

Growth performance of three medicinal plants in terrace ecosystem of Bangladesh

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Abstract: A field experiment was conducted at the Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU) research farm, Gazipur, Bangladesh during February-August 2011 to observe the growth performance of three selected medicinal plants, i.e. *Withenia somnifera*, *Ocimum sanctum* and *Andrographis paniculata*. The plant height of *O. sanctum* was found better than other two species in each sampling dates. *A. paniculata* leaf carried highest chlorophyll as it shown highest SPAD value at all the measuring dates whereas *W. somnifera* shown moderate chlorophyll content. Significantly highest branch number but smallest individual leaf area was found in *Ocimum* and the inverse was found in *W. somnifera*. Maximum, medium and minimum leaf number and total leaf area was found in *A. paniculata*, *O. sanctum* and *W. somnifera*, respectively. Total fresh weight and dry weight of *A. paniculata* was highest at both the sampling dates. Root dry weight of *O. sanctum* and *W. somnifera* significantly higher in both the sampling dates. In case of shoot dry weight, *A. paniculata* always performed significantly better result than *Ocimum* and *W. somnifera*. The study revealed that *A. paniculata* ranked first in respect of CGR followed by *O. sanctum* while *W. somnifera* showed the poorest performance.

Keyword: *Withenia somnifera*, *Ocimum sanctum*, *Andrographis paniculata*.

Introduction

Medicinal plants (MP) are a vital component of non-timber forest products and an important natural wealth of a country. Since time immemorial medicinal plants are in use all over the world. These valuable resources are used by 70 % of the world population for curing diseases through their traditional practitioners (WHO, 2002). Considering safe use of herbal medicines they are gaining importance all over the world including Bangladesh. Use of some selected medicinal plants as an herbal drug by the rural people of Bangladesh is increasing day by day as it is an important source of extra income for their livelihoods. Although the richness of medicinal plants have been decreasing day by day due to over populations, urbanization and industrialization. As a result, the pressure on natural forests is hard. In that case, marginal or small scale cultivation of important medicinal plants significantly can contribute to poor people's livelihood and reduce the pressure on natural forests. Not only that a sustainable cultivation of medicinal plant can therefore be seen as an act of nature conservation (Rashid, 2009).

Most of the medicinal plants collected from wild source and thus many species are getting over exploited and face extinction as they are not protected or cultivated. Some are endangered and some are totally threatened. So, there is a need to cultivate those medicinal plants which have more demand and maximum use irrespective of user group or industries in a sustainable basis.

Among the medicinal plants Ashwagandha (*Withenia somnifera*), Tulsi (*Ocimum sanctum*), and Kalomegh (*Andrographis paniculata*) are most commonly used in Ayurvedic, Unani and Self treatment sector. Tulsi (*Ocimum sanctum*) belonging to the family Lamiaceae is one of the important medicinal species. A number of phenolic compounds with strong antioxidant activity have been identified in these plant extracts (Nakatani, 1997). It is used in traditional medicines for treating low energy, ulcers, vomiting and diarrhea, or as an overall tonic. It is a good insect repellent for white flies, aphid, fruit fly, moth and house fly. Tulsi leaves are used on insect bite to reduce itching (Viyoch *et al.*, 2006). Kalomegh is an annual herb belongs to the family Acanthaceae. It was advertised in England as a substitute for quinine. Leaf and stem are used as bitter tonic possess antityphoid and

antibiotic properties for treatment of dysentery, cholera, diabetes, consumption, influenza, bronchitis, swelling and itches, plies and gonorrhoea. It is important for andrographolide and iron content. Ashwagandha (*Withenia somnifera*) is an important medicinal crop grown primarily for its roots. It belongs to the family Solanaceae. The pharmacological activity of roots is attributed to the presence of several alkaloids specially withanin.

