# Appendix-I Historical events in the science of Allelopathy

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Place in history</th>
<th>Sps. /Effect</th>
<th>Reference/Workers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5th century B.C.</td>
<td>Effect of one plant on other</td>
<td>Democritus</td>
</tr>
<tr>
<td>2</td>
<td>3rd century B.C.</td>
<td>Effect of one plant on other</td>
<td>Theophratus</td>
</tr>
<tr>
<td>3</td>
<td>1832 AD</td>
<td>Effect of one plant on other</td>
<td>De Candolle</td>
</tr>
<tr>
<td>4</td>
<td>1907</td>
<td>Production of toxic compounds</td>
<td>Schreiner and Reed</td>
</tr>
<tr>
<td>5</td>
<td>1909</td>
<td>Production of toxic compounds</td>
<td>Schreiner and Shorey</td>
</tr>
<tr>
<td>6</td>
<td>1920</td>
<td>Allelopathy : Fruit and grass cover</td>
<td>Spencer U. Pickering</td>
</tr>
<tr>
<td>7</td>
<td>1921, 1925</td>
<td>Walnut-Phytopathology</td>
<td>Cook. Massey, A.B.</td>
</tr>
<tr>
<td>8</td>
<td>1924</td>
<td>Sorghum-Wheat</td>
<td>Breazeale</td>
</tr>
<tr>
<td>9</td>
<td>1925</td>
<td>Sorghum-Vetch</td>
<td>Howkins</td>
</tr>
<tr>
<td>10</td>
<td>1937</td>
<td>Coin the term Allelopathy</td>
<td>Hans Molich</td>
</tr>
<tr>
<td>11</td>
<td>1948</td>
<td>Wheat stalk residues</td>
<td>M.C. Calla and Duley</td>
</tr>
<tr>
<td>12</td>
<td>1954</td>
<td>Leaf litter as killer</td>
<td>Koroleff</td>
</tr>
<tr>
<td>13</td>
<td>1961</td>
<td>Inhibitor in leaves</td>
<td>Lerner and Evener</td>
</tr>
<tr>
<td>14</td>
<td>1964</td>
<td>Stubble mulching VS growth</td>
<td>M.C. Kalla and Haskins</td>
</tr>
<tr>
<td>15</td>
<td>1966</td>
<td>Mimosine: plants</td>
<td>Smith and Fowder</td>
</tr>
<tr>
<td>16</td>
<td>1971</td>
<td>Microphyte, Allelochemicals</td>
<td>Whittakar</td>
</tr>
<tr>
<td>17</td>
<td>1972</td>
<td>Weed: Crop interference</td>
<td>Bell and Koepe</td>
</tr>
<tr>
<td>18</td>
<td>1974</td>
<td>Physiological ecology: Allelopathy</td>
<td>Rice</td>
</tr>
<tr>
<td>19</td>
<td>1976</td>
<td>Mango leaf: Nematode infested</td>
<td>Kumar and Nair</td>
</tr>
<tr>
<td>20</td>
<td>1982</td>
<td>Eucalyptus leaf leachates</td>
<td>Singh and Bawa</td>
</tr>
<tr>
<td>21</td>
<td>1985</td>
<td>Allelopathy: Indian work</td>
<td>Parihar, Pathak</td>
</tr>
<tr>
<td>23</td>
<td>1993, 2000</td>
<td>Tree Vs crops and crops vs trees</td>
<td>Suman et al, Lal and Singh</td>
</tr>
<tr>
<td>24</td>
<td>2000, 2008</td>
<td>MPTS litter biomass vs crops</td>
<td>Suman et al,</td>
</tr>
</tbody>
</table>
### Appendix-II

International conf in India and World congress on Allelopathy in last two decades

