Environment & Ecology 35 (4) : 2644—2649, October—December 2017
Website: environmentandecology.com ISSN 0970-0420

Study of Biochemical Properties and Gel Yield of Aloe Vera (*Aloe barbadensis* Miller) under Planting Methods and Organic Manure Levels

Dinesh Kumar Marapi, Y. K. Dewangan, Hemant Kumar Jangde, Saurabh Kumar, Bhujendra Kumar

Received 1 December 2016 ; Accepted 2 January 2017 ; Published online 20 January 2017

Abstract A field experiment was conducted during *kharif* season of 2014-2015 on vertisols soil representing upland of Chhattisgarh. The experiment comprised of 12 treatments consisting of main plot viz. flat bed planting, ridge and furrow planting, raised bed planting and sub plot viz. vermicompost @ 2.5 t ha^{-1}, vermicompost @ 5 t ha^{-1}, FYM @ 5 t ha^{-1} and FYM @ 10 t ha^{-1}. Among the planting methods, highest gel yield (13.09 t ha^{-1}), crude protein (6.56%) and crude fat (2.74%) were recorded with raised bed planting and highest ash content (13.85%) under ridge and furrow planting but highest crude fiber (7.93%) was recorded with flat bed planting. Application of vermicompost @ 5 t ha^{-1} was maximum produced gel yield (12.88 t ha^{-1}), ash content (14.50%), crude protein (6.68%) and crude fat (2.80%) content and whereas, highest crude fiber (7.83%) was recorded with application of FYM @ 5 t ha^{-1}. Interaction between planting methods and organic manure levels, significantly highest gel yield (14.70 t ha^{-1}), ash content (15.90%), crude protein (7.25%) and crude fat (3.10%) were recorded with raised bed planting and application of vermicompost @ 5 t ha^{-1}.

Keywords Planting methods, Organic manure levels, Gel yield, Aloe vera, Biochemical properties.

D. K. Marapi*, Y. K. Dewangan, H. K. Jangde, S. Kumar, B. Kumar
Department of Agronomy, College of Agriculture, IGK, Raipur, CG 492012, India
e-mail: marapidineshkumar@gmail.com
*Correspondence

Introduction

Aloe vera (*Aloe barbadensis* Mill.) is an important and traditional medicinal plant belonging to family liliaceae. Aloe is a crassulacean acid metabolism (CAM) plant. Aloe vera is a xerophytic perennial plant with a short, cylindrical, simple stem of 30—60 cm. The leaves are 40–60 cm long, erect, broad, thick and fleshy which are crowded in a basal rosette. The leaves are succulent, glaucous-green in color, narrow-lanceolate in shape with long acuminate tip with small thorns on both edges. Flowers are yellow to red in color and are borne in dense racemes terminating in the cylindrical spike. Aloe species a perennial succulent is the source of drug aloe. Aloe is the yellow, bitter juice obtained by cutting the leaves at their base and the dark brown mass of drug aloe is ontained by evaporating the juice. Products containing aloe vera are used for the treatment of minor cuts and burns and to heal wounds. They are also contained in a variety of cosmetics including skin creams, lotions and shampoos. Aloe gel enhances immunity, improves liver function, prevents asthma and has anti-inflammatory, anti-ulcerous, anti-diabetic and anti-hypertensive properties. The gel of aloe vera possess various biological and physiological activities viz. heal-

ing ability of skin burns and cutaneous injuries, prophylactic effect against radiation leukopenia ; antiulcer ; inhibitory action against some bacteria and fungi ; inflammation-inhibiting effect ; inhibition of the prostaglandin synthesis by anthraquinone-type compounds ; and inhibition of the AIDS virus by acemannan.

