Potential of *Withania somnifera* Dunal Cultivation as a Medicinal Crop in Jaffna District

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**Abstract:** The medicinal plant, *Withania somnifera* (Ashwagandha) is becoming popular among farmers. Due to its importance, farmers are interested to cultivate it in larger extent. *W. somnifera* is an evergreen shrub reaching height up to 118±32.40 cm. Generally it is propagated by seeds and germination take place 5.6±1.16 days after sowing. Present study was aimed to assess the potential of *W. somnifera* to be cultivated in Jaffna district, Sri Lanka during the cropping period of August 2011 to June 2012. Different field trials and *in vitro* studies were conducted. For field trials, Seeds of *W. somnifera* were water soaked overnight and sown to evaluate the phenology of the plant. Transplanting was done at one month age to main field at 45cm×60cm spacing. Flowering was observed continuously but flowering and fruiting commenced 66.17±3.43 and 79.77±2.07 days after the transplanting, respectively. Harvesting can be done between six to seven month old because in this time root: shoot ratio was optimum but at six month old it was maximum. The highest dry root yield was obtained at six month old stage which was 58.32g. Seed production of *W. somnifera* was registered that plant produced an average of 6581.89 seeds. This number is good enough to get adequate planting material but the germination percentage of *W. somnifera* generally low due to dormancy. To break down the dormancy, seeds were subjected to different treatments including water soaking over night and hot water soaking. Germination percentage significantly increased in all treatments than control (12.5%). Highest germination percentage was obtained in hot water soaking that induced 52.75% germination while water soaking resulted in 33.75% germination. These studies suggest that the climate and soil prevalent in Jaffna are suitable to multiply this herb with least cost techniques.

**Key words:** *Withania somnifera* • Dormancy • Germination percentage • Seeds • Root shoot ratio

**INTRODUCTION**

*Withania somnifera* (Family: Solanaceae) is a well recognized medicinal plant in Sri Lanka. It has been used as both traditional and modern therapeutic agent [1]. It possesses immunomodulatory, anti-inflammatory, antitumor, antioxidant, antistress, hemopoetic and rejuvenating properties [2]. Because of these properties, it is prescribed for many ailments such as sterility, rheumatism, memory loss and aging [3], [4]. Diseases like TB, chronic upper respiratory diseases and HIV have been added to the list of Ashwagandha due to its strong immunostimulatory activity. It is also recognized as a blood tonic, especially in gynecological disorders including anemia and irregular menstruation [5]. Root is the economic important part but all the parts of the plant have shown remarkable importance in the field of pharmacology [6].

There are two cultivars of *W. somnifera* prevalent in Sri Lanka. They are local and Indian cultivar. Indian cultivar is mostly preferred by drug manufacturers because of its starchy nature. Root of local cultivar is fibrous and difficult to make powder for preparation of commercial drugs and home medicine as well. Because of this reason, local cultivar is identified as threatened plant [7]. High demand of this plant resulted importation from other countries. Consequently, cultivation of the plant is immediately needed to make sure their availability to the pharmacological industry as well as to people who associated with traditional system of medicine. If timely steps are not taken for their conservation, cultivation and mass propagation, they may be lost from
the natural vegetation forever. Therefore, propagation of
this plant is vital in suitable agro climatic regions. Cultivation of *W. somnifera* will also help to make waste
land productive, greening the drier tracts [8].

Traditionally *W. somnifera* is propagated from seeds
but the germination percentage is very low [7], [9], [10].
There may be a possibility of dormancy in the seeds that
prevent germination immediately.

Harvesting stage of the plant is one of the important
considerations. Generally, farmers prefer short duration
crops when compare with traditional crops. Identification
of proper harvesting time is essential to farmers to have
better yield [11].

The universal attention on this plant and the high
demand for its roots offer ample scope to cultivate this
plant on commercial scale in Jaffna. Current price for dried
roots, economically attractive returns in comparison to
traditional crops and effortless cultivation without
much irrigation induced farmers towards cultivation of
*W. somnifera*. Present investigation was conducted to
explore the potential of cultivation of *W. somnifera* in
Jaffna in order to save the local cultivar and to supply the
raw material for drug preparation in Indigenous medical
system without importation.

**MATERIALS AND METHODS**

**Experimental Site:** The experiments were carried out at
the laboratory of Department of Agricultural Biology,
Faculty of Agriculture, University of Jaffna, Sri Lanka and
at the herbal garden, Northern Province at Navakkiri,
Jaffna, Sri Lanka during the cropping period of August
2011 to June 2012. Cultivation was conducted at
Thirunelvely area; Jaffna district which falls under the
Northern part of the country. The longitude of the
location is 80° 017’ and latitude is 09° 040’. Average rainfall
and temperature were 124.76mm and 28.3°C, respectively.
Average humidity was 72.5% in day time and 83.2% in
night time. Soil type was non-calcic brown earth [12].

