INTRODUCTION:

For the ecologist, the understanding of the functionnals aspects of an ecosystem requires the knowledge of the processes of growth and productivity, which are the basic aspect of plant and communities responses to the environmental factors.

"The net aerial primary production is the sum of biomass and litter increments and of dead material disappearance" MENAUT (1976). The determination of the net aerial primary production (NAPP) requires the measurement of the biomass and of the dead material (necromass) variations, but also of the disappearance rate of the dead material and the actual mortality.

The WIECERT and EVANS method (1964) revised by LOMNICKI and Al. (1968) is based on the use of paired plots and allows the calculation of NAPP, but without accounting of the decomposition of dead material. BILLE (1976 A) showed that the calculation of the NAPP in the sahelian grassland communities requires the knowledge of the disappearance rate of dead material, because it is very high during the growing season. In the present work, a method based on paired plots is suggested for calculating disappearance rate, mortality and NAPP during a time interval.

This study was conducted in the live-stock Research Center of DAHRA, located in the sahelian zone of Senegal. The mean annual rainfall is 492 mm. The rainy season includes only three months: July, August and September. The measurements were conducted on three representatives grassland communities.

- Community I B characterized by Tephrosia purpurea
- Community II B by Schoenfeldia gracilis
- Community I C by Zornia glochidiata

The study of the vegetation has been published previously (CORNET and Al. 1977)

In each community measurements were made on twenty repetitions of paired plots. Each plot, a quadrat of 0.25 m² in area, was randomly selected in the vegetation. The measures began when the seedlings appeared and were carried on during the whole growing season, at time intervals of 7 or 14 days. The harvested material was dried at 80°C and weighed.

METHOD OF CALCULATION

In accordance with the WIECERT and EVANS method, two similar, paired, plots were studied. At time t₀, an equal biomass b₀, and an equal weight of dead material g₀, are present on each plot. On the plot n° 2 all the dead material was harvested.

At the time t₁ the biomass b₁ is equal on the two plots. These is a weight g₁ of dead material on the plot n° 1, and on the plot n° 2 an amount of dead material h₁ accumulated during the time interval t₁-t₀.

If y₁, is the value of NAPP during the time interval t₁-t₀, and a₁ is the value of the actual mortality, the NAPP of these plots can be calculated as

\[ y₁ = b₁ - b₀ + a₁ \]
The dead material on these plots is produced, and simultaneously, partly decomposed, in a similar manner than forest litter. The evaluation of the amount of dead material is studied in accordance with the works of OLSON (1963) and BERNHARD-REVERSAT (1970).

If \( x \) is the weight of dead material at the instant \( t \), and \( a \), the instantaneous mortality, and \( k \) the disappearance rate of dead material, the variation of dead material can be expressed by the differential equation:

\[
\frac{dx}{dt} = a - kx \quad (2)
\]

or

\[
\frac{dx}{k} = (a - x) \quad kdt
\]

The general integral of this equation is

\[
L_N \left( \frac{a - x}{k} \right) = kt / Cste \quad (3)
\]

Coming back to the experimental conditions of the paired plots method, the two plots are assumed to be identical, and \( k \) have the same values of the two plots.

On the plot no 2, the dead material is harvested at time \( t_0 \). In this case \( x_0 = 0 \), and the equation (3) gives:

\[
L_N \left( \frac{a - x}{k} \right) = Cste
\]

and it can also be written

\[
L_N \left( \frac{1 - x}{k} \right) = -kt
\]

expression which can be expressed in the exponential form:

\[
l - \frac{kx}{a} = e^{-kt}
\]

From this equation \( a = \frac{kx}{1-e^{-kt}} \) \quad (4)

If the interval between two measurements, is taken as time unit.

\[
ai = \frac{ki \cdot xi}{1-e^{-ki}}
\]

As at time \( ti \), \( xi = hi \) on the plot no 2, it can be written

\[
ai = \frac{ki \cdot hi}{1-e^{-ki}}
\]

If the plot no 1 is considered, at time \( t_0 \), \( x_0 = go \), and at time \( ti \), \( xi = gi \), but if no material had died between \( t_0 \) and \( ti \), the weight of dead material at time \( ti \) would be \( xi = gi - hi \), because \( hi \) is the amount of dead material accumulated during this interval. In this case the equation (2) becomes

\[
\frac{dx}{x} = -kx \quad \text{or} \quad \frac{dx}{x} = -k dt
\]

and the integral of this equation is

\[
L_N x = kt + Cste
\]

At time \( t_0 \),

\[
x_0 = go \quad \text{and} \quad Cste = L_N go,
\]

it can be written \( L_N \left( \frac{x_0}{x_0} \right) = kt \). If the interval between two measurements is taken as time unit, it can be written

\[
ki = -L_N \left( \frac{gi - hi}{go} \right)
\]

This rate can be calculated from the experimental data if \( go \neq 0 \). And the net aerial primary production can be calculated from the experimental data with the relation:

\[
yi = bi - bo + \frac{Ki \cdot hi}{1-e^{-ki}}
\]
RESULTS

The study was realised in 1977 and 1978. In 1977 the rainfall was low, 296.7 mm, and the rainy season was late but regular. In 1978, the rainy season began early, but was interrupted by many dry periods. The figure 1 shows biomass and dead material evolution, for each groupment during the growing seasons 1977 and 1978. During the dry season (from November to June) there is not living material left, because the annual species are dead. The dead material decreases in relation with the grazing.

