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# INFLUENCE OF BIOFERTILIZERS ON RATE OF DECOMPOSITION AND NUTRIENT RELEASE FROM LITTER OF CRACK WILLOW (*SALIX FRAGILIS)* UNDER TEMPERATE HIMALAYAN CONDITIONS

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## ABSTRACT

This study was carried out at the forest nursery of Department of Forestry, Faculty of Agriculture and Regional Research Station, Wadura SKUAST-K, Sopore, Kashmir during 2006 and 2007 to examine the role of live biofertilizers in litter decomposition and nutrient release in *Salix fragilis* under natural *Salix* stands. The experiment was laid in completely randomised design with three replications which comprised five treatment combinations of 5 inoculants (no-inoculant; *Azotobacter, Chroococcum, Pseudomonas fluorescens*, effective microorganisms and combinations of *Azotobacter chroococcum* + *Pseudomonas fluorescens* + effective microorganisms). Higher rate of decomposition of *Salix fragilis* litter was recorded in June (89.29%). Lower rate of decomposition of the species was recorded in January (39.07%). Plant N, P, K, Ca, and Mg release showed an increasing trend from July onwards upto November and immobilization of above nutrients was observed in December and January. However, in the succeeding months an increasing trend in the nutrient release was observed. Highest nutrient release was recorded under combined inoculation of *Azotobacter chrococcum* + *Psedomonas fluorescens* + effective microorganisms followed by effective microorganims as compared to other treatments and control. Combined biofertilizer inoculation resulted in a significant increase in total viable bacteria, fungi and actinomycetes followed by effective microorganisms, *Pseudomonas fluorescens*, *Azotobacter chroococcum* and control respectively. Thus the treatment combination of *Azotobacter choococcum* + *Pseudomonas fluerescens* + effective microorganisms proved to be the best for decomposition of *Salix fragilis* litter and nutrient release.

**KEY WORDS :Biofertilizers,Decomposition,Salix fragalis ,nutrients release.**

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# INTRODUCTION

*Salix fragilis* commonly known as crack willow is a deciduous tree, attaining a height of not more than 15meters. Its bark has rough fissures with widely spaced ridges. Leaves are 7-15 cm long, branchlets easily breaking off at their intersection especially during winter and spring. Flowering occurs during April-May. *Salix fragilis* is considered as one of the most important tree species in temperate agro/farm forestry systems. In India it is extensively cultivated in western Himalayas upto 2400 m, mostly in Kashmir and Kullu valleys on moist soils like marshy lands and Nallah sides, but not under water logged conditions. It is a fast growing multipurpose tree species and of late, this species has assumed a lot of importance in extensive planting programmes both in homesteads and as a venue. Large number of crack willows are planted every year because of its multipurpose uses. The trees being deciduous in nature are a source of substantial quantity of organic matter by way of litter fall. Litter production, decomposition and nutrient return in natural forests as well as in plantations are very important aspects of nutrient cycling, since a considerable amount of nutrients are returned through litterfall in the form of leaves, twigs, branches, flowers and are available for reabsorption. The sequential process of litter fall, its decomposition and subsequent mineralization are essential in sustaining a dynamic forest ecosystem (Maguire, 1994).Therefore, keeping in view the litter production, its possible contribution towards soil fertility, the present investigations were under taken to determine the role of microbial inoculation on rate of decomposition and nutrient release from *Salix fragilis* litter.

# MATERIALS AND METHODS

The present investigation were undertaken at the Forestry nursery of Department of Forestry, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir during 2006-07.Bio- inoculants, isolated from local forest stands, were used in the studies.

***Litter decomposition studies***

Litter bag techniques were used for litter decomposition and nutrient release studies. Fresh litter collected from local *Salix* stands were air dried for 24 hours. For bio-inoculation, thirty grams of leaf samples of the species were filled in 60 nylon net bags of size 20 x 10 cm of mesh 2 x 2 mm and placed randomly under natural *Salix* stands. A thin layer of soil of 2 cm thickness was spread on the bags to avoid misplacement. Litter bags, collected at different monthly intervals from the plots treatment wise were first carefully removed the accumulated soil and other foreign material. After removing all the extraneous matter, the samples were washed in running water and finally in distilled water. The contents were dried, weighed and powdered for chemical analysis.

