

Original Research Article

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## Fuelwood Characteristics of Some Important Tree Species in Prevalent Agroforestry Systems of District Budgam, Kashmir Valley, India

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### ABSTRACT

#### Keywords

FVI, Broad leaved species, Fruit trees, agroforestry systems, Kashmir valley.

#### Article Info

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Quantitative analysis of five (05) broad leaved and four (04) fruit tree species viz., *Populus deltoides*, *Populus nigra*, *Robinia pseudoacacia*, *Salix alba*, *Salix fragilis*, *Malus domestica*, *Prunus domestica*, *Prunus dulcis* and *Pyrus communis* respectively was carried out to present the possibility of pruned biomass from broad leaved and fruit cultivars for firewood production. Pruning's/wood samples of various trees were collected from four prevalent agroforestry systems of District Budgam of Kashmir valley viz., Boundary plantation, Homegarden, Horti-agricultural and Horti-silvi-pasture system. The results of the investigation revealed that *Robinia pseudoacacia* elucidated highest FVI as 948.05 and *Prunus dulcis* as 1067.42 among broad leaved and fruit trees species respectively.

### Introduction

Fuelwood is the major tangible benefit to the farmers through agroforestry systems. Their ranking in terms of quantitative values is equally important to evaluate/assess the potential trees for fuelwood needs of the farmers. Fuelwood is the largest energy source for the three-quarters of the world's population who live in developing countries (Scurlock and Hall, 1990).

Indeed, the demand for fuelwood is likely to continue as the most important energy source for rural areas of many countries (Deka *et al.*, 2007). The contribution of fuelwood to the total energy consumed varies from place to

place and is mainly determined by the level of development and availability (Kumar *et al.*, 2011). According to one estimate, about half of all energy (commercial and biomass) consumed is used for cooking food, which is nearly double the energy (fossil fuel and electricity) used by the agriculture and industrial sector combined together (Bhatt *et al.*, 2010).

Keeping this fact in view, the present study was designed to screen out some broad leaved and fruit trees present in various prevalent agroforestry systems for fuelwood farming in terms of firewood properties.

## Materials and Methods

### The study site

The site selected for the present study was District Budgam in Kashmir valley, India with pruned tree biomass collected from most preferred broad leaved and fruit tree species present in four (04) prevalent agroforestry systems of District Budgam i.e., Boundary plantation, Homegarden, Horti-agricultural and Horti-silvi-pasture system. The climate is of the temperate type with the upper-reaches receiving heavy snowfall in winter. The average annual precipitation of the district is 585 mm.

### Sampling procedure

A total of three tehsils namely: Budgam, Beerwah and Chadoora were selected to carry out the above mentioned research problem in District Budgam. Multistage stratified random sampling was used to select the blocks; villages within tehsils and then farmers within villages (Table 1). A total of 252 farmers were selected and interviewed through pre-tested questionnaire regarding different land use patterns (agriculture, agroforestry, horticulture), components of land use systems and their socio-economic status. After reconnaissance, four agroforestry systems were identified as prevalent viz., Boundary plantation, Homegarden, Horti-agricultural system and Horti-silvi-pasture system. Nine tree species were identified as most important tree components of these prevalent agroforestry systems of District Budgam namely: *Populus deltoides*, *Populus nigra*, *Robinia pseudoacacia*, *Salix alba*, *Salix fragilis*, *Malus domestica*, *Prunus domestica*, *Prunus dulcis* and *Pyrus communis*. Ten randomly selected branch cuttings (2–3 cm diameter) of *Populus deltoides*, *Populus nigra*, *Robinia pseudoacacia*, *Salix alba*, *Salix fragilis*, *Malus domestica*, *Prunus*

*domestica*, *Prunus dulcis* and *Pyrus communis* were collected during autumn 2013-14 from prevalent agroforestry systems using stratified random sampling and a composite sample was made. These were divided into four replicates of 10 cm length (Bhatt and Todaria, 1992a; Bhatt *et al.*, 2010) and put immediately in polyethylene bag and sealed to avoid moisture loss. Wood samples of all the tree species, thus collected were transferred to the laboratory for determination of their various properties. Wood moisture content (%) was determined after drying it at  $100 \pm 5^{\circ}$  C for 48 hr (Bhatt and Badoni, 1990). Wood density (g/cc) was calculated using the water displacement technique (Purohit and Nautiyal, 1987). Wood samples were ground in a mechanical grinder and pelleted to determine their calorific values. To estimate the energy of wood samples, pellets of known weight (1 gm) of plant material were burned in an oxygen bomb calorimeter (Bhatt and Bhadoni, 1990). For the estimation of ash content (%), 2 gm of ground sample was burned in a muffle furnace at  $600^{\circ}$  C for 3 hrs following the method given by Purohit and Nautiyal (1987) and Bhatt and Todaria (1992a).