About 450 to 500 medicinal herbs are available in Bangladesh and using in traditional health care systems such as Ayurvedic, Unani, Hekimi and other form of folk treatments (Anon. 2003). *W. somnifera* was used in both ayurvedic and unani as top ten important medicinal species, which is mainly imported. *O. sanctum* and *A. paniculata* were used in unani and self treatment, respectively as major medicinal species but demand of two medicinal species is fulfilled by local production. In Bangladesh, it is estimated that 12,500 tonnes of dried medicinal plant material produced and 5000 tonnes has imported which cost around Tk 330 Million (\$5.8 m) and Tk 480 m (\$ 8m), respectively. Among the total (both produced and imported), price value of *W. somnifera*, *O. sanctum* and *A. paniculata* was Tk 29.2, Tk 6.8 and Tk 5.4 million, respectively. (Dixie *et al.*, 2003). Many works relating to these medicinal plants have already been done but there is a few works in relation to growth performance of these medicinal plants. Hence selection of the above three medicinal species for studying their growth behavior is very important and justified. Keeping the view in mind, the experiment was under taken for monitoring the growth performance of these medicinal plants.

Materials and Methods

The study was conducted at the Bangabandhu Sheikh Mujibur Rahman Agricultural University research farm (24°0'N latitude and 90°25' E longitude) from February 2011 to August 2011. The experimental site has subtropical climate characterized by heavy rainfall from May to September and scanty rainfall during rest of the year. The soil of the experimental field was silty clay of shallow Red Brown Terrace type under Salna Series of Madhupur Tract in agro-ecological zone (AEZ) 28 (Anon. 1998; Haider *et al.*, 1991). The structural class of the soil

was fine and the organic matter content was around 1.74%. The pH of soil was 6.5.

The land was prepared in the early February 2011. The land was prepared properly by ploughing with a tractor followed by harrowing and laddering until a good tilth was obtained. The plots were prepared and leveled smoothly according to the design and layout of the experiment.

The experiment was laid out in RCBD design with three replications. Unit plot size was 2 m × 2 m. The blocks were laid out in north-south direction and the plots were laid out east-west direction to provide the seedlings uniform exposure to sunlight. Adjacent blocks and neighboring plots were separated by 2.5 m and 0.5 m spacing, respectively.

Germination media was prepared by mixing of soil and well decomposed cowdung in a ratio of 3:1. Germination tray was filled up by these cowdung mixed soil after sun drying and sieving. Seeds were collected from known source and sown in germination tray with close observation in Agroforestry Laboratory of BSMRAU. Seeds were broadcasted to the tray. Some additional soil was also broadcasted above the seeds. Then the tray was covered with a plastic sheet and stored in defused light until germination of seeds. After 30 days of seed sowing, seedlings were transferred in to poly bags at secondary nursery bed in lath house for further 30 days. Proper irrigation and light adjustment were done in seedling stage as it was required. Finally 60 Days seedlings were planted in Agroforestry research farm at a spacing of 40 cm × 50 cm. Proper management practices e.g. fencing, irrigation, weeding, disease and pest managements were done for ensuring their survival and growth.

Five plants from each plot were tagged randomly for data recording on various growth stages. Plant height, branch number and SPAD value were recorded monthly basis while leaf number, leaf area, fresh weight and dry weight were recorded two times, at 60 Days after planting (DAP) and 150 DAP. SPAD value was measured by SPAD meter (SPAD-502, Minolta, Japan) and leaf area was measured by using leaf area meter (Model: AM 200) and expressed in cm² plant⁻¹. Total leaf area for each plant was calculated

by multiplying individual leaf area and total number of leaf per plant. Five randomly selected plants from each plot were uprooted and partitioned into root and shoot. These samples were oven dried at 70°C to get a constant weight. The dried samples were weighed and expressed in grams per plant. The sum of those plant parts was recorded as the total dry matter per plant. Crop growth rate was calculated from the dry weight obtained at 60 DAP and 150 DAP.

The following formula was used for CGR calculation.

$$\text{Crop Growth Rate (CGR)} = \frac{1}{\text{GA}} \times \frac{W_2 - W_1}{T_2 - T_1} \text{ g m}^{-2} \text{ day}^{-1}$$

Where, W₁ = dry weight at time T₁, W₂ = dry weight at time T₂, T₁ = 60 days after seedling transplanting, T₂ = 150 days after seedling transplanting and GA = Ground area per plant (m²).

The data on various parameters of selected species were statistically analyzed by using MSTATC software to examine the significant variation of the results due to different treatments. The treatment means were compared by DMRT test at 5% level of significance.

