COURSE OF STUDY *Master degree in Plant Medicine (LM69)*
ACADEMIC YEAR *2024-2025*
ACADEMIC SUBJECT *Statistical procedures for agricultural research and agrometeorology*

General information	
Year of the course	*First year*
Academic calendar (starting and ending date)	*First semester (23 September 2024 - 17 January 2025)*
Credits (CFU/ETCS):	6
SSD	*Agronomy and crop science - AGRI-02/A (ex AGR/02)*
Language	*Italian*
Mode of attendance	*Not mandatory but recommended*

Professor/ Lecturer	
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Virtual room	*TEAMS platform: annamaria.stellacci@uniba.it (krup0w8)*
Office Hours (and modalities: e.g., by appointment, on line, etc.)	*Tutoring will take place from Monday to Friday by appointments. Tutoring could also take place on e-learning platforms (Teams).*

Work schedule			
Hours			
Total	Lectures	Hands-on (on-class exercises, laboratory, working groups, seminars)	Out-of-class study hours/ Self-study hours
150	*32*	*28*	*90*
CFU/ETCS			
6	*4*	*2*	

Learning Objectives	The course aims to provide knowledge and understanding on: ○ principles of experimental planning and design in agronomic research; ○ main parametric methods for univariate and bivariate data analysis; ○ theoretical and applied aspects of agrometeorology and agricultural modelling.
Course prerequisites	Basic knowledge on descriptive statistics and general agronomy.

Teaching strategies	Learning activities will consist in theoretical lectures and applied activities including exercises on statistical procedures studied, study case analysis, seminars and lessons from experts in the studied disciplines.
Expected learning outcomes in terms of	
	Expected learning outcomes, as knowledge and ability, are reported in the annex A of the Didactic Regulation of the course in Plant Medicine (expressed by European Descriptors).

Knowledge and understanding on:	○ Knowledge on the principles at the basis of an experimental design; knowledge on the main parametric methods for univariate and bivariate data analysis (analysis of variance for the main experimental designs used in agriculture for single factor or factorial experiments; comparison between two samples means for paired and unpaired samples; linear correlation and regression analysis); ○ Knowledge on theoretical and applied aspects of agrometeorology and principles of modelling and on the interaction among agrometeorological variables and agronomic management.
Applying knowledge and understanding on:	○ Ability in experiment planning and design for research in agriculture; ○ Ability to apply basic techniques for univariate (comparison between two sample means; analysis of variance) and bivariate (regression and correlation) parametric data analysis; ○ Ability to understand the relationships among environment and agriculture.
Soft skills	• *Making informed judgments and choices* ○ Ability to correctly interpret the results of statistical tests such as: tests to verify the assumptions for the application of parametric data analysis methods; analysis of variance applied to experiments with one or more classification factors with hierarchical and non-hierarchical experimental designs; correlation and linear regression analysis; ○ Critic evaluation of the topics related to the climatic variability, and the actual and predictable climatic effects on the environment and agriculture through mathematical models. • *Communicating knowledge and understanding* ○ Ability to present and summarize the information driving from the data collected within research activities and discuss the results of the statistical analysis performed; ○ Ability to summarize the results of the interaction among climatic variables, plants, sustainable crop management. • *Capacities to continue learning* ○ Ability to further deepen advanced techniques for data analysis (use of hierarchical designs with more than two factors; analysis of covariance; analysis of repeated measure over time; multivariate analysis) and models for the study of the interaction among plant, environmental variables, agronomic management.
Syllabus	
Content knowledge	Statistics in agricultural research. Population and samples, parameters and statistics. Frequency distributions. Elements of descriptive statistics. Measures of central tendency and location: mean, median, mode; quantiles. Measures of variability: sum of squares (SS), mean squares (MS), standard deviation (RMS), coefficient of variation, standard error of the mean. Measures of shape: skewness and kurtosis. Elements of inferential statistics. Probability distributions. Normal distribution, standard normal distribution. Hypothesis testing; type I and type II errors; protection and power of the statistical tests. Testing of the assumptions for parametric data analysis. Experiment planning. Elements of experimentation. Experimental unit, experimental error, replication and randomization, sample size assessment, experimental design. Comparison of two population means. Independent or unpaired samples and paired samples; variance of the population known or unknown. The Student t test for unpaired and paired samples.

