IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT)
e-ISSN: 2319-2402,p- ISSN: 2319-2399.Volume 11, Issue 9 Ver. II (September. 2017), PP 12-16
www.iosrjournals.org

Effect of Different Girth Classes on Gum Arabic Production from *Acacia senegal* in Arid Western Rajasthan

*Kamlesh Pareek, J. C. Tewari, Shiran K, M. K. Gaur, Anil Sharma and Vikash Chaudhary
ICAR-Central Arid Zone Research Institute, Jodhpur-342003, India
Corresponding Author: Kamlesh Pareek

Abstract: *Hot arid regions of India lies between 24-29^o North latitude and 70-76^o East longitude covering an area of 317000 sq. km, which are spread over in the state of Rajasthan, Gujarat, Haryana, Punjab, Telengana, Maharashtra and Karnataka. Particular in Rajasthan, Acacia senegal (L.) Willdenow or Acacia seyal (Fam. Leguminosae) is an important species, the source of gum Arabic is found in the desert state of Rajasthan, especially in arid western Rajasthan. It's habitats in arid western Rajasthan included rocky hills, sandy plains, sandy hummock and sand dunes After repeated trials and error, ICAR-CAZRI, Jodhpur standardized the dose of Ethephon treatment of A. senegal trees for enhanced recovery of gum Arabic. The present study deals with CAZRI developed gum Arabic production technology correlation between different girth classes and gum Arabic production pattern. From the data obtained, after treatment, maximum average gum yield (375g) were obtain from DBH group (51-60 cm) followed by DBH group of 41-50 cm, (average gum yield 322.5 g). In case of DBH group of 20-30 cm, average gum yield was 210 g. it clearly appeared that girth has positively correlation with gum yield. If CAZRI gum inducing technology is applied appropriately with vigorous outreach programmes, the species can be source of income it millions of people in Indian arid and semi-arid regions.*

Date of Submission: 09-09-2017 Date of acceptance: 20-09-2017

I. Introduction

A. senegal (L.) Willdenow or *Acacia seyal* (Fam. Leguminosae) (FAO 1999) is under dry tropical thorn forest in their classification of Indian forests. *Acacia senegal* is native to arid and semi-arid region of sub-Saharan Africa. This species is exotic but has been well naturalized in Indian sub-continent. Chaimphon and Seth (1968). This important species is prominently found in Rajasthan, especially in arid western Rajasthan. It is also found in other parts of India viz., of south-east Punjab, Gujarat, Madhya Pradesh, Maharastra and Haryana. Particular arid western Rajasthan, species were found in rocky hills, sandy plains, sandy hummocks and sand dunes. In extreme western fringes of arid western Rajasthan the species forms important component of traditional agroforestry system (Tewari and Pareek 2015).

A. sengal is commonly under canopy trees which generally attains height of 4.5 to 8.0 m however, in most conducive environmental conditions it can attain height up to 14-15 m. Trunk may vary in diameter often attain a diameter of 25 -35 cm. Bark is grayish white, although in some mature old trees it may be dark, scaly and thin. (Hocking 1993).

A. senegal is main tree component in rocky land forms of arid western Rajasthan. Rocky-semi-rocky land forms are spread over in 12% area of arid western Rajasthan which accounted to be 23,520 sq km. In such land forms *A. senegal* can be a source of income to the farmers if they get some quantity of gum from the trees. The species is known for its edible high quality gum, commonly known as gum Arabic. Gum Arabic is "a dried exudates" obtained from the stems and branches of the species (FAO 1999). India has been a net importer ever since gum Arabic trade has got in its present shape in organized form. Imports, mainly from Sudan and Nigeria (the top gum Arabic producers), are needed to meet the country's requirements. Imports have increased from 4048 tons in 1992 to 26,098 tons in 2011 (UN Data 2011). India has the potential to produce independently a much higher quantum of gum Arabic because *A. senegal* trees are distributed abundantly throughout the arid and semi-arid tropics which constitute approximately 40% of the geographical area of the country. Tewari *e.t al.* (2017) stated that untapped trees or traditional gum tapping method did not produce at all or produced little gum implying that tapping is an important management tool for enhancing gum productivity. Moreover, most important issue is that this rich natural source of the country has left mostly un-tapped because in traditional gum tapping method in which the tree trunks are blazed as various parts of the stem results in production of only 15-45 g gum Arabic/ tree, which is not economically viable and as well as harmful for tree health.

