University of Padua
Faculty of Agriculture

Department of
Environmental Agronomy and Crop Production

Thesis in
Forest and Environmental Sciences

BIENNIAL STUDY OF SEED PRODUCTION IN A HILLY ARRHENATHERION MEADOW

Supervisor: Prof. Michele Scotton
Co-supervisors: Dr Claudia Dal Buono
Dr Antonio Timoni

Graduate: Andrea Ferronato
registration number: 622632

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To our Earth

SUMMARY

ABSTRACT

This paper analyzes the seeds production of the second cut of a hilly arrhenatherion in Pianari place in the town of Marostica (Vi).

The year under review is 2010. The datas obtained are compared with datas from other studies carried out on three cuts of the same field, the first cut of the same year and the first and second cut of the previous year, 2009.

The comparisons have focused primarily on the study of phenology and identified of regressions used to the seeds production estimate. With regard to the regressions that estimating the production of seed, for each species was calculated a mean regression computed with the data of the 4 cuts, so you can find as much as possible a general formula and released by annual climate trends. The results of the estimate seeds production obtained on the basis of the mean regression, were compared with those specific regressions identified cut for cut.

Another purpose of the comparisons between the different cuts was the study of individual species, identifying which of them have during the time more constants productions regard of other species, or understand by what parameters are more influenced the change in seeds production for each species.

Finally, phenological analysis datas, were crossed with those obtained from the total seed production, with the aim of identifying the most appropriate method to define the optimal timing of harvest. In this regard we resorted to the parameters as thermal sum, that used with phenological analysis, allows to release the carried out analysis from the specific weather conditions patterns of the years studied.

RIASSUNTO

Il presente lavoro, riporta la produzione vegetale e lo studio del secondo taglio dell’anno di un arrenatereto collinare che si trova in località Pianari nel territorio comunale di Marostica (Vi).

L’anno preso in esame è il 2010 ed il secondo taglio è stato eseguito in data 4 agosto, i dati ottenuti sono poi stati paragonati con i dati di studi effettuati su altri tre tagli dello stesso prato, il primo taglio dello stesso anno ed il primo e secondo taglio dell’anno precedente, 2009. I confronti principalmente si sono focalizzati su lo studio della fenologia e sulle formule di regressione usate come metodo rapido per la stima della produzione di numero di semi.

Per quanto riguarda l'analisi nei confronti delle diverse formule di regressione, è stata calcolata una regressione media con i dati dei 4 tagli per ogni specie, in modo da individuare una formula il più possibile generale e svincolata dagli andamenti climatici annuali. Un ulteriore scopo dei confronti tra i diversi tagli, è stato quello di studiare con attenzione le singole specie, individuando quali specie presentano nel tempo produzioni più costanti di altre, o da quali parametri è maggiormente influenzata la variazione di produzione per ogni singola specie.

Infine, incrociando i dati dell'analisi fenologica (per ripetere le stese stime in anni futuri, ovviamente più sopraluoghi per la fenologia si fanno, maggiore sarà la precisione nel descrivere l'andamento di produzione, ma possono essere sufficienti per avere un idea anche solo tre rilevazioni) con le formule di regressione, al fine di raccogliere il mix di sementi che più ci torna utile, è possibile stimare il numero di seme prodotto da ogni specie in funzione della somma termica, quindi per ogni data.

1. INTRODUCTION

The environmental recovery operations of tampered areas by human activity (caves, road embankments, areas of passage of gas pipelines etc.) or as a result of natural events (landslides, areas of hydrogeological instability, etc.) contemplate a range of interventions that have as important goal, the defense of soil from erosion (Chisci & Zanchi 1994, Tinsley et al. 2006) and the inclusion of the work in the surrounding landscape (Gisotti 1985). Typical intervention falling in this recovery environment work and that copes this problem is the grassing, intended as construction or improvement of the sward, inserted properly in the environment framework.

In the Alps, restoring eroded areas, took in recent years, an increasing importance. Over 70% of the area affected by technical grassing with protective aim are hilly or mountain areas. The recovery techniques, that have been used, are carefully chosen and have achieved a high quality grade.

Much less consideration is given instead to the choice of species to be used in a lawn. There are many reasons, among them the most important are: lack of knowledge, search of cheaper seeds, difficulty or impossibility of finding suitable seed. Several experiments (Krautzer 2006 a al.; Majerus1999; Peratoner 2003) have shown that compared to mixtures containing variety of species of plains selected for the production of forage, the use of seeds of native species close to the areas of intervention allows in the medium to long term to achieve a better protection from erosion and greater persistence of the turf, especially in the extreme areas In terms of climate and edaphic conditions. Suitable native species, however, are often of difficult multiplication, and requires appropriate agricultural and technological knowledges.

Exceeding these limits seems to be resolved through the seed crops of local ecotypes, which are farmed on a large scale with conventional farming techniques, solution that is been studied in several countries of the Alps (Austria, Switzerland and Italy) and that after an experimental phase (Krautzer et al. 2003 e 2004) is entering the practice, both for public institutions and for specialized farms.

As an alternative to the cultivation of suitable native species, even the meadows and permanent pasture are a source of seed of native ecotypes. The use of the mixture of seeds characterized from native species grasses collected from lawns close to those of application has been long the object of attention (Dinger, 1996). In fact, such a use of land covered with grass, is also encouraged at the legislative level, For instance, in the Friuli - Venezia - Giulia region (Legge n.24/2005), with the intent to protect plant biodiversity and re-evaluate forage mountain areas that in many cases, nowadays, are now abandoned or mowed landscapes purposes only thanks to the public financial contribution.

In this way the functions traditionally attributed to the mixed permanent lawn, that are summarized in following four points by Van der Meer (1994): 1. provide fodder for animals; 2. protect and conserve soil and water resources; 3. provide a suitable habitat for the life of flora and fauna; 4. contribute to the beautification of the landscape; are expanded: the lawn could become also a “lawn for seed” and perform an additional function of preservation of ecotypes and biodiversity propagation.

In recent years we have realized how the conservation of biodiversity is important. This aspect is in fact now increasingly present in international agreements and Community laws for instance: the Convention of Biological Diversity, signed during the United Nations Conference on Environment and Development, held in Rio de Janeiro from 3 to 14 June 1992. That Convention was then implemented at European level by the directive 92/43/CEE, related to conservation of natural and semi natural habitats, one of whose objectives is precisely to reintroduce indigenous species, and ground in Italy by Law 124/94. So far, the recent regulations of EU promote the protection of biodiversity. There are many Interreg projects which have adopted the protection, conservation and increased biodiversity as a guiding principle.

You can observe three different aspects of biodiversity:

biodiversity of species: is the most common aspect of biodiversity, it is simply the number of different species in an ecosystem;

taxonomic biodiversity: indicates the number of genera, orders, families ... present in an environment, that is as these individuals are far apart on the evolutionary ladder;

genetic biodiversity: within the same species, there are the sub-populations that allow the species to adapt to different environments.

Of these three aspects, the most interested in the project, is the last, because one wants to study ways to revive the areas affected by environmental restoration, but preserving the genetic diversity, i.e. using the seed from the same original material area where you must perform the surgery.

Hence that within the scientific community and public institutions involved in the so-called ecological restoration, is expected that the plant material used in the restoration comes from vegetation present in areas geographically and ecologically close to the grassy site. The methods available to obtain native material are: 1. specialized crops in the production of seed of native species; 2. collection of seed from a semi-natural grasslands and its direct use to determine great naturalistic value areas. Unlike the first, this second method does not require the intervention of specializing companies in the production of seed, since it is sufficient that there is a wide availability of semi-natural grasslands from which to draw the seed. Over the last century in most of Eastern Europe and northern Europe countries, species-rich grasslands have suffered a drastic decline (Poschold and Bonn, 1998; Eriksson e al., 2002). The remaining semi-natural grasslands contain a high abundance of plant species (e.g. Eriksson 1997; öster e al. 2007), and other groups of organisms, mushrooms (öster, 2008), insects and birds (Söderström e al., 2001). Hence the semi-natural grasslands are considered resources for the maintenance and creation of other high nature value grasslands.

The work presented below is based on this idea, i.e. permanent grassland made up of native species can be used like a source of seed of native herbaceous species. In this regard there are currently only a few studies, but despite this, have been many steps forward to define in more concrete way the steps that can lead to the assessment of productivity of prairie's seed, in terms of quantity and its temporal distribution during the growing season. In fact, the quantity and quality of seed production have rarely been directly studied into permanent grassland used for forage purposes (Clark 1997).

In order to intervene and to obtain seed from the prairie, has been useful to conduct a study related to the whole annual cycle of the seed of the same meadow phytocoenoses. With the term cycle, is defined a regular ended succession of events or operations. In this case the cycle begins as a plant that which produces seed through various phenological stages. The dissemination phase of the seed, carries ground the seed itself, which can undergo several destinies: predation by insects or micro mammalian; incorporation into the seed bank and subsequent germination with the formation of new individuals.

In particular, was studied the phenology of summer regrowth of the grass and the study of regression, then these data were compared with data from other cutting periods also of previous year, in order to obtain a rapid and accurate method to estimate the number of seeds produced by each species of grass and find the best time for their collection.

2. MATHERIALS AND METHODS

2.1. DESCRIPTION OF THE SITE

2.1.1. Location and topography

The examined lawn, where the observations were made, is a mountain Arrhenatherion (Fig. 1)

+ location of the meadow (municipality, resort): Marostica, Pianari

+ longitude (from Greenwich): E: 11° 37’ 55’’

+ latitude: N : 45° 46’ 38’’

+ altitude: 435 m a.s.l.

+ aspect: 157 °

+ slope: 19.6 %

+ Corine land cover: 243 (Agricultural areas - Heterogeneous agricultural areas - Land principally occupied by agriculture, with significant areas of natural vegetation)

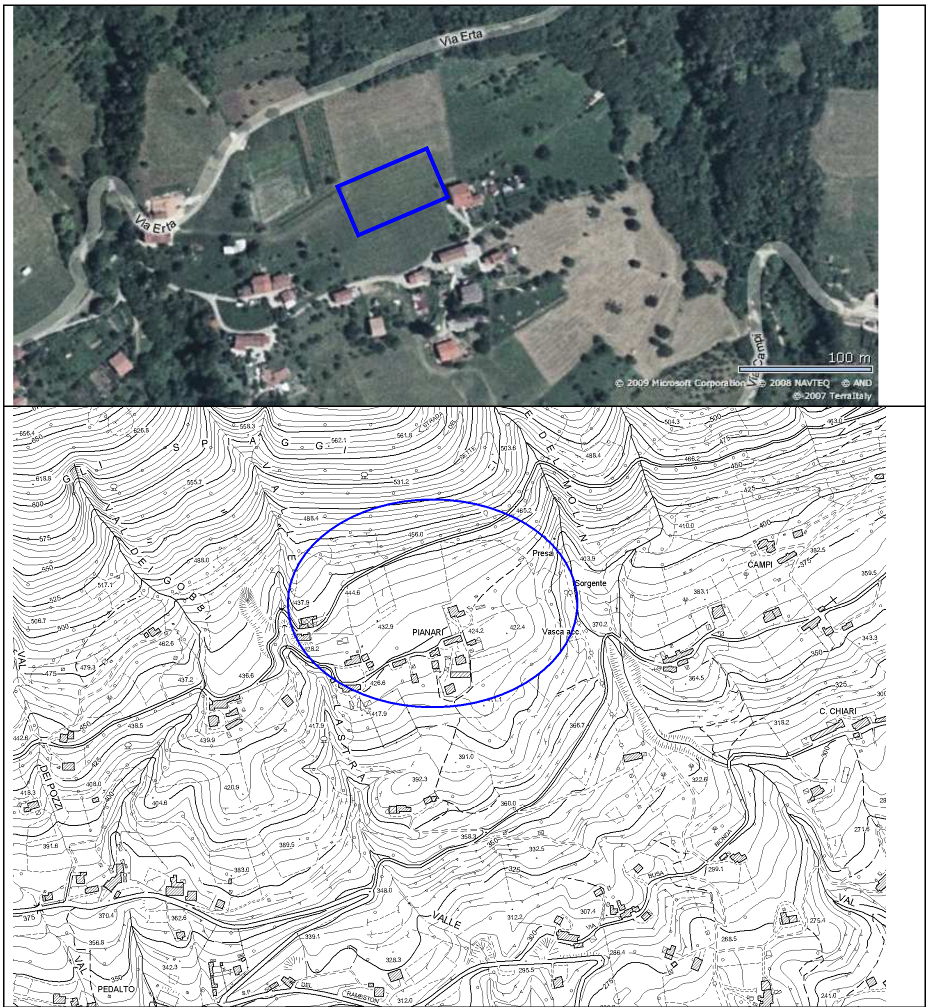


Fig. 1. Aerial photo and topography of the study meadow.

2.1.2. Description of the climate

As in the considered site no meteorological station is available, the climatic aspects will be analysed by referring to two stations close to the site, that of Bassano (fig. 2) and that of Asiago (fig. 3).

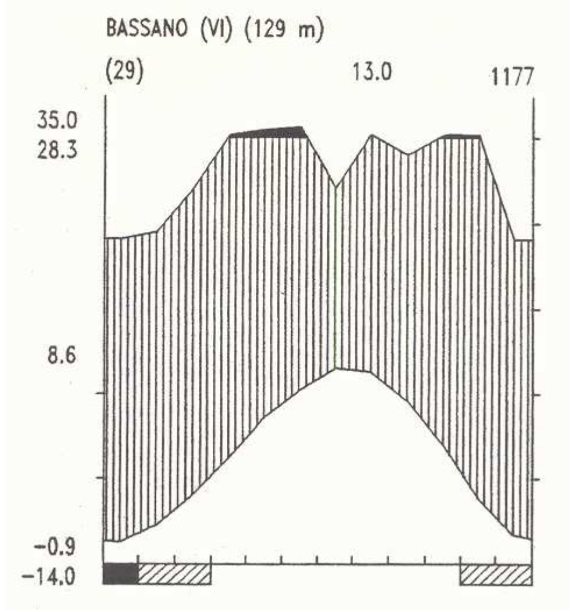


Fig. 2. Climate of the Bassano meteorological station.

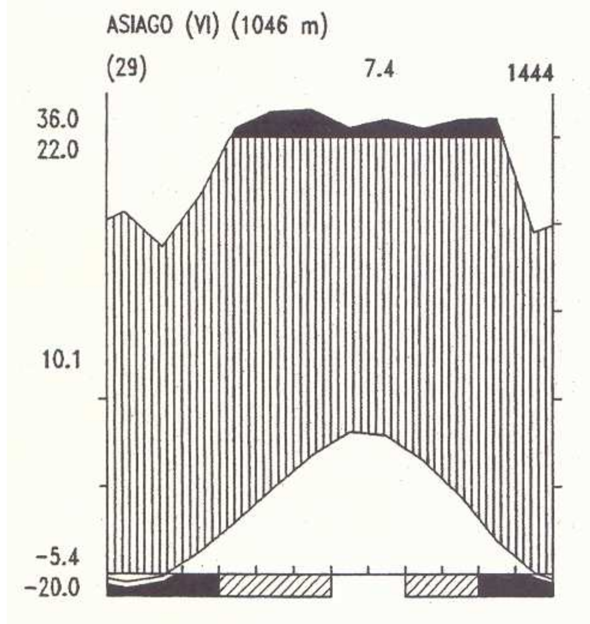


Fig. 3. Climate of the Asiago meteorological station.

As compared to the study site, the two stations are located at lower (Bassano) and at higher (Asiago) altitude. They are located on the same mountainside of the Asiago mountains and have the same general climatic conditions (same aspect, same position to the atmospheric disturbances. For this reason they can be used are reference for the description of intermediate climatic characteristics of the study resort.

From the data of the two stations the following mean climate characteristics can be derived:

+ mean yearly rainfall (mm): 1266

+ mean rainfall in:

Spring (March-May) (mm) 338

Summer (June-August) (mm) 356

Autumn (September-November) (mm) 340

Winter (December-February) (mm) 232

+ mean yearly temperature (° C): 11.1

+ mean date of vegetation beginning (mean daily temperature 7 °C): 22 March (Julian day 81)

+ mean date of vegetation end (mean daily temperature 5°C): 25 November (Julian day 329)

+ mean length of the vegetation period (no. of days): 248 days

The climate is characterized by relatively high rainfall. Its distribution in the year is sub-equinoctial with main maximum in June and secondary maximum in November. In all months April-November the rainfall is higher than 100 mm. Only in the months December – March the rainfall is less than 100 mm even if it remains always higher than 75 mm.

2.1.3. Geology

According to the geological map of the Venetian region (Bassano del Grappa, Sheet no. 37), the geological substratum of meadow is Limestone.

2.1.4. Description of the management

In the last 30 years the meadow was managed by the same farmer, who was once employed in a factory and now retired. As employer and as pensioner he always practised the farmer activity as second job. The farmer is owner of a little stable (3 calves purchased at a weight of 80 kg, fattened up to 300 kg) which are fed with the forage produced in the study meadow and in other close meadow and with a small mays meal supplement.

The meadow (about 1.35 ha) is fertilized with the farmyard produced in the stable. It is distributed on the meadow every two-three years at the end of the vegetative season. The average yearly nitrogen quantity supplied with the farmyard is about 20-25 kg. The production is cut three times per year, kept as loose hay in the hayloft. In this way the farmer has also rather high hayflower at his disposal.

2.2. THE ANALYZED ARRHENATHERION

The arrhenaterion meadows are widespread, in principle, in the high Po-Venetian plain at a height which varies according to different geo-topographical situations, between 1000 and 1300 m above sea level of the alpine area. They were formed as a result of deforestation of forests attributable to lowland hornbeam, the hilly and low-mountain oak woods and some types of beech forest; with subsequent spontaneous grassing.

However, the two conditions that define a Arrhenatherion are:

1. a use made with continuity and timeliness (cuts performed with regularity);
2. abundant and regular fertilization with three macro-elements, in particularly high amount of potassium (result obtained, for example, by using of manure).

The Arrhenatherions are present on soils with very different physico-chemical characteristics. Their broad adaptability to various soil types is a consequence of the abundant fertilizer distributed. This distribution, in fact, ensures in each case a balanced nutrition to the various components of coenosis, but also masks the particular characteristics of the soil.

These meadows are composed of a different number of species, depending on whether they are the most productive of low-altitude (15-20 species) or those of higher altitude (20-25). The species most frequently and in greater quantities are: *Arrhenatherum elatius*, *Dactylis glomerata*, *Festuca pratensis*, *Phleum pratense*, *Poa pratensis*, *P. trivialis* e *Lolium perenne* between grasses; *Trifolium pratense*, *T. repens*, *Lotus corniculatus*, *Vicia cracca* e *Lathyrus pratensis* between legumens; *Galium album*, *Plantago lanceolata*, *Achillea millefolim*, *Crepis biennis*, *Leucanthemum vulgare*, *Centaurea jacea*, *Pimpinella major*, *Taraxacum officinale* ecc., between the other botanic families. Any deficiencies of mineral elements result in a reduction of the best grasses, and a parallel increase of *Bromus erectus*, *Avena pubescens*, *Koeleria pyramidata*, *Briza media*, *Festuca rubra*, *Brachypodium caespitosum*, *Anthyllisv vulneraria*, *Medicago lupulina*, *Galium verum* e *Salvia pratensis.* With the delay in the execution of the cuts, we favored the presence of *Heracleum sphondylium*, *Anthriscus sylvestris*, *Pastinaca sativa*, *Hypericum perforatum*, etc. In principle the Arrhenatherion are cut 2-4 times per year and provide an output ranging between 7 and 11 t ha-1 year-1 of dry. If they are cut 3 times a year, the first cut provides 50-55% of annual production, the second 25-30% and the third 15-20%.

According to the description of the management of Pianari’s Arrhenatherion, this turns out to be a rough lawn with a limited production. This finding is confirmed by the large number of different species that compose it, and by the presence of low productivity species.

Below is the list (Fig. 4) of plants and, for each family and each species it's written the percentage of abundance.

