds. It is seen that the grain has mean values of sphericity ranging from 0.66 to 0.67. Mangaraj and Singh [33] and Sirisomboon et al. [34] have reported the values for sphericity of *Jatropha* seed as 0.61 and 0.64, respectively, which is close to the results of this investigation. In this study, *Jatropha* seed should not be treated as an equivalent sphere for calculation of the surface area. The surface area of *Jatropha* seed increases linearly from 388.73 to 474.91mm2.

Table 4. Physical properties of *J. curcas* seeds at different treatments

Treatments	Length (mm)	Breadth (mm)	Thickness (mm)	Sphericity decimal	Surface area (mm2)
Untreated Soil	16.88 ±0.49	10.77±0.35	7.58±0.47	0.66±0.02	388.73±18.5
FYM	17.01±0.69	11.03±0.4	7.87±0.38	0.67±0.02	407.53±29.3
Vermicompost	18.53±0.66	11.45±0.41	8.77±0.42	0.66±0.02	474.91±20.3

Conclusions

These finding suggest that biomass growth and yield of *Jatropha curcas* was significantly increased with soil containing FYM and Vermicompost over control for all considered parameters. However, vermicompost performed better over FYM with respect to all variables. Moreover, it has positive impacts on soil characteristics and health necessary for better growth of planted biomass. This study showed the practical benefits of employing organic manure for a sustainable farming system.

Acknowledgement

Authors wish to thank Council of Scientific and Industrial Research, New Delhi, for providing financial support to conduct this study.

References

1. Gubitz, G.M., M. Mittelbech and M. Trabi, 1999. Exploitation of tropical oil seed plant *Jatropha curcas* L. Bioresource Technology, 67: 73-82.
2. Openshaw, K., 2000. A review of *Jatropha curcas*: an oil plant of unfulfilled promise. Biomass and Bioenergy, 19: 1–15.
3. Augustus, G.D.P.S., M. Java Beans and G.J. Seiler, 2002. Evaluation and bioinduction of energy components of *Jatropha curcas*. Biomass Bioenergy, 23:161–164.
4. Wood, P., 2005. Out of Africa: Could *Jatropha* vegetable oil be Europe's biodiesel feedstock?. Refocus, 6 (4), 40-44.
5. Kumar, A and S. Sharma, 2008. An evaluation of multipurpose oil seed crop for industrial uses (*Jatropha curcas* L.): A review. Industrial Crops and Products, 28:1-10.
6. Pal, U.R and Y. Shehu, 2001. Direct and residual contributions of symbiotic N fixation by legumes to the yield and N uptake of maize (*Zea mays* L) in the Nigerian Savannah. Journal of Agronomy and Crop Science, 187: 53 - 58.
7. Meelu, O.P., 1996. Integrated nutrient management for ecologically sustainable agriculture. J. Indian Soc. Soil Sci. 44: 582–592.
8. Hillel, D., 1980. Applications of Soil Physics. Academic Press. New York.
9. Sanchez, C.A., 1990. "Soil testing and fertilization recommendations for crop production on organic soils in Florida." Fla. Agr. Exp. Sta. Bull., 876: 44
10. Choudhary, M., L.D. Bailey and C.A. Grant, 1994. Agriculture and agri-Food Canada, Brandon Research centre, R.R. #3, Brandon, P.O. Box 1000 A, R7A 5Y3, Manitoba, Canada.
11. Piper, C.S., 1966. Soil and plant analysis. University of Adelaide, Australia
12. Olsen, S.R., C.V. Cole, F.S. Watanabe and Dean, L.A., 1954. Estimation of available phosphorus in soils by extraction with sodium bicarbonate. (Circular of the US Department of Agriculture 939) USDA, Washington, D.C.
13. Hanway, J.J., Heidel, H., 1952. Soil analysis methods as used in Iowa state college soil testing laboratory. Iowa Agric, 57: 1–31.
14. Sadasivam and Manickem, A., 1992. In: Biochemical methods for Agricultural Sciences, Wiley Eastern Limited, New Delhi. pp. 26-27.
15. Maduako, J.N. and Faborode, M.O., 1990. Some physical properties of cocoa pods in relation to primary processing. Ife Journal of Technology, 2: 1-7.
16. Sacilik, K., Ozturk, R. and Keskin, R., 2003. Some physical properties of hemp seed. Biosys. Eng., 86: 191-198.
17. Altuntaş, E. and Yıldız, M., 2007. Effect of moisture on some physical and mechanical properties of faba bean (*Vicia faba* L.) grains. J. Food Eng., 78: 174–183.
18. Garnayak, D.K., R.C. Pradhan, S.N. Naik, N. Bhatnagar, 2008. Moisture-dependent physical properties of *Jatropha* seed (*Jatropha curcas* L.) Industrial Crops and Products, 27:123-129.
19. Pradhan, R.C., S.N. Naik, N. Bhatnagar and S.K. Swain, 2008. Moisture-dependent physical properties of Karanja (*Pongamia pinnata*) kernel. Industrial Crops and Products, 28:155-161.
20. Pradhan, R.C., Naik, S.N., Bhatnagar, N. and Vijay, V.K., 2009. Moisture-dependent physical properties of *Jatropha* fruit. Industrial Crops and Products, 29:341-347.
21. Bavaskar, V.S. and Zende, G.K., 1973. Soil Fertility under Continuous Manuring and Cropping. Indian Journal of Agricultural Sciences, 43:492-9.

