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Five Years of Phenologic Observations and Agronomic Features of Three Local Poaceae Fodder in North East Algeria

M. Boudelaa, S. Slimani, T.O. Boutebba and [1]S. Boussora
[1]Bovine and Ovine Raising Institute, Fetzara Station, Annaba 23000, Algeria
Plant Biology and Environment Laboratory, Department of Biology, Faculty of Sciences, University Badji Mokhtar, Annaba 23000, Algeria

Abstract: After the prospecting and the harvest of the seeds, a behavioural test was made to put in evidence the different phenologic stages and the notation of some agronomic features as the vigour, the alternativity, the sensitivity to the diseases, the resistance to the cold weather and rainfall, in addition to the faculty of the remontaison of three local graminaceous fodder, *Lolium multiflorum* Lamk, *Festuca arundinacea* Schreb and *Phalaris arundinacea* L. The obtained results show that generally, the three species present a higher germinative faculty in laboratory conditions and good germination (> 70%) in soil. With regard to the phenologic stages, from the lifting until flowering, it was noted that the rye-grass and the tall fescue have a similar chronological evolution. The red canary grass cycle was different as it spends more time to raise and tiller and in spite of that, it flowers one week before the two other species. Otherwise, the notation of the agronomic characters showed that in the montaison stage, the rye-grass was vulnerable to laying down; the tall fescue was less vigorous during the winter especially, in the first year of sowing. The following years, the tall fescue reacted better to the cold weather, the dryness and floods. The red canary grass was slightly sensitive to the rust and oidium diseases. As a whole, these ecotypes seem to have a rather good general rusticity.

Key words: Behaviour, phenology, rusticity, graminaceous fodder, fungal diseases

INTRODUCTION

The knowledge of the local species potentialities requires after the first work of prospecting, the characterization of the vegetable material and consequently the analysis of its variability. This analysis should permit to renew the agricultural potential, creating a genic tank that only the genes banks will be able to perpetuate[1]. In Algeria, several prospecting have been achieved on fodder species and pastoral interest (1975, 1978, 1982, 1988, 1990); the prospecting of 1988 (track by the INRA of Montpellier, the ITGC and the INA of El-Harrach) and that of 1990 (INA and ITGC); The latter were interested to the legumes, but also to the Poaceae perennial as the rye-grass (*Lolium multiflorum* Lamk), the tall fescue (*Festuca arundinacea*.Schreb), the dactyle (*Dactylis Glomerata* L) and the red canary grass (*Phalaris.arundinacea* L). Otherwise, such a study should permit to gather the maximum of data encouraging the introduction of these species into a selection diagram, knowing that the first appeared varieties of graminaceous fodder have been improved from wild ecotypes and some marketed natural populations of other countries[2].

On the other hand, the characterization of these species, *L. multiflorum* Lamk, *F. arundinacea* Schreb and *P. arundinacea* L for future use passes inevitably by a perfected knowledge of the distribution and the repartition of the species material according to the factors of the medium. This type of work has already been achieved on fodder Poaceae of the Festuca species, Lolium and Dactylis[3] and also of the behaviour tests for the determination of phenologic stages and the agronomic notation characters. Many works showed that the plant stage developments during the first use of species were one of the main factors of the fodder nourishing values[4]. Indeed, dice that the stems begin to develop themselves, the proportion of cellulose in tissues increases and the fodder nourishing values decrease quickly. Completed by a summary assessment of the agronomic characteristics, the observation of the development stage of a culture permits to estimate the fodder nourishing value without having resort to chemical analyses.

The present study, however, summarises all observations done during five years on three species. It shows the methods used to describe the plant developmental stages and to enhance the numerous data accumulated concerning local ecotypes.

Corresponding Author: M. Boudelaa, Laboratory of Plant Biology and Environment, Badji Mokhtar University, BP 12, Annaba 23000, Algeria

Table 1: Soil and climatic characters of the studied region

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
P(mm)	102.8	78.7	53.9	45.3	32.1	13.8	2.7	10.3	34.7	71.7	89.4	101.7
T(°C)	10.05	11.5	12.9	15.15	18.10	21.50	23.20	25.25	23.5	19.7	15.7	12.30

Soil texture (%)	Fine sand	Gross sand	Fine clay	Gross clay	Silt
	30	15	13	25	17

Exchangeable cations (meq 100 g^{-1})

Soil mineral Content	N_2 (%)	P_2O_5 (ppm)	K_2O (ppm)	MO (%)	rapport C/N	$CaCO_3$	CEC	Ca	Mg	K	Na	Water pH	Kcl pH
	0.10	20	30	2.5	14.5	0	10	5	4	0.7	0.3	7.3	6.8