POACEAE	73%		
		Anthyllis *vulneraria*	+
Anthoxanthum *odoratum*	2%	Arabis *hirsuta*	+
Arrhenatherum *elathius*	30%	Carex *muricata*	1%
Avenula *pubescens*	4%	Centaurea *nigrescens*	+
Brachypodium *pinnatum*	2%	Colchicum *autumnale*	+
Bromus *erectus*	1%	Convolvolus *arvensis*	+
Dactylis *glomerata*	10%	Crepis *biennis*	1%
Festuca *pratensis*	4%	Galium *mollugo*	+
Festuca *rupicola*	1%	Galium *verum*	+
Lolium *perenne*	2%	Knautia *arvensis*	+
Poa *pratensis*	2%	Leucanthemum *vulgare*	+
Trisetum *flavescens*	15%	Myosotis *silvatica*	+
		Onobrychis *viciifolia*	+
FABACEAE	6%	Pimpinella *major*	+
		Plantago *lanceolata*	2%
Lathyrus *pratensis*	1%	Ranunculus *acris*	+
Lotus *cornicolatus*	1%	Ranunculus *bulbosum*	5%
Medicago *lupulina*	1%	Rhinanthus *freynii*	2%
Trifolium *pratense*	1%	Rumex *acetosa*	1%
Vicia *sativa*	2%	Salvia *pratense*	4%
		Sanguisorba *minor*	+
ALTRE SPECIE	21%	Taraxacum *officinale*	+
Achillea *millefolium*	1%	Tragopogon *pratense*	3%
Ajuga *reptans*	+	Veronica *chamaedrys*	+

Fig. 4. Floristic composition of Pianari Arrhenatherion.

2.3. SPATIAL ORGANIZATION OF THE STUDY

The procedure followed for the analysis of seed production and its distribution during the regrowth must follow some steps.

The first phase is on field, beginning from the vegetation to the harvest, during that period you must do the following operations:

+ compilation of the flora composition.

+ phenology study for each species.

+ analysis of 30 fertile stems at seed maturation period.

A second phase of laboratory, follow, that consists in the analysis of collected fertile stems, and the creation of a regression that correlates inflorescence lenght with the number of seed.

The seed production quantification have been carried out on three 100 m^2 areas (10 x 10) (WP4 plots) casually distributed in the study meadow (fig. 5).

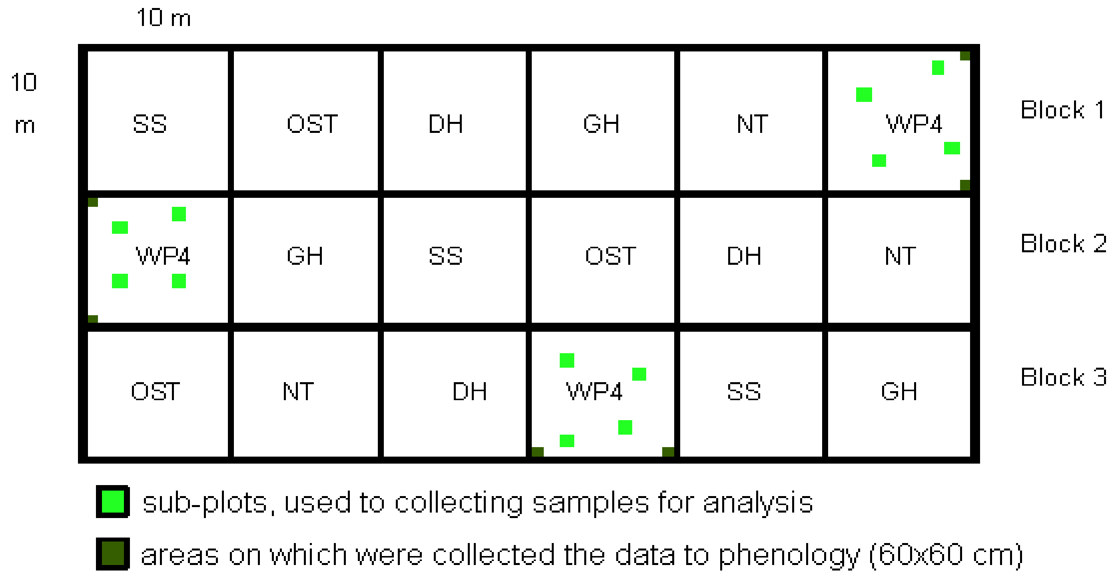


Fig. 5. Experimental design

each block was divided in:

SS: seed strepper

OST: on site threshing

GH: green hay

DH: dry hay

NT: not treated

WP4: areas where both phenology and seed production analysis were done

2.4. STUDY OF PHENOLOGY

The knowledge of the phenology evolution of the entire plants community, and the main pasture species is essential for the proper implementation of all agronomic practices associated with the uses of fields and crops in general.

This knowledge allows to program the optimal management of resources and to identify any phytocoenoses improvements.

this type of survey is aimed to achieve three main objectives:

+ characterize the phenological development of each species present in the field from the beginning to the end of the growing season;

+ characterize in detail the evolution of the phenology of each species in the period from the lowering to seed production

+ identify the optimal time for collecting samples of fertile stems for laboratory analysis.

A specific study about phenology was done during the previous regrowing periods, both in 2009 and in 2010, during the second cut of 2010, the phenology was been taken only in two dates: the first on 19th july and the second the same day of the cutting operation.

The survey was performed on 10 randomly selected plants within each plot used for phenological analysis (WP4). The important aspect of the choice of plants is the randomness. You should not choose only large plants, that are in a more advanced phenological stage, maybe due to the better conditions of nutrition, this situation could be done by a favorable micro-station.

The phenological stages collected and coded were then entered into a spreadsheet for further processing.

These calculations have allowed to define for each species the percentage of individuals in different phenological stages.

For each survey was calculated the accumulated growing degree day GDD, obtained on the basis of daily Minimum and maximum temperature data related to a mean of values from weather stations of Bassano and Asiago. the data was found on the ARPAV website.

The use of accumulated growing degree day, on the phenological analysis is based on the assumption that each phase is characterized by a certain thermo – stage quantified by the accumulation of heat which corresponds to the cumulative daily sum of the useful degrees of temperature, in °C. The Useful degrees of temperature are computed as the difference between the average daily temperature and the value of threshold vegetation, at 0°C from 1st of January. The phenological rhythm of a species can be also considered for its value as indicator of change, because plants respond clearly to the weather and climate changes. Below you find a table that represents the succession of phenologic phases (Fig. 6).

grasses		**other species**	
stage	**Code**	**stage**	**Code**
plant dormancy	**D**	*plant dormancy*	**D**
beginning of vegetation (first leaves formed)	**IV**	*beginning of vegetation (first leaves formed)*	**IV**
tillering	**AC**	*formation of lateral shoots*	**GL**
shoot emergence	**L**	*stalk elongation or rosette formation (from beginning to end)*	**FA**
development of vegetative parts of the plant (from higher leaf sheath extending, to visibility of the higher spikelet)	**SV**	*development of vegetative parts of the plant*	**SV**
earing (from start to fully visible spike)	**SP/PF**	*from button flower to visibility of the first petals*	**PF/BF**
lowering (from the beginning to the end of flowering)	**FI**	flowering (from beginning to end)	**FI**
caryopsis milky or waxy (from ovary to final size but with a maximum waxy texture)	**FLC**	fruit development	**FS**
mature caryopsis (final size and hard consistency)	**FM**	ripe fruit	**FM**
fallen caryopsis	**FC**	fallen fruit	**FC**
end of vegetation	**FV**	end of vegetation	**FV**

Fig.6: succession of phenologic phases

% Due to culms of grasses or at fertile stems of other species
% Due to flowers, ovaries or seeds

Regarding the methodology of the phenological analisis, we have to mention also the negative aspects, that it is important to consider them in order to analyze the results:

• the phenological survey was carried out with subjective assessment that requires skills training especially for the investigation

• for the study you have to analyze a large number of fertile stems in order to have plausible values, otherwise analyzing randomly few fertile stems it can happen that in two successive observations there is, a regression of phenophase.

• it tends to overestimate the number of produced seeds, because assigning by seen the percentages in the methodology the field, you can not figure out the percentage of empty seeds.

2.5. REGRESSION CALCULATION

2.5.1. Analysis of the fertile stems at the flowering

At certain dates (specific for each species), 5 fertile stems at the flowering stages are collected. the aim, is that of determine the number of ovules for each flower and the number of flowers for each inflorescence, during flowering. Some ovules or flowers can degrade after the flowering. This was made for those plants, whose maturation of the seed doesn't give the possibility to identify the number of eggs and flowers in the flowering stage, as legumes and "other species". It is better to perform the analysis of collected fertile stems on the material still fresh. For each inflorescence present on a fertile stem, you have to count the number of flowers, and the misuration of one or more dimensional characteristics of inflorescence, in this way you can compute a regression between the dimension's inflorescence and the number of flowers.

2.5.2. Analysis of the fertile stems at the maturation's seed

At the stage of medium-late ripening of the seed you collect 30 fertile stems for each species, these should be kept individually paying attention that you lose the least amount of fruit, the collection may occur at different dates for each species. The size of the fertile stems has to cover the entire range of variability of the species.

You counting the number of inflorescences and measure the size of each inflorescence, you count the number of flowers / fruits per inflorescence and number of ovules / seeds per fruit.

This is followed by the calculation of the regression between inflorescence size and number of seeds potential and actual products.

2.5.3. Calculations used to derive the regression

All data collected for each inflorescence about length and number of seeds, are filled in a table in an excel sheet. From this I draw a graph, where I put in Y axis the inflorescence length in mm, and in X axis the number of seeds in order to compute the regression of seeds or number of ovules for the same with the ovules.

In the graph it is quite simple to draw the tendency line, and thanks of this line, you obtain its equation. The equation of the tendency line is our regression, that now it is possible to apply to all length of the fertil stems, in order to easily obtain the number of ovules or seeds (depending if it was used regression by seeds or ovules) in this way you don't need to count one by one all seeds.

That makes you spare time, if you need to apply that method in a future practice use.

One of the purpose of that thesis, is that of evaluate the reliability of the regressions, making a comparison with some fertile stems where all seeds were counted. another aim about the use of regression is to find if it is possible use for a specie the same average regression, each year and each cutting. If this is possible, you can understand for which species yes and for which no.

2.6. ANALYSIS OF WEATHER DATA

The data collected during two or more years, are obviously different also between the same specie, such differences can be attributed to different factors, as:

+ intrinsic genetic elasticity

+climate

+ fertilization

in order to better understand, in that case of study, which are the factors that affect the observed change in production between the two years, you need to compare the weather conditions of these years.

First of all, you must collect the weather data of temperature and rain, as mentioned in paragraph "description of the climate", since there isn't a weather station close to Pianari, to obtain a reliable value I consider an average of data from nearby meteorological stations.

The weather datas cover a time span from the 1st January 2009 to the 28th September 2010, enough to cover the period of four cuts.

2.6.1. Temperatures

thanks to the characteristics of temperature, since the temperature is a value that changes in gradual way in the space (i.e. thermal gradient),it is possible to get it also if there isn't the value for the place, by the mean of closer weather stations, moreover in this case, the place for which is needed compute the temperature, is in between two station, higher and lower more or less of five hundred meters of quota.

About temperature in order to understand how to change between two years, I draw two graphs, the first one about the growing degree day GDD (fig.7), that we expect to have a Gaussian shape, but we don't known in which way are related the curves related two years. The second graph (fig.8) will represent the daily increasing of thermic sum, that we expect to have a S shape.

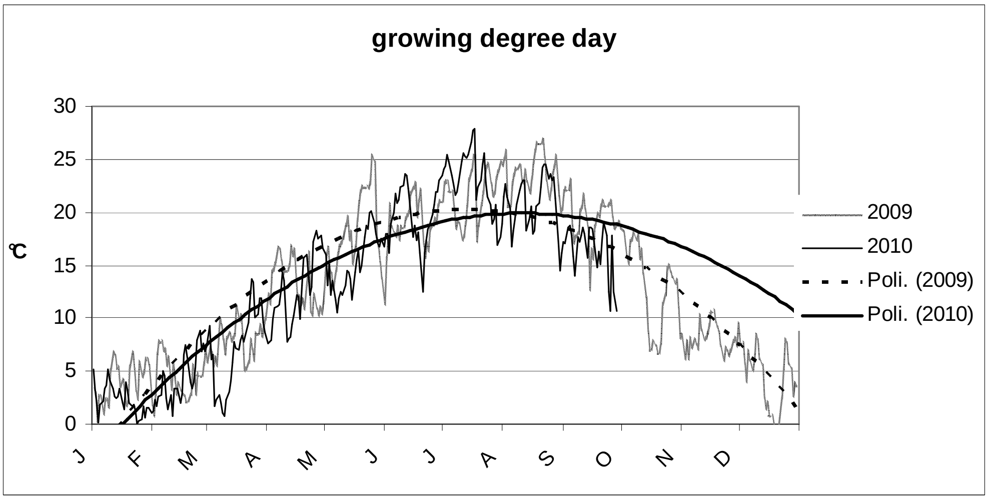


Fig. 7: growing degree day GDD

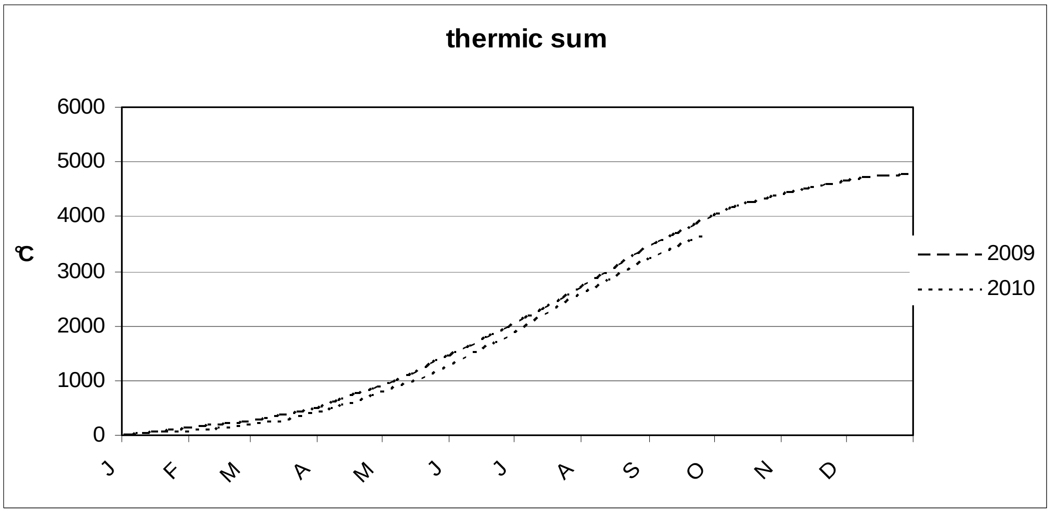


Fig. 8: the daily increasing of thermic sum

At the end of 2009, the termic sum reaches a total value of 4771 °C, and on 28th September of both years (day in which it is available last data of 2010) the values are: 3964 °C in 2009 and 3665 °C in 2010.

At graph of growing degree day, was add the tendency curve in order to simplify reading, both two graphs underline a little delay in the temperature value of the second year of analysis.

It is possible that this little change may shift forward of a few day the phenophase.

2.6.2. Precipitation

Regarding the precipitations, it isn't possible to do the same reasoning made for temperatures, because the rain has not gradual variation in the space, but punctual variation. It would be possible to do the same compute done for temperatures, only if there would be a high number of weather stations, and if there would be scattered in equal way surround the point of interest.

So it becomes possible to reconstruct a kind of gradient that approaches the true value, but this is not our case, because in Bassano and Asiago places are subject to orographic origin rainfall.

But also if it is impossible to get a correct estimation of rain values of Pianari, I reported (Fig. 9) the rain values of two weather stations: Bassano and Asiago, in order to understand the different of rain values between the two years in general.

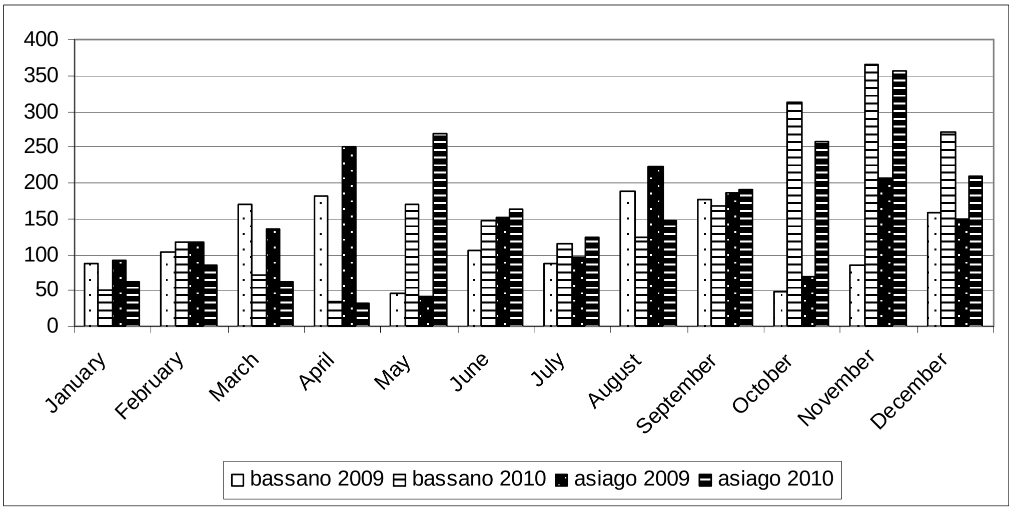


Fig. 9: value by rain gauges of Bassano and Asiago, during the 2009 and 2010

In order to better understand the values, I draw a second graph (fig. 10) with a mean of the values of the two stations per each year.

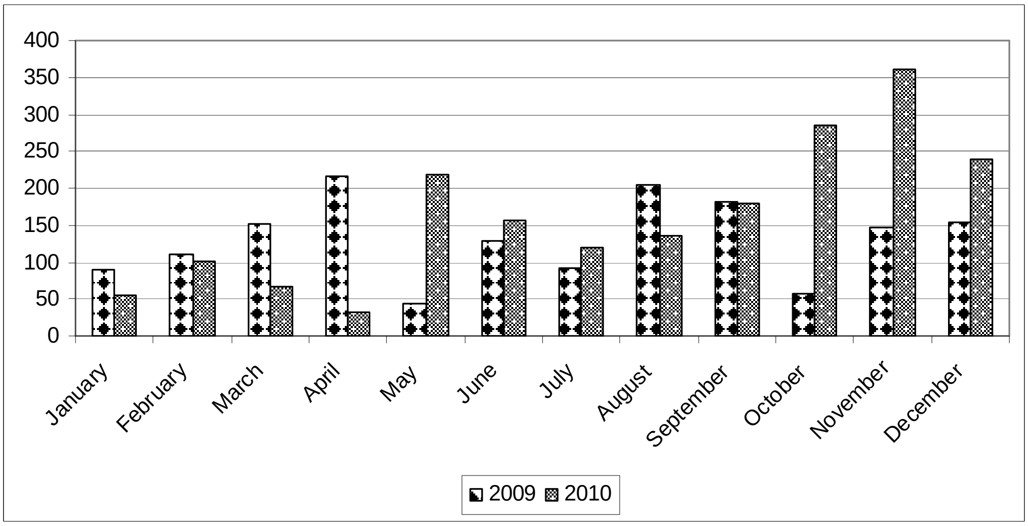


Fig. 10: average values of the two rain gauges

Please note that in the mounths of may, june and july 2010, it rained more than the same mounths of the previous year, that is an important period for the plants growth, This may have favored the production in 2010.

3. RESULTS AND DISCUSSION

3.1. SEED PRODUCTION: PHENOLOGY OF SECOND CUT 2010

To describe the situation and the evolution of the lawn in the second regrowth of 2010, I begin with the rapresentation of phenology evolution, we do not have a lot of data because only two surveys were conducted, but these data are enough to have an idea and make a comparison.

The two dates of surveys and the corresponding values of termic sum are:

DATE	THERMIC SUM
19 of July	1019
2 of August	1313

the values of thermic sum reported to the grow of the plant, are different respect of the values seen before for the comparison of the two years, because it was used a different reference that is the date from which start to the sum the daily value (not 1st of january), but it is taken as a reference the day in which ends to melt the snow, and plants can start to grow. Below are reported the graphs of the phenology's study (fig. 11).