Ethephon (2-chloroethylphosphonic acid) is a synthetic compound of ethylene, phosphate and chloride ions. It is a commonly known as plant growth regulator. In plant increased rates of ethylene biosynthesis

induced by stress activate various developmental responses and gum exudation may be considered as one such developmental response to stress (Hall and Smith 1995). The idea to use Ethephon as gum inducer came from the thought that if ethylene is supplied artificially to the tree via the application of Ethephon, the developmental response to stress could be accelerated, and, consequently, more gum exudates could be obtained. On the basis of this assumption, ICAR- Central Arid Zone Research Institute (ICAR-CAZRI), Jodhpur developed a technology to exude higher quantum of gum Arabic from abundantly distributed *A. senegal* tress in arid western Rajasthan. Paper describes CAZRI gum exudation technology in correlation between different girth classes Vs gum Arabic yields.

About Arid Western Rajasthan

Hot arid regions of India lies between 24-29^{o} North latitude and 70-76^{o} East longitude covering an area of 317000 sq. km, which are spread over in the state of Rajasthan, Gujarat, Haryana, Punjab, Telengana, Maharashtra and Karnataka. Arid western Rajasthan which cover an area of 196000 sq. km (about 61% of total area of Indian hot arid zone) of Indian hot arid zone is considered as principal hot arid region of country (Fig.1). Production and life support system in arid western Rajasthan are constrained by climatic limitations such as, low annual precipitation (100-300 mm/year); very high summer temperature touching a maximum sometimes 48^{o}-50^{o} C; short cool and dry winters; high wind speed (30 to 40 km/hours); high evapo-transpiration; and low humidity (aridity index 0.045- 0.19) (Tewari et al. 2007). Abnormal rainfall and droughts are common features of the tract. Sand dunes are dominant land form. In general soil contains 1.8-4.5 % clay, 0.4-1.3% silt, 63.7-87.3% fine sand and 14.3 -30.3% coarse sand (Narain and Tewari 2005). *A. senegal*, the source of gum Arabic is found prominently in extreme western part of arid western Rajasthan however, it is also distributed in many other arid and semi-arid areas of the state.

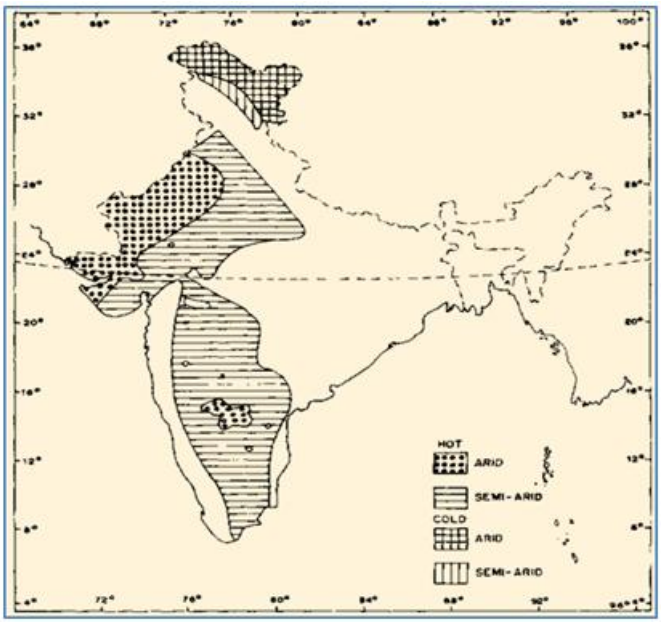

Fig.1. Arid regions of India

II. Material and Methods

The Technology

After repeated trials and error, ICAR-CAZRI, Jodhpur standardized the dose of Ethephon treatment of *A. senegal* trees for enhanced recovery of gum Arabic. It was found that Ethephon solution containing 780 mg active ingredient/4 ml was found optimum dose for maximum yield of gum Arabic. The standardized Ethephon solution for gum Arabic production is giving the name- CAZRI gum inducer. Application of CAZRI gum inducer on *A. senegal* trees was done as follows.

A 50^{o} downward slanted hole of 14- 16 mm in diameter and about 4 cm deep was made on the tree trunk (35-50 cm above the ground) using a hand or electrical drill. This technique was used to ensure that maximum amount of the applied CAZRI gum inducer was utilized by the tree for the process of gum exudation. One 4-ml dose of CAZRI gum inducer is applied. After the treatment, the hole was covered with moistened clay/ natural bee wax. Whole procedure of ethephon-induced gum Arabic exudation technique is shown in Fig. 2. In this method Ethephon which is directly injected into the tree trunk reaches rapidly in plant tissues involved in gum production.