P: Precipitation; T: Temperature

Table 2: Notation scales of the phonologic stages and the sensibility to diseases used in this study

Scale of notation of the phonologic stages	Scale of notation of the sensibility to diseases
Raising (90% of plants raise)	No infection (0 %) (No Stains)
Tillering beginning montaison	Some tasks on less (2,5%) of the leaves area
Montaison (Ears go up at 50% of plants)	Stains until (5 %) of the leaves
Beginning epiaison (some visible ears)	Stains until (10%) of the leaves
Full epiaison (50% of plants with ears)	Stains until (25 %) of the leaves
End epiaison (90% of plants with ears)	Attack of (25 %) of the foliar mass
Full flowering (50% of plants bloom)	Beginning of the stem destruction (35 %) of attack
Fruition (50% of plants with fruits)	All plants including the dead stems
Scattering of the seeds	

MATERIALS AND METHODS

Three spontaneous fodder species belonging to the family of the Poaceae were the subject of the actual work. The red canary grass (*P. arundinacea* L) described the first time in Algeria by MAIRE in 1955[5], the rye-grass (*L. multiflorum* Lamk) and of the tall fescue (*F. arundinacea* Schreb) both described by QUEZEL and SANTA, in 1962[6].

The seedling of the three species has been achieved in naked soil to a light depth of 2cm. Every species occupies 4 linear parcels of 2 m each. The distance between the lines was 20 cm and between the parcels was 80 cm. Table 1 gives the main features of the climate and the soil of the survey region. The climate is Mediterranean characterized by a yearly average temperature of 17 °C and a yearly rainfall of 600-800 mm. Soil was made of a balanced texture (sandy-slimy-clay) fairly provided with nitrogen, poor in phosphorus and potassium and presents a good mineralization of the organic matter. Its pH neighbouring the neutrality, does not require any necessity of correction. In the same way the acidity reserve was very weak, which implies no antagonism between the exchangeable cations and ions absorption, resulting in no deficiency of these elements.

The studied parameters were the recognition of the different phenologic stages, from the seedling until the harvest and the notation of some agronomic parameters as the alternativity, vigour, the sensitivity to the diseases, the resistance to the cold weather, laying down of crop by the wind and the aptitude for the remontaison.

For the phenologic stage observations, the notation scale of Gate[7] and Jeangros and Amaudauz[8] were used Table 2. The indication of precocity index represents the period to which starts the epiaison of a Graminaceous and/or Poaceae, or the flowering of a legume. Such stage is characterized by the apparition of 10 ears or flowers by square meter[9]. The sensitivity to the diseases has been noted according to the scale of Mac Intosh and Eveling[10] Table 2.

RESULTS

The phenology, science that studies the periodic phenomenon of the plant life, provides some data for important agronomic research. For us, the study of the periodic phenomenon limits itself exclusively to establish, from the seedling to the harvest, the vegetation date of various phases in days and in the accumulated heat (Sum Temperatures Index (STI), in order to divide the vegetative period into sub-periods. Results are summarised in Table 3.

Germination and seed viabilities: In laboratory conditions, seeds of the three species are viable and presented a good germinative faculty 100%. However, the best germination percentage in the soil has been observed in red canary grass 100%, followed by the tall fescue 78% and the rye-grass 74% Table 3. Thus, statistical analysis showed significant differences between species at $p<0.005$.

Phenologic differences between species: At the Poaceae, the totality of the foliar tissues develops itself from the trilled vegetative point that is situated outside the foliar girdles, surrounding the basis of the stem. The vegetative point gives birth successively and regularly to initial leaves, which lie down to form leaves constituted of a limb

Table 3: Germinative faculty and dates of the main phenologic stages in days and heat accumulated in degree day (Sum temperatures index: Σθ). The duration of the phenologic stage and the calculation of the sum of temperatures index is a function of the date of seedling