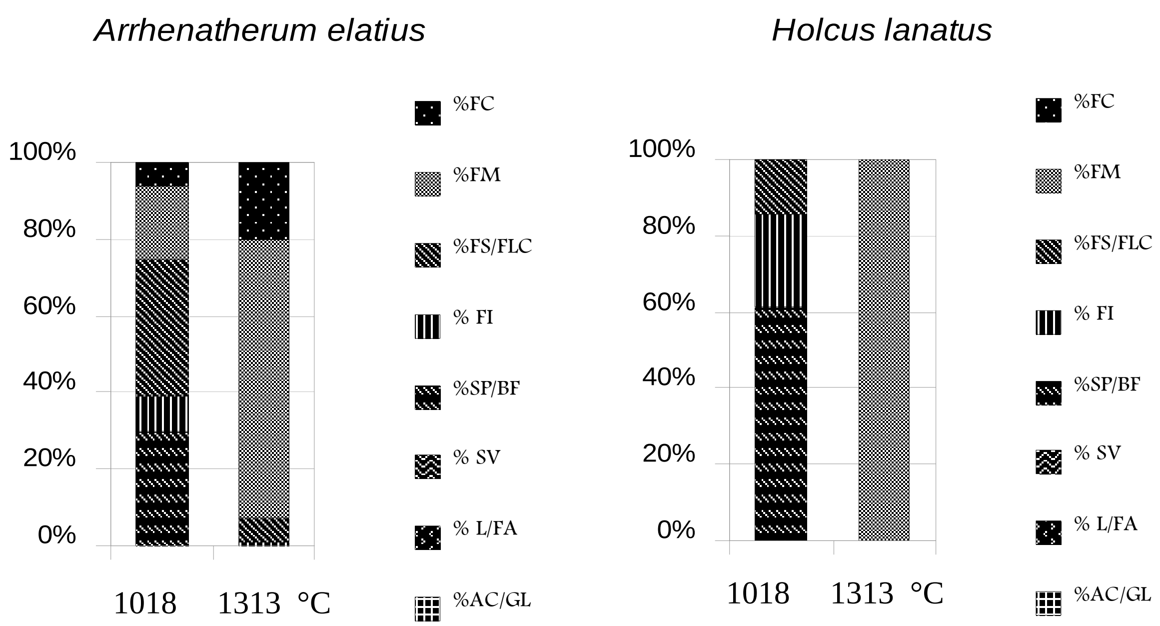


Fig. 11: phenological surveys of Poaceae

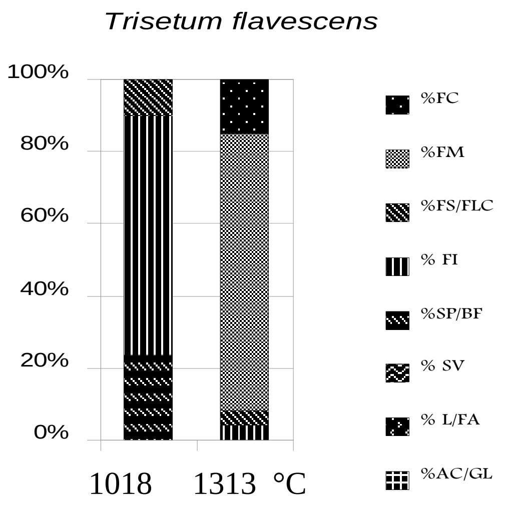
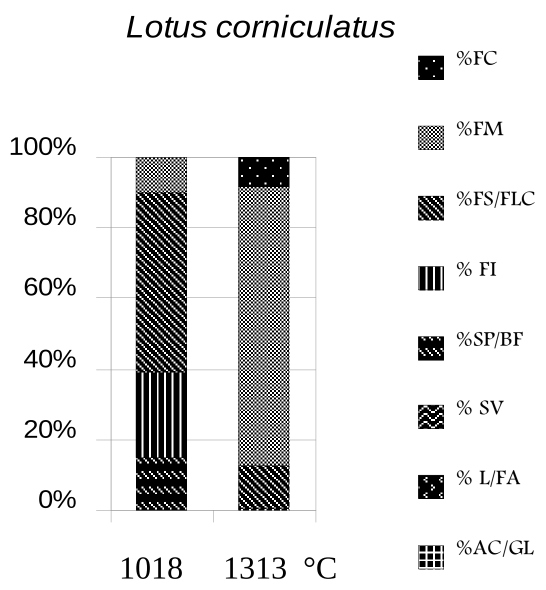
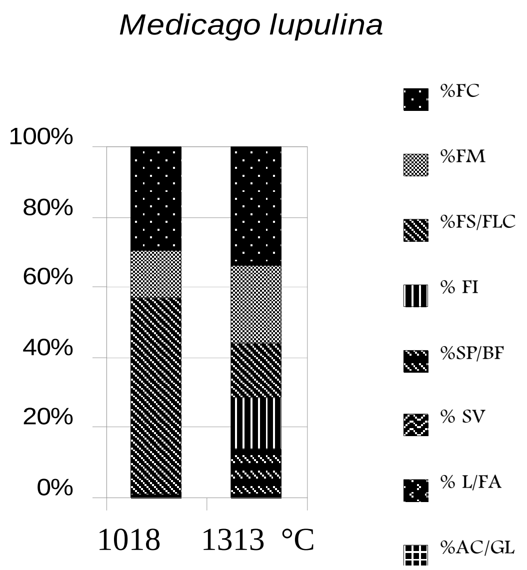
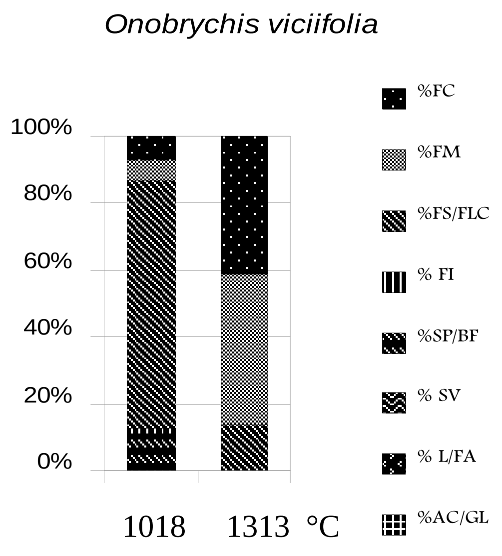


Fig. 11: phenological surveys of Poaceae







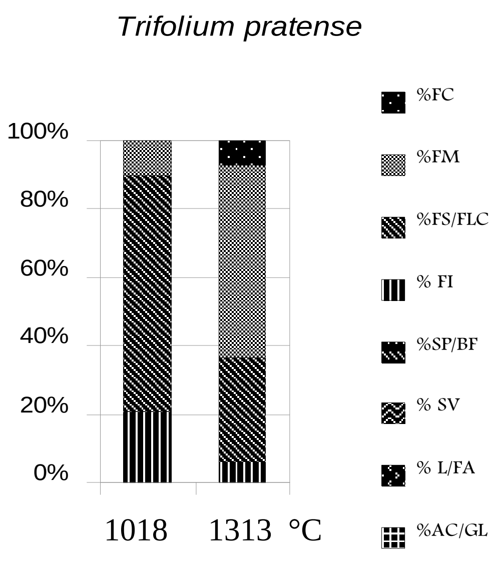


Fig. 11: phenological surveys of Fabaceae

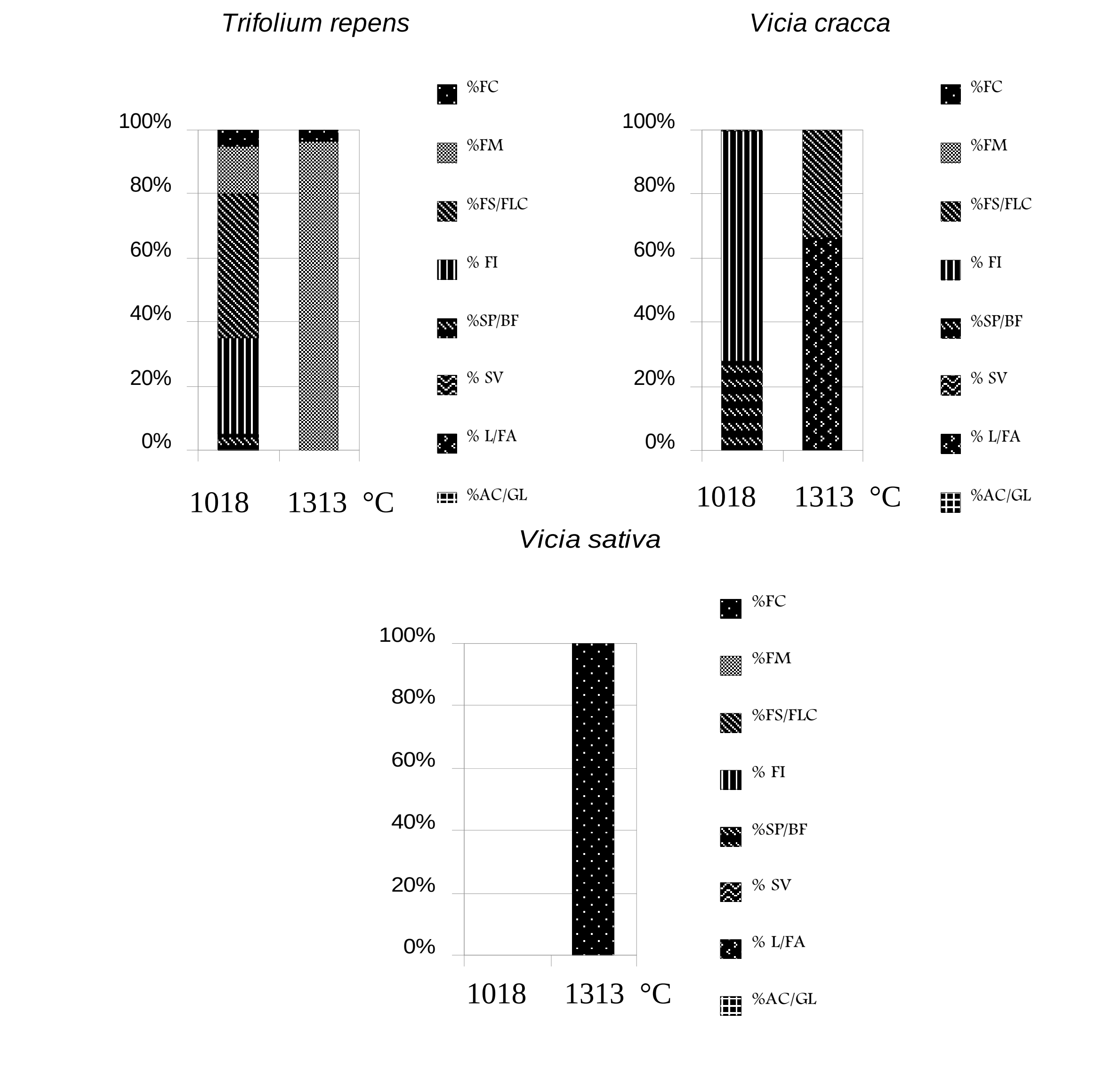


Fig. 11: phenological surveys of Fabaceae

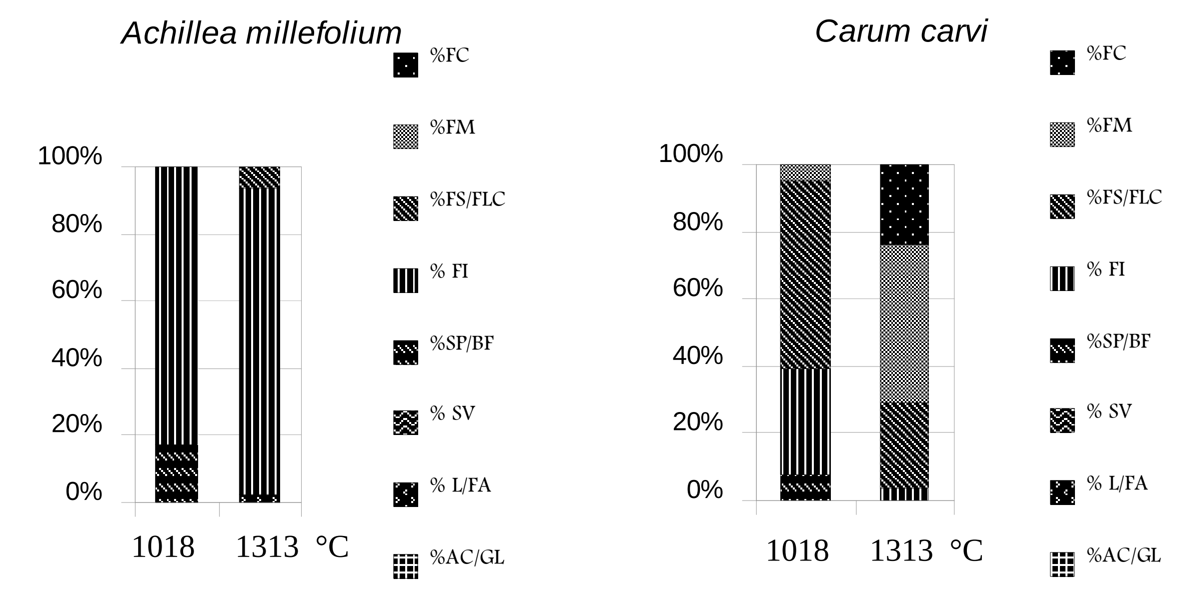


Fig. 11: phenological surveys of other species

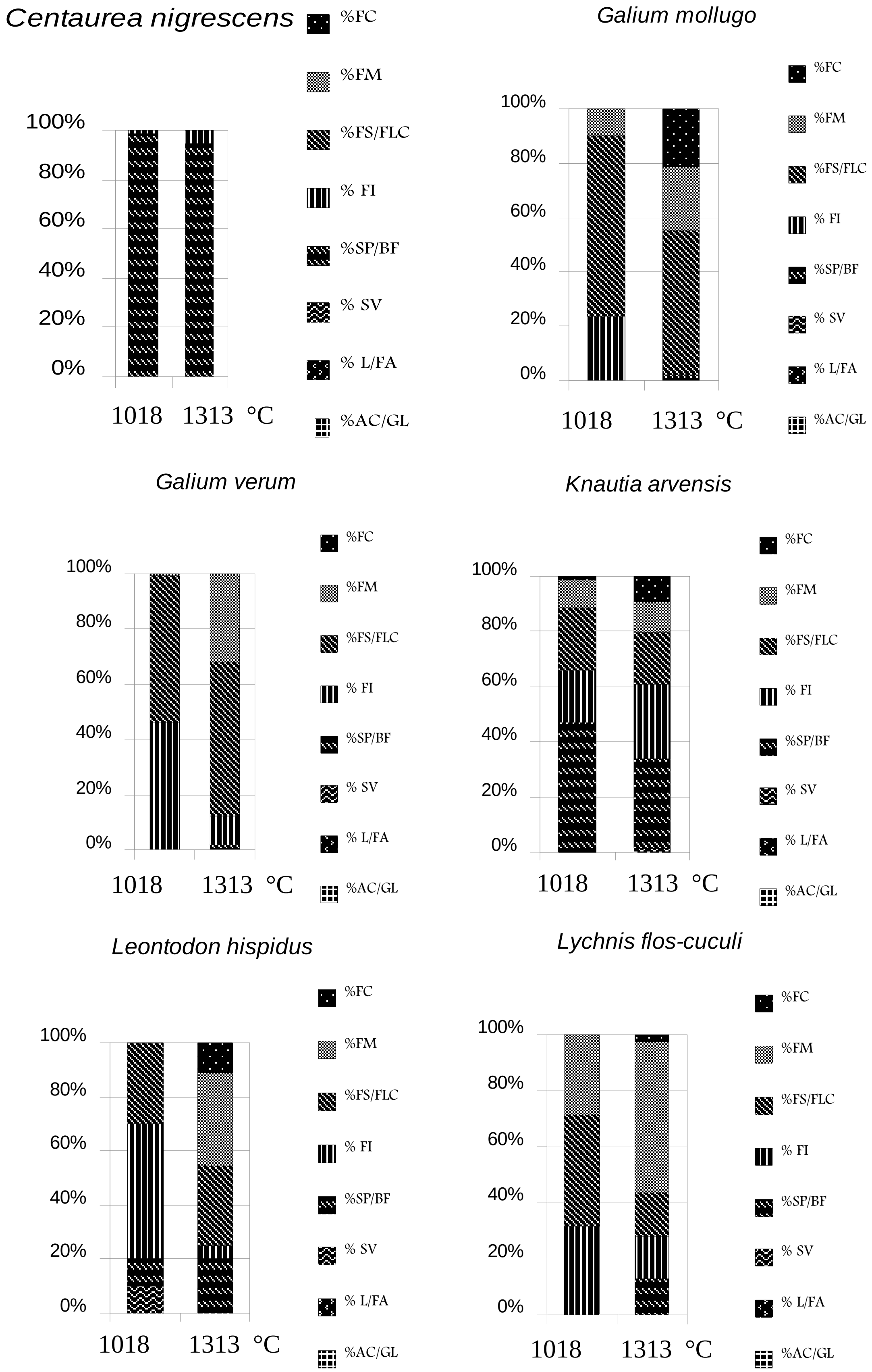


Fig. 11: phenological surveys of other species

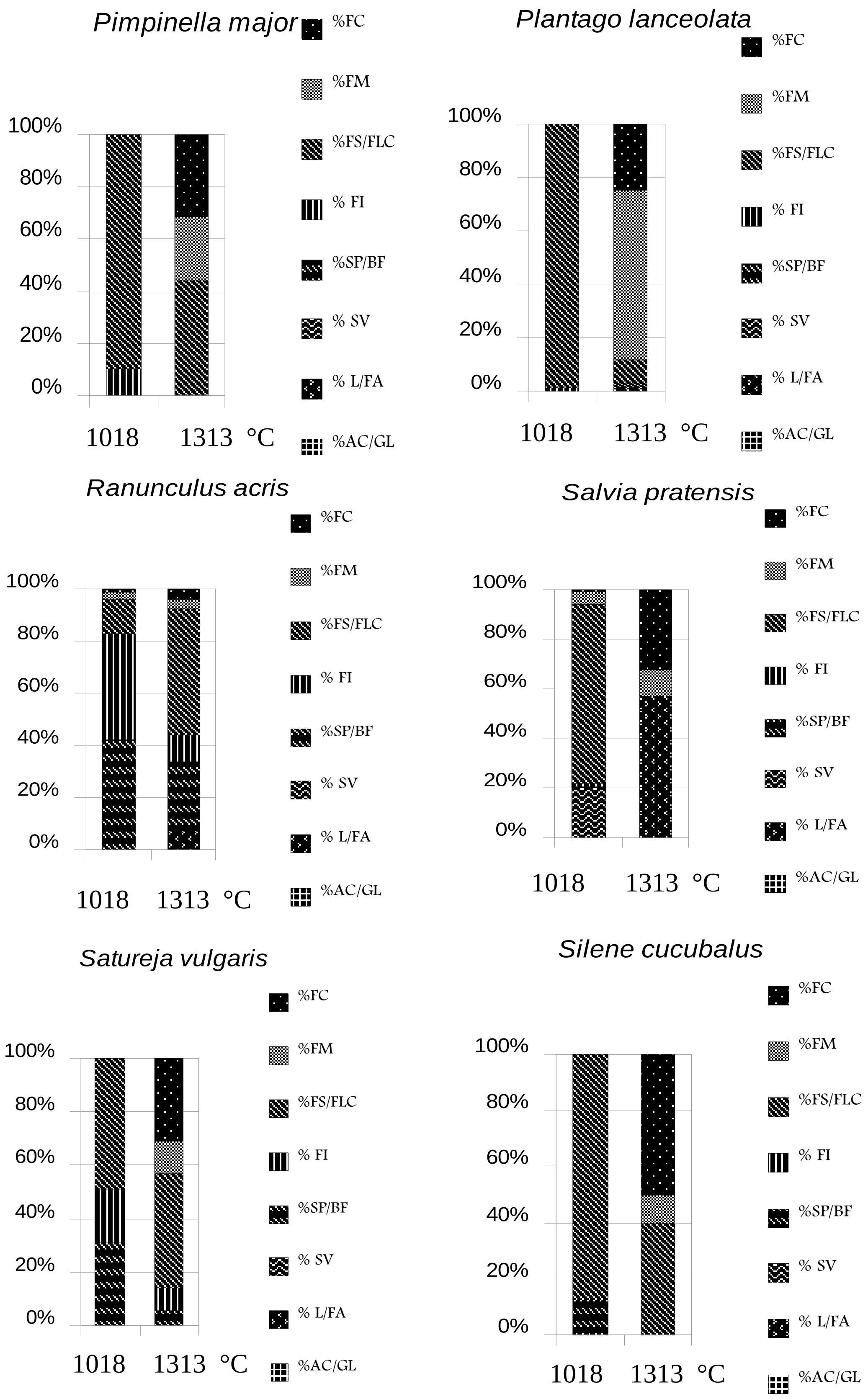


Fig. 11: phenological surveys of other species

Thanks to these graphs, for the field in question, it is possible also for the next years to, estimate the mixture of seed that it is possible to collect in different dates with different value of thermic sum. For the cut performed on 2nd of August 2010, we know which are the plants that were producing fruit, than we are able to rise to the mixture, can then be used.
The mixture of that cut, was composed mainly by the presence of:
+All the three grasses species Arrhenatherum elatius, Holcus lanatus, Trisetum flavescens;
+and about the other species: Lotus corniculatus, Onobrychis viciifolia, Trifolium pratense, Trifolium repens, Carum carvi, Lychnis flos-cuculi, Plantago lanceolata.
Another benefit of these graphs is the ability to detect how the phenophase of ripe fruit is distributed over time, that is calculated on the total number of seeds produced through the use of regression analysis, we understand how the production rates are distributed in the different dates of observation . This is fundamental in order to make the comparison between the amount of seeds calculated by regression and that actually counted the seeds on a fertile stalk.