**Plant Material:** Seeds of *W. somnifera* were collected from
herbal garden at Navakkiri, Jaffna, Sri Lanka. Seeds were
extracted from the fruits and air dried for one week before
storage in air-tight paper bags until used for experimental
trials. Seeds were soaked in distilled water for overnight
[1] and germinated in the nursery bed. Nursery bed was
prepared with addition of sterile soil, sand and cow dung
at the ratio of 3:1:1. The time required for seedling
emergence was noticed. Seedlings of 30 days old were
transplanted to a well prepared field. Spacing was
maintained as 45cm×60cm. Irrigation was done two days
interval to the nursery bed and twice a week to main field.
Thereafter, time taken for flowering, fruiting, ripening and
harvesting were recorded on the marked plants.

**Root: Shoot Ratio:** Healthy plants of *W. somnifera* from
one to seven and twelve month old plants were selected
for this study. They were uprooted completely. Soil
attached in root parts was washed out by using distilled
water. They were allowed for shade dry up to 30minutes.
Thereafter, shoot and root parts were separated by using
sharp knife and chopped into small pieces. They were put
into paper bags with proper labelling. Those were kept in
an oven at 105°C for overnight. Weight of root and shoot
were taken as fresh and dry weight basis with the help of
top loading balance. Four replications were maintained.

**Seed Production:** Twelve healthy plants of *W. somnifera*
were selected randomly at Herbal garden which had
150 plants. Readings such as branches/plant,
fruits/branch and seeds/fruit were recorded from the
plants. Finally, seed production/plant were calculated and
recorded from selected plants.

**Break down the Dormancy:** Mature healthy fruits of
*W. somnifera* were collected and allowed to shade dry for
three months. Seeds were obtained from the fruits were
preserved for further studies. To prepare a standard seed
bed, sterile top soil and sand were mixed with cow dung
in 3:1:1 ratio. Selected seeds of *W. somnifera* were soaked
in water for 24 hours and hot water at 80°C for two hours
and sown into seed bed. Control sets were kept. Four
replications were maintained for each treatment and
100 seeds were used in every replicate. Media was wet
and seeds were sown properly. The seedbed was wet
regularly. Germination percentage was taken after 10 days
of sowing. The following formula was used for the
assessment of germination percentage [13].

\[
\text{Germination percentage (\%) = } \frac{\text{Number of seeds germinated}}{\text{Total number of seeds sown}} \times 100
\]

Results were analysed by using completely
randomized design based on LSD mean separation
procedure.

**RESULTS AND DISCUSSION**

**Phenology:** Withania somnifera is a common herbaceous
evergreen shrub of 118±32.40 cm height. Seeds were
germinated within 5.6±1.16 days. After the germination
plants were allowed up to three weeks in the nursery bed.
Table 1: Root and shoot weight of *Withania somnifera* and its root: shoot ratio in relation to months as fresh and dry weigh basis.

<table>
<thead>
<tr>
<th>Plant age</th>
<th>Root (g) (Fresh weight basis)</th>
<th>Shoot (g) (Fresh weight basis)</th>
<th>Root (g) (Dry weight basis)</th>
<th>Shoot (g) (Dry weight basis)</th>
<th>Root:shoot (Fresh basis)</th>
<th>Root:shoot (Dry basis)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.05</td>
<td>0.36</td>
<td>0.01</td>
<td>0.05</td>
<td>0.14 ± 0.02^d</td>
<td>0.24 ± 0.02^a</td>
</tr>
<tr>
<td>2</td>
<td>0.23</td>
<td>1.53</td>
<td>0.05</td>
<td>0.24</td>
<td>0.15 ± 0.04^d</td>
<td>0.20 ± 0.07^a</td>
</tr>
<tr>
<td>3</td>
<td>6.78</td>
<td>39.88</td>
<td>4.54</td>
<td>22.38</td>
<td>0.17 ± 0.07^e</td>
<td>0.20 ± 0.03^b</td>
</tr>
<tr>
<td>4</td>
<td>20.73</td>
<td>66.87</td>
<td>9.34</td>
<td>22.79</td>
<td>0.31 ± 0.15^k</td>
<td>0.41 ± 0.17^b</td>
</tr>
<tr>
<td>5</td>
<td>36.46</td>
<td>101.28</td>
<td>17.62</td>
<td>38.77</td>
<td>0.36 ± 0.10^b</td>
<td>0.45 ± 0.09^b</td>
</tr>
<tr>
<td>6</td>
<td>120.06</td>
<td>235.41</td>
<td>58.32</td>
<td>89.98</td>
<td>0.51 ± 0.15^a</td>
<td>0.65 ± 0.13^b</td>
</tr>
<tr>
<td>7</td>
<td>43.85</td>
<td>128.97</td>
<td>29.5</td>
<td>54.63</td>
<td>0.34 ± 0.09^b</td>
<td>0.54 ± 0.02^a</td>
</tr>
<tr>
<td>12</td>
<td>59.76</td>
<td>170.74</td>
<td>32.08</td>
<td>76.37</td>
<td>0.35 ± 0.10^b</td>
<td>0.42 ± 0.11^b</td>
</tr>
</tbody>
</table>

Means followed by same letters within last two columns do not differ significantly based on LSD test \((p < 0.05)\). Values are mean ± standard deviation of five replicates.

