



## Effect of diameter class, ethephon concentration and environment variables on gum production from *Acacia tortilis* in arid zone of western Rajasthan

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**Abstract:** *Acacia tortilis* is one of the important tree species for gum production in arid regions of western Rajasthan. However, the studies are lacking in standardization of gum production in this species. Therefore, study was carried out to standardize the ethephon dose in various diameter classes and the effect of climatic factors on gum production in different seasons. Results showed that the high statistical difference for gum yield in different season and different diameter classes with varying concentration of ethephon. The production of gum was more in summer season (S1) i.e., 298.2 g tree<sup>-1</sup>, diameter class (D3) (293 g tree<sup>-1</sup>) and ethephon treatment (T2) (314.7 g tree<sup>-1</sup>). Correlation and regression analysis showed high association of gum yield with temperature and relative humidity. The regression analysis revealed 99% and 86% variability in gum yield due to mean temperature and mean relative humidity, respectively. The results will help in using the standardized dose of ethephon in various diameter classes along with understanding the effect of various climatic factors on gum production in *A. tortilis*.

**Key words:** *Acacia tortilis*, gum production, ethephon, temperature, relative humidity.

*Acacia tortilis* is one of the important species of genus *Acacia* belonging to family Leguminaceae. *Acacia tortilis* (Israeli babool) was introduced from Israel to India during 1958 by the ICAR-Central Arid Zone Research Institute, Jodhpur and it has been found a very promising species particularly for sand dune stabilization (Muthana and Arora, 1979). It has the ability to survive in harsh conditions, withstand drought and flood condition, tolerate salinity and seasonal water logging.

It yields fuel woods; leaves are lopped for fodder and fruits also form good fodder for the livestock. Being thorny species, it is widely used as fence around fields and act as shelter belts. The species also yields gum which is having high medicinal properties and has number of therapeutic applications. The properties of gum are like gum arabic and known as 'poor man gum'. The gum obtained from *Acacia tortilis* is used as a food additive and also for medicinal purposes (Yadav *et al.*, 2013; Shiran *et al.*, 2018). However, like *Acacia senegal* the natural gum production from this species is very less. Therefore, ethephon is used as inducer for increasing gum production from trees. However, increasing concentration of ethephon ensure higher gum production. Ethephon concentration, more than optimum

amount leads to death and die back of trees (Das *et al.*, 2014; Raj and Jhariya, 2021). So, there is need to standardize the concentration of ethephon to be used for gum production from this species.

In addition to these, various factors such as site quality, soil nutrients, tapping techniques, tree growth parameters (height and girth) affects the yield of gum. Tree girth significantly affects gum yield (Unanaonwi and Bada, 2013). The yield of gum is reported to be directly influenced by various environmental factors like temperature, rainfall and relative humidity at tapping time (Ballal *et al.*, 2005; Raj and Jhariya, 2021).

Mostly the gum trade is mainly focused on *Acacia senegal* which is known to have best quality. However, the species is overexploited looking into the demand of the market and *A. tortilis* can be a appropriate alternative with equal quality, easy availability and better price. Thus, structural analysis of polysaccharide from *A. tortilis* revealed that it is useful for neutraceutical, pharmaceutical and biological application of the gum exuded (Lakhera and Kumar, 2017). Therefore, this study aims to evaluate the gum exudation potential of *Acacia tortilis* in different girth classes in different season with different concentration of ethephon.

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## Materials and Methods

### Experimental site

The study was conducted on research farm of ICAR-Central Arid Zone Research Institute, Jodhpur in year 2018-19 (26°14' N 72°59' E and altitude of 216 m) The average annual rainfall of 360 mm is received mostly during July - October with mean maximum air temperature of 45°C. Three distinct seasons are observed in the year, as summer (March-June), rainy (July-October) and winter (November-February). The soil of the experimental site is classified as coarse loamy Typic haplocambids. At 0-15 cm soil depth pH of soils varied from 8.0 to 8.3 and have 0.14% organic carbon, 14.20 kg ha<sup>-1</sup> available P, 250.6 kg ha<sup>-1</sup> available K (Fig. 1).

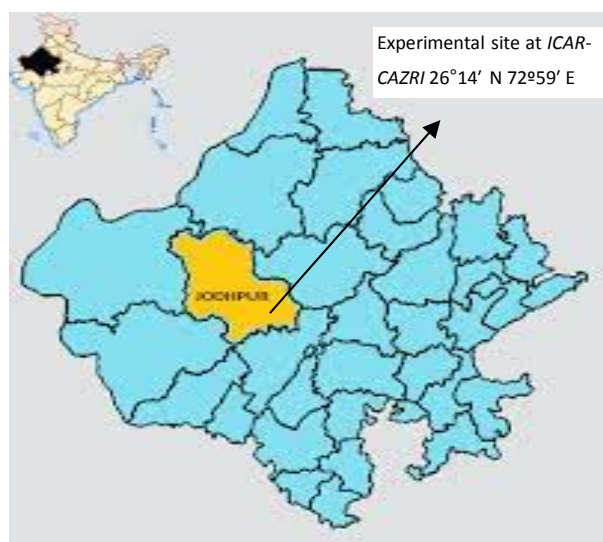


Fig. 1. Map of the experimental site.