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Congress</th>
<th>Place/Country</th>
<th>Organizers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1st Int symposium Allelopathy in Agroecosystem (Agriculture and Forestry), Feb. 12-14, 1992,</td>
<td>HAU, Hisar, India</td>
<td>Dr. S. S. Narwal</td>
</tr>
<tr>
<td>2</td>
<td>2nd Int symposium Allelopathy in sustainable Agriculture forestry and environment September 6-8, 1994</td>
<td>IARI, New Delhi International Soc. Allelopathy was formed during this period</td>
<td>Dr. S. S. Narwal</td>
</tr>
<tr>
<td>3</td>
<td>1st world cong. Allelopathy A Science for the Future September 16-20, 1996 University of Cadiz</td>
<td>Cadiz Spain,</td>
<td>Dr. F. A. Maciaiah</td>
</tr>
<tr>
<td>4</td>
<td>3rd Int symposium Allelopathy in ecological Agriculture and forestry August 18-21, 1998</td>
<td>Dharwad, Karnataka</td>
<td>Dr. S. S. Narwal</td>
</tr>
<tr>
<td>5</td>
<td>2nd World cong Allelopathy Critical Analysis &amp; Future Prospects, August 9-13, 1999</td>
<td>Lakehead University. Thunder Bay, Ontario CANADA P7B 5E1</td>
<td>Dr. A. U. Malik</td>
</tr>
<tr>
<td>6.</td>
<td>3rd World cong Allelopathy Challenges for a new Millennium August 26-30, 2002 EPOCHAL.</td>
<td>Tsukuba Science City, Ibaraki JAPAN</td>
<td>Dr. Yoshiharu Fujii</td>
</tr>
<tr>
<td>7</td>
<td>4th Int symposium Allelopathy in sustainable terrestrial and aquatic ecosystem August 23-25, 2004</td>
<td>CCS, HAU, Hisar, India</td>
<td>Dr. S. S. Narwal</td>
</tr>
<tr>
<td>8</td>
<td>4th World cong Allelopathy Establishing the Scientific Base” August 21-26, 2005 Australia</td>
<td>Australia</td>
<td>Dr. Rex Stanton</td>
</tr>
<tr>
<td>9</td>
<td>5th World cong Allelopathy Growing Awareness of the Role of Allelopathy in Ecological, Agricultural, and Environmental Processes September 21-25, 2008</td>
<td>Saratoga Springs New York, USA</td>
<td></td>
</tr>
</tbody>
</table>
Appendix-III Cost of cultivation (Rs.)

<table>
<thead>
<tr>
<th>Input in operation</th>
<th>Oats</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre sowing irrigation 10 hrs @ Rs 90/hrs</td>
<td>900.00</td>
</tr>
<tr>
<td>Seed</td>
<td>1200.00</td>
</tr>
<tr>
<td>Sowing by tractor seed drill 3 hrs/ha @Rs 400/hr</td>
<td>1200.00</td>
</tr>
<tr>
<td>Manuall labour used in various farm operations 20 man days @ Rs 135 /day</td>
<td>2700.00</td>
</tr>
<tr>
<td>Irrigation 2 No. 7 hrs/irrigation @Rs 90/hrs</td>
<td>1260.00</td>
</tr>
<tr>
<td>Harvesting 15 man days @ Rs 135 /day</td>
<td>2025.00</td>
</tr>
<tr>
<td>Transport of produce</td>
<td>5000.00</td>
</tr>
<tr>
<td>Other charges</td>
<td>1000.00</td>
</tr>
<tr>
<td>Total</td>
<td>15285.00</td>
</tr>
</tbody>
</table>

\[ N = \text{Rs } 502 /q \text{ urea} @ \text{Rs } 10.91/\text{kg}, \ P =\text{Rs } 946/q \text{ DAP} @ \text{Rs } 20.57/\text{kg}, \ K = \text{Rs } 500/q @\text{Rs } 8.33/\text{kg} \]

\[ 811.38 + 822.64 + 330.35 + 15285.00 = 17252.37 \]

*Dalbergia* sp biomass biomass (3t/ha) Rs 350/t  
+ 40 kg N/ha through urea  
\[ 1050 + 436.54 + 15285.00 = 16771.54 \]

Subabool/Legumes (2 t/ha) Rs 300/t  
+ 40 kg N/ha through urea  
\[ 600 + 436.54 + 15285.00 = 16321.54 \]

*Dalbergia* sp biomass 1.5t + Subabool/Legume 1t/ha  
+ 40 kg N/ha through urea525 + 300 + 436.54 + 15285.00 = 16546.54
Appendix-IV  Cost of cultivation, gross and net return (Rs/ha/year) as influenced by different treatments

