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Morphological Characterization of Three Legumes (Vicia spp.) in the Semi-Arid Region of Setif-Algeria using Fuzzy Logic Inference System

K. Abed-Cheniti [1], M. Dekhili[2], S. Bouharati[3]
[1,2] Department of Agronomy, Faculty of Nature and Life, Setif 1 University, Algeria
[3] Laboratory of Intelligent Systems, Faculty of Technology, Setif 1 University, Algeria
([1]khalissaabed@yahoo.fr, [2]dekhili48@yahoo.fr, [3]sbouharati@yahoo.fr)

Abstract- In agriculture, prevention performance of a parcel is paramount. In this study, we tried to predict the yield from species of varieties of leguminous species in a semi-arid region. Several variables are taken into consideration as the number of leaf, flower, and stem ...etc. Since these variables are characterized by uncertainty and imprecision, we proposed a tool for data analysis based on artificial intelligence techniques, including the principles of fuzzy logic. The result was very satisfactory. Program established for predicting the performance of a plot just from imprecise inputs variables of the system.

Keywords- *leguminous species, morphological characteristics, semi-arid region, fuzzy logic.*

I. INTRODUCTION

Food is undoubtedly one of the major constraints to livestock production in Algeria. The examination of the fodder balance has identified a weakness in the coverage needs of livestock, resulting in a negative impact on animals' productivity. Regarding the question of forage production in Algeria, it will come down to:

- The availability structurally deficient for the needs of livestock.
- The availability unevenly distributed in space and time.
- Forage availability is very close to the limit.

Indeed cattle feeding are based on the stubble grazing, vegetation and fallow land and the associations hay (oat-vetch) [1]; [2]. Such a limited source induces intensive agriculture stems constituting an aspect of production. This mode of production is exposed to climatic hazards and deficiencies in nitrogenous materials. Legumes have advantages both biological and agronomic with other pasture forage component of dietary supplements ruminants [3]. As legumes cultivated, vetches are an excellent substitute food for livestock, they are generally used in combination with oats [4].

If all the conditions are right, pure culture can give good results. However, before the first action, it is necessary to characterize these forage resources. Thus the present work is therefore in this context, and the main objective is to characterize morphologically some vetch species in the semi-arid region of Setif in Algeria, determine the most discriminate variables and find the varieties the most relevant and most efficient to satisfy the food needs of our livestock both quantitatively and qualitatively. As the data characterizing these parameters are distinguished by their vagueness and uncertainty, we found it useful to apply the principles of artificial intelligence including the principles of fuzzy logic in data analysis. The principles of fuzzy inference are perfectly suited to these data.

II. MATERIALS AND METHODS

A. Natural Environment

This study was conducted in the central area of Setif district in Algeria, at the experimental station, is a site located in the south-west and 5 km from the town of Setif, about 1081 m of altitude, characterized by a continental climate with high temperature variations both annual daily so by very hot and dry summers, and very cold winters with low and irregular rainfall of 450 mm on average.

B. Plant Material

The test focused on three species of vetch (*Vicia sativa* L.; *Vicia ervilia* sp. and *Vicia narbonenses* L.) each of them is represented by six varieties as shown in the Table 1.

TABLE 1: LIST OF SPECIES AND VARIETIES STUDIED

Species / **Varieties**	***Vicia narbonensis* L.**	***Vicia ervilia***	***Vicia sativa* L**
1	V1	V1	José
2	V2	V3	Fig
3	V3	V5	Baraka
4	V4	V6	715
5	V5	V7	709
6	V6	V8	Hifa

C. Experimental protocol and conduct of the experiment

The trial was established as an experimental protocol that follows a completely randomized split-plot. Sowing was done manually on 25/12/2007 at a depth of 2-3 cm, with a plot as previous crop and cereals which different cultural practices were carried out -Table 2.