### Statistical analysis

All data were subjected to analysis of variance (ANOVA) using R- software. Means were separated using the comparisons based upon the least significant difference (LSD) (Level of significance  $P < 0.05$ ).

## Results and Discussion

### Wood moisture content (%)

Wood moisture content showed significant variation among broad leaved tree species, however, non-significant difference was recorded among fruit trees. In broad leaved species, maximum moisture content was

observed in *Populus deltoides* (64.63%) which was at par with *Populus nigra*, *Salix alba* and *Salix fragilis*. Whereas, minimum moisture percentage was evaluated in *Robinia pseudoacacia* (59.07%). Among fruit trees, *Pyrus communis* recorded higher wood moisture per cent of 47.40 and *Prunus dulcis* recorded lower moisture content of 34.25 % (Tables 2 and 3). Moisture in wood generally decreases its calorific value, which is established by a number of investigators (Saravannan *et al.*, 2013). Effective calorific value also depends on the moisture content. The higher the moisture content, the less efficient is the wood as a fuel since the net calorific value for heating is reduced (Bhatt *et al.*, 2010; Bhatt *et al.*, 2004). Moreover, it has been recorded that the moisture content of wood varies with the dimensions of branches, season of the year, and so on. Thus, water content cannot be considered as part of the intrinsic value of a species as a fuel since it can vary (Sotelo Montes *et al.*, 2011; Bhatt and Todaria, 1992b).

**Wood density (g/cc)**

Wood density plays an important role in biomass energy. A critical view of the data in Tables 2 and 3 explicated a significant difference in wood densities among the species. As far as broad leaved species are concerned, maximum wood density was found to be 0.64 g/cc in *Robinia*

*pseudoacacia* and minimum value of 0.41 g/cc in *Populus deltoides*. In fruit trees, maximum wood density was recorded in *Prunus dulcis* (0.89 g/cc) and minimum in *Prunus domestica* (0.66 g/cc) which was at par with *Pyrus communis* and *Malus domestica*. An ideal fuel wood species should have high calorific value coupled with high wood density and low ash content. The results of the present investigation are in conformity with the earlier findings of Kumar *et al.*, (2011), Purohit and Nautiyal (1987) and Bhatt and Todaria (1992b).

**Ash content (%)**

Results of the present investigation elaborate the non-significant and significant differences among broad leaved and fruit treespecies respectively in terms of ash content. In broad leaved trees, maximum ash content was recorded in *Populus deltoides* (1.48%) with minimum content in *Robinia pseudoacacia* (1.19%) (Table 2).

Likewise in fruit trees, *Pyrus communis* had maximum ash content of 1.98% and minimum of 1.55% in *Malus domestica* (Table 3). High wood ash content is less desirable for fuel, as it is non-combustible, and reduces the heat of combustion. The findings of present study are in concurrence with Goel and Behl (1996) and Bhatt and Tomar (2002).

**Table.1** Details/ Methodology for the selection of sample areas

Selected Tehsils	Beerwah	Budgam	Chadoora
Selected Blocks (06)	2	2	2
Selected Villages (06 per Block)	6 x 2 = 12	6 x 2 = 12	6 x 2 = 12
Selected Farmers (7 per Village)	6 x 2 x 7 = 84	6 x 2 x 7 = 84	6 x 2 x 7 = 84
<b>Grand Total</b>	<b>252</b>		