Results and Discussion

Plant height: Plant height of *O. sanctum*, *A. paniculata* and *W. somnifera* varied significantly at different days after planting (DAP). Significantly the tallest plant (23.33, 37.67, 61.33 and 71.67 cm at 60, 90, 120 and 150 DAP, respectively) was recorded for *O. sanctum* at all the sampling dates followed by *A. paniculata* (Table 1). At 60 DAP, plant height of these three MP was significantly different. At 90 and 120 DAP, plant height of *A. paniculata* and *W. somnifera* was identical. At 150 DAP, plant height of *O. sanctum* and *A. paniculata* was identical. For all the species height increment was found increasing sharply up to 120 DAP due to their vegetative growth stage and after 120 DAP the increasing rate become slower.

Table 1. Plant height and branch number of *O. sanctum*, *A. paniculata* and *W. somnifera* at different days after planting (DAP)

Treatment	Plant height (cm)				Branch number			
	60 DAP	90 DAP	120 DAP	150 DAP	60 DAP	90 DAP	120 DAP	150 DAP
<i>O. sanctum</i>	23.33a	37.67a	61.33a	71.67ab	11.33 a	17.33 a	21.67 a	27 a
<i>A. paniculata</i>	18.67b	24.00b	47.67b	68.33b	11.0 a	15 b	16.0 b	18.67 b
<i>W. somnifera</i>	14.67c	25.00b	48.00b	57.5 c	0.67 b	2.33 c	4.0 c	6 c
CV%	3.53	11.54	7.32	2.27	7.53	5.2	2.4	4.54

Branch number: The maximum number of branch per plant was recorded in *O. sanctum* irrespective of sampling dates while lowest number of branch per plant was recorded in *W. somnifera* at all the sampling dates (Table 1). At 60 DAP the number of branch per plant in *O. sanctum* (11.33) and *A. paniculata* (11.00) was identical but at 90, 120 and 150 DAP branch number per plant was significantly varied among the three studied species.

SPAD value: Generally higher SPAD value indicates the healthiness and higher chlorophyll content of leaf and

plant as well. A distinct and clear variation was observed in case of SPAD value of leaf. For all the studied species, SPAD value was increased up to 120 DAP and at 150 DAP it decreased again. Optimum growth phase of these medicinal species was observed up to 120 DAP, because chlorophyll content (SPAD value) as well as photosynthetic rate was increasing up to 120 DAP and then decreased.

Significantly the highest SPAD value was recorded in *A. paniculata* for all the measuring dates followed by *W.*

somnifera. SPAD value of *O. sanctum* was significantly lower at 90 DAP (47.12) and 120 DAP (45.94). But at 60 DAP, SPAD value of *O. sanctum* (44.91) was identical with *W. somnifera* (45.82) and at 150 DAP it (40.87) was identical (41.53) with *A. paniculata* (Fig. 1).

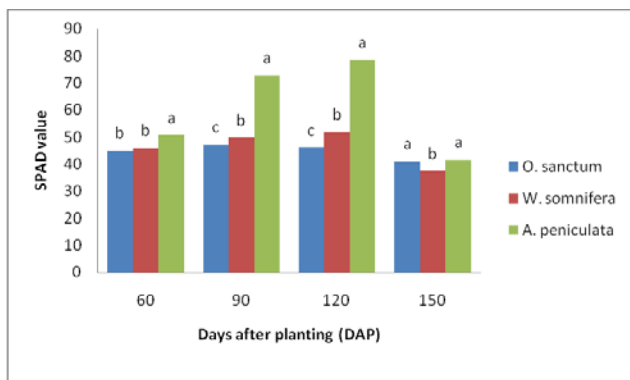


Fig. 1. SPAD value of *O. sanctum*, *W. somnifera* and *A. paniculata* at different days after planting (DAP)

Table 2. Leaf number, Single leaf area and Total leaf area of *O. sanctum*, *A. paniculata* and *W. somnifera* at 60 DAP and 150 DAP

Treatment	Leaf number		Single leaf area (cm ²)		Total Leaf area (cm ²)	
	60 DAP	150 DAP	60 DAP	150 DAP	60 DAP	150 DAP
<i>O. sanctum</i>	376	523	30.3 c	26.7 c	11392.8	13964.1
<i>A. paniculata</i>	467	1120	45.76 b	45.68 b	21369.92	51161.6
<i>W. somnifera</i>	42	41	142.5 a	118.9 a	5985	4993.8

Total fresh weight: At 60 DAP, highest (38.86 gm) and lowest (19.5 gm) total fresh weight was recorded in *A. paniculata* and *O. sanctum*, respectively. *W. somnifera* total fresh weight (20.72 gm) found moderate. But at 150 DAP *A. paniculata* fresh weight was still highest but the lowest was recorded in *W. somnifera* (Fig. 2).