### Methodology

A total of 54 *A. tortilis* trees were selected in different diameter classes for gum exudation studies. The experiment was conducted in three factorial randomized block design with three replications. The first factor is diameter class i.e. 7-14 cm (D1), 14-21 cm (D2) and >21 cm (D3), second factor is ethephon concentration i.e. T1 (97.5 mg ml<sup>-1</sup>) T2 (195 mg ml<sup>-1</sup>) and T3 (390 mg ml<sup>-1</sup>) and third factor is seasons summer (S1) and winter (S2). Therefore, 54 trees were selected for treatment with uniform allocation of each treatment to each tree i.e. 18×3=54 treatment combination in three replications were applied. The girth of the trees was measured using measuring tape. Then

girth was converted to diameter using formula Diameter=Girth/ $\pi$ . The gum tapping was done by making 50° downward slanting hole (14-16 mm diameter and 4 cm deep) on the tree trunk by using hand or electrical drill. The different dose of ethephon is applied through the hole. After the treatment, the hole was covered with moistened clay. The data on gum yield was recorded after 7-10 days. The observations viz., gum yield/tree, rate of gum exudation (RGE) (g tree<sup>-1</sup> day<sup>-1</sup>), time of treatment (o' clock on a given day), temperature (°C) and relative humidity (%) were recorded. The treatment was given in two different seasons i.e. summer and winter. The treatments were given during April and May for summer season and January and February for winter season during in all the selected trees. The production of gum started in 7-10 days. The gum was collected in different pickings and yield of each picking was summed up to get the total yield of gum from each tree. Rate of gum exudation was calculated by dividing total gum yield from a single tree by number of days to obtain that yield.

### Statistical analysis

The data obtained were statistically analyzed by ANOVA for 3×3 factorial RBD using the SPSS software package (SPSS v.22; SPSS, Armonk NY). Duncan's multiple range test was performed at P=0.05 to separate the treatment means within each measured parameters.. Pearson's correlation coefficient and regression analysis was used to measure the strength of the association between the two variables.

## Results and Discussion

### Gum yield

Gum yield showed significant differences (P<0.01) among the treatments viz., different seasons, different diameter classes with different concentration of ethephon. The yield of gum was ranging between 224.3 to 314.7 g tree<sup>-1</sup> over the mean of seasons and diameter classes. However, among the diameter classes highest gum yield was in diameter class D3 (293 g tree<sup>-1</sup>). The ethephon treatment T2 gave maximum gum yield of 314.7 g tree<sup>-1</sup> while Summer season had greater yield (298.2 g tree<sup>-1</sup>) of gum than winter season. The gum yield was significantly higher by 42% and 6.08% in diameter class D3 compared to D1 and D2. Tree girth has significant effect on

Table 1. Mean effects of season, diameter class and ethephon concentration on gum yield from *Acacia tortilis*

| Treatments                 | Gum yield (g tree <sup>-1</sup> ) |
|----------------------------|-----------------------------------|
| Seasons (S)                |                                   |
| Summer (S1)                | 298.2 <sup>a</sup>                |
| Winter (S2)                | 218.5 <sup>b</sup>                |
| Diameter classes (D)       |                                   |
| D1                         | 206.5 <sup>b</sup>                |
| D2                         | 276.2 <sup>a</sup>                |
| D3                         | 293.0 <sup>a</sup>                |
| Ethephon concentration (T) |                                   |
| T1                         | 236.0 <sup>b</sup>                |
| T2                         | 314.7 <sup>a</sup>                |
| T3                         | 224.3 <sup>b</sup>                |
| Significance               |                                   |
| S                          | ***                               |
| D                          | ***                               |
| T                          | ***                               |
| S×D                        | NS                                |
| S×T                        | *                                 |
| D×T                        | NS                                |
| S×D×T                      | NS                                |

NS: Non-significant; \*P < 0.05; \*\*P < 0.01; \*\*\*P < 0.001; Different letters indicate significant differences according to the Duncan's multi-range test (P ≤ 0.05)

gum yield and yield increases as the girth of tree increases (Unanaonwi and Bada, 2013; Pareek *et al.*, 2017). Increasing girth of the tree maximize gum duct formations that ensure higher gum production through tapping. The gum production was higher in summer season which was further enhanced by higher ethephon concentration with higher girth class (Raj and Jhariya, 2021). The interaction of season and ethephon concentration was also found significant; however no significant interaction was observed among season and diameter class, diameter class and ethephon concentration and among the all three treatments (Table 1). Gum production is more in summer season due to high temperature and less relative humidity (Vasishth and Guleria, 2017) and ethephon works more efficiently by release of more ethylene in summer season (Raj and Jhariya, 2021).