TABLE 2: CULTIVATIONS CARRIED OUT ON THE EXPERIMENTAL PLOT

Date	***Cultural method***
the start of September	Deep plowing (25 cm)
end September	Backcrossing
end September	Spreading basal dressing (TSP100 Kg / ha)
November	Backcrossing and harrowing before planting and Teflon weeding in planting nearly 2l / ha

The main plot is divided into elementary plots spaced by 80 cm apart and divided into three replicates. Each of these elementary plots is represented by two lines of 2.5 m long and spaced by 60 cm. 15 seeds were sown per line.

D. Climate:

According to Table 3, we find that the experimental year was dry because it was characterized by low rainfall (372.3 mm), which is not even the usual average in the region (450 mm) in addition to a poor distribution -table 3.

TABLE 3: CLIMATIC CONDITIONS OF THE CAMPAIGN (2007-2008)

Months	***sep***	***oct***	***nov***	***dec***	***jan***	***feb***	***mar***	***apr***	***may***	***jun***	***july***	***total***
Temp. min. (°C)	35.80	28.10	20.20	15.80	18.20	21.20	21.10	19.25	32.49	39.56	39.20	/
Temp. max. (°C)	11.40	08.20	00.20	-2.40	-2.60	-1.44	-0.06	07.55	08.36	10.57	14.60	/
Pluviometry (mm)	79.50	25.30	16.50	06.00	10.00	19.30	48.90	21.30	75.80	15.20	54.50	372.3

Regarding temperatures, lower are common in this experimental year (2007/2008) and they often coincide with the flowering stage of legumes where abortion of certain flowers (March, April and May).

Maximum temperatures are also very important, they occur at the end of cycle of leguminous plants where, they promote fertility pods (filling).

E. Data Collection and Analysis:

All measurements and notations were made on field for each species. Twelve variables were selected for analysis. They focus on biometric characters and yield components. These are all continuous quantitative variables -Table 4. The notations were carried out at different times of the growing season and the analysis program used for processing was the Fuzzy logic approach.

TABLE 4: VARIABLES ABBREVIATIONS

Variables	***Abbreviations***
Number of ramifications	Nr
Length of major axis	Lpr
Length of the leaflet	Lfl
Number of leaves on the main axis	Nfe
Number of flowers	Nfr
Number of pods / plant	Ngp
Pod weight / plant	Pgp
Number of seeds / pod	Ngrg
Number of seeds / plant	Ngrp
Seed weight / plant	Pgpp
Yield	RDT

III. FUZZY LOGIC INFERENCE

The fuzzy logic approach, a sub-field of intelligent systems, is being widely used to solve a wide variety of problems in medical, biological and environmental applications. Fuzzy logic deals with the analysis on a higher level, using linguistic information acquired from domain experts. The above-mentioned capabilities make fuzzy logic a very powerful tool to solve many biological problems, where data may be complex or in an insufficient amount. The fuzzy logic concept provides a natural way of dealing with problems, and the source of imprecision is an absence of sharply defined criteria rather than the presence of random variables. The fuzzy approach considers cases where linguistic uncertainties play some role in the control mechanism of the phenomena concerned [5]. Fuzzy inference systems (FIS) are powerful tools for the simulation of nonlinear behaviors with the help of fuzzy logic and linguistic fuzzy rules [6]. Especially for medical expert systems, the theoretical framework of fuzzy logic in a rich environment is very adequate. The adequacy of each approach is borne out by the success of the model in practice [7].

In this study, we propose a fuzzy algorithm in decision-making. For all the algorithms presented below, there is a common rule form for rules that associate an observation vector.

A. Fuzzy Logic Modeling:

- *Assemble Input-Output Data sets*

As the effect of each parameter remains in the field of imprecise and fuzzy, each variable is represented by a membership function. The degree of influence on the location of species of seeds is reflected by a degree in the fuzzy membership function. The first step is to collect all inputs

variables (e.g., the morphological characteristics in which the study was based on and also the agronomic characteristics are: Number of ramifications (Nr), Length of major axis (Lpr), length of the leaflets (Lfl), Number of leaves on the main axis (Nfe), Number of flowers (Nfr), Number of pods/plant (Ngp), Pod weight/plant (Pgp), Number of seeds/pod (Ngrg), Number of seeds/plant (Ngrp), Seed weight/plant (Pgrp), seed weight/plant/pod weight/plant (Pgrp/Pgp), yield (Rdt)) and the consequence as output (e.g. the varieties and the species).