3.2. STUDY OF REGRESSIONS

During the study of the four harvests (1st 2nd of 2009, 1st 2nd of 2010), we obtained the formulas of regression, depending on the cuts for those species for which it was possible. Once obtained all the possible regressions for each species, we tried to do the mean between all regressions available for the same specie, this work was done both for ovules and seeds, even though we know that are more reliable the regressions of the ovules, as they are subject to a lower number of stochastic factors of variability.

3.2.1. Study of regressions of the second harvest 2010

At the moment of the harvest on the 4th of August 2010, 30 fertile stems were collected, we paid attention to lose minimum number of seeds for each fertile stem. To these fertile stems were taken measures biometrics, with a total counts of number of product seeds, and with a precise estimate of number of ovules.
Starting from these datas it was possible to create a table, and a graph, by the graph thanks to the use of excel, it was computed the formula of regression, a specific one for the number of ovules and a specific one for the number of seeds.
Obtained Regressions were applied to biometrics measures, obtained by measuring of all fertile stems of 12 square meters named WP4. At certain species for which was impossible obtain a regression formula, has resorted to the use of average value of seeds per fertile stem.
The species that obtained a regression: *Arrhenatherum elatius, Galium mollugo, Galium verum, Leontodon hispidus, Lotus corniculatus, Medicago lupulina, Onobrychis viciifolia,*

Plantago lanceolata, Salvia pratensis, Trisetum flavescens, Trifolium pratense, Trifolium repens.

Instead for: *Achillea millefolium* and *Pimpinella majo,*we computed an average.

Below we reported the graphs used to obtain the regression formulas specific for each species at second harvest of 2010 (Fig. 12).

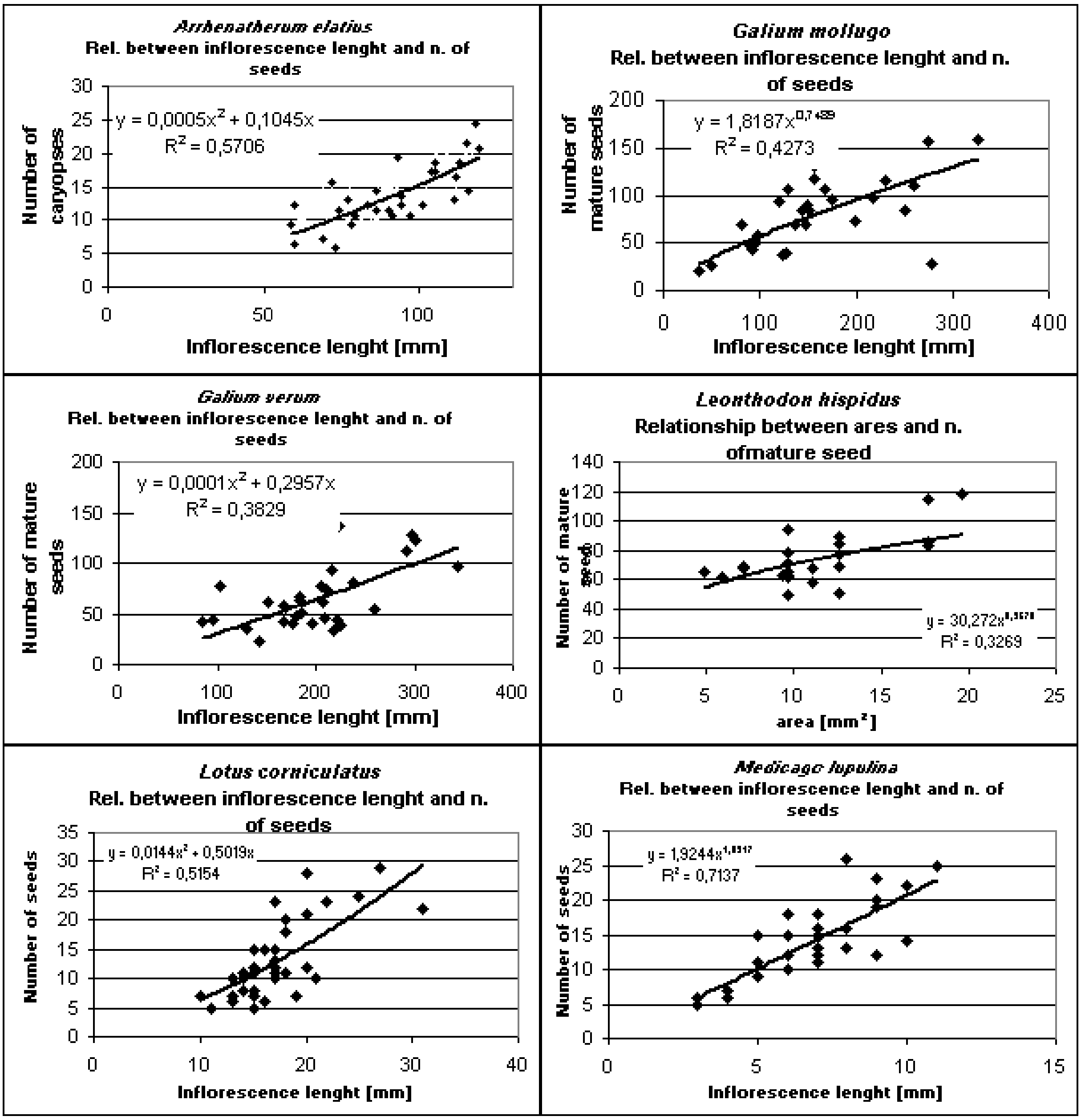


Fig. 12: graphs used to obtain the regression formulas, specific for each species, at second harvest of 2010

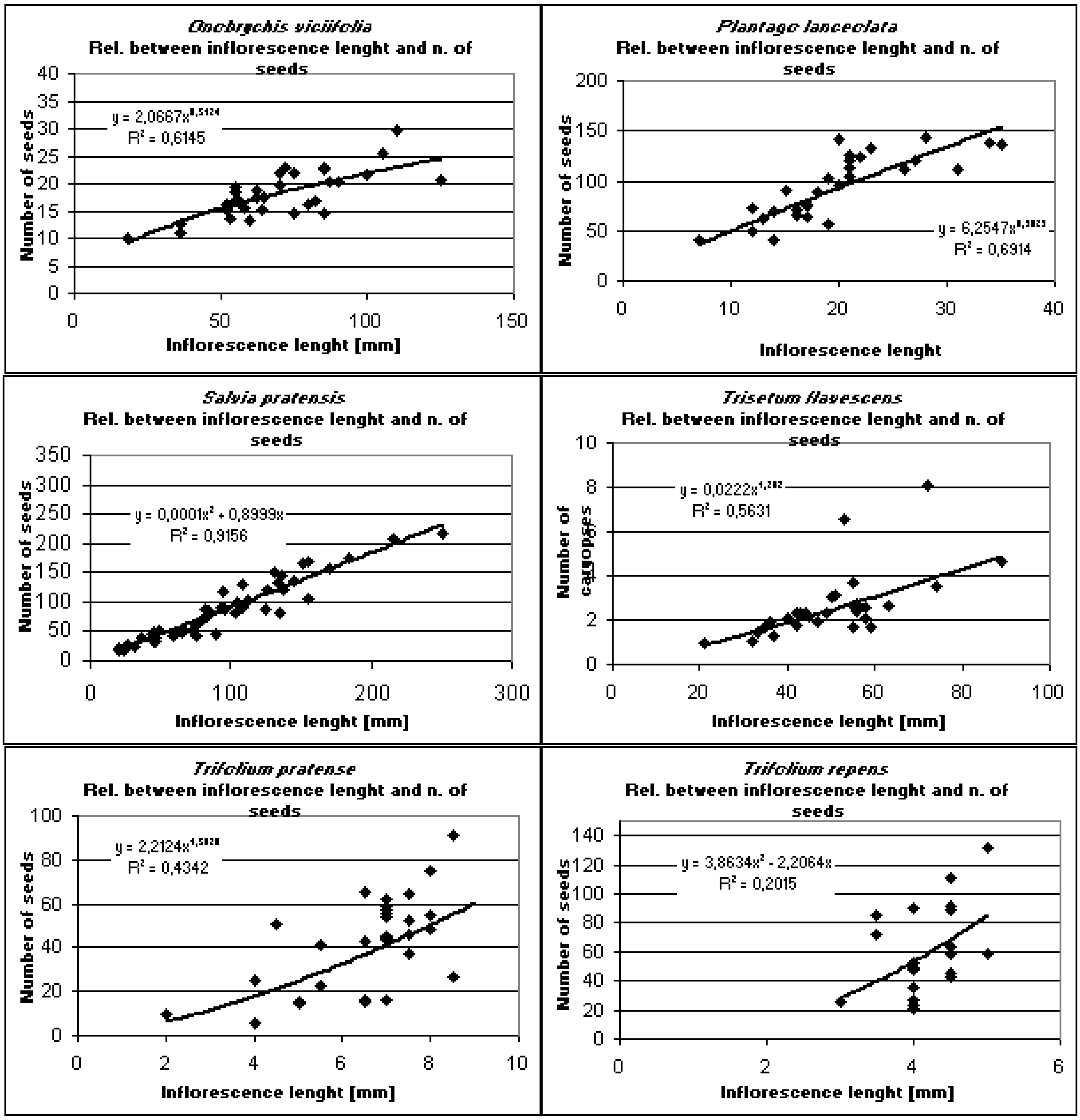


Fig. 12: graphs used to obtain the regression formulas, specific for each species, at second harvest of 2010

but for some species it was impossible find a regression: Achillea millefolium, Knautia arvensis, Pimpinella major, Ranunculus acris, Satureja vulgaris.

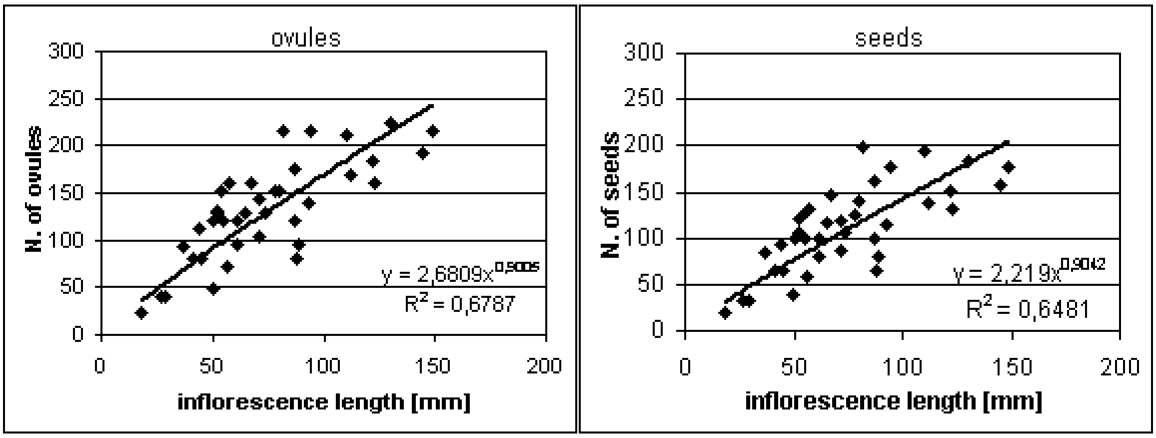
3.2.2. In which way was computed the mean regression

Calculating the mean regression, were used only those species that had at least two regressions related to two different cuts, so you can compute the regressions based on all available datas to compare with the original regressions.

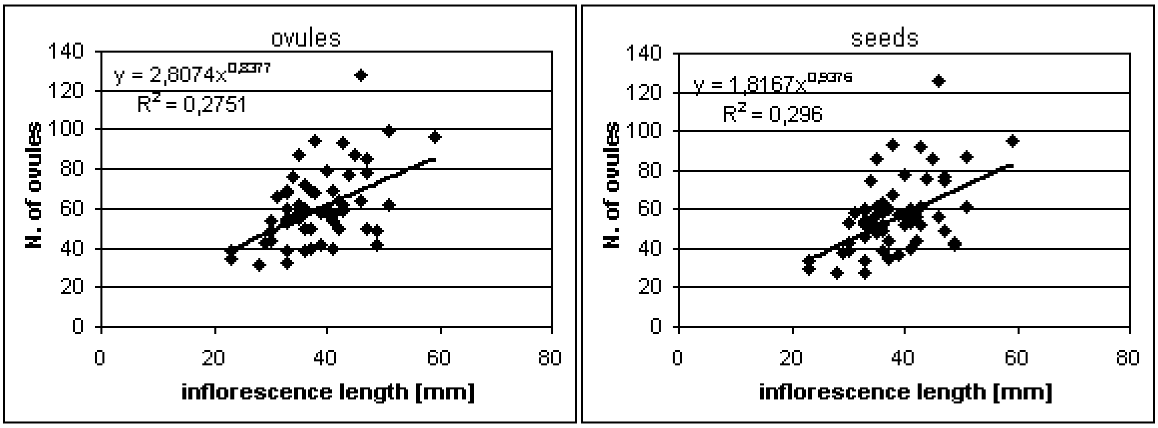
With the mean regression of the specie, was recomputed the total number of ovules and seeds, using the datas provided by analysis of all stems harvested on WP4's areas. To compare the result of the two regressions was used the statistical analysis the method of "T of student", used to understand if two medium are significantly different.

Attached are reported the graphs used to obtain the medium of the years regression formulas to compute amount of ovules and seeds for each species (Fig. 13)

Ajuga reptans



Anthoxanthum odoratum



Arrhenatherum elatius

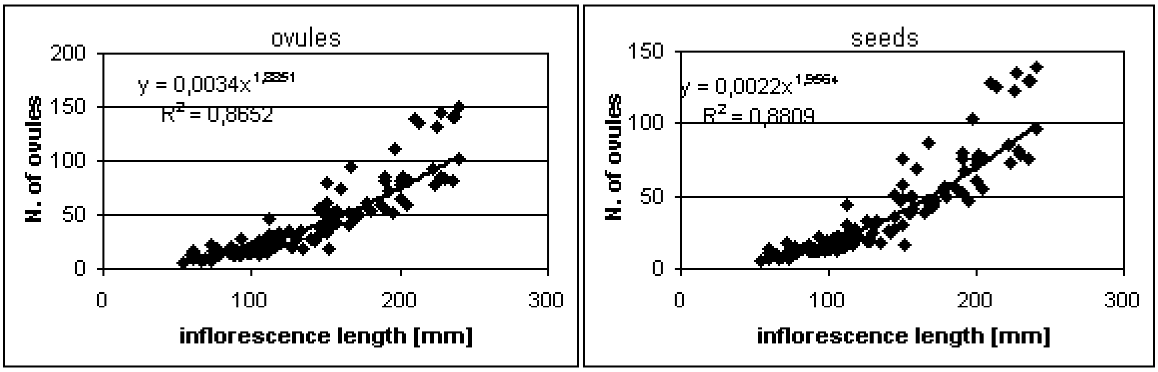
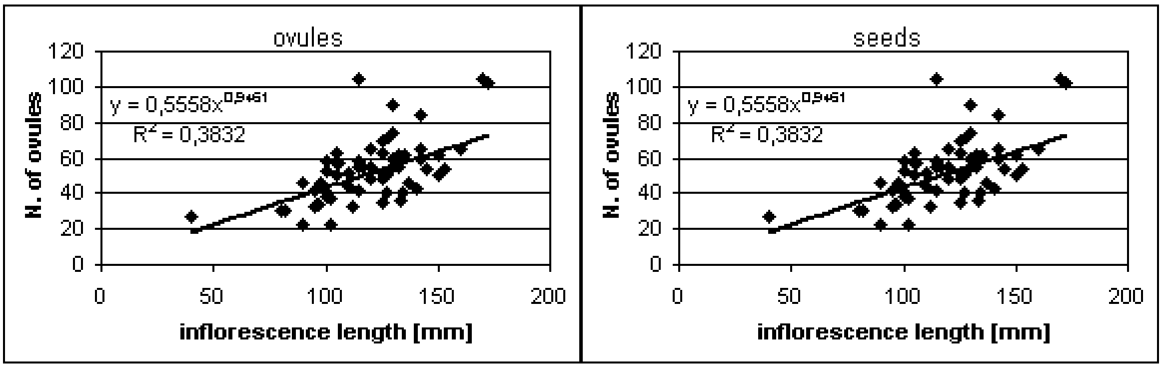
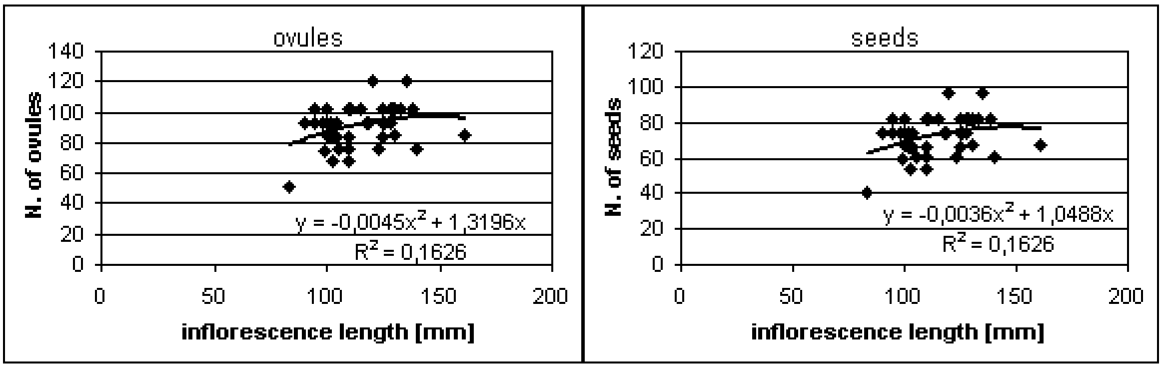


Fig. 13: medium of the years regression formulas to compute amount of ovules and seeds for each species