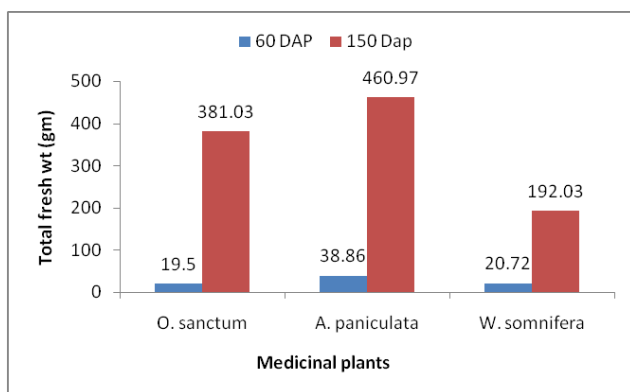


Fig. 2. Total fresh weight of *O. sanctum*, *A. paniculata* and *W. somnifera* at 60 DAP and 150 DAP

Root and shoot fresh weight: At 60 DAP, significantly highest root weight was recorded in *O. sanctum* and the lowest in *A. paniculata*. In case of shoot weight the inverse was observed (Fig.3).

At 150 DAP, significantly lowest root weight was recorded in *A. paniculata*. *O. sanctum* and *W. somnifera* root weight was found identical. In case of shoot weight,

Individual leaf area, leaf number and total leaf area:

Leaf area is a key parameter for studying many physiological processes associated with plants. Leaf area is made up of the total green lamina area of emerged leaves (Keating and Carberry, 1993). There was a significant variation of leaf area among *O. sanctum*, *W. somnifera* and *A. paniculata* (Table 2). At both the sampling dates (60 DAP and 150 DAP) significantly largest leaf area was observed in *W. somnifera* (142.5 cm² and 118.9 cm²) followed by *A. paniculata* (45.76 cm² and 45.68 cm²) and the smallest leaf area was observed in *O. sanctum* (30.3cm² and 26.7cm²). Interestingly, for all the species larger leaf area was observed during the 1st sampling at 60 DAP than the 2nd sampling at 150 DAP.

At both the sampling dates (60 DAP and 150 DAP), maximum leaf number was recorded in *A. paniculata* (467 and 1120, respectively) followed by *O. sanctum* and *W. somnifera*. In case of total leaf area the same trend was followed. At the first sampling leaf number of *W. somnifera* was higher than the first sampling date. Fresh weight production.

significantly highest shoot weight was recorded in *A. paniculata* followed by *O. sanctum* and *W. somnifera*.

Total dry weight: The data on dry matter accumulation of *O. sanctum*, *W. somnifera* and *A. paniculata* at 60 and 150 DAP are presented in Fig. 4. Total dry weight was found highest, moderate and lowest in *A. paniculata*, *O. sanctum* and *W. somnifera*, respectively at both sampling dates. Chen *et al.* (1983) reported that dry matter production largely depends on leaf area index development, which was related to branching.

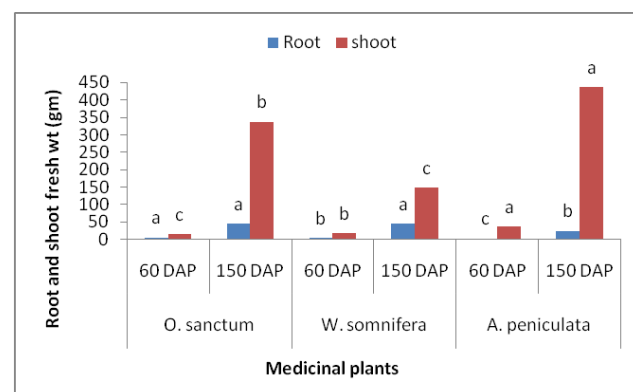


Fig. 3. Root and shoot fresh weights of *O. sanctum*, *W. somnifera* and *A. paniculata* at 60 DAP and 150 DAP

Root and shoot dry weight: Root dry weights of *O. sanctum* and *W. somnifera* were significantly higher in both the sampling dates. At 60 DAP, *A. paniculata* root weight (0.78 gm) was identical with *O. sanctum* (0.58 gm)

and *W. somnifera* (0.67gm) but at 150 DAP *A. paniculata* root weight (9.01 gm) was significantly lower than those values (Fig. 5).