	L. multiflorum Lamk	*F. arundinacea Schreb*	*P. arundinacea L*	
Seedling density		940 seeds/m^2 (for the 3 species)		
Number of seeds				
Germinated and raised		615/940	739/940	940/940
Percentage of germination (%)		74%	78.7%	100%
Date of seedling		04/11/1995 (for the 3 species)		
Number of days and degree x day Σθ, (temperatures >0°C)				
Lifting duration	14 d (Σθ, 219°C)	22 d (Σθ, 345°C)	19 d (Σθ, 298°C)	
Tillering duration	29 d (Σθ, 445°C)	29 d (Σθ, 445°C)	50 d (Σθ, 691°C)	
Montaison duration	53 d (Σθ, 740°C)	53 d (Σθ, 740°C)	62 d (Σθ, 844°C)	
Epiaison duration	170 d (Σθ, 2203°C)	170 d (Σθ, 2203°C)	160 d (Σθ, 2040°C)	
Flowering duration	177 d (Σθ, 2309°C)	177 d (Σθ, 2309°C)	170 d (Σθ, 2192°C)	

d: day

and a girdle. For the tall fescue the rye-grass, the lifting took place 22 and 14 days after sowing, respectively. The red canary grass reached this stage in an intermediate time of 19 days. In addition, it has been observed that the variation of this character according to the species was not important and significant at the 8th day.

The tillering consists of the formation of a tray, says consistent tillering of the broadcast of tillers and roots adventives[11]. The tillering stage has been obtained 29 days after the sowing for both the tall fescue and the rye-grass. In contrast, the same stage has been reached after 58 days for the red canary grass (two times superior). The montaison is a phase of the first development characterized by a slow elongation, then more and faster of the enter-nodal of the main stem and tillers and by the differentiation and the magnification of inflorescences. The past time from the seedling to the montaison was 53 days for the rye-grass and the tall fescue and 62 days for the red canary grass.

The epiaison was characterized by the inflorescence of the last leave girdle. This stage has been reached in 160 days after sowing for the red canary grass. However, for the rye-grass and the tall fescue, the epiaison dates were homogeneous, where it took place during 170 days. The date of realization of this stage varies according to the varieties, the places and years. According to Niqueux and Arnaud[11], the date of epiaison of a given variety can be predicted from the knowledge of the climatic characteristics, the place of culture, based on the sums of Q_{10} temperature to give better account of the low temperatures.

The elongation of the stem continues after the epiaison and end with the apparition of inflorescence (3n), where the time of flowering take place. The time from sowing to flowering was 170 days for the red canary grass and 177 days for both the tall fescue and the rye-grass.

Phenology and sum of the temperatures: According to Niqueux and Arnaud[11], the sum of the daily average

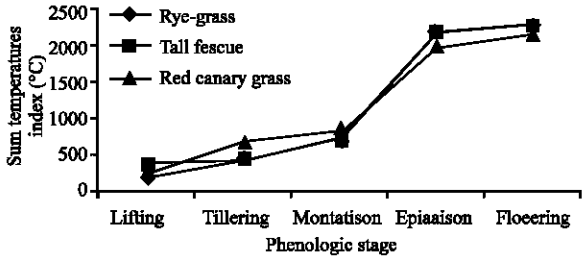

Fig. 1: Phenologic evolution according to sum temperatures index

temperatures since the beginning of vegetation until the realization of a phenologic stage is appreciably constant whatever the climatic conditions are. To verify this affirmation, we calculated between 1995 and 2000 the sum of the temperatures until the stage of "full epiaison" and that from the daily temperature records in "Berrahal Weather Station", situated near the experimental station of Fetzara. Table 3 and Fig. 1 express the realization of the plant phenologic stages according to the accumulated heat during the whole vegetative phase (sum temperatures index in degree/day). The daily temperature which was higher than 0°C showed that the lifting stage requires an accumulated temperature of 219, 298 and 345°C, respectively, the rye-grass, the red canary grass and the tall fescue. Concerning the tillering, the red canary grass needs 690°C, whereas the need of the tall fescue and the rye-grass, were 445, 740, 2203 and 2309°C for the respective stages of tillering, montaison, epiaison and flowering. Thus, red canary grass is relatively more heat demanding for the realization of the phenologic periods, except for the flowering that has been achieved one week in advance compared to the two other species with an accumulated heat of 2192°C/day. In general, the chronological evolution of the phenologic stages was nearly similar at the three lineages.

Yearly phenologic variation: Table 4 of the inter-annual variation of the stage sowing-lifting and sowing-epiaison

Table 4: Duration of the phenologic stage seedling-raising and seedling-epiaison in days for several years (1995-2000)

		Year						
	Stage	95/96	96/97	97/98	98/99	99/00	X±SD	CV (%)
P. arundinacea L	S.L	11	22	20	12	19	16.8 ± 2	42.73
	S.E	158	156	161	162	159	159 ± 2.13	1.34
F. arundinacea Schreb	S.L	35	19	26	24	22	25.2 ± 5.4	21.5
	S.E	178	165	184	169	170	173 ± 6.8	3.95
L. multiflorum Lamk	S.L	11	21	18	20	14	16.8 ± 3.8	22.4
	S.E	178	155	165	69	170	167 ± 7.5	4.5

S.L: seedling-lifting stages S.E: seedling-epiaison stages CV: coefficient of variation SD: Standard deviation.