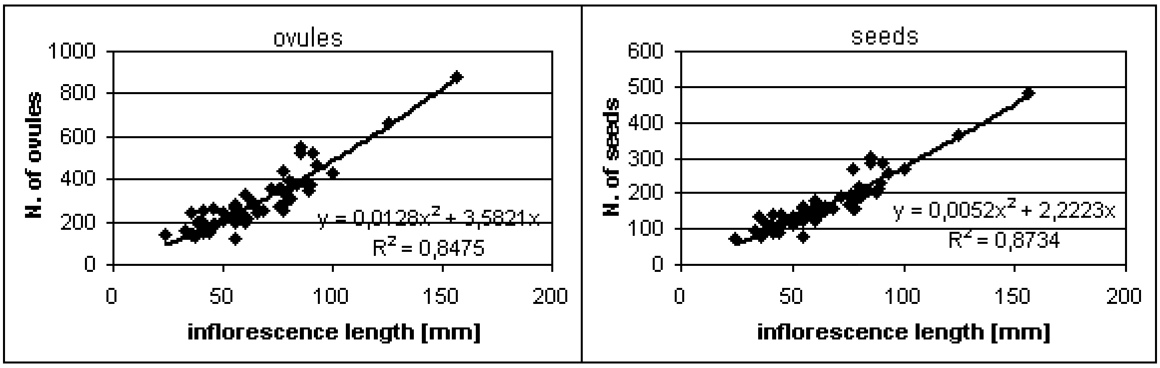
Avenula pubescens



Brachypodium pinnatum



Dactylis glomerata



Festuca pratensis

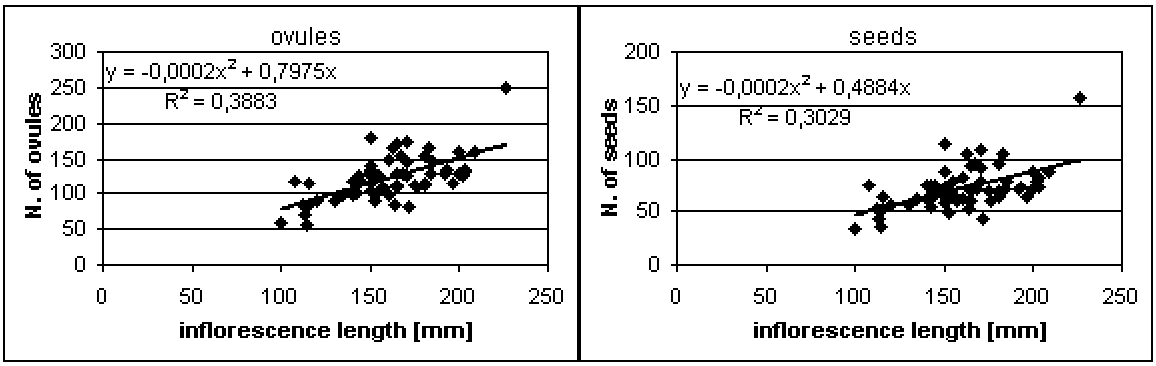
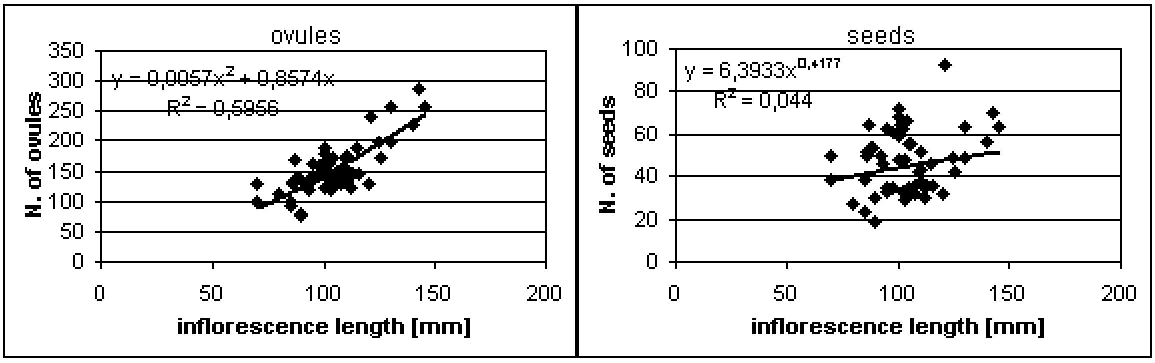
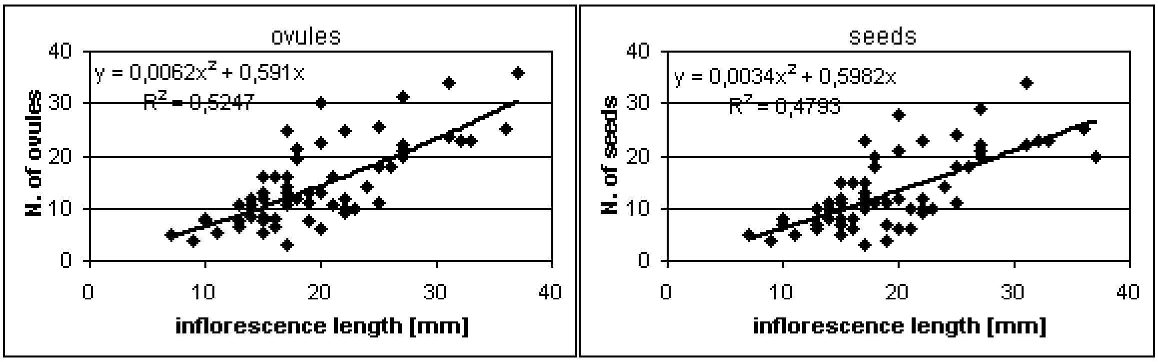


Fig. 13: medium of the years regression formulas to compute amount of ovules and seeds for each species

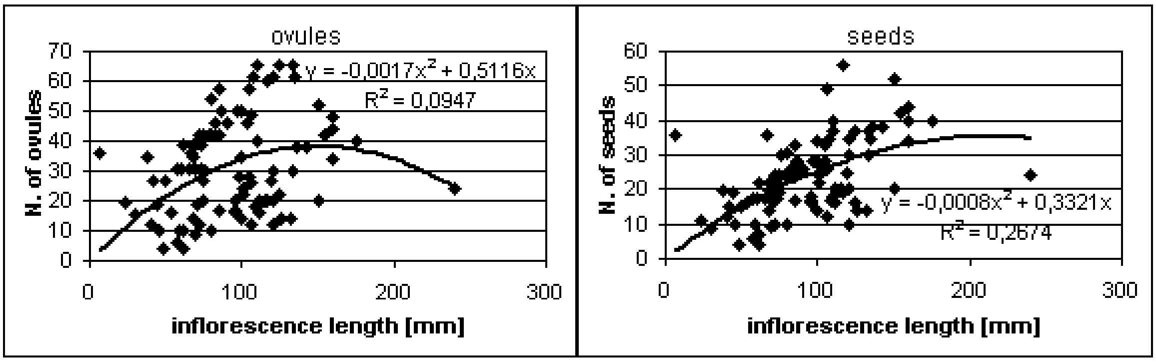
Festuca rupicola



Lotus corniculatus



Myosotis sylvatica



Onobrychis viciifolia

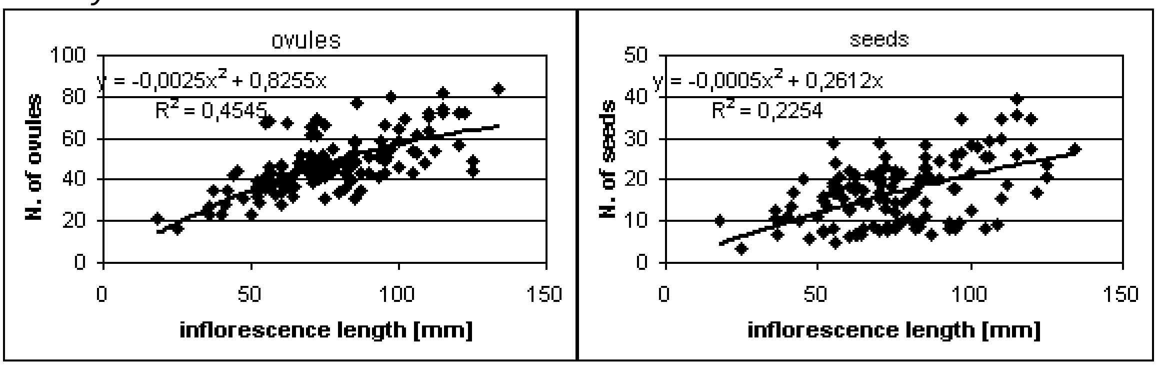
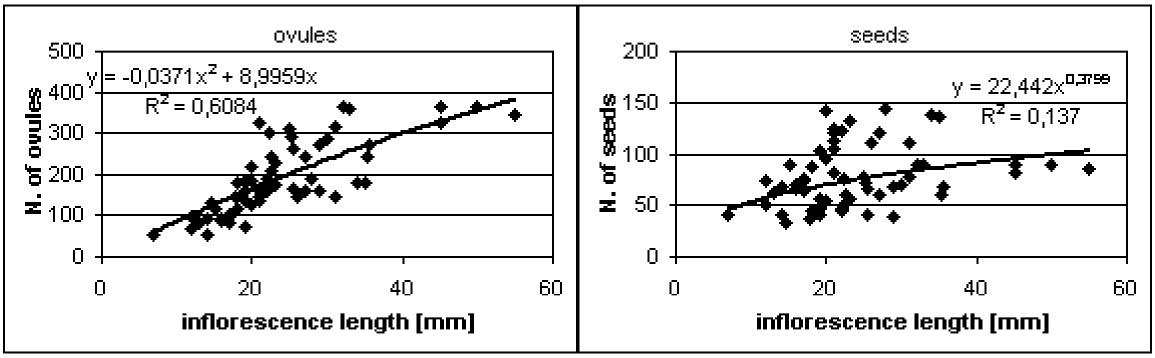
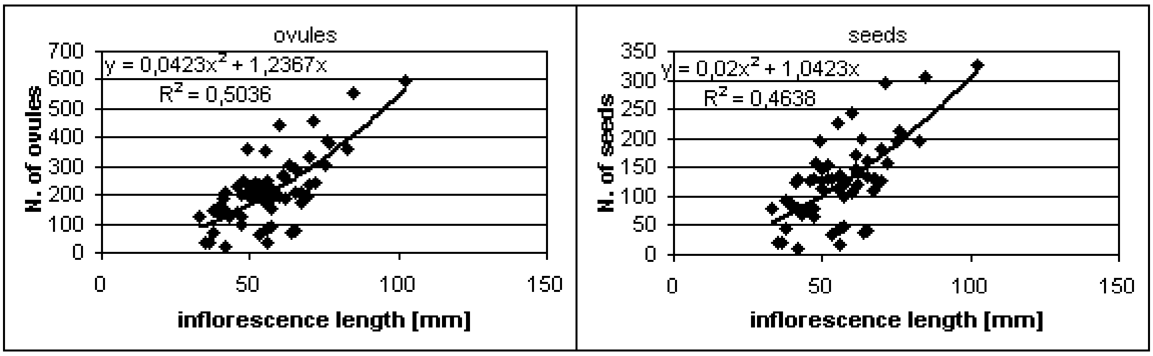


Fig. 13: medium of the years regression formulas to compute amount of ovules and seeds for each species

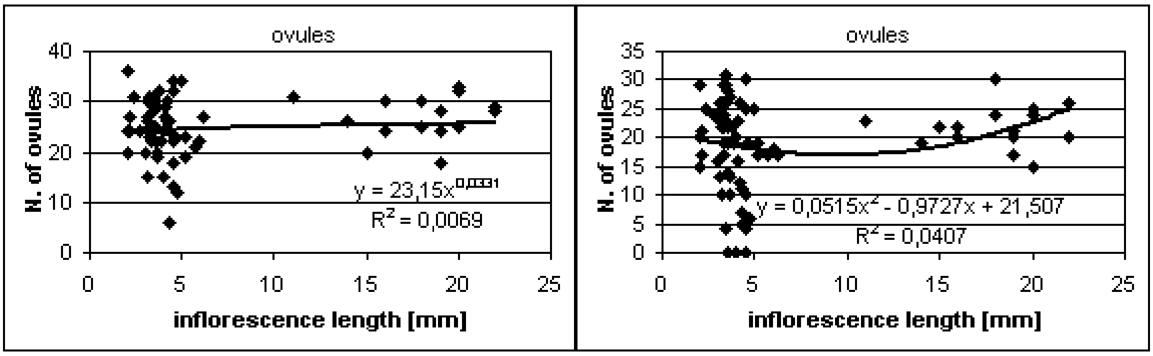
Plantago lanceolata



Poa pratensis



Ranunculus acris



Rhinanthus freynii

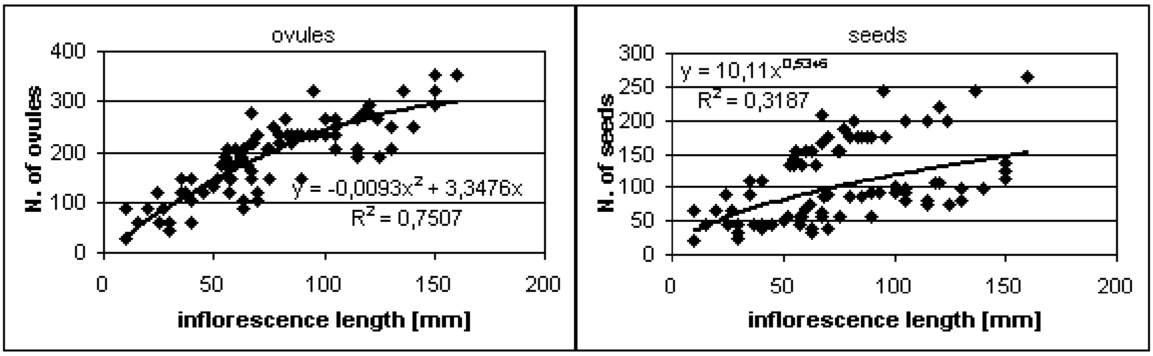
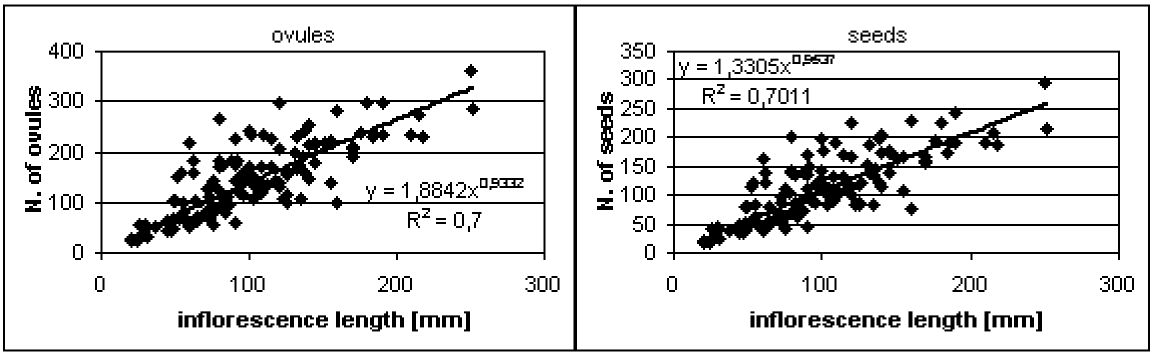
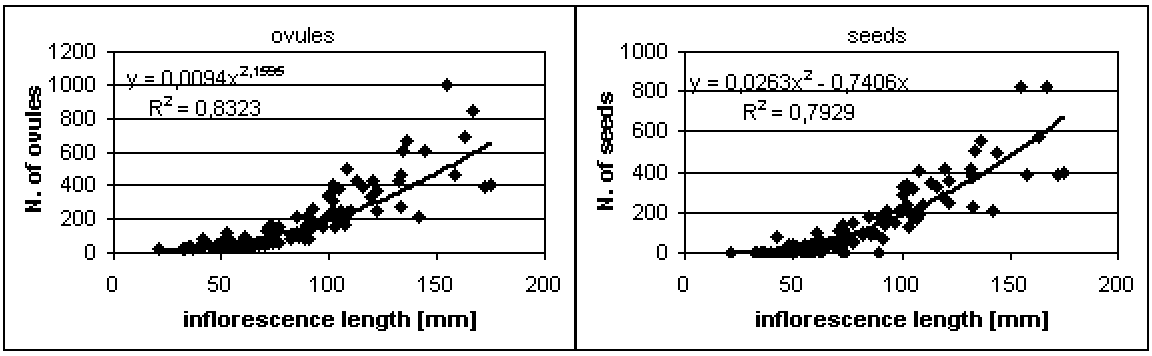


Fig. 13: medium of the years regression formulas to compute amount of ovules and seeds for each species

Salvia pratensis



Trisetum flavescens



Trifolium pratense

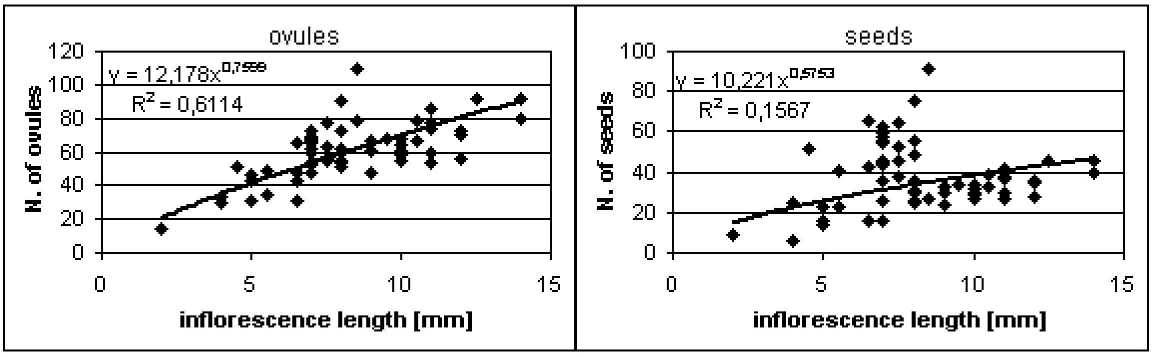


Fig. 13: medium of the years regression formulas to compute amount of ovules and seeds for each species

3.2.3 Results of the comparisons of the regressions

Now I report the tables with the results of statistical method of "T of student", that had shown us which average regressions can be used (Fig.14):

Ajuga reptans

1st regrowth of 2009

ovules regression

Dataset	1	2
Sample num.	3	3
Average	315	297
St. deviation	289	272
t	**0,08**	
degrees of freedom	**4**	
P (significance level)	**0,94**	

the difference between the observed means
is not significant due p<0,05

seeds regression

Dataset	1	2
Sample num.	3	3
Average	265	200
St. deviation	243	184
t	**0,37**	
degrees of freedom	**4**	
P (significance level)	**0,73**	

the difference between the observed means
is not significant due p<0,05

1st regrowth of 2010

ovules regression

Dataset	1	2
Sample num.	7	7
Average	53	91
St. deviation	40	69
t	**1,26**	
degrees of freedom	**12**	
P (significance level)	**0,23**	

the difference between the observed means
is not significant due p<0,05

seeds regression

Dataset	1	2
Sample num.	7	7
Average	45	84
St. deviation	33	63
t	**1,46**	
degrees of freedom	**12**	
P (significance level)	**0,17**	

the difference between the observed means
is not significant due p<0,05

Anthoxanthum odoratum

1st regrowth of 2009

ovules regression

Dataset	1	2
Sample num.	7	7
Average	364	405
St. deviation	231	263
t	**0,31**	
degrees of freedom	**12**	
P (significance level)	**0,76**	

the difference between the observed means
is not significant due p<0,05

seeds regression

Dataset	1	2
Sample num.	7	7
Average	333	403
St. deviation	209	262
t	**0,55**	
degrees of freedom	**12**	
P (significance level)	**0,59**	

the difference between the observed means
is not significant due p<0,05

Fig. 14: results of statistical method of "T of student".

1st regrowth of 2010

ovules regression

Dataset	1	2
Sample num.	11	11
Average	814	782
St. deviation	818	786
t	**0,09**	
degrees of freedom	**20**	
P (significance level)	**0,93**	

the difference between the observed means is not significant due p<0,05

seeds regression

Dataset	1	2
Sample num.	11	11
Average	755	686
St. deviation	757	689
t	**0,22**	
degrees of freedom	**20**	
P (significance level)	**0,83**	

the difference between the observed means is not significant due p<0,05

Arrhenatherum elatius

1st regrowth of 2009

ovules regression

Dataset	1	2
Sample num.	12	12
Average	4351	4119
St. deviation	2132	2004
t	**0,27**	
degrees of freedom	**22**	
P (significance level)	**0,79**	

the difference between the observed means is not significant due p<0,05

seeds regression

Dataset	1	2
Sample num.	12	12
Average	4019	3899
St. deviation	1976	1897
t	**0,15**	
degrees of freedom	**22**	
P (significance level)	**0,88**	

the difference between the observed means is not significant due p<0,05

2nd regrowth of 2009

ovules regression

Dataset	1	2
Sample num.	12	12
Average	1331	1130
St. deviation	704	595
t	**0,76**	
degrees of freedom	**22**	
P (significance level)	**0,46**	

the difference between the observed means is not significant due p<0,05

seeds regression

Dataset	1	2
Sample num.	12	12
Average	1200	1062
St. deviation	636	559
t	**0,56**	
degrees of freedom	**22**	
P (significance level)	**0,58**	

the difference between the observed means is not significant due p<0,05

1st regrowth of 2010

ovules regression

Dataset	1	2
Sample num.	12	12
Average	5972	6527
St. deviation	3497	3882
t	**0,37**	
degrees of freedom	**22**	
P (significance level)	**0,72**	

the difference between the observed means is not significant due p<0,05

seeds regression

Dataset	1	2
Sample num.	12	12
Average	5536	4896
St. deviation	3250	2911
t	**0,51**	
degrees of freedom	**22**	
P (significance level)	**0,62**	

the difference between the observed means is not significant due p<0,05

Fig. 14: results of statistical method of "T of student".

2nd regrowth of 2010

ovules regression

Dataset	1	2
Sample num.	12	12
Average	420	520
St. deviation	224	276
t	**0,98**	
degrees of freedom	**22**	
P (significance level)	**0,34**	

the difference between the observed means is not significant due p<0,05

seeds regression

Dataset	1	2
Sample num.	12	12
Average	372	372
St. deviation	199	197
t	**0,00**	
degrees of freedom	**22**	
P (significance level)	**1,00**	

the difference between the observed means is not significant due p<0,05

Avenula pubescens

1st regrowth of 2009

ovules regression

Dataset	1	2
Sample num.	12	12
Average	655	623
St. deviation	509	485
t	**0,15**	
degrees of freedom	**22**	
P (significance level)	**0,88**	

the difference between the observed means is not significant due p<0,05

seeds regression

Dataset	1	2
Sample num.	12	12
Average	514	423
St. deviation	399	329
t	**0,61**	
degrees of freedom	**22**	
P (significance level)	**0,55**	

the difference between the observed means is not significant due p<0,05

1st regrowth of 2010

ovules regression

Dataset	1	2
Sample num.	12	12
Average	1399	1518
St. deviation	502	539
t	**0,56**	
degrees of freedom	**22**	
P (significance level)	**0,58**	

the difference between the observed means is not significant due p<0,05

seeds regression

Dataset	1	2
Sample num.	12	12
Average	1102	1107
St. deviation	395	393
t	**0,03**	
degrees of freedom	**22**	
P (significance level)	**0,97**	

the difference between the observed means is not significant due p<0,05

Brachypodium pinnatum

1st regrowth of 2009

ovules regression

Dataset	1	2
Sample num.	5	5
Average	514	3299
St. deviation	27	1938
t	**3,21**	
degrees of freedom	**8**	
P (significance level)	**0,01**	

the difference between the observed means is significant due p<0,05

seeds regression

Dataset	1	2
Sample num.	5	5
Average	407	2483
St. deviation	21	1458
t	**3,18**	
degrees of freedom	**8**	
P (significance level)	**0,01**	

the difference between the observed means is significant due p<0,05

Fig. 14: results of statistical method of "T of student".

