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Analysis of decomposition parameters of green manure in the Brazilian Northeast with Association Rules Networks

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Abstract

Modern agricultural processes are increasingly looking at the use of chemicals, so the constant search for organic alternatives to fertilization becomes frequent. The use of data mining using association rule networks (ARN) can aid in the analysis of the parameters involved in choosing which plant to use as green manure. In this work, an analysis of the parameters of green manures used in the Brazilian Northeast is presented, demonstrating the applicability of the computational technique as well as its use to gain in productivity.

1 Introduction

Inadequate processes of occupation of arable areas and the need for rapid food production, coupled with economic interests in the pursuit of profitability in the agricultural sector, have contributed to the worsening of environmental degradation causing severe changes in the physical, chemical and biological attributes of the soil causing a drop in the productive potential [3].

It is possible to practice organic agriculture only to substitute inputs used in conventional agriculture, however, in ecologically based agriculture the sustainable production is possible, in which the aim is to intensify the free natural functions of the ecosystem [2].

With the problem of ecological production versus productivity, one must understand the importance of using plant species, known as green fertilizers, capable of attributing improvements to the production environment, since chemical inputs are not allowed in ecologically based agriculture [8].

Leguminosae are extremely important as green manure, but the greatest difficulty encountered for the use of these species is related to the time of decomposition of this type of plant, which directly affects the productivity of the crop. The choice of the plant type is related to the desired degradation time [6].

This work proposes the use of extraction of patterns for the discovery of parameters directly related to the half-life rate of legumes used as green manure in the Brazilian Northeast.

Data mining techniques, in particular, mining association rules may contribute to the study of parameters related to agroecological production [5]. The discovery of association rules is a data mining technique that seeks to identify certain patterns of data in large databases, allowing, after their interpretation, to acquire specific knowledge about the problem under analysis [7].

An association rule characterizes how much the presence of a set of elements in the records of a database implies in the presence of some other distinct set of elements in the same records [1]. The format of an association rule can be represented as an implication LHS $\Rightarrow$ RHS, where LHS and RHS are, respectively, the Left Hand Side and Right Hand Side of the rule, defined to disjoint sets of items.

For each rule (LHS $\Rightarrow$ RHS), extracted from a set of transactions T, a support value (*sup*) is given that checks the strength of the association LHS and RHS in relation to the total items. The confidence values (*conf*) measures the strength of the logical implication of the rule.

1.1 Association Rules Network (ARN)

Proposed by [9], the central idea of ARNs is that the association rules discovered by the mining algorithm can be synthesized, pruned, and integrated in the context of specific research objectives. In particular, if there is a variable of interest ("target" or "objective"), a network can be formed with the most relevant variables related to the objective and, afterwards, to elaborate a structure that can be tested using statistical methods, i.e., to couple a data mining task with statistical analysis.

As described by [4], ARNs use as a representation a *B-graph* (backward-directed hypergraph), which after the pruning processes, can transform the ARN according to the objective.

2 Decomposition of Green Manure and ARN

The work was conducted during the second semester of 2015, at Embrapa Meio-Norte/UEP Parnaíba, (0305'S, 4146'W and 46.8m altitude).

Seven types of legumes were planted: *Crotalária breviflora*, *Crotalária juncea*, *Crotalária mucronata*, *Canavalia ensiformis L.*, *Cajanus cajan* Fava Larga, *Cajanus cajan* IAPAR 43 e *Tephrosia candida*.

At 120 days, plant height (AP) parameters were determined; Fresh shoot mass (MFPA); Dry shoot mass (MSPA); Fresh root mass (MFR) and Dry root mass (MSR). Germination (G), flowering (F) and pod formation (PV), as well as the collector diameter (DC) and number of branches per plant (NR) were also evaluated.

The residual decomposition constant (k) was calculated for each species, following the simple exponential model used by [10], as well as the half-life for the decomposition evaluation, expressing the time period, in days , required for half of the material to decompose.

After the calculations, all parameters were categorized from 1-6 (one to six) according to the values obtained in the experiments, and then the mining of the association rules was performed with values of *minsup* = 0.3 and *minconf* = 0.5, since these measures were the ones that presented a better number of rules. With the generated rules, the construction of the respective ARN was made.

3 Results and Discussion

The Association Rule Network target was the "HalfLife=6.0" (Figure 1), which indicates a longer half-life, resulting in a longer decomposition time of the green manure.

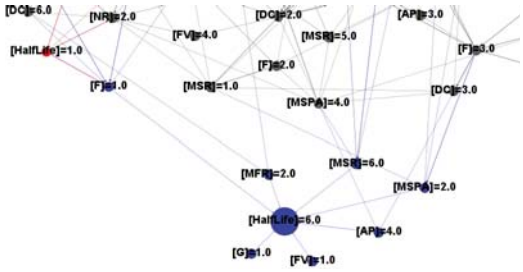

Figure 1: Association Rule Network clipping with target "HalfLife = 6.0"

By verifying the nodes with level 1 (one), i.e. directly connected to the target, one perceives 7 (seven) proper conditions for a greater time of decomposition. First stands out nodes without predecessors, "[G]=1.0" and "[FV]=1.0". It can be inferred that plants with a germination time and a formation of pods in a shorter period tend to decompose more slowly and thus are important characteristics for the evaluation of new compounds.

The fresh root parameter (MFR) presents the "[MFR]=2.0" node, indicating a low rate for this index in plants with longer half-life. In relation to the "[MSR]=6.0" node, it is also inferred its connection

with high values for all other mass items (MFR, MSR and MSPA), which corroborates to the search for species that promote a high index of mass in their root and air compositions.

The nodes "[MSPA]=2.0" and "[F]=1.0" undergo lower half-life influences, "[HalLife]=3.0" and "[HalLife]=1.0", respectively, leading to the need for further study. A decomposition rate in category 4.0 (four) was also observed for the plant height parameter (AP).

4 Conclusion

With the mining through the use of ARN, it was possible to generate the discovery of a knowledge directly linked to studies of green fertilizers, as well as positively influence the choice of the plant according to the crop, and therefore boosting productivity.

For future work, Mining will be performed with other types of plants that can be used as green manure, and compare it with the productivity of the crop in which each species is commonly handled.

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