#### Relation between seasonal gum yield and picking time of gum

The correlation studies carried out between the season of gum tapping and the gum yield

and it revealed that summer season is highly correlated with the production of gum. The gum was collected in three pickings and all the three pickings showed significant positive correlation with gum yield from *A. tortilis*. The highest correlation  $r=0.863$  (P<0.01) was between the second picking of gum and gum yield. Whereas, in winter season no correlation and even negative correlation between gum picking and gum yield was found (Table 2). The time of gum picking is very important for gum collection. The maximum gum yield is generally obtained from first and second picking. The general time interval in various pickings of gum is 8-10 days. Similar results with high correlation ( $r=0.93$ ) of gum yield of first pick with total yield of gum in *A. senegal* was reported by Ballal *et al.* (2005). Adam *et al.* (2011) reported the highest gum yield in third picking out of total five pickings of gum in *Acacia polyacantha*. They observed that there was a considerable variation in the gum yield from pick to pick and from tree to tree. The variation in gum yield in different pickings can be attributed to climatic factors and management practices.

Table 2. Pearson correlation coefficients (r) between seasonal gum yield and picking time of gum

| Parameters              | Gum yield            |        |
|-------------------------|----------------------|--------|
|                         | Summer               | Winter |
| 1 <sup>st</sup> picking | 0.861**              | .153   |
| 2 <sup>nd</sup> picking | 0.863**              | -.045  |
| 3 <sup>rd</sup> picking | 0.763*               | -.123  |
| ** Significant p<0.01   | * Significant p<0.05 |        |

#### Relationship between climatic factors (Temperature and Relative humidity) and gum yield

The gum production from *A. tortilis* was recorded in both summer and winter season. Trees which were treated in summer season (April and May) gave the higher yield (298.2 g tree<sup>-1</sup>) compared to the trees tapped in winter season (Januray-February) (Table 3). Generally, it can be inferred from the data that production of gum is high from the trees when they are tapped in summer season. The production of gum from *A. tortilis* species is illustrated in Fig. 2.

During the treatment of trees, the temperature in summer season was high (32.8-34.0°C) and relative humidity (25.1-32.4%) was low and



Fig. 2. Gum exudation from *Acacia tortilis* trees.

Table 3. Effect of temperature and relative humidity in various seasons on gum yield

| Seasons | Month    | Temperature (°C) | Relative humidity (%) | Gum yield (g tree <sup>-1</sup> ) |
|---------|----------|------------------|-----------------------|-----------------------------------|
| Summer  | April    | 32.8             | 25.1                  | 298.2                             |
|         | May      | 34.0             | 32.4                  |                                   |
| Winter  | January  | 17.6             | 52.3                  | 218.5                             |
|         | February | 19.2             | 44.1                  |                                   |

hence the production of gum is high i.e. 298.2 g tree<sup>-1</sup>. On the other hand temperature was low (17.6-19.2) and relative humidity was high (44.1-52.3%) during winter season and hence the production of gum was lesser than summer season that was 218.5 g tree<sup>-1</sup> (Table 3). the high positive correlation observed between the

mean temperature and the gum yield ( $R=0.99$ ) in correlation analysis.. The regression analysis showed that 99% variability in gum yield is explained by the mean temperature during the treatment of trees for gum production (Fig 3). Similar results are reported on positive

