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UNIVERSITAT POLITÈCNICA DE VALÈNCIA

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Instituto Madrileño de Investigación y Desarrollo Rural, Agrario y alimentario

Testing and Validation of Monitoring Technologies to Assess the Performance and Genotyping of *Poa pratensis* (C3) Mixed with Other Grass Species (C4)

Pedro V. Mauri, Lorena Parra, Jaime Lloret, Salima Yousfi, and José F. Marín

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Introduction

Precision agriculture is becoming popular in the last years due to its benefits for farmers.

Recent review concludes that most of IoT irrigation systems focuses on monitoring the soil (few monitored the plants) → Very important on gardens

Measuring a single or limited parameter → problematic

Trade off: (i) ***cost*** of sensors (minimize the parameters);

(ii) **value** of information (plant vs soil)

Introduction

We need to define the parameters that offers the most valuable information to identify irrigation needs to minimize the cost of monitoring networks.

Our proposal:

Evaluate, test, and validate which of the monitored parameters in experimental plots of turfgrass offers more valuable information.

Related work

We are going to analyze the correlation of parameters monitored in PA and the use of parameters for genotyping and monitoring crops and gardens.

- Several indexes can be used NDVI, GA, and GGA to estimate turfgrass resistance to water scarcity (Marin et al.).
- NDVI is used for other crops such as wheat (Fernandez-Gallego, and Yousfi et al.) and maize (Buchaillot et al.) for genotyping and monitoring stress.
- Canopy Temperature (CT) is used combined with other parameters for maize (Zhang et al.) with image, and weed (Kumar et al.) with soil moisture (SM)
- Culpepper et al. measured the CT for turfgrass and compare it with NDVi but no correlation was found. Hong et al. measure both NDVI and CT in turfgrass under different water regimens.

Material and methods

Experimental Plots:

4 Different combinations

Poa pratensis (C3 plant, consumes more water) with C4 plants (consumes less water):

Cynodon dactylon → *PC*

Buchloe dactyloides → *PB*

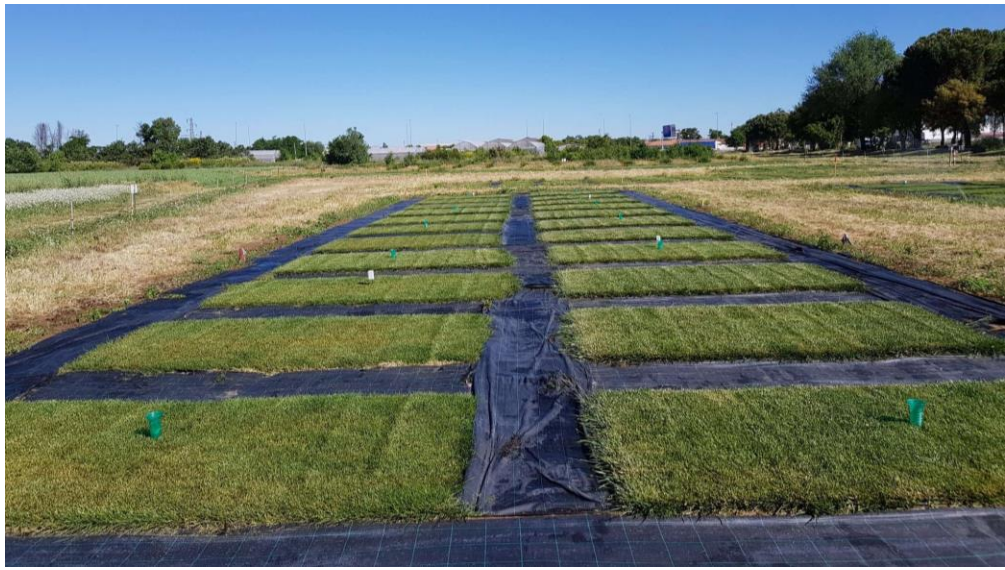
Zoysia japonica → *PZ*

Control (3 species all of them C4)

Festuca arundinacea,

Lolium perenne,

Poa pratensis



Same environmental conditions

Material and methods

Data gathering:

Experimental period of 6 weeks (October to November 2019)

Variables:

- Soil variables (SM) → TDR 350 FieldScout
- Plant variables
  - CT → IR thermometer Fluke 561
  - NDVI → GreenSeeker
  - GA and GGA → SONY DSC-W120 (camera)

Material and methods

Data processing:

Images analyzed with BreedPix

Data analyzed with Statgraphics Centurion

- ANOVA
- Bivariate correlations

Results

Testing the benefits of sensing devices to evaluate the performance of different grass combinations:

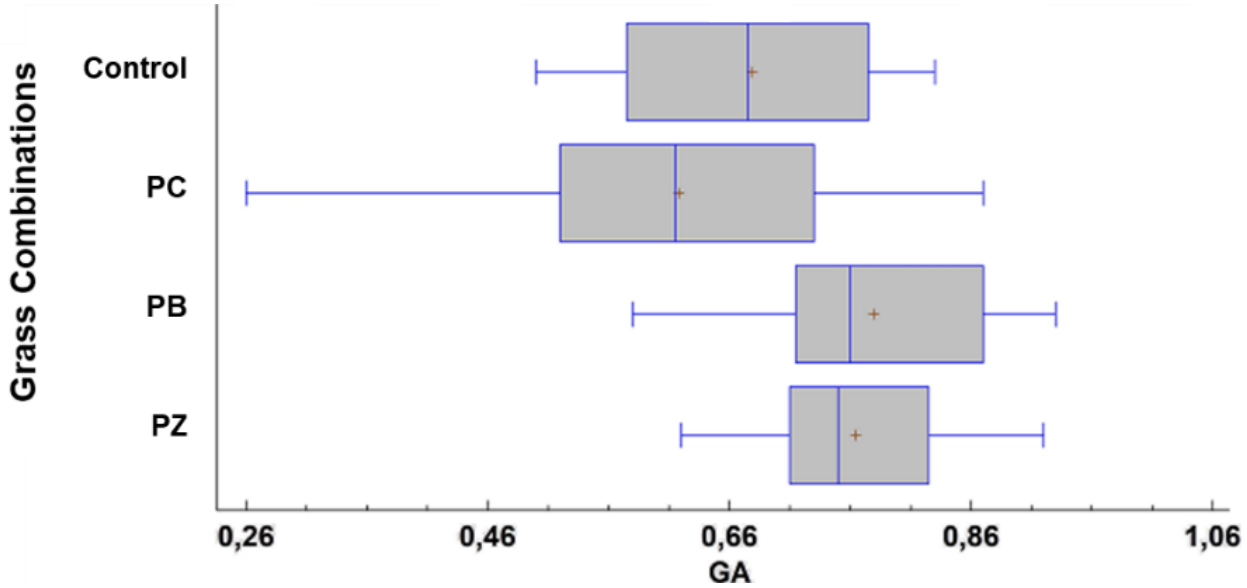
	SM	CT	NDVI	GA	GGA
Control	35.2583 [a]	14.6125 [a]	0.76 [a]	0.67875 [b]	0.35 [a]
PC	35.5 [a]	14.8417 [a]	0.745 [a]	0.61805 [a]	0.295 [a]
PB	34.3944 [a]	14.6056 [a]	0.79 [b]	0.77944 [c]	0.48 [b]
PZ	36.3722 [a]	14.4694 [a]	0.77 [b]	0.76472 [c]	0.425 [b]
Level of significance	0.8727 [ns]	0.9579 [ns]	0.0005***	0.0000***	0.0000***

Summary of anova and kruskal-wallis. Significance levels: ns, not significant; * $p < 0.05$; ** $p < 0.01$ and *** $p < 0.001$. The different letter succeeding the means are significantly different ($p < 0.05$) according to tukey's honestly significant difference (HSD) test.

- GA is the best indicator of grass species

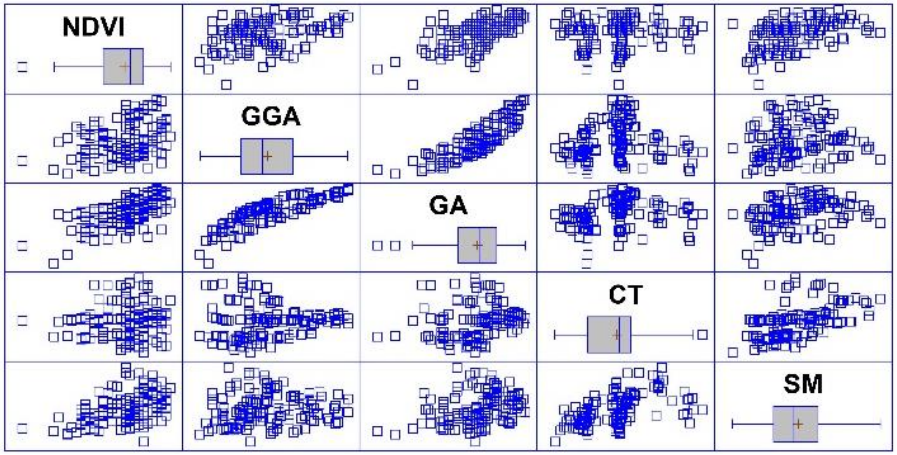
Results

Testing the benefits of sensing devices to evaluate the performance of different grass combinations:

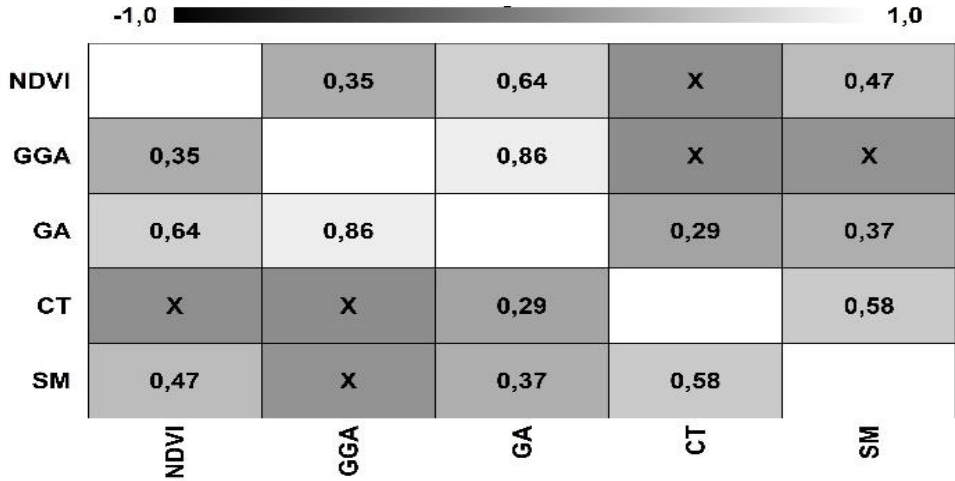


Results

Correlation between evaluated variables:



a)



b)

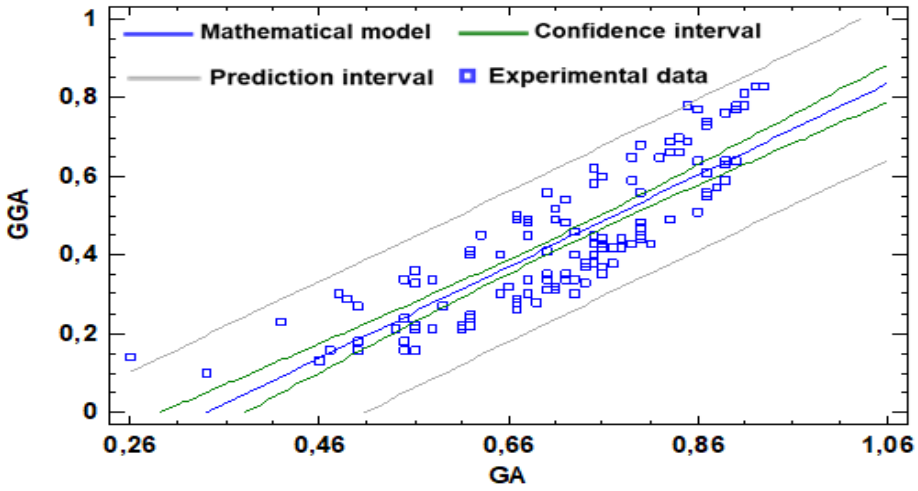
Correlation between different variables, a) Dispersion Matrix, b) Spearman Correlation Graphic (where X means that their correlation is not statistically significant, and the numbers indicate the strength of correlations from -1 to +1).