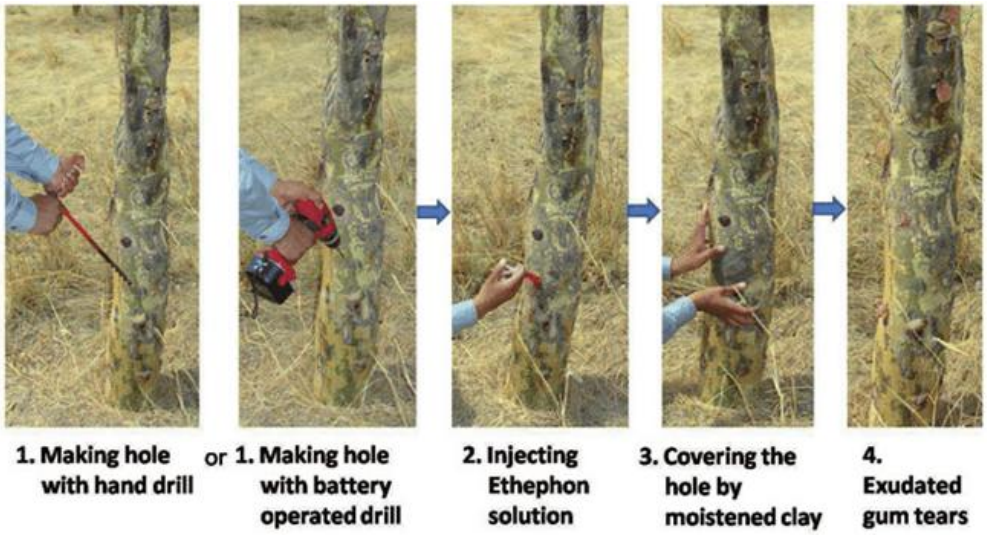

Fig. 2 Steps followed for application of CAZRI gum inducer to enhance gum Arabic production from *A. senegal*

Gum Production from *A. senegal* in Relation to Tree Basal Area

Two experiment sites with same age of plantation year (1990) were carried out in silvatum of CAZRI, Jodhpur where soil is shallow with murum layer just below 1.0 meter depth. With the help of satellite remote sensing, GPS data were collected using Garmin Montana 650 of all two experimental sites (Fig.3). Seventy trees of *A. senegal* of uniform age having different DBH were selected to form seven DBH classes. Thus, each DBH classes was represented by ten trees (DBH= 20-30 to >90 having interval of 10 cm) which were treated as per standard procedure using 4 ml of CAZRI gum inducer during first week of April, 2013. Gum exudation was initiated ten day after the treatment was employed and continued up to forty days from date of treatments (Fig 4).

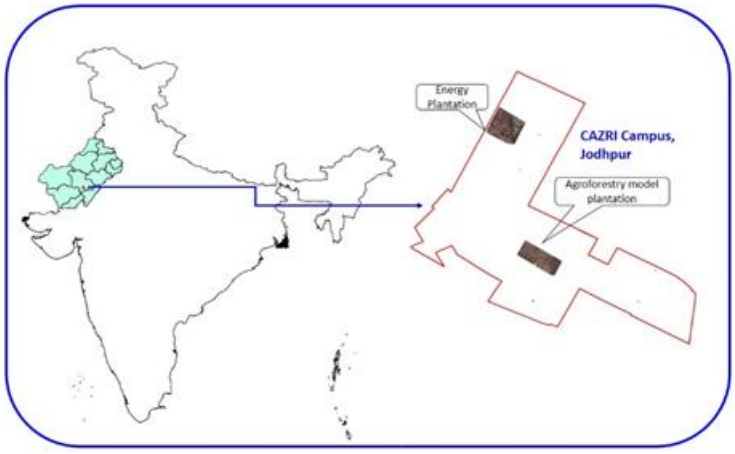

Fig3. Two experimental sites of *Acacia senegal* silvatum of CAZRI, Jodhpur

Fig.4. Gum Arabic exuded from stem and branches treated tree of Acacia senegal

III. Results and Discussion

Gum Production from *A. senegal* in Relation to DBH of Trees

A study of gum exudation in relation to different girth classes in *A. senegal* was carried out at CAZRI research farm. Girth and gum yield were recorded after treatment of CAZRI gum inducer. Gum yield was monitored at regular intervals (Fig.4). Standardized does of CAZRI gum inducer was given to every single tree in each group. After treatment, maximum average gum yield (375g) were obtain from DBH group (51-60 cm) followed by DBH group of 41-50 cm, (average gum yield 322.5 g). In case of DBH group of 20-30 cm, average gum yield was 210 g. From the study it appeared that girth has positively correlation with gum yield. It is evident from Fig. 4 that 51-60 cm and 41-50 cm DBH classes produced maximum gum Arabic. Beyond these classes gum yields showed a more or less positively correlated in between different girth classes trends (**R^2 = 0.1112)**. It has observed that average gum yield increase up to (25.49g./tree) in between 20-30 to 51-60 girth classes. Perhaps, some other factors playing an important role in variation of gum yield.

