Influence of tapping position, intensity of tapping and season on gummosis of guggal (Commiphora wightii), oleo-gum-resin yield and quality

JATINDRA NATH SAMANTA1, KUNAL MANDAL2, RAJU SARAVANAN3, NARENDRAATMARAM GAJBHIYE4 and VELUMANI RAVI5

ICAR-Directorate of Medicinal and Aromatic Plants Research, Anand, Gujarat 387 310

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ABSTRACT

The experiment was conducted during 2009 and 2010 to find out different tapping position on the guggal plant [Commiphora wightii (Arn.) Bhand.] with varying intensity of tapping to maximize the gum production and tested them at different seasons to know the gum production potential as well as the quality changes with respect to different seasons. Favourable soil moisture and plant water status critically enhanced physiological functions which resulted in higher energy status, sap flow and turgor to enable gum oozing without break. Multiple tapping at different locations proved to be superior to single tapping. To maximize guggal yield, multiple tapping is needed at the right season. Wound created during tapping on the bark promoted wound response by inducing the resin ducts to release the oleo-gum to seal the wound.

Key words: Guggal, Gummosis, Oleo-gum-resin yield, Season, Tapping

The indigenous technique of guggal [Commiphora wightii (Arn.) Bhand.] gum extraction involves making multiple bark–deep incisions on the stems of trees and use a suspension or slurry of guggal gum to flood the injured area (Mandal et al. 2011). Gum starts oozing after few days from these sites. There is a causal link between infection of pathogenic bacterium Xanthomonas auxonopodis introduced during tapping of stem and gum exudation in guggal (Samanta and Mandal 2014, Samanta et al. 2012). The tapped trees die invariable due to the infection. It was postulated that plant death following gum oozing could be due to physiological disturbances or involvement of pathogens in the process (Samanta and Mandal 2014).

Bacterial infections in plant tissue lead to localized wound responses and hence, the induction of oleo gum resin production in response to such infection might be localized in the stem tissue while tapping. Since, guggal is a slow growing species and it takes at least 5-6 years for the plants to attain tapping maturity, death of the plant after tapping becomes a severe limitation to guggal gum production. There is an urgent need to utilize the gum extraction to the fullest potential from each tree before it dies. It would be possible to increase the quantum of gum production by multiplying gum oozing sites on guggal plant through repeated wounding. With this aim, we tried different tapping position on the plant with varying intensity of tapping to maximize the gum production and tested them at different seasons to know the gum production potential as well as the quality changes with respect to different seasons. Our results were encouraging in terms of higher gum production and we could identify the seasonal effect on gum quality.

MATERIALS AND METHODS

Bacteria associated with plant material were isolated by standard methodology (Samanta et al. 2012) and utilized for induction of gummosis. The experiment was conducted during 2009 and 2010 at the research farm of Directorate of Medicinal and Aromatic Plants Research (22° 35' N, 72° 56' E).

For the study on effect of seasons on gum yield and quality, field-grown plants (>5 years old, r = 4) were tapped in four different seasons—post winter (February), summer (May), post–rainy (September) and winter (December)—with ~108 cfu/ml bacterial suspension. Gum was collected from the tapped positions and yield was recorded. To study the influence of different tapping positions (main trunk, M; primary branch, P; secondary branch, S and tertiary branch, T) on gum yield, of mature guggal plants (>7 years old) were tapped to as explained earlier. Each tree was considered as a replication and 10 replications were maintained for each treatment. In another experiment, five different treatments, comprising different combinations of tapping sites were maintained. Individual plants were tapped

1Executive R & D (Microbiology) (e mail: jatinsamanta@gmail.com), 2Principal Scientist (e mail: mandal_kunal@yahoo.co.in), ICAR-CRIJAF, Kolkata; 3Senior Scientist (e mail: rajusar@gmail.com), 4Principal Scientist, ICAR-CTCRI, Thiruvananthapuram, Kerata; 5(e mail: gajbhiye_narendra@yahoo.co.in), ICAR-DMAPR, Anand, Gujarat.
Seasonal influence and plant water relationship on guggal yield

Guggal plant growth pattern, leaf production and canopy coverage varied with seasons. As expected, the results of tapping at different seasons clearly demonstrated that seasons greatly influenced the gum yield and quality of oleo-gum. Plants tapped in the month of September produced the highest gum (49.4±3.4 g/plant), while it was the lowest in plants tapped during May (3.1±0.6 g/plant). December and February tapping produced similar gum yields. The plant water potential ($Y_w$) was significantly different during growth phases and influenced by the season (Fig 1). Post monsoon period had the highest soil moisture content (12-13%) as well as lowest $Y_w$ (~0.8 MPa), whereas, during the month of May the soil water potential was lowest with relatively moderate $Y_w$ (~ 0.6 MPa). December and February tapping coincided with higher $Y_w$ (0.4 MPa to 0.6 MPa). Guggal gum yield in different seasons was indirectly influenced by the soil moisture content. The gum yield at different seasons showed positive correlation with soil moisture level (Fig 2A). The month of May was characterized by very low soil moisture and the least quantity gum production. Whereas, the month of September had higher soil water with highest gum yield (Fig 2B). December and February tapping resulted in intermediate gum yields which were lower than that of the September and significantly higher than that of the May. The $Y_w$ and seasonal gum tapping indicated a clear pattern of lower gum yield with lower plant water status (Fig 2 C). Although the individual plants showed variations in terms of gum yield during September tapping, the gum yield was superior compared to other seasons.