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Cost of cultivation</th>
<th>Gross income</th>
<th>Net income</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Disc harrow (3)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SF Sole fertilizer (recommended doses) (90 kg N, 40 kg P, 40 kg K)</td>
<td>1967.33</td>
<td>27812.80</td>
<td>7410.43</td>
</tr>
<tr>
<td><em>Dalbergia</em> sp biomass (3t/ha) + 40 kg N/ha through urea</td>
<td>1486.54</td>
<td>33066.40</td>
<td>13144.86</td>
</tr>
<tr>
<td>Subabool /Legumes (2 t/ha) + 40 kg N/ha through urea</td>
<td>1036.54</td>
<td>34026.40</td>
<td>14554.86</td>
</tr>
<tr>
<td><em>Dalbergia</em> sp 1.5t + Subabool /Legume 1t/ha + 40 kg N/ha through urea</td>
<td>1261.54</td>
<td>33546.40</td>
<td>13849.86</td>
</tr>
<tr>
<td><strong>Cultivator (3)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SF Sole fertilizer (recommended doses) (90 kg N, 40 kg P, 40 kg K)</td>
<td>1967.33</td>
<td>28026.40</td>
<td>8074.03</td>
</tr>
<tr>
<td><em>Dalbergia</em> sp <em>Butea monosperma</em> biomass (3t/ha) + 40 kg N/ha through urea</td>
<td>1486.54</td>
<td>33546.40</td>
<td>14074.86</td>
</tr>
<tr>
<td>Subabool /Legumes (2 t/ha) + 40 kg N/ha through urea</td>
<td>1036.54</td>
<td>34212.80</td>
<td>15191.26</td>
</tr>
<tr>
<td><em>Dalbergia</em> sp 1.5t + Subabool /Legume 1t/ha + 40 kg N/ha through urea</td>
<td>1261.54</td>
<td>33920.00</td>
<td>14673.46</td>
</tr>
<tr>
<td><strong>Cultivator (1) + Rotavator (1)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SF Sole fertilizer (recommended doses) (90 kg N, 40 kg P, 40 kg K)</td>
<td>1967.33</td>
<td>28320.00</td>
<td>8667.63</td>
</tr>
<tr>
<td><em>Dalbergia</em> sp biomass (3t/ha) + 40 kg N/ha through urea</td>
<td>1486.54</td>
<td>34106.40</td>
<td>14934.86</td>
</tr>
<tr>
<td>Subabool /Legumes (2 t/ha) + 40 kg N/ha through urea</td>
<td>1036.54</td>
<td>35012.80</td>
<td>16291.26</td>
</tr>
<tr>
<td><em>Dalbergia</em> sp 1.5t + Subabool /Legume 1t/ha + 40 kg N/ha through urea</td>
<td>1261.53</td>
<td>34640.00</td>
<td>15693.46</td>
</tr>
<tr>
<td><strong>MB Plough (1) + cultivator (2)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SF Sole fertilizer (recommended doses) (90 kg N, 40 kg P, 40 kg K)</td>
<td>1967.33</td>
<td>28212.80</td>
<td>7560.43</td>
</tr>
<tr>
<td><em>Dalbergia</em> sp biomass (3t/ha) + 40 kg N/ha through urea</td>
<td>1486.54</td>
<td>33946.40</td>
<td>13774.86</td>
</tr>
<tr>
<td>Subabool /Legumes (2 t/ha) + 40 kg N/ha through urea</td>
<td>1036.54</td>
<td>34932.80</td>
<td>15211.26</td>
</tr>
<tr>
<td><em>Dalbergia</em> sp 1.5t + Subabool /Legume 1t/ha + 40 kg N/ha through urea</td>
<td>1261.54</td>
<td>34532.80</td>
<td>14586.26</td>
</tr>
</tbody>
</table>

Rabi products (oats fodder @ Rs 75/q)
Appendix-V; Allelopathy in Trees and Forests: A Selected Bibliography in 20th century

Allelopathy in trees and forests is an important health care issue. Allelopathy is the chemical modification of the site by an individual to enhance interference effectiveness. Allelopathy also involves the ecological communications between species which can positively or negatively influence growth, behavior, reproduction, and survival of associated species.


• Jobidon, R. 1986. Allelopathic potential of coniferous species to old field wees in eastern Quebec. Forest Science 32:112-118.


• Smith, ML. 1990. Water soluble extracts from leaves of shining sumac inhibit germination and radicle growth of loblolly pine. Tree Planters' Notes 41:33-34.


• Suman, B. L. 2002. Effect of cereals and legume residues and tillage management on growth, yield and quality of sorghum 14th IFOAM 2002 c/o Bldg. 20, 8801 East Saanich Rd. Sidney BC V8L 1H3 CANADA.


• Yadav, SS, Nandal, DPS, Hooda, MS, and Bahadur, R. 1996. Effects of Eucalyptus leaves and bark extracts on germination and growth of mustard. Proceedings of the International Conference Allelopathy: Field
Tillage, or cultivation, is the agricultural preparation of the soil by ploughing, ripping or turning it. Tillage can also mean the land that is tilled in the process of fostering the growth of something; "the cultivation of bees for honey": the act of raising or growing plants (especially on a large scale). The process of promoting the growth of a biological culture. There are two types of tillage: primary and secondary tillage (http://en.wikipedia.org/wiki/Cultivation)

Intensive tillage; Intensive tillage systems leave less than 15% crop residue cover or less than 500 pounds per acre (560 kg/ha) of small grain residue. These types of tillage systems are often referred to as conventional tillage systems but as reduced and conservation tillage systems have been more widely adopted, it is often not appropriate to refer to this type of system as conventional. These systems involve often multiple operations with implements such as a mold board plow, disk, and/or chisel plow. After Moldboard plowing, a disk is often used to break clods. Then a a finisher .....with a harrow, rolling basket, and cutter head can be used ..... can be used to prepare the seed bed. There are many variations.