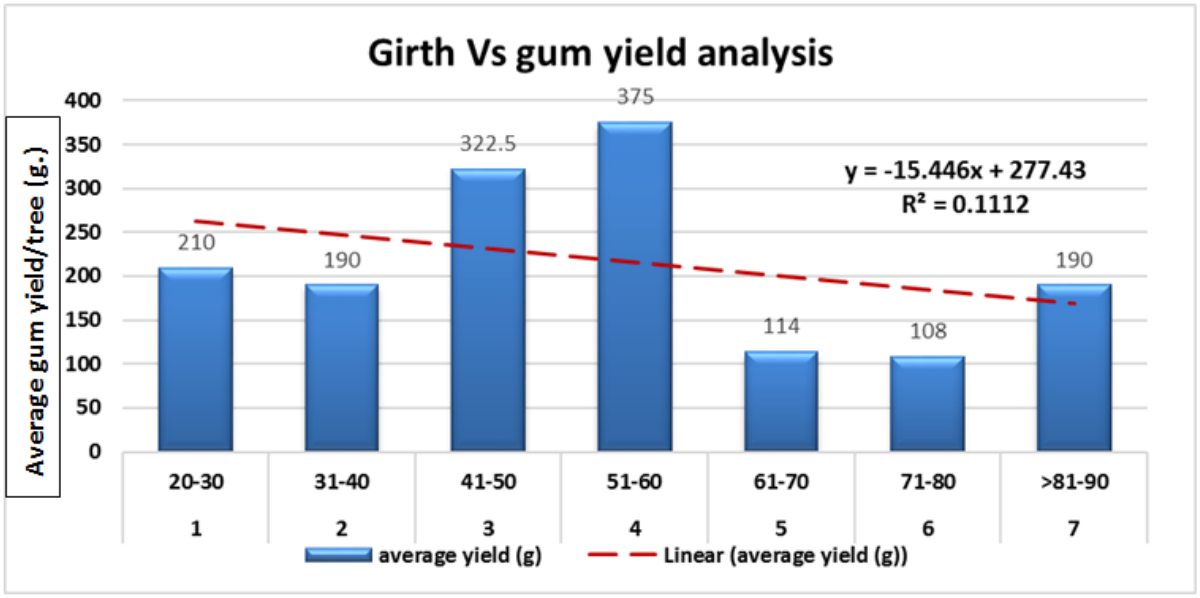

Fig.4 DBH groups Vs gum yield analysis of *Acacia senegal*

IV. Conclusion

The procedure employed in the present study causes no injury to trees of *A. senegal*. In case of traditional method by blazing the tree stems, in one hand the gum production is very low (30-40 g/tree) and on the other trees are injured to very high extent, which even some time causes large scale mortality. Results obtained during the present course of experimentations indicated that gum Arabic exudation after treatment of CAZRI gum inducer continued up to one month or little more. On an average by using CAZRI gum inducer technology gum yield was 375 g/tree obtained. It was also observed that there is positively correlation between tree girth classes and gum exudation. This might be due to the abundance of vascular bundles rich of rays, which are responsible for preserving gum deposits. Seif Eldin (1996) also maintained that wood is characterized by the presence of numerous rays in which gum deposits could be observed. It appear that there is some genetic X environmental effects such as tree age and size, genetic source of seeds, variation in soil fertility, density of grasses under the tree, space between trees, and the weather play some role in production of gum (Ram *et al*., 2012).

Gum Arabic is a commercially important commodity which is used in food industries, dairy products, bakery products, flavour fixative, beverages and in pharmaceutical industry for processing many preparations. The market cost of pure gum Arabic in India ranged from Rupees 1200-1500/ kg (18.46 – 23.07 US $/ kg). It has many others application ranging from cosmetics to textile. If CAZRI gum inducing technology is applied appropriately with vigorous outreach programmes, the species can be source of income it millions of people in Indian arid and semi-arid regions. Gum Arabic plays an important role in rural life, providing an additional income to rural families especially in years when productions of crops fail (Chikemi, *et al* 1997). The researches described in this paper if adopted precisely, the technology has potential to change scenario of gum Arabic production of India.