	Analysis of variance for single factor and factorial experiments. General overview; primary and secondary sources of variability. Analysis of variance for single factor experiments: completely randomized design (CRD), randomized complete block design (RCBD), latin square design (LSD). Analysis of variance for factorial experiments in not hierarchical and hierarchical designs: RCBD, split-plot and strip plot (split-block) designs. Analysis of the relationships between two series of data. Linear regression and correlation analysis. Analysis of variance of a linear regression model; test of the significance of the regression parameters. Computation and testing of significance of the Pearson correlation coefficient. Comparison between treatment means; post-hoc tests for mean comparison. Brief description of the potentiality of the analysis of covariance. Definitions of meteorology, agrometeorology, climatology and agroclimatology. Agrometeorological variables. Solar radiation. Laws of radiation (Planck, Wien, Stefan-Boltzmann; Lambert cosine law). Energy balance and partitioning of the net radiation (Rn). Instruments for measuring the components of the energy balance (Rs, Rb, Rd, albedo; PAR; Rl; Rn). Eliophany and estimation of solar radiation. Effects of solar radiation on crops. Units of measures and numerical applications (conversion of measure units; energy associated to one mole of photon; expression of the radiation flux density into equivalent evaporation). Temperature and heat. Temperature parameters. Heat transfer processes: conduction, thermal radiation, convection. Thermal sum. Air and soil temperature regimes. Effects on crops. Measure instruments. Temperature and agronomical techniques. Relative air humidity. Definitions and general aspects. Dew-point temperature. Effects on the crops. Measure instruments. Precipitations. Definitions and general aspects. Precipitation characteristics: amount, distribution, frequency, intensity, duration. Measure of the rainfall. Probability of rainfall. Importance of the rainfall for agriculture crops. Wind. Intensity and direction. Measure of wind speed. Effects on crops. Evaporation and evapotranspiration. Definition and general aspects. Methods of measure and estimation of the evapotranspiration. Empirical and mechanistic models; micro-climatic methods. Mathematical models. Definitions, classification and general aspects (empirical and mechanistic mathematical models; stochastic and deterministic models; static and dynamic models). Choice and application of models. Calibration, validation and analysis of sensitivity. Applications of agrometeorology.
Texts and readings	Notes of the lectures and teaching material distributed during the course • Camussi et al., 1995. Metodi statistici per la sperimentazione biologica. Zanichelli Bologna. • Gomez K.A., Gomez A.A., 1984. Statistical procedures in agricultural research. New York, Chichester, etc.: Wiley, 2nd edition • Ceccon P., Borin M., 1995 - Elementi di agrometeorologia e agroclimatologia. Imprimitur. The study of selected chapters will be suggested by the teacher.
Notes, additional materials	Additional readings • Quinn G.P., Keough M.J., 2002. Experimental Design and Data Analysis for Biologists. Cambridge. • France J., Thornley J.H.M., 1984 - Mathematical Models in agriculture. Butterworths, London. • Benincasa F., Maracchi G., Rossi P., 1991 – Agrometeorologia. Patron,

	Bologna. • Scientific papers provided by the teacher. Further material will be provided by the teacher on request.
Repository – Didactic materials	The teaching material presented during the lessons (power point lessons, texts, book chapters, publications) will be made available on the Teams platform. The power point of the lessons cannot be used as study material but as a support to the use of the suggested textbooks chapters and other teaching material provided. For the foreign students, the didactic material will be provided in English language as well as the tutoring activity.

Assessment	
Assessment methods	The final exam consists of a written test and an oral test. The written test could be performed as an intermediary exam (esonero). The written exam will include three exercises on the following subjects: Student t test for unpaired data; single-factor analysis of variance for an experiment arranged into a latin square design; simple linear regression and correlation analysis. The oral test will include questions related to the lectures, exercises and laboratory classes on agrometeorology and statistical procedures. The evaluation of the student is based on criteria previously fixed such as those reported in the Annex A of the Didactic Regulation of the Master Course in Plant Medicine and is expressed in thirtieths.
Assessment criteria	• *Knowledge and understanding* ○ The student is able to understand the main issues at the basis of planning and design of an experiment for agricultural research; ○ The student is able to understand the main parametric univariate and bivariate methods of data analysis (analysis of variance for the main experimental designs in agriculture for single-factor or factorial experiments; comparison between two sample means; bivariate analysis: correlation and linear regression); ○ The student knows the main theoretical and applied aspects of agrometeorology and the principles of mathematical modelling in agriculture. • *Applying knowledge and understanding* ○ Ability to plan an experimental design for agricultural research; ○ Ability to apply basic parametric data analysis techniques for univariate and bivariate datasets; ○ Ability to study the relationships among environment and agriculture. • *Making informed judgements and choices* ○ Ability to correctly interpret the results of statistical tests for the assessment of the effect of single-factor or factorial experiments evaluated using not hierarchical and hierarchical experimental designs. ○ Critical evaluation of the topics related to the climatic variability, and the actual and predictable climatic effects on the environment and agriculture through mathematical models. ○ Ability to create connections among the theoretical and applied contents of the experimental methodology, agrometeorology and modelling principles studied during the course. • *Communicating knowledge and understanding* ○ Ability to present and discuss the results of the research activities. ○ Ability to summarize the results of the interaction among climatic variables and agriculture.

	• *Communication skills*
	  ○ ability to organize the acquired knowledge in form of didactic presentation.
	• *Capacities to continue learning*
	  ○ Ability to further deepen and understand advanced techniques for data analysis (use of hierarchical designs with more than two factors; analysis of covariance; analysis of repeated measure over time; multivariate analysis) and models for the study of the interaction among plant, environmental variables and agronomic management.

Final exam and grading criteria	The final score is within 18/30 to 30/30. The exam is considered passed if a final score of at least 18/30 is reached.
Further information	