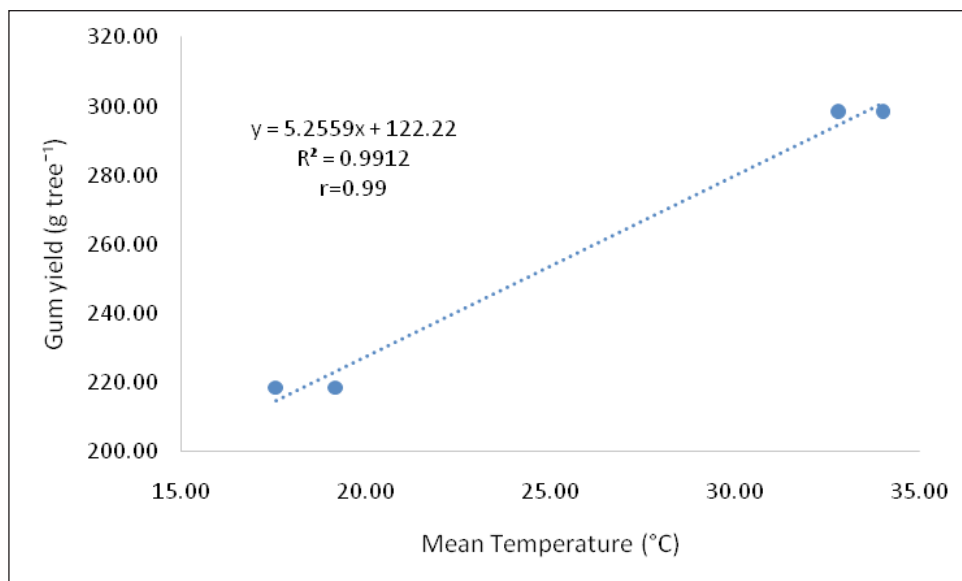


Fig. 3. Regression analysis between mean temperature (°C) and gum yield (g tree<sup>-1</sup>).

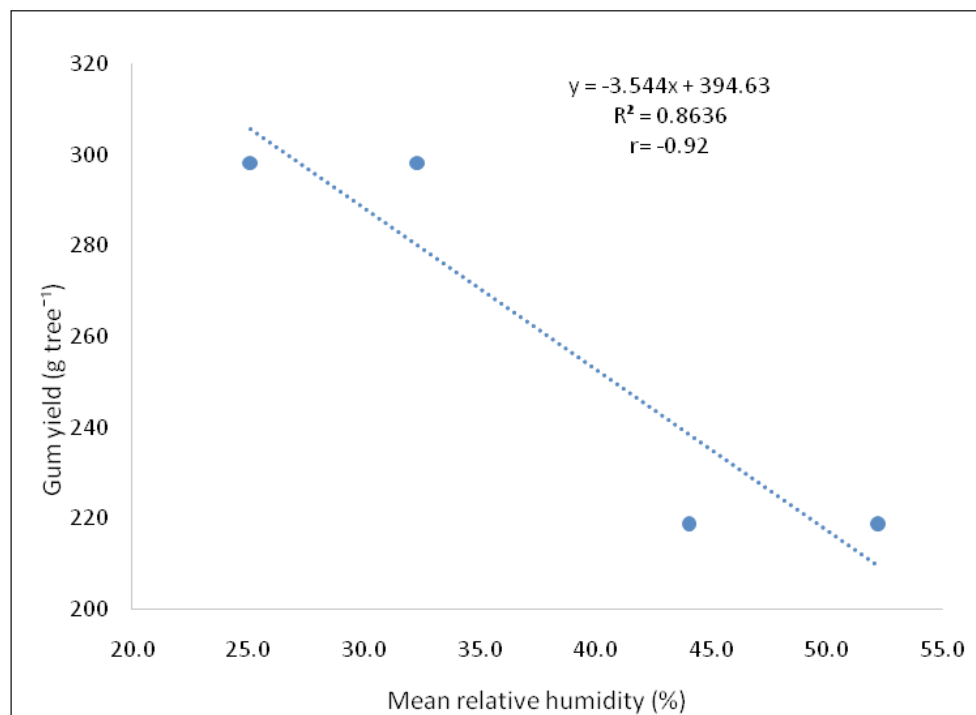


Fig. 4. Regression analysis between mean relative humidity (%) and gum yield (g tree<sup>-1</sup>).

association of temperature and gum yield by Ballal *et al.* (2005) and Raj and Jhariya (2021).

Similarly correlation and regression analysis for relative humidity and gum yield was carried out. The correlation value for mean relative humidity and gum yield was  $r=-0.92$ . The negative correlation shows that as the relative humidity decreases the gum yield increases. The regression analysis showed that 86 percent variability in gum yield due to relative humidity during the treatment season (Fig. 4). Rising temperature stimulate stress on plant/tree which helps in gum exudation whereas increasing moisture (relative humidity) in atmosphere suppress gum production. Process of gum production varies with temperature (positively) and relative humidity (negatively) (Pareek *et al.*, 2017, Raj and Jhariya, 2021).

### Conclusion

*Acacia tortilis* is not much explored for its gum production potential unlike *A. senegal*, Though the gum induced from species have big market in pharmaceutical and food industries. The gum induction from the species is low in natural condition; therefore, the impact of, diameter, climatic condition and different level of ethephon concentration is studied This study concluded that production of gum increases with

increase in diameter of trees and increases with increase in ethephon concentration upto a certain level (as obtained with T2) beyond this, the tree starts showing defensive mechanism towards gum production or mortality. Temperature and relative humidity shows strong association with gum production. As the temperature rises with low relative humidity, the production of gum increases. So that production of gum was more in summer season compared to winter season. This study will be helpful in using the right dose of ethephon for gum production as well as in predicting the correct time for treatment in relation to climatic factors like temperature and humidity in *Acacia tortilis*.

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