Acknowledgement

Research was funded by "Network project of Harvesting, Processing and Value addition of Natural Resins and Gums" Indian Institute of Natural Resins and Gums, Namkum, Ranchi, India. We thank to Coordinator of the project and Director, IINRG, Namkum, Ranchi for their support.

References

[1]. Bhatt JR, Ram Mohan YH.. Ethephon-induced gum production in *Acacia senegal* and its potential value in the semi-arid regions of India. *Current Sci.* 59(23), 1990,1247–1250.
[2]. Champion HG, Seth SK. (1968). A Revised Survey of the Forest Types of India. Delhi: *Manager of Publications*.
[3]. Chikemi, BN, Casadei E, Coffen, JJ W, Abdel A, HO and Cesareo D. (1997). A Review of production, marketing and quality control of gum Arabic in Africa.
[4]. Diallo, AM, Nielsen, LR and Hansen, JK. Study of quantitative genetics of gum Arabic production complicated by variability in ploidy level of *Acacia senegal* (L.) Willd *Tree Genetics & Genomes* 11(80), 2015, 1-13.
[5]. FAO. (1999). Compendium of food additives specifications. Rome: FAO. Food and nutrition paper 52, addendum 7, Gum Arabic.
[6]. Hall MA, Smith AR.. Ethylene and the responses of plants to stress. *Bulg J. Plant Physiol*. 21 (2–3), 1995,71–79.
[7]. Hocking, D. Trees for Drylands. Oxford and IBH Publishing Co., Pvt., Ltd., New Delhi-Bombay-Calcutta, (1993) 370 p.
[8]. Kaul RN and Chitnis BK. Kummat-the tree of the rocky desert. *Indian Farming*, 13 (12), (1964) 9-10.
[9]. Narian P and Tewari JC. Trees on agricultural fields: a unique basis of life support in *Thar* desert. In *Multipurpose Tree in Tropics: Management and Improvement Strategies (eds.)* V.P. Tewari and R.L. Srivastava (MoEF, Gol; APAFRI; Goethe-Institute, Max Muller Bhwan, New Delhi; DST, GoI: National Medicinal Plant Board, New Delhi), Arid Forest Research Institute, Jodhpur, (2005) pp. 516-523.
[10]. Ram M, Tewari JC and Harsh LN. An Improved Gum Tapping from *Acacia senegal*: An Option for Better Livelihood. *LAP Lambert Acedemic Publishing Company*, Saarbrucken, Germany, (2012), p 78.
[11]. Seif AG and Zarroug, M. (1996). Production and Commercialization of Gum Arabic in Sudan. In: *Domestication and Commercialization of Non-Timber Forest Production in Agroforestry Systems*, Working Paper Record No. FNC11/1966, *Forests National Corporation*, Khartoum-Sudan.
[12]. Tewari JC and Pareek K. Annual Progress Report on *Network Project on Harvesting, Processing and Value Addition of Natural Resins and Gums, CAZRI Centre*, ICAR-CAZRI, Jodhpur, (2012) 17p
[13]. Tewari JC and Pareek K. Annual Progress Report on *Network Project on Harvesting, Processing and Value Addition of Natural Resins and Gums, CAZRI Centre*, ICAR-CAZRI, Jodhpur, (2016) 26p.
[14]. Tewari JC, Kumar S, Ratha Krishnan P, Ram Moola and Sharma AK.. *CAZRI's Experiences with Ethephon Induced Gum Exudation: Research and Development in Arid Regions.* CAZRI, Jodhpur, (2012) 15p.
[15]. Tewari JC, Pareek K, Shiran K, Niranjan P. On Exudation of Gum Arabic through Advance Technology. *Int J Environ Sci Nat Res*. 2(5), (2017) 555596.
[16]. Tewari JC, Sharma AK, Narain P and Singh R. Restorative forestry and agroforestry in hot arid region of India: A review. *Journal of Tropical Forestry* (23 (i &ii), (2007) 1-16.
[17]. UN data. (2011). [Internet]. [accessed 2013 May 14]. Available from: http://data.un.org/Data.aspx?q¼gumþarabic&d¼ComTrade&f¼_l1Code%3a14%3bcmdCode%3a130120.

Kamlesh Pareek. "Effect of Different Girth Classes on Gum Arabic Production from Acacia senegal in Arid Western Rajasthan." IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT), vol. 11, no. 9, 2017, pp. 12–16.