Reduced tillage; Reduced tillage systems leave between 15 and 30% residue cover on the soil or 500 to 1000 pounds per acre (560 to 1100 kg/ha) of small grain residue during the critical erosion period. This may involve the use of a chisel plow, field cultivators, or other implements. See the general comments below to see how they can effect the amount of residue.

Conservation tillage; Conservation tillage systems are methods of soil tillage which leave a minimum of 30% of crop residue on the soil surface or at least 1,000 lb/ac (1,100 kg/ha) of small grain residue on the surface during the critical soil erosion period. This slows water movement, which reduces the amount of soil erosion; it also warms the soil, enabling the next year’s crop to be planted earlier in the spring. Conservation tillage systems also benefit farmers by reducing fuel consumption and soil compaction. By reducing the number of times the farmer travels over the field, farmers realize significant savings in fuel and labor. Conservation tillage was used on about 38%, 109,000,000 acres (440,000 km²), of all US cropland, 293,000,000 acres (1,190,000 km²) planted as of 2004 according to the USDA.

No-till
Strip-Till
Mulch-Till
Ridge-Till

**Purposes Of Tillage:** This is to produce the medium condition which is suitable for plant growth. *Seeds need these conditions in order to germinate:*
- Water: This causes the seeds to swell and burst triggering the germination process, the radicle of the seed pushes down while the pumule pushes upwards.
- Oxygen: This is needed for seeds to respire.
- Suitable Temperature: This creates the right ambiance required for proper growth.

**General comments:** The type of implement makes the most difference but other factors can have an effect. The table in this publication gives some idea of the amount of residue that might be left with different tillage operations.
- The greater the speeds with which you move some tillage implements (disks and chisel plows), the more intensive the tillage (i.e., less residue is on the soil surface).
- Increasing the angle of disks causes residues to be buried more deeply. Increasing their concavity makes them more aggressive.
- Chisel plows can have spikes or sweeps. Spikes are more aggressive.

The reason the percent residue is used to define tillage systems is that the amount of crop residue impacts the amount of soil loss due to erosion. This graph demonstrates the amount of soil that might be expected to be lost with different amounts of crop residue.
- Look at this reference to see how to measure crop residues.
- In the same reference as above you can see what different amounts of corn and soybean residue look like.
- See Soybean management practices to see what types of tillage are currently recommended for Soybean Production.
- Types of tillage systems in the USA
- Click here to see the distribution tillage systems across the United States in 1995.
- Click here to see the acres of tilled land in the United States.
- Here you can see the number of conservation tillage acres.
- More maps can be found here

**Definitions**
- *Primary tillage* loosens the soil and mixes in fertilizer and/or plant material, resulting in soil with a rough texture.
- *Secondary tillage* produces finer soil and sometimes shapes the rows. It can be done by using various combinations of equipment: plough, disk plough, harrow, dibble, hoe, shovel, rotary tillers, subsoiler, ridge or bed forming tillers, roller.
- Weed plants (seeds, tubers, etc.) may be exhausted by repeated tilling. The weeds expend energy to reach the surface, and then get turned into the soil by tilling. The cycle is repeated until the weeds are dead.
History of tilling; Tilling was first performed via human labor, sometimes involving slaves. Hoofed animals could also be used to till soil via trampling. The wooden plough was then invented. It could be pulled by mule, ox, elephant, water buffalo, or similar sturdy animal. Horses are generally unsuitable, though breeds such as the Clydesdale could work. The steel plough allowed farming in the American Midwest, where tough prairie grasses and rocks caused trouble. Soon after 1900, the farm tractor was introduced, which eventually made modern large-scale agriculture possible.

Alternatives to tilling; Modern agricultural science has greatly reduced the use of tillage. Crops can be grown for several years without any tillage through the use of herbicides to control weeds, genetically modified crops that tolerate packed soil, and equipment that can plant seeds or fumigate the soil without really digging it up. This practice, called no-till farming, reduces costs and environmental change by reducing soil erosion and diesel fuel usage (although it does require the use of pesticides). Most organic farming tends to require extensive tilling, as did most farming throughout history, although researchers are investigating farming in polyculture that would eliminate the need for both tillage and pesticides, such as no-dig gardening.

8th International Oat Conference, 28 June 2 July 2008 Minneapolis, Minnesota, USA

7th International Oat Conference, 18-22 July 2004 Helsinki, Finland,

6th International Oat Conference: 13-16 November 2000 held at Lincoln University, Lincoln, NZ.

5th International Conference Oats, 199 Dale Pinto, and Pauline Sadler

4th International Oat Conference, Adelaide, Australia. 25 Goering KJ, Jackson LL
Dehaas BW,

3rd International Oat Conference. Lund, Sweden 1989


1st International Oat Conference, 1981