***Chemical analysis of the samples***

The fine powder of the residues sampled periodically was used for the estimation of nitrogen, phosphorous, potassium, calcium and magnesium as per standard procedures.

***Bio-inoculation***

For inoculation the different broth cultures of bio-inoculants were applied to the litter bags without disturbing them.

***Average weight loss***

Average weight loss of litter from litter bags was calculated by subtracting the final mass of dry matter after oven drying from original (initial) mass of dry matter at monthly intervals.

# RESULTS AND DISCUSSION

***Average weight loss (g) during the decomposition of litter of Salix fragilis***

The data presented in Table 1 indicates that average weight loss was maximum (20.08 g) in the month of June and minimum (5.09 g) in the month of January. Among the bio-inoculations

the combined inoculation influenced maximum weight loss (13.17 g) followed by effective micro-organisms (11.80 g), *Pseudomonas fluorescens* (10.06 g) and *Azotobacter chroococcum* (5.92 g). The interaction between the inocula and months were also significant. It can be seen from the data that the decomposition of litter was faster particularly during the month of June and slower during the month of January. The faster rate of weight loss in June could be attributed to more penetration of solar radiation and subsequent temperature rise which might have boosted microbial activities (Sweft *et al.,* 1979). Slow rate of decomposition in January could be ascribed to the low temperature which also have resulted into low activity of decomposers (Pandey and Singh, 1982; Bahuguna *et al*., 1990; Maithani *et al*., 1996).

***Nutrient release during decomposition of crack willow litter***

The observation on the nutrient release from litter during decomposition is depicted in Fig.1

***Nitrogen release during decomposition***

The mixed bio- inoculation resulted in maximum nitrogen release (Fig. 1) in June from crack willow litter bags and proved superior over mono-inoculants. It was followed by individual inoculation of *Azotobacter chroococcum*, effective microorganisms and Pseudomonas fluorescens. But, nitrogen release from litter bags depicted, in general, a decreasing trend in the winter months of December and January. The higher nitrogen release from litter bags in June, due to application of inoculations, lies in the fact that they enrich the litter bags with nitrogen through atmospheric nitrogen fixation and develop more microbial colonies inside the litter bags which therefore degrade, the litter material more quickly and hence improve the soil environment (Singh *et al*., 1998). Our findings are in agreement with the results of Kumar and Deepu (1992), who also observed an increase in N release but decrease in absolute amount of nitrogen in leaf litter of *Casuarinia, Acacia* and Leucaena. Further, the decrease in nitrogen release in January may be due to the adverse climatic conditions and rapid immobilization of N by microorganisms. Moreover, the leaching of water soluble nitrogenous substances might have accounted for its decrease (Nykvist 1963; Kumar *et al*., 2001).

***Phosphorus release during decomposition***

The release of phosphorous (Fig. 1) into available pool increased within all the treatments except control. Phosphorous release was more in the inoculated litter when compared to control. The phosphorous release into the available pool was maximum (0.21 %) in June. Minimum release was observed in January (0.045%). The combined inoculation showed the best results, followed by *Pseudomonas fluorescence*, effective micro-organisms, *Azotobacter chroococcum* and control. The initial decrease in phosphorous release from litter bags could be attributed to the better retention of P due to its immobile nature and the subsequent increase in P during the later half of study could be due to the rapid loss of P bounded in easily leachable compounds (Upadhyah, 1987).

***Potassium release during decomposition***

The potassium release into the available pool increased gradually from July onwards to November, followed by decrease upto January (Fig. 1). However, from February to June a sharp increase was noticed. Maximum potassium release was recorded in June and minimum in January. The combined microbial inoculation resulted in maximum potassium release in June from litter bags and proved superior over individual inoculants. The increase in K release from litter bags in June could be attributed to high rainfall coupled with high humidity, temperature and microbial activity (Kunhamu, 1994). However, a decline in K release from litter bags in winter months may be ascribed to lower rate of decomposition of litter and immobilization of K by microbes (Nykvist, 1963).