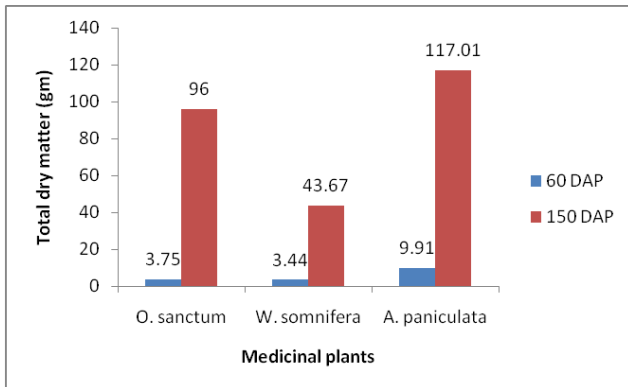


Fig. 4. Total dry matter production of *O. sanctum*, *W. somnifera* and *A. paniculata* at 60 DAP and 150 DAP

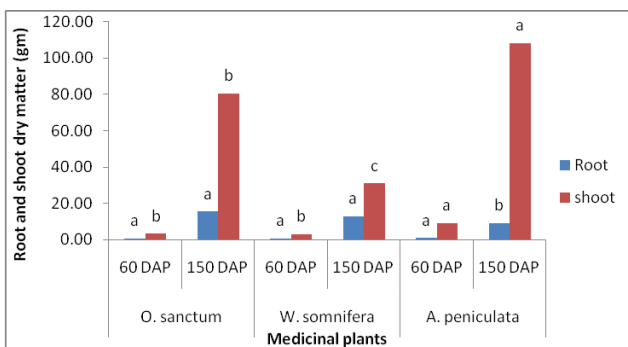


Fig. 5. Root and shoot dry weights of *O. sanctum*, *W. somnifera* and *A. paniculata* at 60 DAP and 150 DAP

In case of shoot dry weight *A. paniculata* always performed significantly better result than *O. sanctum* and *W. somnifera*. In both the sampling dates *O. sanctum* shoot dry weight (3.17 and 80.69 gm) was significantly lower than *A. paniculata* (9.13 and 108 gm). *W. somnifera* shoot dry weight (2.77 and 30.88 gm at 60 and 150 DAP) was identical with *O. sanctum* at 60 DAP but significantly lowest at 150 DAP.

Crop Growth Rate (CGR): Crop Growth Rate (CGR) depends mainly on the amount light intercepted by the crop canopy and there is a functional relationship between CGR and Leaf area (Wilson, 1981). Growth analysis is done for the purpose of quantifying pattern of dry matter production in plants (Hedge, 1988). Crop growth rate was

calculated from the dry weight obtained at 60 DAP and 150 DAP. Highest, moderate and lowest CGR was found in *A. paniculata* (5.95), *O. sanctum* (5.126) and *W. somnifera* (2.23), respectively (Fig. 6).

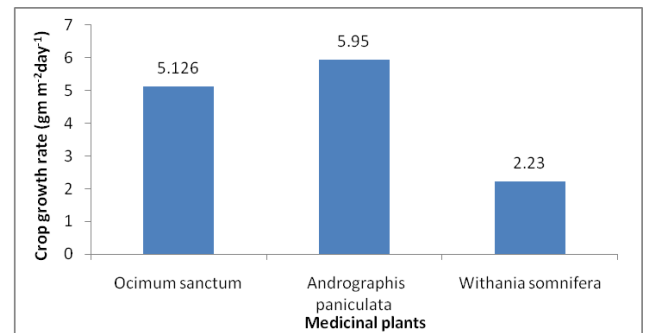


Fig. 6. Crop Growth Rate of *O. sanctum*, *A. paniculata* and *W. somnifera*

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