1st regrowth of 2010

ovules regression

Dataset	1	2
Sample num.	3	3
Average	7857	8370
St. deviation	2939	3180
t	**0,21**	
degrees of freedom	**4**	
P (significance level)	**0,85**	

the difference between the observed means is not significant due p<0,05

seeds regression

Dataset	1	2
Sample num.	3	3
Average	6218	6298
St. deviation	2325	2393
t	**0,04**	
degrees of freedom	**4**	
P (significance level)	**0,97**	

the difference between the observed means is not significant due p<0,05

Dactylis glomerata

1st regrowth of 2009

ovules regression

Dataset	1	2
Sample num.	11	11
Average	3711	3288
St. deviation	3233	2841
t	**0,33**	
degrees of freedom	**20**	
P (significance level)	**0,75**	

the difference between the observed means is not significant due p<0,05

seeds regression

Dataset	1	2
Sample num.	11	11
Average	2157	1568
St. deviation	1875	1354
t	**0,85**	
degrees of freedom	**20**	
P (significance level)	**0,41**	

the difference between the observed means is not significant due p<0,05

1st regrowth of 2010

ovules regression

Dataset	1	2
Sample num.	10	10
Average	3188	6876
St. deviation	3583	8088
t	**1,32**	
degrees of freedom	**18**	
P (significance level)	**0,20**	

the difference between the observed means is not significant due p<0,05

seeds regression

Dataset	1	2
Sample num.	10	10
Average	1828	1901
St. deviation	2036	2103
t	**0,08**	
degrees of freedom	**18**	
P (significance level)	**0,94**	

the difference between the observed means is not significant due p<0,05

Festuca pratensis

1st regrowth of 2009

ovules regression

Dataset	1	2
Sample num.	7	7
Average	1381	1387
St. deviation	1059	1053
t	**0,01**	
degrees of freedom	**12**	
P (significance level)	**0,99**	

the difference between the observed means is not significant due p<0,05

seeds regression

Dataset	1	2
Sample num.	7	7
Average	825	647
St. deviation	632	491
t	**0,59**	
degrees of freedom	**12**	
P (significance level)	**0,57**	

the difference between the observed means is not significant due p<0,05

1st regrowth of 2010

ovules regression

Dataset	1	2
Sample num.	12	12
Average	1813	16821
St. deviation	1165	10761
t	**4,80**	
degrees of freedom	**22**	
P (significance level)	**0,00**	

the difference between the observed means is significant due p<0,05

seeds regression

Dataset	1	2
Sample num.	12	12
Average	1079	1080
St. deviation	694	691
t	**0,00**	
degrees of freedom	**22**	
P (significance level)	**1,00**	

the difference between the observed means is not significant due p<0,05

Festuca rupicola

1st regrowth of 2009

ovules regression

Dataset	1	2
Sample num.	4	4
Average	827	675
St. deviation	661	521
t	**0,36**	
degrees of freedom	**6**	
P (significance level)	**0,73**	

the difference between the observed means is not significant due p<0,05

seeds regression

Dataset	1	2
Sample num.	4	4
Average	325	144
St. deviation	307	111
t	**1,11**	
degrees of freedom	**6**	
P (significance level)	**0,31**	

the difference between the observed means is not significant due p<0,05

1st regrowth of 2010

ovules regression

Dataset	1	2
Sample num.	8	8
Average	1233	1439
St. deviation	1412	1696
t	**0,26**	
degrees of freedom	**14**	
P (significance level)	**0,80**	

the difference between the observed means is not significant due p<0,05

seeds regression

Dataset	1	2
Sample num.	8	8
Average	454	75
St. deviation	548	90
t	**1,94**	
degrees of freedom	**14**	
P (significance level)	**0,07**	

the difference between the observed means is not significant due p<0,05

Lotus corniculatus

1st regrowth of 2009

ovules regression

Dataset	1	2
Sample num.	6	6
Average	250	855
St. deviation	182	638
t	**2,24**	
degrees of freedom	**10**	
P (significance level)	**0,05**	

the difference between the observed means is significant due p<0,05

seeds regression

Dataset	1	2
Sample num.	6	6
Average	230	178
St. deviation	168	130
t	**0,61**	
degrees of freedom	**10**	
P (significance level)	**0,56**	

the difference between the observed means is not significant due p<0,05

2nd regrowth of 2010

ovules regression

Dataset	1	2
Sample num.	12	12
Average	4556	20056
St. deviation	2202	9677
t	**5,41**	
degrees of freedom	**22**	
P (significance level)	**0,00**	

the difference between the observed means is significant due p<0,05

seeds regression

Dataset	1	2
Sample num.	12	12
Average	4281	5278
St. deviation	2067	2564
t	**1,05**	
degrees of freedom	**22**	
P (significance level)	**0,31**	

the difference between the observed means is not significant due p<0,05

Myosotis sylvatica

1st regrowth of 2009

ovules regression

Dataset	1	2
Sample num.	2	2
Average	70	129
St. deviation	10	14
t	**4,93**	
degrees of freedom	**2**	
P (significance level)	**0,04**	

the difference between the observed means is significant due p<0,05

seeds regression

Dataset	1	2
Sample num.	2	2
Average	59	66
St. deviation	8	7
t	**1,02**	
degrees of freedom	**2**	
P (significance level)	**0,42**	

the difference between the observed means is not significant due p<0,05

1st regrowth of 2010

ovules regression

Dataset	1	2
Sample num.	12	12
Average	3261	1012
St. deviation	1770	543
t	**4,21**	
degrees of freedom	**22**	
P (significance level)	**0,00**	

the difference between the observed means is significant due p<0,05

seeds regression

Dataset	1	2
Sample num.	12	12
Average	2744	514
St. deviation	1489	276
t	**5,10**	
degrees of freedom	**22**	
P (significance level)	**0,00**	

the difference between the observed means is significant due p<0,05

Onobrychis viciifolia

1st regrowth of 2009

ovules regression

Dataset	1	2
Sample num.	5	5
Average	781	1071
St. deviation	755	988
t	**0,52**	
degrees of freedom	**8**	
P (significance level)	**0,62**	

the difference between the observed means is not significant due p<0,05

seeds regression

Dataset	1	2
Sample num.	5	5
Average	268	303
St. deviation	262	280
t	**0,20**	
degrees of freedom	**8**	
P (significance level)	**0,84**	

the difference between the observed means is not significant due p<0,05

2nd regrowth of 2009

ovules regression

Dataset	1	2
Sample num.	5	5
Average	1193	1129
St. deviation	1076	1021
t	**0,10**	
degrees of freedom	**8**	
P (significance level)	**0,93**	

the difference between the observed means is not significant due p<0,05

seeds regression

Dataset	1	2
Sample num.	5	5
Average	420	545
St. deviation	378	493
t	**0,45**	
degrees of freedom	**8**	
P (significance level)	**0,66**	

the difference between the observed means is not significant due p<0,05

1st regrowth of 2010

ovules regression

Dataset	1	2
Sample num.	7	7
Average	1920	1737
St. deviation	1153	1002
t	**0,32**	
degrees of freedom	**12**	
P (significance level)	**0,76**	

the difference between the observed means is not significant due p<0,05

seeds regression

Dataset	1	2
Sample num.	7	7
Average	666	817
St. deviation	403	471
t	**0,64**	
degrees of freedom	**12**	
P (significance level)	**0,53**	

the difference between the observed means is not significant due p<0,05

2nd regrowth of 2010

ovules regression

Dataset	1	2
Sample num.	6	6
Average	569	524
St. deviation	424	402
t	**0,19**	
degrees of freedom	**10**	
P (significance level)	**0,86**	

the difference between the observed means is not significant due p<0,05

seeds regression

Dataset	1	2
Sample num.	6	6
Average	197	246
St. deviation	147	189
t	**0,51**	
degrees of freedom	**10**	
P (significance level)	**0,62**	

the difference between the observed means is not significant due p<0,05

Plantago lanceolata

1st regrowth of 2009

ovules regression

Dataset	1	2
Sample num.	11	11
Average	585	777
St. deviation	347	468
t	**1,09**	
degrees of freedom	**20**	
P (significance level)	**0,29**	

the difference between the observed means is not significant due p<0,05

seeds regression

Dataset	1	2
Sample num.	11	11
Average	306	347
St. deviation	192	209
t	**0,47**	
degrees of freedom	**20**	
P (significance level)	**0,64**	

the difference between the observed means is not significant due p<0,05

2nd regrowth of 2010

ovules regression

Dataset	1	2
Sample num.	12	12
Average	1339	2339
St. deviation	580	2324
t	**1,45**	
degrees of freedom	**22**	
P (significance level)	**0,16**	

the difference between the observed means is not significant due p<0,05

seeds regression

Dataset	1	2
Sample num.	12	12
Average	693	1780
St. deviation	272	1769
t	**2,10**	
degrees of freedom	**22**	
P (significance level)	**0,05**	

the difference between the observed means is significant due p<0,05

1st regrowth of 2009

ovules regression

Dataset	1	2
Sample num.	10	10
Average	4504	4566
St. deviation	3776	3784
t	**0,04**	
degrees of freedom	**18**	
P (significance level)	**0,97**	

the difference between the observed means is not significant due p<0,05

seeds regression

Dataset	1	2
Sample num.	10	10
Average	2706	2949
St. deviation	2257	2444
t	**0,23**	
degrees of freedom	**18**	
P (significance level)	**0,82**	

the difference between the observed means is not significant due p<0,05

1st regrowth of 2010

ovules regression

Dataset	1	2
Sample num.	12	12
Average	12885	11893
St. deviation	12805	11826
t	**0,20**	
degrees of freedom	**22**	
P (significance level)	**0,85**	

the difference between the observed means is not significant due p<0,05

seeds regression

Dataset	1	2
Sample num.	12	12
Average	7667	6512
St. deviation	7618	6476
t	**0,40**	
degrees of freedom	**22**	
P (significance level)	**0,69**	

the difference between the observed means is not significant due p<0,05

Ranunculus acris

1st regrowth of 2009

ovules regression

Dataset	1	2
Sample num.	11	11
Average	82	560
St. deviation	51	557
t	**2,84**	
degrees of freedom	**20**	
P (significance level)	**0,01**	

the difference between the observed means is significant due p<0,05

1st regrowth of 2010

ovules regression

Dataset	1	2
Sample num.	11	11
Average	296	1811
St. deviation	292	2259
t	**2,21**	
degrees of freedom	**20**	
P (significance level)	**0,04**	

the difference between the observed means is significant due p<0,05

1st regrowth of 2009

ovules regression

Dataset	1	2
Sample num.	12	12
Average	10316	11265
St. deviation	10211	11102
t	**0,22**	
degrees of freedom	**22**	
P (significance level)	**0,83**	

the difference between the observed means is not significant due p<0,05

seeds regression

Dataset	1	2
Sample num.	12	12
Average	5732	8522
St. deviation	5680	8399
t	**0,95**	
degrees of freedom	**22**	
P (significance level)	**0,35**	

the difference between the observed means is not significant due p<0,05

1st regrowth of 2010

ovules regression

Dataset	1	2
Sample num.	11	11
Average	3890	4273
St. deviation	4210	4635
t	**0,20**	
degrees of freedom	**20**	
P (significance level)	**0,84**	

the difference between the observed means is not significant due p<0,05

seeds regression

Dataset	1	2
Sample num.	11	11
Average	2130	3232
St. deviation	2307	3506
t	**0,87**	
degrees of freedom	**20**	
P (significance level)	**0,39**	

the difference between the observed means is not significant due p<0,05

Salvia pratensis

1st regrowth of 2009

ovules regression

Dataset	1	2
Sample num.	11	11
Average	3497	4853
St. deviation	2047	2766
t	**1,31**	
degrees of freedom	**20**	
P (significance level)	**0,21**	

the difference between the observed means is not significant due p<0,05

seeds regression

Dataset	1	2
Sample num.	11	11
Average	2698	3695
St. deviation	1584	2106
t	**1,25**	
degrees of freedom	**20**	
P (significance level)	**0,22**	

the difference between the observed means is not significant due p<0,05

2nd regrowth of 2009

ovules regression

Dataset	1	2
Sample num.	8	11
Average	57	4853
St. deviation	41	2766
t	**4,87**	
degrees of freedom	**17**	
P (significance level)	**0,00**	

the difference between the observed means is significant due p<0,05

seeds regression

Dataset	1	2
Sample num.	8	11
Average	43	3695
St. deviation	32	2106
t	**4,87**	
degrees of freedom	**17**	
P (significance level)	**0,00**	

the difference between the observed means is significant due p<0,05

1st regrowth of 2010

ovules regression

Dataset	1	2
Sample num.	12	12
Average	9235	9524
St. deviation	6533	5646
t	**0,12**	
degrees of freedom	**22**	
P (significance level)	**0,91**	

the difference between the observed means is not significant due p<0,05

seeds regression

Dataset	1	2
Sample num.	12	12
Average	7294	7774
St. deviation	5344	4608
t	**0,24**	
degrees of freedom	**22**	
P (significance level)	**0,82**	

the difference between the observed means is not significant due p<0,05

2nd regrowth of 2010

ovules regression

Dataset	1	2
Sample num.	9	9
Average	1151	997
St. deviation	678	583
t	**0,52**	
degrees of freedom	**16**	
P (significance level)	**0,61**	

the difference between the observed means is not significant due p<0,05

seeds regression

Dataset	1	2
Sample num.	9	6
Average	894	209
St. deviation	526	63
t	**3,14**	
degrees of freedom	**13**	
P (significance level)	**0,01**	

the difference between the observed means is significant due p<0,05

Trisetum flavescens

1st regrowth of 2009

ovules regression

Dataset	1	2
Sample num.	12	12
Average	8192	11109
St. deviation	10410	14057
t	**0,58**	
degrees of freedom	**22**	
P (significance level)	**0,57**	

the difference between the observed means is not significant due p<0,05

seeds regression

Dataset	1	2
Sample num.	12	12
Average	7831	9353
St. deviation	10015	11834
t	**0,34**	
degrees of freedom	**22**	
P (significance level)	**0,74**	

the difference between the observed means is not significant due p<0,05

2nd regrowth of 2009

ovules regression

Dataset	1	2
Sample num.	9	9
Average	709	555
St. deviation	884	687
t	**0,41**	
degrees of freedom	**16**	
P (significance level)	**0,69**	

the difference between the observed means is not significant due p<0,05

seeds regression

Dataset	1	2
Sample num.	9	9
Average	511	468
St. deviation	643	579
t	**0,15**	
degrees of freedom	**16**	
P (significance level)	**0,89**	

the difference between the observed means is not significant due p<0,05

1st regrowth of 2010

ovules regression

Dataset	1	2
Sample num.	12	12
Average	8224	7909
St. deviation	5581	5279
t	**0,14**	
degrees of freedom	**22**	
P (significance level)	**0,89**	

the difference between the observed means is not significant due p<0,05

seeds regression

Dataset	1	2
Sample num.	12	12
Average	7887	7744
St. deviation	5403	5169
t	**0,07**	
degrees of freedom	**22**	
P (significance level)	**0,95**	

the difference between the observed means is not significant due p<0,05

2nd regrowth of 2010

ovules regression

Dataset	1	2
Sample num.	9	9
Average	385	394
St. deviation	375	376
t	**0,05**	
degrees of freedom	**16**	
P (significance level)	**0,96**	

the difference between the observed means is not significant due p<0,05

seeds regression

Dataset	1	2
Sample num.	9	9
Average	256	21
St. deviation	258	20
t	**2,73**	
degrees of freedom	**16**	
P (significance level)	**0,01**	

the difference between the observed means is significant due p<0,05

Trifolium pratense

1st regrowth of 2009

ovules regression

Dataset	1	2
Sample num.	11	11
Average	1339	2837
St. deviation	1436	3048
t	**1,47**	
degrees of freedom	**20**	
P (significance level)	**0,16**	

the difference between the observed means is not significant due p<0,05

seeds regression

Dataset	1	2
Sample num.	11	11
Average	751	661
St. deviation	868	711
t	**0,27**	
degrees of freedom	**20**	
P (significance level)	**0,79**	

the difference between the observed means is not significant due p<0,05

2nd regrowth of 2010

ovules regression

Dataset	1	2
Sample num.	12	12
Average	583	636
St. deviation	666	736
t	**0,19**	
degrees of freedom	**22**	
P (significance level)	**0,85**	

the difference between the observed means is not significant due p<0,05

seeds regression

Dataset	1	2
Sample num.	11	12
Average	350	426
St. deviation	414	497
t	**0,40**	
degrees of freedom	**21**	
P (significance level)	**0,69**	

the difference between the observed means is not significant due p<0,05

Fig. 14: results of statistical method of "T of student".

Below there is a table (Fig. 15) that summarizes the specific regression formulas for each cut and those average calculated. In the table, the formulas that are written in italics are significantly different from mean reversion regressions for P <0.05 calculated with the "student t".