Intensity and tapping position on gum yield

From a single portion of stem, the highest gum yield (81.1±15.1 g/plant) was obtained at the collar region of the main branch, while tapping on twig produced the lowest

![Fig 1 Soil moisture content (%), plant water potential (MPa) and guggal gum yield during different tapping seasons](image1)

![Fig 2 Correlation matrix of plant water potential with soil moisture content (A), gum yield with soil moisture content (B) and gum yield with plant water potential (C) in guggal during different tapping seasons.](image2)
INFLUENCE OF TAPPING ON GUMMOSIS OF GUGGAL

Gum (2.7±0.7 g/plant) (Fig 4). Profuse gummosis after tapping of the main stem and primary branches resulted in continued gum exudation which lasted for a fortnight before cessation of gum production. The bark thickness and amount of resin ducts per unit area might have contributed to the higher gum exudation on main stem. Plants tapped at five positions (T5) produced the highest gum (175.0±9.0 g/plant), while it was the lowest when tapped at two primary branches (71.0±6.6 g/plant) (Fig 5).

Influence of season on guggal quality

Guggal gum composition in terms of gugglostreon–Z and gugglostreon–E significantly varied due to the season of tapping. Seasonal influence followed increasing trend towards the drier months starting from September tapping which was immediately followed the monsoon. There was a greater variation in gugglostreon–Z compared to gugglostreon–E. The content of gugglostreon–Z varied from...
0.2% during September tapping to 0.6% in the (3 fold) month of May. The change in gugglostreon–E content in the oleo-gum resin was not appreciable in different tapping seasons. September tapping coincided with post-monsoon growth flush of guggal with maximum canopy coverage and higher plant photosynthetically active phase. The transpiration demand was also high during this period due to higher leaf area. During the December and February tapping, the soil moisture depletion did not lead to severe stress due to the natural adaptation of guggal to prolonged soil moisture depletion. However, during the summer months of April and May posed extreme stress situation due to lower soil moisture, high ambient temperature coupled with high solar radiation. When drought is prolonged Oleoresinosis in trees such as, pine and fir is reduced owing to lower substrate and/or energy availability (Lorio 1988). The $Y_w$ was reduced markedly due to the complete canopy cover and larger leaves immediately after monsoon. Guggal sheds leaves during winter and produces smaller leaves in dry seasons to conserve water. The higher photosynthetic potential during post monsoon was partly responsible for increased gum yield.

Tapping during the month of December and February coincided with higher water status of guggal due to lower transpiration demand. Plant water potential remained favorable during these months due to winter season. Samanta et al. (2012) indicated that higher guggal growth rate and oleo-gum resin yield could be achieved by maintaining soil moisture levels between field capacity and 20%. Drought has differential influence on above- and underground growth of plants and profound negative effect on shoot growth (Xu et al. 2009, Álvarez et al. 2011). Loblolly pine which produces resin when induced, produce lower resin when extreme drought stress occurs during late summer season (Lorio and Hodges 1968, Lorio et al. 1995, Lombardero et al. 2000). Extreme water deficits can ultimately lead to a collapse of the carbon allocation to secondary metabolism (Herms and L Mattson 1992). Induced increases in resin flow of pine trees, however, were greatest in the fastest growing trees during the season of greatest growth and decreased during stress conditions (Lombardero et al. 2000).

Favorable soil moisture and plant water status critically enhanced physiological functions which resulted in higher energy status, sap flow and turgor to enable gum oozing without break. May was the hottest month tested for tapping and many plants, which were otherwise productive failed to produce gum. Multiple tapping at different locations proved to be superior to single tapping. Wound created during tapping on the bark promoted wound response by inducing the resin ducts to release the oleo-gum to seal the wound. Since, wound response can be localized or systemic, it will be interesting to understand the extent of these local or systemic responses contribute to the gummosis of guggal. To maximize guggal yield, multiple tapping is needed at the right season. Tapping at multiple sites of a same tree is practiced in other species such as, Boswellia papayrifera to maximize gum yield (Mengistu et al. 2012). Since, guggalstroene is the active constituent of guggal, any increase in its content indicates positive influence and improvement in quality of guggal.

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