Calcium, sodium, potassium, manganese, magnesium, copper, zinc, chromium and the anti-oxidant selenium are also present in aloe vera [1, 2]. Sugars are derived from the mucilage layer of the plant which surrounds the inner gel and are known as mucopoly saccharides, which enhance the immune system and help to detoxify the unwanted components like ammonia [3]. Twelve phenolic compounds are found exclusively in the plant sap. Saponins form about 3% of the gel [4—7]. In this regard, improved planting methods play a significant role to enhance crop productivity due to well developed root system. Planting methods provide loose fertile layer of soil that result in well developed root system and consequently higher nutrient and water uptake [8]. Organic manures are considered to be safe and yielding good produce by improving water penetration, water holding capacity, improvement in soil structure, microbial biomass, nutrient availability and drought and heat stress resistance. The beneficial effect of organic manures on growth and yield of crops could be attributed to the fact that after proper decomposition and mineralization, the manures supply nutrients directly to the plants and also have solubilizing effect on fixed forms of nutrients in soil. It also helps in improving the soil pH which has an impact on plant growth. Nutrient management in aloe vera field may be one of the strategies for increasing of the yield of aloe vera. In this background information, the field experiment was conducted to study effect of planting methods and organic manure levels on chemical properties of aloe vera gel under Chhattisgarh plains.

Materials and Methods

Field experimental was carried out during *kharif–rabi* season of 2014-2015 at the Instructional farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur, CG. The soil of experimental field was clayey in texture, locally known as Kanhar (*vertisols*). The soil was neutral in pH and medium in available nitrogen and available phosphorus and high in available potassium content. The experiment was laid out in split plot design with three replications. The treatments allotted to main plots were flat bed planting, ridge and furrow planting and raised bed planting and the treatments allotted to sub plots were vermicompost @ 2.5 t ha^{-1}, vermicompost @ 5 t ha^{-1}, FYM @ 5 t ha^{-1} and FYM @10 t ha^{-1}. Organic manures and vermicompost were incorporated at the final stage of field preparation as per the treatment details. Extracted gel of leaves from the net plot was weighed by a spring balance of 5 kg capacity. The gel yield kg ha^{-1} obtained was converted to quintal ha^{-1} for statistical analysis. The moisture, ash, crude protein, crude fat, crude fiber of the samples was determined following procedures as described by AOAC [9]. Thermal drying method was used in the determination of moisture contents of the samples. The ash contents were determined using the ignition method. Determination of crude protein was done by first determining the total organic nitrogen using the Kjeldahl method and then multiplied by 6.25 to calculate crude proteins. Crude lipid estimation was performed using Soxhlet extraction technique with petroleum ether solvent. Moisture free sample was subjected to acid and alkaline hydrolysis to measure crude fiber contents.

Statistical analysis as per the procedure laid down by Gomez and Gomez [10]. The significance of treatment effects was tested with variance ratio (f-value). Appropriate standard errors and critical difference at 5% probability level to test the statistical significance of the results.

Results and Discussion

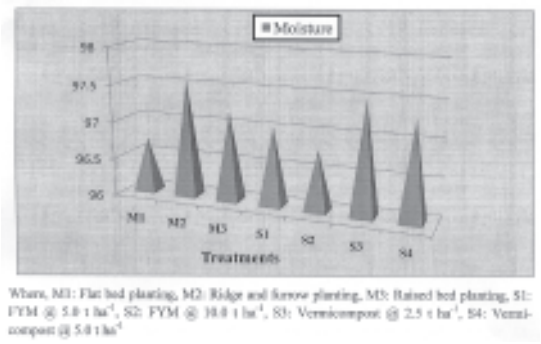
Gel yield

The gel yield of aloe vera as influenced by different treatments is presented in Table 1. Gel yield was influenced significantly due to various planting methods. Among the planting methods, highest gel yield (13.09 t ha^{-1}) was produced with raised bed planting and it was followed by ridge and furrow planting. The lowest gel yield (10.95 t ha^{-1}) was produced with flat bed planting. The gel yield was influenced significantly

Table 1. Gel yield and biochemical properties of aloe vera gel as influenced by planting methods and organic manure levels. NS–Nonsignificant, S–Significant, M_1 : Flat bed planting, M_2 : Ridge and furrow planting, M_3 : Raised bed planting, S_1 : FYM @ 5.0 t ha^{-1}, S_2 : FYM @ 10.0 t ha^{-1}, S_3 : Vermicompost @ 2.5 t ha^{-1}, S_4 : Vermicompost @ 5.0 t ha^{-1}.