22. Shanmugam, K. and Ravi K.V., 1980. Effect of organic amendments on physical properties of soil and yield of sorghum. Madras agric. J., 67: 445-449.

23. Kapur, M.L., Rana, D.S. and Meelu, O.P., 1981. Save on fertilizer through the use of farm yard manure. Indian Farming, 30:27-31.

24. Bhatia, K.S. and K.K. Shukla, 1982. Effect of continuous application of fertilizers and manure on some physical properties of eroded alluvial soil. J. Indian Soc. Soil Sci. 30:33-36.

25. Sultan, A.I., 1997. Vermicology – The Biology of Earthworms. Orient Longman Ltd, New Delhi, 92p.

26. Gaur, A.C. and Singh, G., 1995. Recycling of rural and urban waste through conventional and vermi-composting. In: H.L.S. Tondon, Editor, Recycling of Crop, Animal, Human and Industrial Waste in Agriculture, Fertilizer Development and Consultation Organization, New Delhi. 31–49.

27. Nanthakumard, S. and Veeragavathatham, D., 2000. Effect of integrated nutrient management on growth parameters and yield of brinjal (*Solanum melongena* L.) cv. PLR-1. South Indian horticulture, 48 (no.1/6)

28. Prabhu, M., D. Veeraragavathatham and K. Srinivasa, 2003. Effect of nitrogen and phosphorous on growth and yield of brinjal. South- Indian-Horticulture, 51:152-156.

29. Kumar, A. and S. Sharma, 2005. Potential of *Jatropha* and cultural practices to maximize its yield. In: conference proceedings 11th ICPQR, 13-15th Dec. IIT Delhi, New Delhi

30. Atiyeh, R.M., S. Lee, N.Q. Arancon, C.A. Edwards and J.D. Metzger, 2002. The influence of humic acids derived from earthworms-processed organic wastes on plant growth. Bioresource Technology, 84:7–14.

31. Arancon, N.Q., C.A. Edwards, S. Lee and R. Byrne, 2006. Effects of humic acids from vermicomposts on plant growth. Eur. J. Soil Biol. 46:65–69.

32. Arancon, N.Q. and C.A. Edwards, 2006. Effects of vermicomposts on plant growth, Proceedings of the Vermi-Technologies Symposium for Developing Countries Department of Science and Technology—Philippine Council for Aquatic and Marine Research and Development, Los Banos, Philippines (2006).

33. Mangaraj, S., Singh, R., 2006. Studies on some engineering properties of *Jatropha* for use as biodiesel. Bioenergy News, 9:18–20.

34. Sirisomboon, P., P. Kitchaiya, T. Pholpho, W. Mahuttanyavanitch, 2007. Physical amd mechanical properties of *Jatropha curcas* L. fruits, nuts and kernels. Biosyst. Eng., 97:201–207.