**Table.2** Evaluation of fuelwood values of important tree species of District Budgam (Kashmir valley)

<b>Plant species</b>	<b>Wood moisture content (%)</b>	<b>Wood density (g/cc)</b>	<b>Ash content (%)</b>	<b>Calorific value (KJ/gm)</b>	<b>Fuelwood Value Index (FVI)</b>
<i>Populus deltoides</i>	64.63	0.41	1.48	18.53	513.33
<i>Populus nigra</i>	63.02	0.42	1.48	18.55	526.41
<i>Robinia pseudoacacia</i>	59.07	0.64	1.50	22.22	948.05
<i>Salix alba</i>	63.34	0.46	1.45	19.38	614.81
<i>Salix fragilis</i>	63.41	0.46	1.46	19.37	610.28
<b>Mean</b>	62.72	0.51	1.47	19.61	642.57
<b>CD (p≤0.05)</b>	1.19	0.04	N.S	1.16	345.00

**Table.3** Evaluation of fuelwood values of important fruit tree species of District Budgam (Kashmir valley)

<b>Plant species</b>	<b>Wood moisture content (%)</b>	<b>Wood density (g/cc)</b>	<b>Ash content (%)</b>	<b>Calorific value (KJ/gm)</b>	<b>Fuelwood Value Index (FVI)</b>
<i>Malus domestica</i>	42.09	0.81	1.55	16.54	864.34
<i>Prunus domestica</i>	46.69	0.66	1.57	16.19	738.26
<i>Prunus dulcis</i>	34.25	0.89	1.56	18.71	1067.42
<i>Pyrus communis</i>	47.40	0.67	1.98	15.54	525.84
<b>Mean</b>	42.60	0.75	1.66	16.75	828.95
<b>CD(p≤0.05)</b>	N.S	0.19	0.32	1.75	354.60

### **Calorific value (KJ/gm)**

Perusal of the data on fuelwood properties explicated that there exist significant variation among evaluated tree species (Tables 2 and 3). In broad leaved trees, *Robinia pseudoacacia* exhibited highest calorific value (22.22 KJ/gm), followed by *Salix alba* (19.38 KJ/gm) which was found to be at par with *Salix fragilis* (19.37 KJ/gm), *Populus deltoids* (18.53 KJ/gm) and *Populus nigra* (18.55 KJ/gm) (Table 2). However, among fruit tree species (Table 3), the highest energy value of 18.71 KJ/gm was recorded for *Prunus dulcis* followed by *Malus domestica* (16.54 KJ/gm) with lowest value evaluated for *Pyrus communis* (15.54 KJ/gm) which was found to be at par with *Malus domestica* (16.54 KJ/gm) and *Prunus domestica* (16.19KJ/gm). The present study findings are in conformity with Cuvilas *et al.*, (2014) and Obernberger *et al.*, (2006). Effective calorific value also depends on the moisture content, wood density and ash content. The higher the moisture and ash content, the less efficient is the wood and vice-versa (Bhatt *et al.*, 2010, Kumar *et al.*, 2010 and Bhatt *et al.*, 2004).

### **Fuel Wood Value Index (FVI)**

For estimation of ideal fuelwood species, a fuelwood value index (FVI) was calculated as calorific value x density/ash (Bhatt and Todaria, 1992b). Data pertaining to fuelwood index value (Tables 2 and 3) revealed that all the species viz., broad leaved trees and fruit trees showed marked difference with respect to FVI. In broad leaved species, maximum fuelwood value index was observed in *Robinia pseudoacacia* (948.05) followed by *Salix alba* (614.81). However, minimum value of (513.33) was recorded in *Populus deltoides*. Likewise, among fruit trees, *Prunus dulcis* (1067.42) recorded highest fuelwood value index followed by *Malus domestica* (864.34) and lowest by *Pyrus communis*

(525.84). For determination of suitability of a wood as fuel, a combination of three factors viz., calorific value, density, and ash will be most appropriate as stated by Saravanan *et al.*, (2013) in *Melia dubia*, Deka *et al.*, (2007) for ranking fuelwood species of Assam, Goel and Behl (1996) in *Acacia auriculiformis*, *Acacia nilotica*, *Prosopis juliflora* and *Terminalia arjuna* and Jain (1994) in tree and shrub species of India.

In conclusion, the results of the current study indicates that *Robinia pseudoacacia* among broad leaved *Prunus dulcis* among fruit trees are amenable source of fire wood production due to their ideal energy values. Extensive farming of *Robinia pseudoacacia* and *Prunus dulcis* under scientific supervision particularly for *Robinia pseudoacacia* for firewood production could bridge the gap between the demand and supply which people are facing today.

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