- *Fuzzyfication of inputs*

The data for the inputs were classified into three linguistic categories: The input1 representing the number of ramifications (Nr) -Fig. 1. (Low between 0 and 4; Middle between 4 and 10 and height between 9 and 15). In the same way, all other inputs (LRP; LFL; NFE and NFR) are fuzzyfied. According thus inputs, we can identify the varieties and the species as outputs.

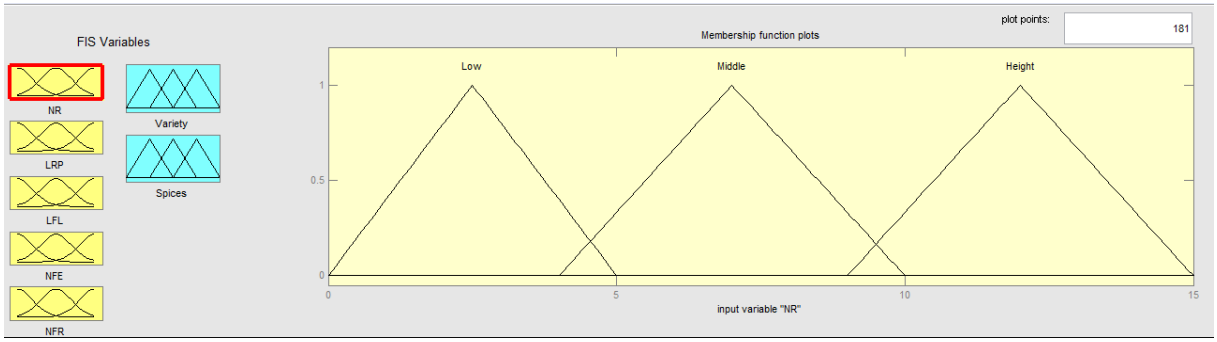

Fig. 1: The first entry representing the number is represented by tree universes of discourse.

The others inputs (NGP; PGP; NGRG; NGRP and PGPP) are also fuzzyfied in the same way, all other inputs (LRP; LFL; NFE and NFR) are fuzzyfied. According thus inputs, we can identify the agriculture-yield like an output –Figure 2.

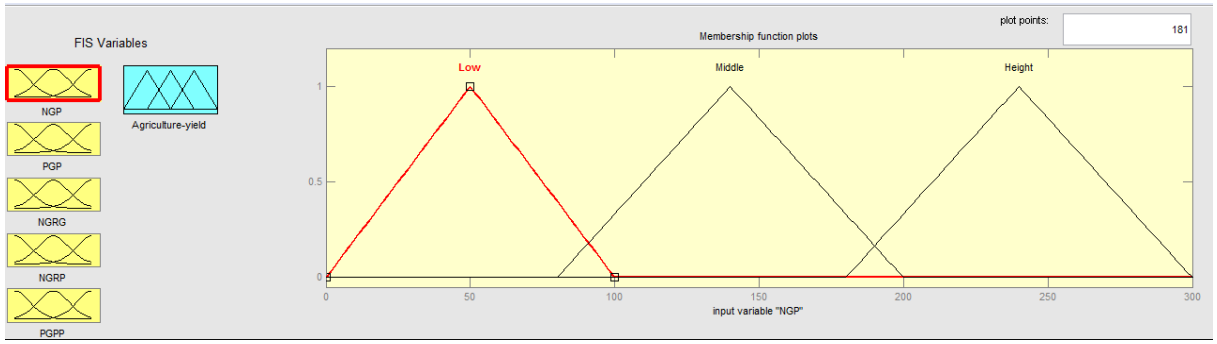

Fig. 2: The first entry representing the pods/plant is represented by tree universes of discourse.