This figure shows that the dry periods brake up the growing curves in 1978. The effect of the dry periods was variable, depending on groupment and soils.

The biomass was known with mean confidence limits of 19.3 % (probability 0.95). The confidence limits was 25.3% for the weight of dead materials.

The table 1 gives the calculated results of NAPP and the actual mortality expressed in grams of dry weight/m² and the disappearance rate expressed in g/g/m². The evolution of these values is shown by the figure 2.

Table 1: The calculated values of disappearance rate (ki), mortality (ai) and the net aerial primary production (yi).

<table>
<thead>
<tr>
<th>Date</th>
<th>ti - to</th>
<th>I_B</th>
<th>I_B</th>
<th>I_C</th>
<th>I_C</th>
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<td>ki</td>
<td>ai</td>
<td>yi</td>
<td>ki</td>
<td>ai</td>
</tr>
<tr>
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<td>9*</td>
<td>1,2</td>
<td>1,6</td>
<td>5,4*</td>
<td></td>
</tr>
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<td>0,9</td>
<td>0,125</td>
<td>0</td>
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<tr>
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<td>67,55</td>
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<td>Total 77</td>
<td></td>
<td>216,05</td>
<td>245,0</td>
<td>176,8</td>
<td></td>
</tr>
</tbody>
</table>

| 26/06/78| 10** | 9,4  | 12,7**| 20,8** |
| 04/07/78| 14    | 0,213| 2,22 | 5,52 | 0,065| 3,2 |
| 19/07/78| 15    | 0,127| 2,66 | 27,26| 0,096| 4,3 |
| 30/07/78| 11    | 0,037| 2,55 | 63,25| 0,057| 4,11 |
| 09/08/78| 10    | 0,323| 29,84| 64,44| 0,012| 25,55 |
| 19/08/78| 10    | 0,381| 14,55| 25,55| 0,081| 8,86 |
| 30/08/78| 11    | 0,343| 67,92| 6,22 | 0,266| 33,94 |
| 08/09/78| 9     | 0,574| 76,87| 77,67| 0,472| 46,6 |
| 21/09/78| 13    | 0,327| 29,90| 56,90| 0,319| 35,98 |
| 30/09/78| 9     | 0,593| 38,98| 61,98| 0,425| 58,92 |
| 11/10/78| 11    | 0,010| 39,90| 19,60| 0,227| 15,12 |
| 26/10/78| 15    | 0,287| 50,61| 0    | 0,030| 58,69 |
| Total 78|       | 1417,8| 1447,2| 1203,2|

* Since the germination
** Is a under-estimation
Figure 1: Evolution of biomass and amount of dead material in three grassland communities.
Figure 2: Evolution of the net aerial productivity calculated, the actual mortality, and the disappearance rate of dead material.
DISCUSSION AND CONCLUSION

From this results it is pointed out that, the net production is low in the beginning of the rainy season and their increases proportionally with the accumulation of biomass, because of the increasing photosynthetic surface. The net daily productivity raised to a maximum in September, at this period the leaf area index is the highest and the water budget is good. The highest calculated values are: 9.1 g/m²/day for the IIB groupment in 1978,
8.5 g/m²/day for the IB groupment in 1978 and
6.0 g/m²/day for the IC groupment in 1977.
The net productivity is in relationship with the available water. During the growing season, the drought reduces or stops the production.

The amount of dead material stored depends on the mortality and on the disappearance rate. It decreases during the active growing period, and can be reduced to zero (BILLE 1976B) during the rainy years. The mortality is low at the beginning of the rainy season and then increases with the aging of plants, but occasional droughts lead to sharp increases in mortality.

The disappearance rate of dead material is the sum of the consumption by insects and other animals of the microfauna and of the microbial decomposition. The rate is low during the dry season because, the insects populations are small and the microbial activity is reduced to zero, by the dessication. This rate increases during the growing season. During the rainy season of 1978, for the three communities, this rate is much higher than in the 1977 season. It is supposed that the plant material dead during the dry periods of the 1978 rainy season is easily decomposable, because consisting of young tissues.

An other experiment was realised in an other grassland-community of the sahelian zone (BERNHARD-REVERSAT personal communication) it consisted in the weight losses measurement of samples of dry grass and disappearance rates which are comparable with those obtained in the present work.

In conclusion, in the grassland communities of the sahelian zone, the measurement based on the paired plots method can be used to calculate the net aerial primary production, if mortality and disappearance rate of dead material are calculated by the relation described here (5) (6) (7). The knowledge of the production components allows to understand the fonctionnement of the vegetation considered as the primary producer, in relation with the environmental factors.

REFERENCES


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