Treatments		Gel yield (t ha^{-1})	Biochemical content (%) of aloe vera gel Ash	Protein	Fiber	Fat
Planting methods						
Flat bed planting		10.95	12.38	5.78	7.93	2.51
Ridge and furrow planting		11.57	13.85	5.90	7.20	2.56
Raised bed planting		13.09	13.67	6.56	6.89	2.74
SEm±		0.32	0.36	0.16	0.25	0.07
CD (p = 0.05)		1.29	NS	NS	NS	NS
Organic manure levels						
FYM @ 5.0 t ha^{-1}		11.06	12.05	5.70	7.83	2.26
FYM @ 10.0 t ha^{-1}		11.70	13.87	5.77	7.28	2.74
Vermicompost @ 2.5 t ha^{-1}		11.83	12.78	6.17	7.40	2.62
Vermicompost @ 5.0 t ha^{-1}		12.88	14.50	6.68	6.77	2.80
SEm ±		0.23	0.24	0.12	0.18	0.04
CD (p = 0.05)		0.68	0.73	0.35	0.53	0.14
Interaction						
$M_1 \times S_1$		10.20	10.50	5.50	8.90	2.16
$M_1 \times S_2$		11.00	12.23	5.90	8.20	2.70
$M_1 \times S_3$		10.70	11.50	5.62	7.20	2.80
$M_1 \times S_4$		11.90	15.00	6.10	7.40	2.40
$M_2 \times S_1$		11.70	14.06	5.60	7.80	2.16
$M_2 \times S_2$		11.10	14.70	4.82	6.30	3.00
$M_2 \times S_3$		11.43	14.06	6.50	8.00	2.20
$M_2 \times S_4$		12.06	12.60	6.70	6.70	2.90
$M_3 \times S_1$		11.30	11.60	6.00	6.80	2.46
$M_3 \times S_2$		13.00	14.40	6.60	7.35	2.53
$M_3 \times S_3$		13.36	12.80	6.40	7.20	2.86
$M_3 \times S_4$		14.70	15.90	7.25	6.20	3.10
Sub plot at same	SEm±	0.64	0.73	0.33	0.49	0.15
Level of main plots	CD (p = 0.05)	1.38	1.48	0.72	1.07	0.30
Main plot at same	SEm±	0.47	0.51	0.24	0.36	0.10
Level of sub plots	CD (p = 0.05)	1.63	1.81	0.85	1.26	0.37

due to different organic manure levels. Among the different organic manure levels, highest gel yield (12.88 t ha^{-1}) was produced with application of vermicompost @ 5 t ha^{-1} followed by application of vermicompost @ 2.5 t ha^{-1}. The lowest gel yield (11.06 t ha^{-1}) was produced with application of farm yard manure @ 5 t ha^{-1}. Various planting methods and different organic manure levels showed their interaction effect on gel yield of aloe vera. The raised bed planting was produced statistically superior over all the treatments at the same level of application of vermicompost @ 5 t ha^{-1}. The application of vermicompost @ 5 t ha^{-1} was produced to be statistically superior over FYM @ 5 t ha^{-1} while it was at par with application of vermicompost @ 2.5 t ha^{-1} at the same level of raised bed planting. Maximum gel yield was found under raised planting method with vermicompost @ 5 t ha^{-1}. Highest gel yield was significantly affected by raised bed planting and vermicompost due to higher herbage yield to leads higher herbage yield. Kothari and Reddy [11] reported that raised bed planting method produce 49.8% and 33.9% higher yield as compared to flat bed and ridge planting of safed musli.



Where, M1: Flat bed planting, M2: Ridge and furrow planting, M3: Raised bed planting, S1: FYM @ 5.0 t ha^{-1}, S2: FYM @ 10.0 t ha^{-1}, S3: Vermicompost @ 2.5 t ha^{-1}, S4: Vermicompost @ 5.0 t ha^{-1}

Fig. 1. Moisture content of aloe vera gel as influenced by planting methods and organic manure levels. Where, M_1 : Flat bed planting, M_2 : Ridge and furrow planting, M_3 : Raised bed planting, S_1 : FYM @ 5.0 t ha^{-1}, S_2 : FYM @ 10.0 t ha^{-1}, S_3 : Vermicompost @ 2.5 t ha^{-1} , S_4 : Vermicompost @ 5.0 t ha^{-1}.