- *Fuzzyfication of outputs*

The data for the outputs were fuzzyfied into three linguistic categories: The output of agriculture-yield was divided into:

Low between 0 and 2; Middle between 3 and 5; Height upper 4 shown in Figure 3.

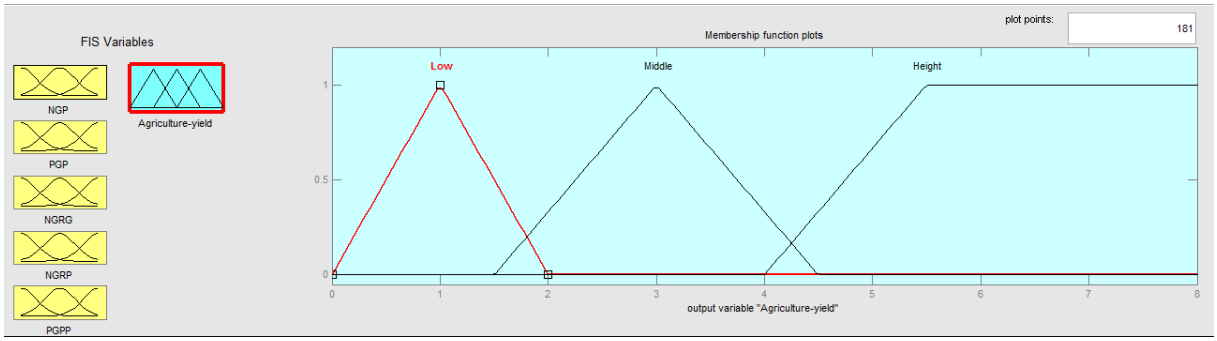

Fig. 3: The output variable represented by tree universes of discourse.

B. Fuzzy Rules

The rules determined by the choice of the fuzzy membership function are defined for each input variable. In general form, If X1 is X1(1), and X2 is X2(2), and ….Xn is:

Xn(n), then Y1 is Y1(1). After system is done, we can choose randomly values for inputs and read instantly the result at output. Example on figure 4. The second group of inputs determines also randomly the second output.