		Ajuga reptans	**Anthoxanthum odoratum**	**Arrhenatherum elatius**
09_I	ovuli	y = 2,4819x0,9043	y = 8,3669x0,5522	y = 0,0011x2 + 0,1237x
	semi	y = 1,6742x0,9043	y = 8,2468x0,5522	y= 0,0066x1,7154
09_II	ovuli			y = 0,0067x1,7033
	semi			y = 0,0063x1,7033
10_I	ovuli	y = 5,9159x0,7681	y = -0,0038x2 + 1,6809x	y = 0,0035x2 - 0,2292x
	semi	y = 5,4278x0,7681	y = -0,0033x2 + 1,4737x	y = 0,0032x2 - 0,2122x
10_II	ovuli			y = 0,0007x2 + 0,1459x
	semi			y = 0,0005x2 + 0,1045x
media	ovuli	y = 2,6809x0,9005	y = 2,8074x0,8377	y = 0,0034x1,8851
	semi	y = 2,219x0,9042	y = 1,8167x0,9376	y = 0,0022x1,9564

		Avenula pubescens	**Brachypodium pinnatum**	**Dactylis glomerata**
09_I	ovuli	y = 0,7895x0,8606	*y = 14,191x0,4039*	y = 4,1386x - 12,135
	semi	y = 0,5437x0,8606	*y = 11,279x0,4039*	y = 2,5746x - 7,549
09_II	ovuli			
	semi			
10_I	ovuli	y = 0,0011x2 + 0,3333x	y = -0,0028x2 + 1,0132x	y = 0,0069x2 + 4,4622x
	semi	y = 0,001x2 + 0,3x	y = -0,0022x2 + 0,8053x	y = 0,0038x2 + 2,4374x
10_II	ovuli			
	semi			
media	ovuli	y = 0,5558x0,9461	y = -0,0045x2 + 1,3196x	y = 0,0128x2 + 3,5821x
	semi	y = 0,3768x0,9775	y = -0,0036x2 + 1,0488x	y = 0,0052x2 + 2,2223x

		Festuca pratensis	**Festuca rupicola**	**Lotus corniculatus**
09_I	ovuli	y = 2,4176x0,7657	y = 2,6815x - 140,4	*y = 0,0207x2 + 0,1078x*
	semi	y = 1,3216x0,7657	y = 0,6561x - 34,353	y = 0,0099x2 + 0,3113x
09_II	ovuli			
	semi			
10_I	ovuli	*y = 0,3566x1,1532*	y = 0,0024x2 + 1,2882x	
	semi	y = 0,2232x1,1532	y = 0,0009x2 + 0,4966x	
10_II	ovuli			*y = 0,0155x2 + 0,5378x*
	semi			y = 0,0144x2 + 0,5019x
media	ovuli	y = -0,0002x2 + 0,804x	y = 0,0057x2 + 0,8574x	y = 0,0062x2 + 0,591x
	semi	y = -0,0002x2 + 0,4905x	y = 6,3933x0,4177	y = 0,0034x2 + 0,5982x

		Myosotis sylvatica	**Onobrychis viciifolia**	**Plantago lanceolata**
09_I	ovuli	*y = 0,154x + 7,7665*	y = 9,2334x0,4201	y = -0,112x2 + 12,608x
	semi	y = 0,1511x + 7,3427	y = 3,0741x0,4476	y = -0,0278x2 + 3,1343x
09_II	ovuli		y = 0,6207x0,8211	
	semi		y = 1,2865x0,8211	
10_I	ovuli	*y = 0,5311x*	y = 3,2438x0,5966	
	semi	*y = 0,3014x*	y = 0,6245x0,5966	
10_II	ovuli		y = 4,3973x0,5124	y = 8,2179x0,9023
	semi		y = 2,0667x0,5124	*y = 6,2547x0,9023*
media	ovuli	y = -0,0017x2 + 0,5116x	y = -0,0025x2 + 0,8255x	y = -0,0371x2 + 8,9959x
	semi	y = -0,0008x2 + 0,3321x	y = -0,0005x2 + 0,2612x	y = 22,442x0,3799

		Poa pratensis	Ranunculus acris	Rhinanthus freynii
09_I	ovuli	y = 2,8589x1,0596	*y = -1,7429x2 + 13,46x*	y = -0,0103x2 + 3,7054x
	semi	y = 1,8464x1,0596	y = -1,5251x2 + 10,904x	y = -0,0077x2 + 2,7889x
09_II	ovuli			
	semi			
10_I	ovuli	y = 0,0105x2,2322	*y = -0,0525x2 + 2,4555x*	y = -0,005x2 + 2,6932x
	semi	y = 0,0192x2,2322	y = -0,0432x2 + 2,0085x	y = -0,0019x2 + 1,0455x
10_II	ovuli			
	semi			
media	ovuli	y = 0,0423x2 + 1,2367x	y = 23,352x0,0268	y = -0,0093x2 + 3,3476x
	semi	y = 0,02x2 + 1,0423x	NO REGRESSIONE	y = 10,11x0,5346

		Salvia pratensis	Trisetum flavescens	Trifolium pratense
09_I	ovuli	y = 6,7581x0,711	y = 0,0234x2,0282	y = 20,708x0,5031
	semi	y = 5,145x0,711	y = 0,0193x2,0282	y = 10,162x0,5031
09_II	ovuli	*y = 1,0031x1,024*	y = 0,6568x1,0408	
	semi	*y = 0,7637x1,024*	y = 0,554x1,0408	
10_I	ovuli	y = 6,2056x0,7075	y = 0,0155x2 + 0,4899x	
	semi	y = 5,0648x0,7075	y = 0,0151x2 + 0,4794x	
10_II	ovuli	y = 0,0001x2 + 1,1821x	y = 0,4169x1,202	y = 5,6679x1,2161
	semi	*y = 0,0001x2 + 0,8999x*	*y = 0,0222x1,202*	y = 2,2124x1,5028
media	ovuli	y = 1,8842x0,9332	y = 0,0094x2,1595	y = 12,178x0,7599
	semi	y = 1,3305x0,9537	y = 0,0263x2 - 0,7406x	y = 10,221x0,5753

Fig. 15: specific regression formulas for each cut and those average calculated.

3.3 COMPARED FOR EACH SPECIES IN DIFFERENT CUTS AND YEARS

With the aid of charts and graphs, have been comparing the values of the inflorescence length, number of eggs, and density of eggs on the fertile stem for the different cuts. These comparisons, are made to understand, if for different species, the relation between length of inflorescence and number of products ovules, is more or less constant through different years and different cuts period. Is possible note if a species production is more affected by climatic conditions of the year, or if a specie is more affected by the cut period, (an extreme example are no reheading species). This analysis allows us to understand which species were more predictable than other on the seed production.

As a comparison value is used number of ovules, because respect to the seeds, is less affected by stochastic factor, and report more accurately the potential of the plant.

To describe the behavior of species, begin with the grasses, we know that the density of fertile stems per square meter, is affected by the temperature of the previous year, because are the weather conditions of the previous year that affect the tillering, therefore for that species only watch the weather patterns of this year, may lead to wrong conclusions.

We know and will consider, that at ecological level the interactions are more complicate than we can analyze to create a "operational work system ".

Arrhenatherum elatius

In the following table (Fig. 16), are reported all the datas obtained by application of regression, biometric measures and calculated values of *Arrhenatherum elatius*,

year	2009		2010	
cut period	I	II	I	II
Average length of inflorescence	132,5	92,5	139,0	72,5
n° ovules/m2	4119	1130	6527	520
n° fertile stems / m^2	119	72	150	36
n° ovules/fertile stems	34	16	43	15
ovules density on fertile stem	0,26	0,17	0,31	0,20
n° seeds/fertile stem	28,0	14,9	32,6	10,5
seeds density on fertile stem	0,21	0,16	0,23	0,14
inverse of the density [mm / N° of seeds]	4,7	6,2	4 ,3	6,9

These is the species that gives its name to the type of lawn and is always present. On average, the inflorescences are long half in the second cut than the first, instead the number of ovules per square meter, is also 10 times less in the second harvest compared to the first. This means that in addition to lowering the number of fertile stems per square meter, it also reduces the density of production per unit length of inflorescence.

Is possible note that on 2010, the first cut producted more than first cut of 2009, but the second cut produced less than second cut of 2009, this observation is based on ovules production per square meter.

the percentage of production between the two cuts is on average: 86% of production in the first cut, and 14% in the second cut, the percentage of production into the year can fluctuate with a standard deviation of 10%. To collect the seeds of this species, it is better to intervene in the first cut.

Trisetum flavescens

In the following table (Fig. 17), you can see report all datas obtained by application of regression, biometric measures and calculated values of *Trisetum flavescens*,

year	2009		2010	
cut period	I	II	I	II
Average length of inflorescence	92,0	51,7	92,5	45,7
n° fertile stems / m^2	45,9	10,4	44,7	7,1
n° ovules/m2	11109	351	7909	296
n° of ovules / fertile stem	242	34	177	42
n° seeds / m2	9353	351,3	7744	15,7
seeds/ fertile stem	96,1	33,7	185,1	2,2
inverse of the density [mm / N° of seeds]	1,0	0,7	2 ,0	0,049

It is the second reheading grass, thus present in both cuts, that over the years seems to maintain a very constant inflorescence length and number of fertile stems per square meter, with 45 fertile stems at first cut and 10 at the second. Between 2009 and 2010, instead, also if inflorescence length and number of fertile stems per square meter remain constant, it changes a lot the density of ovules in the fertile stem.

With these values you can think that it might depend on the weather, that if very similar in the fall, allow a similar tillering, but if the following spring there were different weather conditions have favored the production of a year than the other. the percentage of production between the two cuts is on average: 97% of production in the first cut, and 3% in the second cut, the percentage of production into the year is practically constant over the years, with a standard deviation of 0,38%.

Unlike many other species, it showed a slightly better production in 2009. To collect the seeds of this species, it is better to intervene in the first cut.

Other species:

About the other species (unlike the grass which is a family with flowers very similar to each other), the kind of inflorescence and the type of biometrics measures can be very different each other.

Achillea millefolium

In the following table (Fig. 18), I report all datas obtained by application of regression, biometric measures and calculated values of *Achillea millefolium,*

year	2009		2010	
cut period	I	II	I	II
total n° heads /m2	65	198	7	166
n° fertile stem /m^2	6	19	1	12
n° ovules/m2	1187	3608	10	2898
n° ovules/fertile stems	190	195	17	252
ovules /head	18	18	1	17
n° seeds / m2	703	1963	70	2047
seeds/ fertile stem	112	106	120	178
n° seeds / head	11	10	10	12
heads / fertile stem	10	11	12	14

There is much difference in production between the first and second cut from 3 to 15 times in favor of the seconds cuts. This species find more space and resources in the second harvest period, this is probability due to the strong drop of grasses competition. The value that shows an important change is the number of fertile stem per square meter. The percentage of production between the two cuts is on average: 13% of production in the first cut, and 87% in the second cut. In order to collect seeds of this specie, you must intervene in the second cut of the year. For this species we are unable to make observations about the change in density of the seed on single fertile stem, because there are not available the regressions for each single cut. Also for the second cut of 2009 was used the regression of the first cut 2009, the same for the 2010.

Galium mollugo

In the following table (Fig. 19), I report the datas obtained by application of regression, biometric measures and calculated values of *Galium mollugo*,

year	2009		2010	
cut period	I	II	I	II
n°fertile stem /m ^{2}	4	71	23	49
Average length of inflorescence	69	110	15	118
n°ovules/m2	1838	9885	589	5863
density of ovules on fertile stem	6	1	2	1
n°seeds / m2	850	4574	307	3058
n°seeds/ fertile stem	193	64	13	63

Data from the first cut of 2009, appear to be a little abnormal compared to the other three. Specie present in all cuts, but most productive in the second cut of the year, almost 6 times compared to the first cut, the percentage of production between the two cuts is on average: 12% of production in the first cut, and 88% in the second cut, the percentage of production into the year fluctuate with a standard deviation of 5%. That value is due by a high number of fertile stem per square meter and a greater length of inflorescence. But there is a countertrend value that is the density of ovules on the fertile stem, that is greater in the first cut of the year than than the second cut of the year.

Galium verum

In the following table (Fig. 20), you can note all datas obtained by application of regression, biometric measures and calculated values of *Galium verum*,

year	2009		2010	
cut period	I	II	I	II
n°fertile stem /m ^{2}	1	5	7	12
n°ovules/m2	295	1553	119	1972
density of ovules on fertile stem	393	316	17	161
n°seeds / m2	136	717	27	437
n°seeds/ fertile stem	393	146	4	36
Average length of inflorescence	109	72	13	114

It presents the same behavior of *Galium mollug*, but with a lower production, due to a lower density of fertile stems, and lower production of seed per square meter. Also for this specie in order to collect the seed the second cut of the year is better.

Knautia arvensis

In the following table (Fig. 21), I report all datas obtained by application of regression, biometric measures and calculated values of *Knautia arvensis*,

year	2009		2010	
cut period	I	II	I	II
n°fertile stem /m ^{2}		8		24
n°ovules / m2		1642		4533
n°seeds / m2		607		1689
n°seeds / fertile stem		95		70
n°head / m2		32	2	77

Species found almost exclusively in the second cut, because absent in the first cut in 2009, and present in the first cut of 2010, with just 2 heads to m^2. The year 2010 must have been very favorable for this species, as it has nearly tripled the seed production, about the density of ovules on head, we can't do a consideration because to do the calculations was used the same regression formula, that generated by second cut 2010.

Exclude that this large gap between the second cut 2009 and the second cut 2010, is due to poor ability to observation because it is a species easy to investigate.

Leontodon hispidus

In the following table (Fig. 22), I report all datas obtained by application of regression, biometric measures and calculated values of *Leontodon hispidus*,

year	2009		2010	
cut period	I	II	I	II
n°fertile stem /m ^{2}	2	1	3	2
n°ovules / m2	121	114	87	101
density of ovules on fertile stem	81	81	26	55
n°seeds / m2	62	58	45	98
n°seeds / fertile stem	41	41	13	54

Species with few specimens per square meter, but with a constant presence, of 2 or 3 per square meter. The few data available, give us a quite constant situation through different cuts period. Even if slightly favorable the cut to operate in order to collect the seeds is the second of the year.

Lotus corniculatus

In the following table (Fig. 23), I report all datas obtained by application of regression, biometric measures and calculated values of *Lotus corniculatus*,

year	2009		2010	
cut period	I	II	I	II
n°fertile stem /m ^{2}	2	50	6	81
n°ovules / m2	428	31721	1012	20056
density of ovules on fertile stem	233	641	184	248
n°seeds / m2	89	7109	167	5278
n°seeds / fertile stem	70	144	30	65
Average length of the pod	20	22	17	17
st. dev of pod length	7	21	6	4
density of ovules per mm of pod	2,51	2,37	3,30	3,08

Specie always present in the meadow, with few fertile stem in the first cut, in mean the 97% of the ovules production is concentrate in the second cut period, fairly constant value with a standard deviation of 2,5%.

In 2010 despite a 40% increase in production of fertile stem per square meter, there was still a 35% decrease in seed production. Drop of production, may be due to a decrease of pods's length. the decrease is about of 20% between the firsts cuts and of 30% between the seconds cuts.

During the same year, the lengths of the pods remain constant, for this we can assume that the weather condition influence both number of fertile stems per square meter, both the length of pod and also the density of ovules inside the pod.

Peak production occurred in the second cut of 2009, where there wasn't the largest number of fertile stem per square meter, but there was the greater average length of pods, equal to 22 mm.

Lychnis flos-cuculi

In the following table (Fig. 24), you can observe all datas obtained by application of regression, biometric measures and calculated values of *Lychnis flos-cuculi*,

year	2009		2010	
cut period	I	II	I	II
n°fertile stem /m ^{2}	0	0,5	0,3	9,3
average of flowers per fertile stem		4,7	4	3,9

Almost not at all represented during the spring regrowth, in this field we have 10 fertile stem per square meter, the average number of flowers on fertile stem remains very constant, between 4 and 5 flowers per fertile stem.

When developing less fertile stem, they produce each on average more flowers until 4,7. While in the second cut of 2010, where there was the maximum density of fertile stems per square meter, each fertile stem on average produced 3,9 flowers.

Medicago lupulina

In the following table (Fig. 25), I report all datas obtained by application of regression, biometric measures and calculated values of *Medicago lupulina*,

year	2009		2010	
cut period	I	II	I	II
n° fertile stem /m ^{2}	7	5	26	25
n° ovules / m2	881	798	2133	2272
density of ovules on fertile stem	120	174	84	89
n° seeds / m2	369	334	1240	1321
n° seeds / fertile stem	50	73	49	52
average length of total raceme per fertile stem	15	31	24	26
density of seeds on raceme	3	2	2	2

For this species the year 2010 was most favourable, by averaging of the same years, there is from 2009 to 2010 a increase of 77% of n° fertile stem /m2, an increase of 62% of n° ovules / m2, an increase of 73% of n° seeds / m2, a decrease of n° seeds / fertile stem of 23%, the more the production increases, the more the number of seeds per fertile stem decreasing.

It is a specie always well represented in both cuts, even if it has a slightly greater presence in the first cut. It was calculated the total length of racemes for each fertile stem and averaged for each cut, datas show that while in 2010 the values are constant, in 2009 there is a wide swing. Since it is a small species, with regard to the first cut of 2009, you can think that the cause may be lack of experience of investigation.

Onobrychis viciifolia

In the following table (Fig. 26), I show all the datas obtained by application of regression, biometric measures and calculated values of *Onobrychis viciifolia*,

year	2009		2010	
cut period	I	II	I	II
n° fertile stem /m ^{2}	5	10	16	6
n° ovules / m2	446	471	1012	262
density of ovules on fertile stem	85	47	64	46
density of ovules on raceme	0,9	0,6	0,6	0,6
n° seeds / m2	126	227	514	123
n° seeds / fertile stem	21	23	30	22
average length of total raceme per fertile stem	92	79	107	76
density of seeds on raceme	0,2	0,3	0,3	0,3

This specie seems to have no strong relation of production between cuts and years, it is always present on the meadow, but with a so short series of data, it is difficult to say which is the best cutting period in order to collect this specie. But you can note, that on the first cuts, there is a greater length of raceme for each fertile stem. this value allows in the first cut of 2009 a production a high amount of ovules per square meter.

Looking the number of fertile stems per square meter, also for this specie the weather conditions of the 2010, were more favourable compared to 2009.

The only value that remains more or less constant is the density of ovules per unit length of raceme and of consequence the number of seeds per unit length of raceme.

Pimpinella major

Below (Fig. 27), you note all datas obtained by application of regression, biometric measures and calculated values of *Pimpinella major*,

year	2009		2010	
cut period	I	II	I	II
n°fertile stem /m ^{2}		0,8		1,8
n°ovules / m2		143		1844
density of ovules on fertile stem		172		1054
n°seeds / m2		60		1560
n°seeds / fertile stem		72		892
average n. of umbel simple per fertile stem		50		80

Species present only in the second cut of the year, looking almost all parameters: number of fertile stems per square meter, number of ovules per square meter, density of ovules on fertile stem, number of seeds per square meter, number of seeds per fertile stem and number of umbel simple per fertile stem, all these factors show that there was a production of 26 times higher in 2010 than in 2009. It is maybe due to the weather condition of the 2010,that were favourable compared to 2009. Of 12 points on the field where the data were collected, on 2009 this species was found only in one plot, while in 2010 it was detected in 7 plots.

Plantago lanceolata

You can find below (Fig. 28), all datas obtained by application of regression, biometric measures and calculated values of *Plantago lanceolata*,

year	2009		2010	
cut period	I	II	I	II
n°fertile stem /m ^{2}	5	52	1	29
n°ovules / m2	712	7047	84	2339
density of ovules on fertile stem	147	135	101	82
n°seeds / m2	318	3149	64	1780
n°seeds / fertile stem	61	60	77	62
average length of inflorescence	13	12	17	13
density of seeds in unit length of inflorescence	4,6	5,2	4,7	4,8

This species is more productive during the second cut of the year, probably due to the lack of competing of the reheading species, the seed production for each fertile stem seems to be very constant over time. You notice a trend, that at higher density of fertile stems per square meter (1; 5; 29; 52), the length of the inflorescence decreases (17; 13; 13; 12).

A very important value because of its consistency over time is the density of seeds in unit length of inflorescence: for every millimetre of inflorescence 4.8 seeds are produced, this value can be safely used to do a rapidly regression.

Ranunculus acris

All datas obtained by application of regression, biometric measures and calculated values of *Ranunculus acris* are reported (Fig. 29).

year	2009		2010	
cut period	I	II	I	II
n°ff / m2	3	1	11	3
n°ovuli/m,2	514	307	1660	210
density of ovules on fertile stem (n°. of ovules pe r mm)	150	217	149	84
n°semi / m2	421	252	1362	173
n°semi / FF (n°. of seeds per mm)	178	178	122	69
media fiori /ff	6,1	8,8	6,0	3,4

This species is not evenly spread across the lawn and it is more present during the first regrowth. For Ranunculus acris 2010 was more favorable than the previous year, but as we have already had occasion to note for other species, in the second cut of 2010 the production was slightly lower than in the second cut of 2009. This is not noticeable by the number of fertile stems per square meter, but from the production of eggs and consequently of seeds per square meter. Looking at the data, however, we can say that the decline in the second cut of 2010 is due to drastic reduction in the number of flowers on fertile stem.

The regression of the first cut of 2009 has been applied to all cuts, to this species.

Salvia pratensis

(Fig. 30) all datas obtained by application of regression, biometric measures and calculated values of *Salvia pratensis* are reported.

year	2009		2010	
cut period	I	II	I	II
n°ff / m2	26	1	37	5
n°ovuli/m,2	4448	27	9524	748
density of ovules on fertile stem (n°. of ovules pe r mm)	168	33	260	155
n°semi / m2	3387	21	7774	105
n°semi / FF (n°. of seeds per mm)	103	25	235	22
media L tot spighe per ff	88	29	194	130
densità (mm of inflorescenze/n°of seeds)	0,9	1,2	0,8	6,0

The species is always present in the lawn but produces 98% of annual production during the first cut. the 2010 was the most productive of 2009 with an increase in production of eggs of 56.4% that is almost the same for the production of seed. This also indicates that the percentage of eggs that fail to reach the stage of seed remains constant over the years, percentage equal to 76%. Since this species for every cut you have available the specific regression, we can see by both the data of density of eggs on fertile stem both by the number of seed on fertile stem as in the first cuts the seed is denser on the inflorescence

Satureja vulgaris

You can find below (Fig. 31), all datas obtained by application of regression, biometric measures and calculated values of *Satureja vulgaris*.

year	2009		2010	
cut period	I	II	I	II
n°ff / m2	2	33	2	17
n°ovuli/m,2	71	2975	105	1007
density of ovules on fertile stem (n°. of ovules pe r mm)	37	91	47	58
n°semi / m2	36	1487	69	662
n°semi / FF (n°. of seeds per mm)	19	46	31	38
n°fi/ ff	9	23	12	15

This specie is always present in the lawn but it produces 95% of annual production during the second cut. The most seed production per square meter, which occurs in the second cuts is due both to increased production of fertile stems per square meter, and to the highest number of flowers per fertil stem. This species didn’t have a real regression because each flower produces always 4 eggs, so is corrected the number of produced eggs, and the more uncertain value is the number of produced seeds.

From observations made it longer make comments on how the species is present in different plots WP4 on which was made the analysis. During the first cuts the species is found only on half of the plots, while in the seconds cuts, where the species has the highest production, the specie covers more or less uniform across the lawn.