Table 2: Seed production of *Withania somnifera*

<table>
<thead>
<tr>
<th>Observation</th>
<th>Maximum</th>
<th>Minimum</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Branches/ plant</td>
<td>11</td>
<td>2</td>
<td>6.5</td>
</tr>
<tr>
<td>Fruits/ branch</td>
<td>111</td>
<td>3</td>
<td>38.8</td>
</tr>
<tr>
<td>Fruits/ plant</td>
<td>390</td>
<td>22</td>
<td>211.64</td>
</tr>
<tr>
<td>Seeds/ fruit</td>
<td>28</td>
<td>34</td>
<td>31.1</td>
</tr>
<tr>
<td>Seeds/ plant</td>
<td>12129</td>
<td>684.2</td>
<td>6581.89</td>
</tr>
</tbody>
</table>

Transplanting was done at one month old stage. Well prepared land was given to the plant to encourage the root penetration and better growth. Cow dung was incorporated as an organic manure to enhance the growth. Watering improved the growth of *W. somnifera* in early stage of the plant. After the transplanting, irrigation was done twice a week. That was good enough for growth of the plants. Flowering was observed continuously. Flowering was commenced 66.17±3.43 days after the transplanting. Flowers are dull yellow colour. Cross pollination facilitated mainly by ants and bees. At the same time fruiting was commenced 13.6±2.07 days after flowering. Complete ripening of fruit was taken 19.2±18.84 days after the fruiting. Green colour immature fruits became as red colour fruits at the end of ripening. Seeds are very tiny, kidney shaped and yellow colour. Plant showed perennial habit. That means renewal of shoots were observed continuously but it was mainly depend on the irrigation.

**Harvesting Time:** Optimum time period for harvesting of the plant was determined with reference to root: shoot ratio (R/S). Because the crop whose economic part (root) is below the ground, it is difficult to decide the right stage of harvesting. The R/S ratio is the important parameter to determine the root biomass and it is the accurate method [14].

Ratio between roots and shoots ratio (R/S) on fresh weight basis was taken for comparison with dry basis. At initial growth stage (1-3 months) of *W. somnifera* (R/S) was below 0.3 which is quite less as compared to that found in the later stages of the plant. Gradually R/S was increased after three months. The maximum R/S \((0.65±0.13)\) was obtained at six month age and root yield was 58.32g in dry weight basis (DWB). Thereafter, R/S declined. Even though at seven month old stage also considerable R/S \((0.54±0.09)\) was obtained but the root yield decreased which was 29.5g in (DWB). High significant difference was obtained between six and seven month old stage. In general root of this crop is ready for harvest after 180-210 days from planting [15].

**Seed Production:** Seed production of *W. somnifera* is important parameter to determine the requirement of propagation material because this plant is mainly propagated by seeds [7], [16]. Seed production of *W. somnifera* is presented in Table 2. The plant produced two to 11 branches. Six fruits/branch and 111fruits/branch were produced as minimum and maximum, respectively. Mean number of fruits produced in a branch was 38.8 and 211.64 fruits were produced in a plant. On an average a fruit produced 31.1±1.73 seeds. Therefore, a plant produced an average of 6581.89 seeds. This shows the ability of the plant seldom propagated form their seeds.
Break down the Dormancy: The figure 1 shows the germination percentage with the assigned treatments. Water soaked and hot water soaked seeds were germinated significantly when compared to control (12.5±2.08%). Water soaking for 24 hours is normally practiced in Jaffna [17]. However hot water soaking gave high significant germination percentage of 52.75±3.50 compared to water soaking (33.75±2.75%). Bhuyar et al. [18] reported that hot water soaking (80°C for 5 min) resulted highest germination percentage in Rauvolfia serpentina. Another study revealed hot water treatment resulted 70% of germination [13]. Water is an indispensable factor in the external environment for the stimulation of germination in seeds. Soaking the seeds in water at room temperature helps in softening the seed coats, removal of inhibitors and reduces the time required for germination and increases germination percentage [19].

In [20], the authors have reported that seeds of W. somnifera have dormancy and KNO₃ (1%) for six hours was given higher germination percentage (79%).

CONCLUSION

These results revealed that Jaffna has the suitable soil and climatic condition for the cultivation of this medicinal plant. Economic important part can be harvested between six to seven months old with optimum root biomass. This will help the farmers to get adequate income. The present work has established some effective methods for breaking seed dormancy and improved germination of W. somnifera through water soaking and hot water soaking. These methods being simple and low cost may be readily adopted by unskilled and poor farmers for developing healthy planting stock and cultivation of this species.

REFERENCES