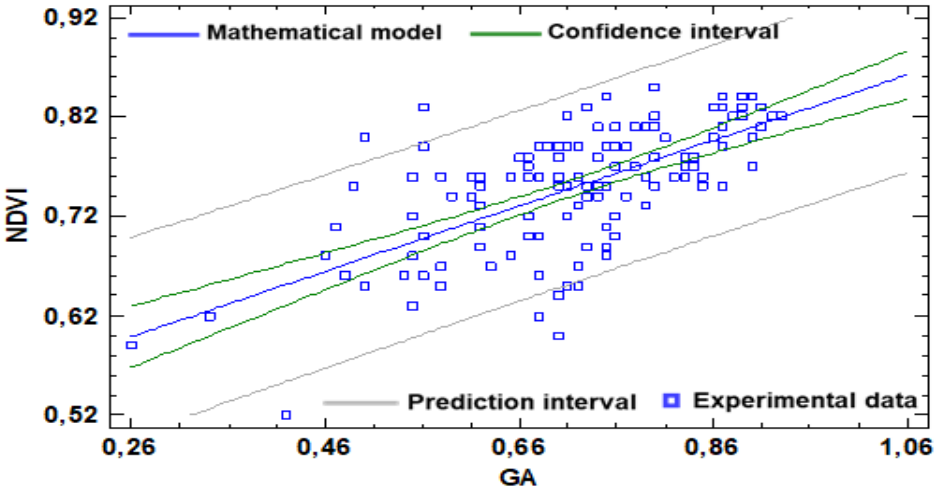
Strongest correlations for plant aspect (electromagnetic spectrum): GA vs GGA, & GA vs NDVI.

Regarding the plant-soil interaction, a correlation was found between SM vs CT.

Results

Correlation between evaluated variables:



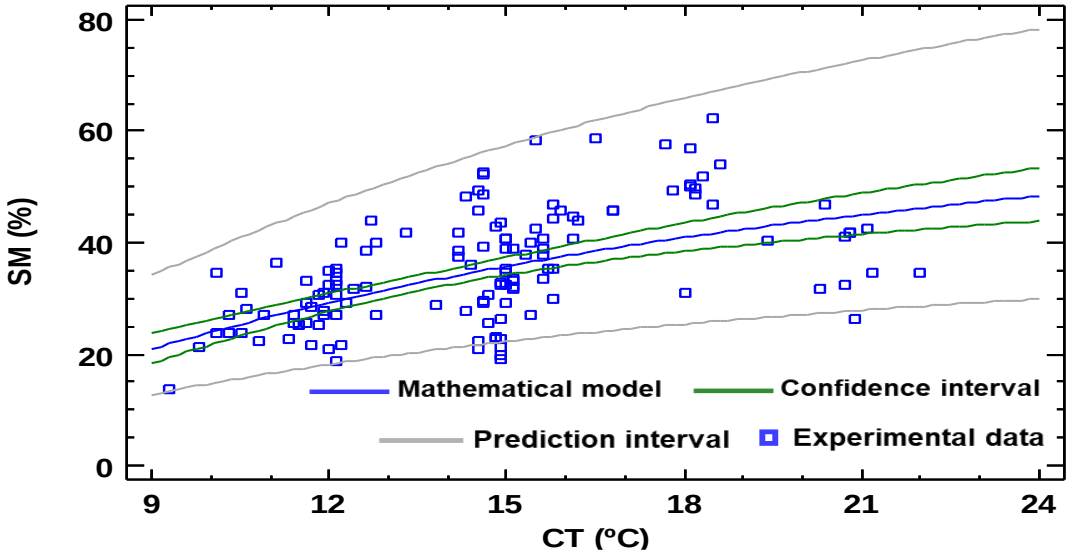


GGA =1,16152*GA -0,395785

NDVI = 0,513359 + 0,329084*GA

Results

Correlation between evaluated variables:



SM (%) = exp(4,38257 - 12,0825/CT (ºC))

Results

Correlation between evaluated variables:

The obtained results will allow the attainment of two objectives.

- 1: Verify a methodology to identify species compose a lawn
- 2: Correlation of variables allow a reduction of parameters. Monitor GA →estimate GGA & NDVI. Monitor SM → CT.

  Will facilitate the integration of IoT systems with the daily activities carried out in lawns such mowing or irrigating, which can be problematic with sensor deployed over the ground to measure CT.

Note that obtained results are only based on data from *Poa pratensis*

Conclusions

5 variables monitored in precision agriculture are evaluated for genotyping, and the existing correlation between variables are explored.

GA index the best one to identify species

Several correlation are found that can benefit the future deployments of IoT systems (avoid measuring CT, GGA and NDVI). It will reduces the cost and complexity of systems

Conclusions

Further tests are needed in order to obtain wider results.

1- Include more parameters (soil and air temperature)

2- For the genotyping, we will include data of other grass mixtures to determine if GA by itself can identification more genotypes.

Questions

pedro.mauri@madrid.org

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