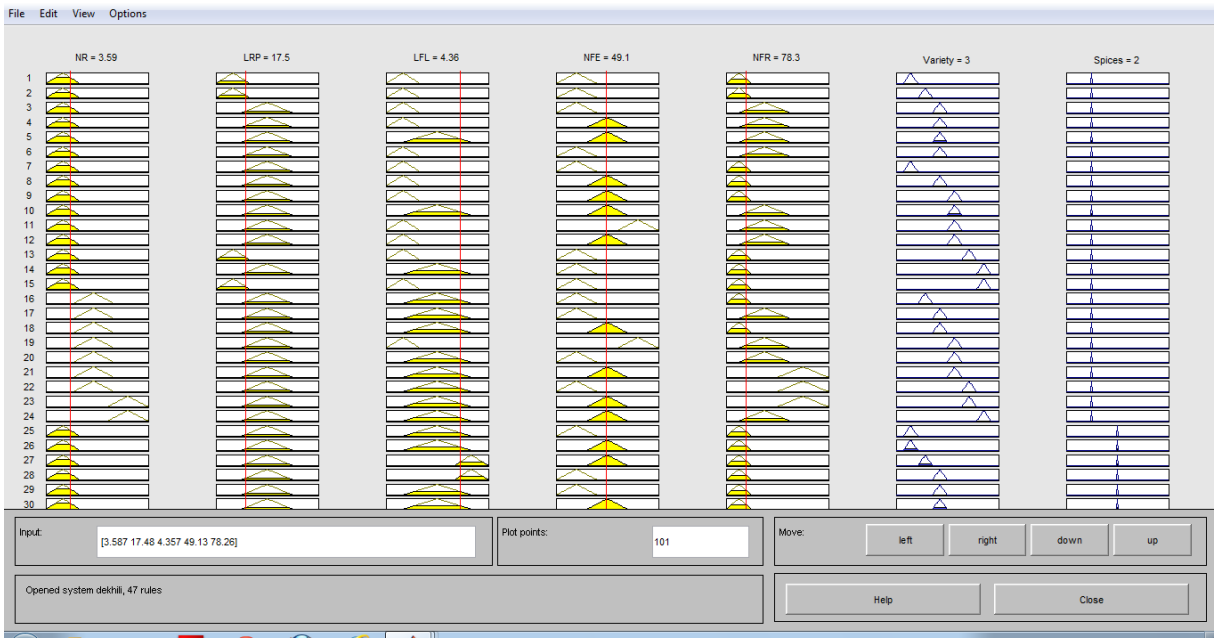

Fig. 4: The result of the first identification group

IV. RESULTS

Based on the input values of the two proposed systems, as these values are considered as fuzzy variables, we can instantly read the output fuzzy variables and that after defuzzyfication.

The first group proposed system provides information on the species and variety, while the second provides information on the performance. The result is that from the species and variety we are able to predict the expected return –Figure 5.

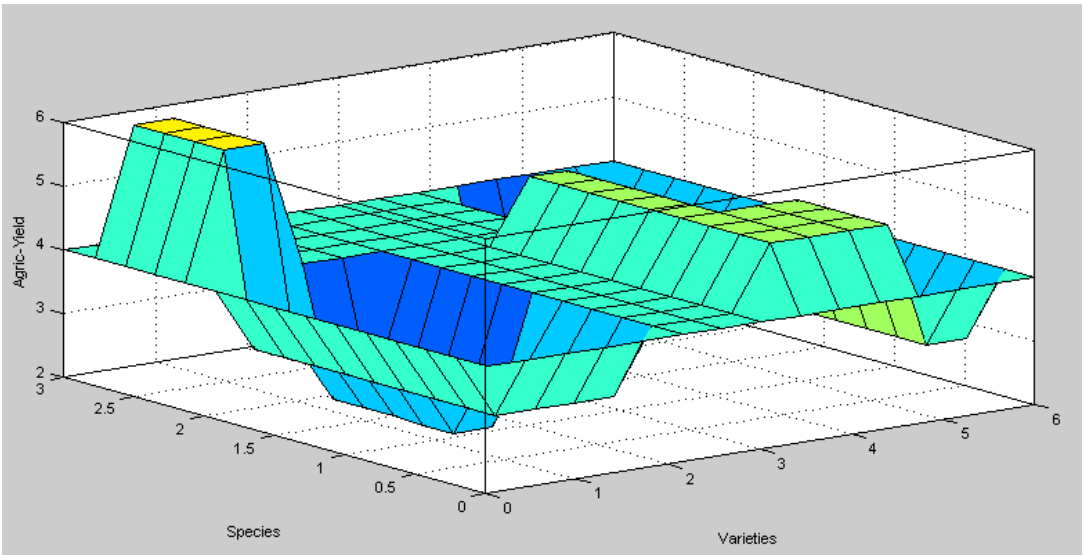

Fig. 5: The final result of the tow proposed systems

V. CONCLUSION

The identification of species and varieties of forage, and agriculture-yield interested breeders and government agencies responsible for monitoring the agriculture productivity. For botanists the observation of number of ramifications, length of major axis, length of the leaflet, number of leaves on the main axis, number of flowers, number of pods/plant, pod weight/plant, number of seeds/pod, number of seeds/plant, seed weight/plant, seed weight/plant and pod weight/plant is an element of the confirmation of the identification.

In the study morphological characters are considered as fuzzy variables. The main goal of this study is to identify which species and which variety gives maximum performance in a field. We attempt by using the fuzzy logic to put key to identify the performance in a field according morphological characters. The obtained results allowed identifying the most species and varieties in the region of study. The goal of this study is to design and perform a pilot investigation which will provide preliminary data. Modern methods of computational intelligence such as fuzzy logic are used to achieve the highest accuracy of pattern recognition. We should emphasize that our fuzzy system is not meant to replace or substitute for an experienced physician. On the contrary, we envisage that the fuzzy logic system should be viewed as a decision support in the most accurate.

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