Trifolium pratense

In the following table (Fig. 32), I show all the datas obtained by application of regression, biometric measures and calculated values of *Trifolium pratense*.

year	2009		2010	
cut period	I	II	I	II
n°ff / m2	20	20	10	9
n°ovuli/m,2	2600	3161	765	636
density of ovules on fertile stem FF (n°. of ovules per mm)	131	155	78	73
n°semi / m2	606	738	539	426
n°semi / FF (n°. of seeds per mm)	35	36	55	49
media somma L infiorescenza	8,2	9,1	8,8	8,6
N°fi ogni mm di infiorescienza	4,2	4,0	6,2	5,7

The species is present in both the cuts and across year you can observe a slight difference in production between the first and second cut. This observation can be made only by the values of the number of fertile stems per square meter but not by the number of eggs or seeds produced, for the two cuts of 2009 it was used the same regression calculated with the values of the first cut. The same regression, I apply for 2010 for which it was used the values of the second cut.

Comparing the different years, for this species, 2009 was more productive, in terms of fertile stems per square meter. In parallel we note that in 2010 produced inflorescences more dense, with an increase of 44% compared to 2009.

A value that appears to remain constant is the average of the sum of the lengths of inflorescences per fertile stem.

Trifolium repens

You can find below (Fig. 33), all datas obtained by application of regression, biometric measures and calculated values of *Trifolium repens*.

year	2009		2010	
cut period	I	II	I	II
n°ff / m2		9	1	3
n°ovuli/m,2		1776	154	511
density of ovules on fertile stem (n°. of ovules pe r mm)		199	263	180
n°semi / m2		313	75	187
n°semi / FF (n°. of seeds per mm)		35	129	66
L media racemo		4,8	6,0	4,4
x seme ogni mm di racemo		7	22	15

The species is always present in the lawn even if it wasn't found in the first cut of 2009. Looking at the number of fertile stems per square meter, there is a greater output in the second cut. In the first cut the length of the racemate has an increase of a third, moreover the inflorescence of the first cut is also more dense of seed.
A value that does not appears very constant is the distribution in the meadow. Among the 12 plots of observation, it is hardly found in the first cut of 2009, and present on 9 plots in the second cut of 2009, and in 2010 was observed respectively on 1 and 7 plots.

3.3.1. general observations on the behavior of grasslands essences

From the observations made it can be seen that for different species, Arrhenatherum elatius, Achillea millefolium, Galium verum, Onobrychis viciifolia, Ranunculus acris, while in 2009 the values were close to each other, the first cut in 2010 was more productive than the same in 2009 and the second was less than the second in 2009.
In fact, the drop in seed production by the grass between first and second cut is equal to about one quarter in 2009, while about half in 2010.
Having studied the species of the second cut of 2010, most of those analyzed have the highest production during the second cut (*Achillea millefolium, Galium mollugo, Galium verum, Knautia arvensis, Leontodon hispidus, Lotus corniculatus, Lychnis flos-cuckoos , Pimpinella major, Plantago lanceolata, Satureja vulgaris, Trifolium repens*), because most of the production of the first cut, is given by Poaceae, which mostly does not reconstruct fertile stems in the second cut.
As for the difference in production between one year and the other, 9 of the analyzed species (*Trisetum flavescens, Achillea millefolium, Galium mollugo, Galium verum, Leontodon hispidus, Lotus corniculatus, Plantago lanceolata, Satureja vulgaris, Trifolium pratense*) had a higher yield in 2009 and 8 (*Arrhenatherum elatius, Knautia arvensis, Lychnis flos-cuckoos, Medicago lupulina, Onobrychis viciifolia, Pimpinella major, Ranunculus acris, Salvia pratensis*) had a higher production in 2010.
There aren't species that show over the different cuting periods, a particular constancy in growth or in the production, but certainly most of all is the value of the length of the inflorescence of Poaceae, which is very constant between the first and second cuts each year.
A species that has a certain constant is Ranunculus acris: taking into account that we have for this specie the regression of both the first cuts of the two years, you will notice that each fertile stem produces a value very consistent in ova. About Salvia pratensis, however, that there are all four regressions, we observe that the species seem very consistent in the

production of fertile stems per square meter, though then there isn't a constant on the production of seed.

3.4. ESTIMATE OF THE REAL SEED PRODUCTION REFER TO A SPECIFIC DATE

From the graphs obtained with the study of the phenological analysis, we can see that the inflorescences, simple or composed of different species, do not produce the seed so concentrated in a time, but they have a gradual maturation. This means that each species of grass has a longer or shorter period during which it continues to spread. Applying the formula of regression on the length of the inflorescence gives the total production of seed throughout the period of cutting, since, as just mentioned, the length of the inflorescence matures and spreads in a period of shorter or longer time.

In order to know the real value of production of seed for a species or the entire lawn in a particular date, you must cross the result obtained by the use of regression with the percentages obtained from the study of the phenological analysis.

For the 18 species previously considered in the regression study, below (Fig. 34) I show the values of the number of seeds produced by each species at the time of the cut, which therefore correspond to the real production that there was really available for collection.

Achillea millefolium	2009		2010	
	I	II	I	II
%fenology	0	0	0	0
n° seed by regression	646	1963	7	2047
n° seeds at cutting time	0,0	0,0	0	0,0

Ajuga reptans	2009		2010	
	I	II	I	II
%fenology	2,5		0	
n° seed by regression	50		49	
n° seeds at cutting time	1,3	0,0	0	0,0

Anthoxanthum odoratum	2009		2010	
	I	II	I	II
%fenology	39,7		24	
n° seed by regression	235		629	
n° seeds at cutting time	93,4	0,0	151	0,0

Arrhenatherum elatius	2009		2010	
	I	II	I	II
%fenology	31	77	10	73
n° seed by regression	1213	1062	629	372
n° seeds at cutting time	377,3	818,0	63	270,5

Avenula pubescens	2009		2010	
	I	II	I	II
%fenology	16		40	
n° seed by regression	423		1107	
n° seeds at cutting time	68,5	0,0	443	0,0

Brachypodium pinnatum	2009		2010	
	I	II	I	II
%fenology	71		0	
n° seed by regression	1034		1574	
n° seeds at cutting time	737,0	0,0	0	0,0

Carex contigua	2009		2010	
	I	II	I	II
%fenology	100		0	
n° seed by regression	3		5	
n° seeds at cutting time	3,3	0,0	0	0,0

Centaurea nigrescens	2009		2010	
	I	II	I	II
%fenology		0		
n° seed by regression		10,8		
n° seeds at cutting time	0,0	0,0	0	0,0

Cerastium fontanum	2009		2010	
	I	II	I	II
%fenology			50	
n°seed by regression			844	
n°seeds at cutting time	0,0	0,0	421,75	0,0

Crepis biennis	2009		2010	
	I	II	I	II
%fenology	0		50	
n°seed by regression	365		45	
n°seeds at cutting time	0,0	0,0	23	0,0

Dactylis glomerata	2009		2010	
	I	II	I	II
%fenology	75		0	
n°seed by regression	1437		1584	
n°seeds at cutting time	1080	0,0	0	0,0

Festuca pratensis	2009		2010	
	I	II	I	II
%fenology	80		0	
n°seed by regression	378		1080	
n°seeds at cutting time	303,0	0,0	0	0,0

Festuca rupicola	2009		2010	
	I	II	I	II
%fenology	85		50	
n°seed by regression	48		50	
n°seeds at cutting time	40,9	0,0	25	0,0

Galium mollugo	2009		2010	
	I	II	I	II
%fenology	0	99	5	24
n°seed by regression	850	4574	307	3058
n°seeds at cutting time	0,0	4529	15	725

Galium verum	2009		2010	
	I	II	I	II
%fenology	0	70	0	32
n°seed by regression	136	717	27	437
n°seeds at cutting time	0,0	502	0	141

Holcus lanatus	2009		2010	
	I	II	I	II
%fenology		90		
n°seed by regression		114		
n°seeds at cutting time	0,0	103	0	0,0

Knautia arvensis	2009		2010	
	I	II	I	II
%fenology		1,25		11
n°seed by regression		607		1689
n°seeds at cutting time	0,0	7,6	0	192

Lathyrus pratensis	2009		2010	
	I	II	I	II
%fenology	0	0		
n°seed by regression	4	6,125	0	
n°seeds at cutting time	0,0	0,0	0	0,0

Leontodon hispidus	2009		2010	
	I	II	I	II
%fenology	30	20	50	34
n°seed by regression	62	58	45	98
n°seeds at cutting time	18,5	12	22	33

Leucanthemum vulgare	2009		2010	
	I	II	I	II
%fenology	0		0	
n°seed by regression	294		491	
n°seeds at cutting time	0,0	0,0	0	0,0

Lotus corniculatus	2009		2010	
	I	II	I	II
%fenology	72	68	15	79
n°seed by regression	89	6945	167	5278
n°seeds at cutting time	63,9	4722	25	4170

Medicago lupulina	2009		2010	
	I	II	I	II
%fenology	20	18	4	23
n°seed by regression	369	334	1240	1321
n°seeds at cutting time	75,0	60,2	50	299

Myosotis sylvatica	2009		2010	
	I	II	I	II
%fenology	45		27	
n°seed by regression	11		514	
n°seeds at cutting time	5,0	0,0	139	0,0

Onobrychis viciifolia	2009		2010	
	I	II	I	II
%fenology	53	22	17	45
n°seed by regression	126	227	476	123
n°seeds at cutting time	66,2	48,8	81	55,4

Pimpinella major	2009		2010	
	I	II	I	II
%fenology		37		
n°seed by regression		60		
n°seeds at cutting time	0,0	22	0	0,0

Plantago lanceolata	2009		2010	
	I	II	I	II
%fenology	23	76	47	63
n°seed by regression	318	3149	64	173
n°seeds at cutting time	72,9	2393	30	109,5

Poa pratensis	2009		2010	
	I	II	I	II
%fenology	47		45	
n°seed by regression	2457		6512	
n°seeds at cutting time	1165,5	0,0	2931	0,0

Ranunculus acris	2009		2010	
	I	II	I	II
%fenology	26	9	23	4
n°seed by regression	421	252	1362	173
n°seeds at cutting time	108,8	23,7	311	6,6

Rhinanthus freynii	2009		2010	
	I	II	I	II
%fenology	25		0	
n°seed by regression	8522		2963	
n°seeds at cutting time	2128,6	0,0	0	0,0

Rumex acetosa	2009		2010	
	I	II	I	II
%fenology	0		5	
n°seed by regression	265		60	
n°seeds at cutting time	0,0	0,0	3	0,0

Salvia pratensis	2009		2010	
	I	II	I	II
%fenology	45	88	30	11
n°seed by regression	3387	21	7774	105
n°seeds at cutting time	1515	18	2332	11,0

Sanguisorba minor	2009		2010	
	I	II	I	II
%fenology	41	0	0	
n°seed by regression	7	6	10	
n°seeds at cutting time	2,7	0,0	0	0,0

Satureja vulgaris	2009		2010	
	I	II	I	II
%fenology	0	71,5	0	13
n°seed by regression	36	1487	69	662
n°seeds at cutting time	0,0	1063	0	83

Taraxacum officinale	2009		2010	
	I	II	I	II
%fenology	0			
n°seed by regression	8			
n°seeds at cutting time	0,0	0,0	0	0,0

Tragopogon pratense	2009		2010	
	I	II	I	II
%fenology	0		31	
n°seed by regression	45		29	
n°seeds at cutting time	0,0	0,0	9	0,0

Trifolium campestre	2009		2010	
	I	II	I	II
%fenology	89	0	14	
n°seed by regression	234	52	69	
n°seeds at cutting time	208,0	0,0	10	0,0

Trisetum flavescens	2009		2010	
	I	II	I	II
%fenology	33	40	0	77
n°seed by regression	9353	351	7744	16
n°seeds at cutting time	3040	140,5	0	12,1

Trifolium pratense	2009		2010	
	I	II	I	II
%fenology	59	96	0	56
n°seed by regression	606	738	539	426
n°seeds at cutting time	357,0	709	0	240,8

Trifolium repens	2009		2010	
	I	II	I	II
%fenology		0	0	97
n°seed by regression		313	75	187
n°seeds at cutting time	0,0	0,0	0	181

Veronica chamaedrys	2009		2010	
	I	II	I	II
%fenology	50		0	
n°seed by regression	36		1902	
n°seeds at cutting time	18,0	0,0	0	0,0

Vicia cracca	2009		2010	
	I	II	I	II
%fenology	0	0		
n°seed by regression	2	24		
n°seeds at cutting time	0,0	0,0	0	0,0

Fig. 34: calculations needed to obtain number of seeds produced by each species at the time of the cut

By the graphs that we have already reported with the data of phenological analysis, you can not understand when the species reach their peak of productivity, whereby it is necessary to represent data in a high way. In the following charts (Fig. 35) you can see the permanence of the phenophase over second cut of 2010 (thick lines) using as reference the thermic sum. In the graphs you can also see the comparison with the same cut of the previous year (thin lines), so you can see the similarity of trend with the same amount of thermal sum.

The graphs show the two Poaceae in the course of the second cut and 4 species more productive of the other families, for a total of 74% of egg production of the second cut 2010.

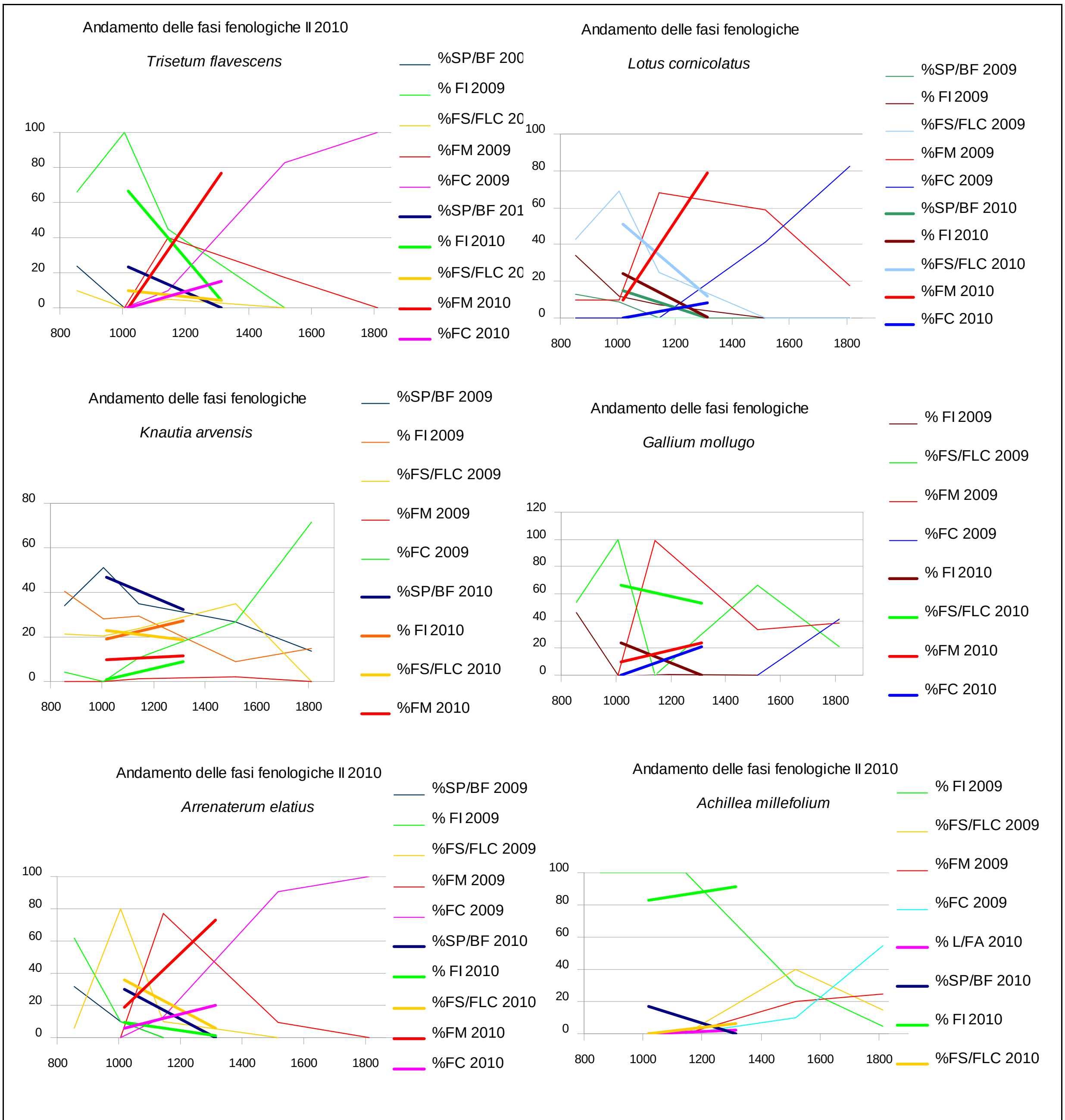


Fig. 35: permanence of the phenophase over second cut of 2010 (thick lines) and second cut of 2009 (thin lines).

Considering that in the second cut 2010, only two phenological surveys were made on 19th July and on 2nd August, while for the second cut in 2009 they were done 5 from July 16th to August 26th, you may notice a good overlap of data for each phenophase inside common time interval (total heat). This confirms both the excellent capacity of the thermal sum as a reference measure for the different years, and the assumption that by using the thermal sum with one or two phenological surveys you can use the same lawn as seeds source for several years without the repetition of the entire process of study, but based on data obtained during the phenological study.

4. CONCLUSIONS

The maximum production of meadow seed, takes place during the first cut and it is mainly due to the regrowth of grasses in spring, while the other species contribute only marginally to this production.

To understand how much can be attest the decline in seed production between the two cuts, in respect of the years under examination, we can see that between the first and second cut of 2009 there was a drop in seed production at 34 %, while the decline in production in 2010 was 57%.

The factors that determine the seed production, are:

+ the floristic composition of the meadow, understood as the density of fertile stems of the species: the percentage of presence of species can vary from year to year depending also by the climate, which may encourage some to the detriment of others and determine different productions;

+ the morphological characteristics and production of reproductive organs of different species, or the biometric characteristics of the inflorescence, the number of fertile stems per stalk growing, the number of flowers per fertile stem and the percentage of fertile flowers that produce seed (floret site utilization, FSU).

Another important quality feature is the vitality of the seed, however, in this work was not taken into account.

It 'can be seen that the seed production varies greatly throughout the season and this is the reason why it’s very important to choose the right date of collection. The identification of this optimal time to harvest the seed is interfere by the different phenological rhythms of many species. While taking the proper precautions one can not avoid a loss of product for natural dissemination.

A goal of this paper is to provide a quick method for estimating the number of product seeds, in order to identify the best mix for different purposes. As we have shown, once identified a donor site for a zone, the analysis carried out in the first year can afford to collect the desired mixture for several years, before performing further analysis to confirm an immutate situation over time, or useful to correct estimates in an environment that may have undergone some change.

Another important element is the evolution over the time of the seed production of individual species and the population as a whole. The knowledge of this aspect becomes particularly important when the lawn is cut with the aim of obtaining seed more than the crop. In fact, in consequence of the different phenological rhythm of the various species of the prairie, the quantity, quality and composition of the seed crop may vary greatly depending on the time of intervention.

The useful analysis for the study of the lawn is the study of phenology, which through the use of thermic sum, allows each year to identify the most favorable period for the collection of seed for each species. The advantage of the thermal sum is that by adding the degrees day after day can be predicted even if at short notice, the date of surgery.

The second analysis required to estimate the number of produced seeds is the identification of regressions that appear more influenced by the climate trend. As for the lawn under consideration, having been studied more years, it was possible to detect even if not for all species a mean regression, which is statistically more robust for use in the following years to use in the lawn in question.

The determination of the number of mature seeds present for the various species to the progressive increase of the thermic sum, allow to compared production between different species. This result is important for two reasons:

the choice of composition of mixtures of seed that can be achieved by deciding to cut at different dates according on the different uses that you want to do with the material collected, or to different characteristics of the station of destination for the collected seed.

It helps us to consider another factor in the timing of collection. For example about the estimation of the production of eggs, in the examined cut, the production of the alone 5 most productive species has covered 77% of the total production of the lawn, and the only *Lotus corniculatus* species most production in this cut, has produced by only 44% of the total. This can lead us to understand even for which species it is not necessary to catch at the time of it's maximum production. Disadvantage it, because the harvest of their seed is guaranteed by the large amount of its production, and highlights those species for which due to a lower production, not properly evaluate the collection period, may lead to not collection of the seed produced by these species, which in the study carried out are: *Leontodon hispidus*, *Ranunculus acris*, and *Onobrychis viciifolia*.

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