Biochemical properties

Moisture content

The data on moisture content in gel are presented in Fig. 1. The moisture content was influenced not significantly due to various planting methods and different organic manure levels. However, highest moisture content was obtained with ridge and furrow planting. The moisture content of gel was obtained lowest with flat bed planting. Among the organic manure levels, application of vermicompost @ 2.5 t ha^{-1} was obtained superior over the application @ farm yard manure @ 10 t ha^{-1}.

Ash content

The ash content in gel was influenced not significantly influenced due to various planting methods. Highest ash (13.85%) content in gel was obtained with ridge and furrow planting. However, ash content in gel was influenced significantly due to different organic manure level. Among the different organic manure levels, higher ash (14.50%) content in gel was obtained with the application of vermicompost @ 5 t ha^{-1}, which was at par with application farm yard manure @ 10 t ha^{-1}. Various planting methods and organic manure levels showed their interaction effect on ash content in gel. The raised bed planting was found to be statistically superior over all the treatment except flat bed planting at the same level of application of vermicompost @ 5 t ha^{-1}. The application of vermicompost @ 5 t ha^{-1} was found to be statistically seperior over all the treatment at the same level of raised bed planting Saha et al. [4] reported that organic source of fertilizer in the form of vermicompost and vermiwash was found to be effective and comparable with inorganic source of fertilizer in increasing content gel ash and aloin of aloe vera.

Crude protein content

The data pertaining to crude protein content in gel as influenced by different treatments were recorded presented in. The crude protein content in gel was influenced nonsignificantly due to various planting methods. Among various planting methods, highest crude protein (6.56%) content in gel was recorded with the raised bed planting. The different organic manure levels were influenced significantly on crude protein in gel. Among the different organic manure levels, highest crude (6.68%) protein content was recorded with application of vermicompost @ 5 t ha^{-1} and it was statistically at par with application of vermicompost @ 2.5 t ha^{-1} (Table 1). The interaction effect between planting methods and organic manure levels were found significant. The raised bed planting was obtained statistically superior over flat bed planting and it was at par with ridge and furrow planting at same level of application of vermicompost @ 5 t ha^{-1}. The application of vermicompost @ 5 t ha^{-1} was obtained statistically superior over application of FYM @ 5 t ha^{-1}, while it was at par with application of FYM @ 10 t ha^{-1} at same level of raised bed planting. The crude protein content in gel was increased with increased level of vermicompost might be due to enhanced nitrogen content in the respective treatments. The results are similar findings by Vasileva and Athar [12].

Crude fiber content

The crude fiber content in gel was influenced not

significantly due to various planting methods. Among various planting methods, Highest crude fiber (7.93%) content in gel was recorded with the flat bed planting. Lowest crude fiber content in gel was recorded with the raised bed planting. The crude fiber was influenced significantly due to various organic manure levels. Among the organic manure levels, significantly highest crude fiber (7.83%) content in gel was recorded with application of farm yard manure @ 5 t ha^{-1} and it was at par with application of vermicompost @ 2.5 t ha^{-1}. The lowest crude fiber content in gel was recorded with application of vermicompost @ 5 t ha^{-1} Various planting methods and different organic levels showed their interaction effect on crude fiber content of aloe vera. The flat bed planting was found statistically superior over flat bed planting, which was at par with ridge and furrow planning at the same level of application of farm yard manure @ 5 t ha^{-1}. The application of farmyard manure @ 5 t ha^{-1} was found superior over vermicompost @ 5 t ha^{-1}, which was at par with FYM @ 10 t ha^{-1} at same level of raised bed planting. Application of nitrogen had depressing effect on crude fiber content because it resulted in increased leaf weight and wider leaf-stem ratio which might had decreased the crude fiber content in sorghum Saini [13] reported that the decrease in crude fiber content was significant up to highest dose of nitrogen (125% of the recommended) having minimum value of 29.2% in comparison to 30.5 and 31.9% present in the crop plants received 100 and 75% nitrogen of the recommended dose, respectively.