***Exchangeable calcium release during decomposition***

Exchangeable calcium release from litter bags increased significantly from July to November, where it dropped upto January and again an increasing trend in release was noticed from February onwards to June (Fig. 4). Maximum release was noticed in June and minimum in January. Among the microbial inoculations, the combined inoculations showed the best results. The maximum release of Ca from litter bags in June could be attributed to rapid rate of decomposition of litter which is responsible for majority of Ca-release to the ecosystem (Gosz *et al*., 1973). The decrease in Ca-release in January may be ascribed to lower rate of decomposition due to low temperature conditions and immobilization of Ca by microorganisms. Our results are in conformity with the results of Thomas (1969), who also showed similar results.

***Exchangeable magnesium release during decomposition***

Significant and maximum Mg-release (Fig.1) was recorded in June under combined microbial inoculations which was superior over mono-inoculants. It was followed by mono-inoculation of effective micro-organisms, *Pseudomonas fluorescens* and *Azotobacter chroococcum*. But Mg release from litter bags showed a heavy decrease in the winter months. The increase in Mg-release from litter bags in June can be attributed to rapid leaching losses which is triggered by higher rates of mineralization of this element held up in the litter. Our results are in agreement with the findings of Sivakumar (1992), who made the similar observations. Moreover, the significant decrease in Mg release from litter bags in January may be due to biological immobilization of Mg, which is also suggested as a mechanism of Mg retention in the initial stages of scot pine litter decomposition (Staff and Berg, 1982).

**Table 1**
***Average weight loss (g) during the decomposition of leaf litter of Salix fragilis***

| | 2006 | | | | | | 2007 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **July** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **June** | |
| Control | 0.16 | 0.50 | 1.80 | 1.90 | 3.00 | 2.00 | 1.60 | 6.89 | 7.95 | 8.97 | 11.48 | 13.47 | 4.73 |
| AZ | 0.81 | 1.80 | 4.00 | 4.80 | 3.13 | 4.10 | 3.91 | 6.69 | 7.95 | 8.97 | 11.48 | 13.47 | 5.92 |
| PS | 1.10 | 2.98 | 3.40 | 6.20 | 7.50 | 6.50 | 5.49 | 12.97 | 15.29 | 17.28 | 20.08 | 21.89 | 10.06 |
| EM | 2.24 | 4.00 | 6.23 | 7.90 | 7.90 | 7.30 | 6.99 | 14.69 | 17.66 | 20.00 | 21.79 | 24.87 | 11.80 |
| AZ + PS + EM | 2.43 | 4.90 | 7.93 | 8.93 | 9.97 | 8.97 | 7.89 | 15.97 | 18.99 | 21.75 | 23.68 | 26.69 | 13.17 |
| Means | 1.35 | 2.83 | 4.67 | 5.94 | 6.30 | 5.77 | 5.69 | 11.44 | 12.97 | 15.39 | 17.70 | 20.08 | - |

***CD (0.05)***
***Treatment = 0.04*** ***Control = No inoculant*** ***AZ = Azotobacter chroococcum***
***Month = 0.07*** ***PS = Pseudomonas fluorescens*** ***EM = Effective microorganisms***
***Treatment x month = 0.16 AZ + PS + EM = Azotobacter chroococcum + Pseudomonas fluorescens + Effective microorganisms***

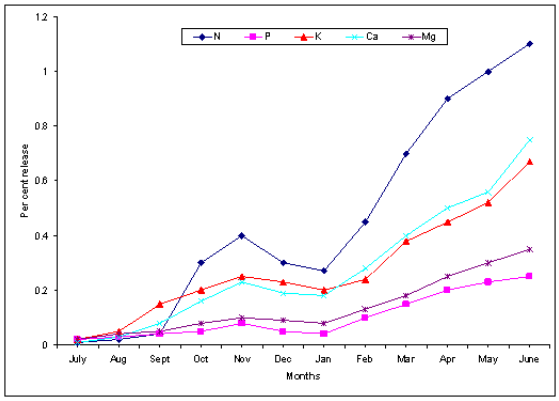


**Figure 1**
***Nutrient release in litter of crack willow during decomposition***

**Plate 1**
***Decomposition of crack willow under natural conditions***

**Plate 2**
***A general view of litter bag experiment***

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