Crude fat content

The crude fat content in gel was influenced not significantly due to various planting methods. Among various planting methods, highest crude fat content (2.74%) in gel was found with the raised bed planting. Lowest crude fat content in gel was found with flat bed planting. The crude fat was influenced significantly due to different application of organic manure levels. Among the organic manure levels, highest crude fat (2.80%) content in gel was obtained with application of vermicompost @ 5 t ha^{-1} which was at per with application of farm yard manure @ 10 t ha^{-1} and vermicompost @ 2.5 t ha^{-1} . The interaction effect between various planting methods and different organic manure levels were influenced significantly on crude fat content in gel. The raised bed planting was found to be statistically superior over flat bed planting, while it was at par with ridge and furrow planting at the same level of application of vermicompost @ 5 t ha^{-1} due to the release of higher plant nutrients for the aloe vara. This finding confirmed by Azam et al. [14] highest crude fat of fodder sorghum was recorded with the application of NPK fertilizers at the rate of 80–50–25 kg/ha as compare to other treatments. Saini [13] reported that the highest crude fat (2.18%) was obtained with the highest dose (125% nitrogen of the recommended) as compared to 2.06 and 1.89% with 100 and 75% nitrogen of the recommended dose, respectively. Similar result also found by Singh and Sumeriya [15].

References

1. Chen W, Lu Z, Viljoen A, Hamman J (2009) Intestinal drug transport enhancement by Aloe vera. Planta Medica 75 : 587—595.
2. Muhammad A, Zora S, Ahmad K (2009) Post harvest aloe vera gel-coating modules fruit ripening and quality of arctic snow nectarine kept in ambient and cold storage. Int J Food Sci and Tech 44 : 1024—1033.
3. Segovia PG, Mognetti C, Bello AA, Monzo JM (2009) Osmotic dehydration of aloe vera (*Aloe barbadensis* Miller). J Food Engg 97 : 154—160.
4. Saha R, Palit S, Ghosh BC, Mittra BN (2005) Performance of Aloe vera as Influenced by organic and inorganic sources of fertilizer supplied through fertigation. Acta Hort 2 : 676.
5. Xiu LC, Changhai W, Yongmei F, Zhaopu L (2006) Effect of heat treatment and dehydration on bioactive polysaccharide acemannan and cell wall polymers from *Aloe barbadensis* Miller. J Food Engg 75 : 245—255.
6. Vega–Galvez A, Uribe E, Lemus-Mondaca R, Miranda M (2007) Hot air-drying characteristics of aloe vera (*Aloe barbadensis* Miller) and influence of temperature on kinetic parameters. LWT-Food Sci Tech 40 : 1698—1707.
7. Vega–Galvez A, Notte–Cuello E, Lemus-Mondaca R, Zura L, Miranda M (2009) Mathematical modelling of mass transfer during rehydration process of aloe vera (*Aloe barbadensis* Miller). Food and Bioproducts Proc 87 : 254—260.
8. Khan MB, Rafiq R, Hussain M, Farooq M, Jabran K (2012) Ridge sowing improves root system, phosphorus uptake, growth and yield of maize *(Zea mays* L.) hybrids. J Anim and Pl Sci 22 : 309—317.

9. AOAC (2000) Official methods of analysis of the Association of Official Analytical Chemists. 15th edn. Association of Official Analytical Chemists inc. Suite 400 2200 Wilson Boulevard, Arlington, Virginia 22201, USA, pp 69—81.
10. Gomez KA, Gomez AA (1984) Statistical procedure for agricultural research. 2nd edn. John Wiley and Sons Publ.
11. Kothari SK, Reddy PS (2009) Response of safed musli (*Chlorophytum borivilianum* Santapau and Fernandes) to methods of planting, spacing, harvesting age and cropping system. J Medicinal and Aromatic Pl Sci 31 : 302—307.
12. Vasileva V, Athar M (2012) Effects of manure and mineral fertilizer application on crude protein content of lucerne (*Medicago sativa* L.). J Biol 2 : 1—4.
13. Saini A (2012) Forage quality of sorghum (*Sorghum bicolor*) as influenced by irrigation, nitrogen levels and and harvesting stage. Ind J Sci Res 3 : 67—72.
14. Azam M, Waraich EA. Pervaiz A, Nawaz F (2010) Response of a newly developed fodder sorghum (*Bicolor* L. Monech) variety (F-9917) to NPK application. Pak J Life Soc Sci 8 : 117—120.
15. Singh P, Sumeriya HK (2012) Effect of nitrogen on yield, economics and quality of fodder sorghum genotypes. Ann Pl Soil Res 14 : 133—135.