Table 5: The main agronomic characters of the 3 Poaceae fodders

	L. multiflorum	*F. arundinacea*	*P. arundinacea*
Alternativity	+	+	+
Vigour	+	-	+
Disease sensibility	0	0	(3) Rust, (3) Oidium
Cold weather resistance	+	+	+
Résistance to laying down	-	+	+
Remontaison aptitude	good enough	good enough	good enough

(+): alternativee, vigourous, resistant, (-): non alternative, non vigourous, non resistant, (0 and 3): infection degree according to the studied Scale

in days (from 1995 to 2000) showed that the variation can be significant from one year to another. The most important variation has characterised the ray-grass and the tall fescue. The inter-annual variation of the seedling-lifting stage was also significant. The respective coefficients of variation of red canary grass, tall fescue and rye-grass (42.7, 21.5 and 22.4) were lower to 12. The difference between the plant that raised early and those that rose late were located on average between 5 days for the rye-grass and 7 days for both red canary grass and the tall fescue. Concerning the stage seedling-epiaison (grazing stage), the yearly gaps were relatively weak. The coefficients of variations (1.3, 3.9 and 4.5) were lower to 12. The average gaps within the species are 3 days for the red canary grass, 9 days for the rye-grass and 10 days for the tall fescue. The average inter-specific and inter-annual variation was around 9 days. Otherwise, the comparison of the duration of realization of this stage between the most precocious year and the year most belated were located here at the surrounding of 6, 19 and 23 days for the red canary grass, the tall fescue and the rye-grass, respectively.

On the basis of the observation set, the five years can be classified according to their phenologic precocity by the following way:

- Precocious year: 1997
- Middle years: 1999, 2000
- Belated years: 1996, 1998

This general ordering corresponds to the date of seedling until the full epiaison stage of the 3 species in the Fetzara Station.

Agronomic characters: The principal agronomic characters kept in this survey are reported in the Table 5. The alternativity is the faculty that a variety possesses to produce ears every year of seedling. It is expressed by the percentage of appeared ears. The studied species are all alternatives. The non alternatives varieties are sought-after by the breeders who want to lay out, even during the seedling year, an appetizing foliate fodder and well grazed by animals. Otherwise, the biggest part of the Mediterranean species and particularly North Africans present a faculty to produce alternative tillers-ears after every cut, contrary to a big number of European species. These particular faculties allow the local populations to resist often to rough and unfavourable climatic conditions.

The vigour is the power that allows a plant, when it is in germination, to grow quickly and well. It also constitutes the whole of the intrinsic properties of the seedling which gives a satisfactory performance; its antithesis being their weakness[12]. In the contrary, ISELY[13], considers two main ideas which enter in the most concepts of vigour: The speed of growth and the non susceptibility to the adverse conditions of growth. He concluded that the vigor is the total sum of all attributes of seeds which support the installation and the establishment of the seedlings under unfavourable conditions of soil. Besides, CARLETON and COOPER[14], mentioned that the vigour of the seedlings is in fact nothing but the ultimate expression of a category of well calibrated seeds compared to another category of small sized ones. AMSTRONG[15] confirms it and considers that the weight of 1000 seeds (tetraploid varieties) ranging between 4.5 and 5 g gets a great strength of installation for the cultures and a good growth during the winter and the beginning of spring.

Considering the divergences of the authors in the concepts of vigour, the following criteria have been kept: The size of the plant and its port, the importance of foliage

and its colour, in addition to the sanitary state. This character of vigour has been noted two months after the seedling. Put a side, the tall fescue, which was weak and sensitive in the first year of sowing, the two other species were rather vigorous.

The Poaceae fodders were susceptible to be attacked by diseases, the fungi, the bacteria and the viruses. Moreover, on the aerial organs, the rusts are responsible for orange, brown or black pocks. The mildews provoke the leave's yellowing or drying. The odium covers the body and organs with white mycelium causing various stains[16]. The sensitivity to the diseases has been studied by the infection degree according to the scale of Mac Intoch and Eveling[10].

Concerning these species the rye-grass and the tall fescue did not express any symptom of diseases. For the red canary grass, it was observed orange rust and a white spots on the leaves (odium) with a degree of infection of 3 for the two respective diseases. However, it is important to signal that these symptoms appeared in the spring when the conditions of humidity and temperature became favourable for fungal attack. Concerning, the parasitic attack, only, the tall fescue was otherwise vulnerable to the slugs in the humid conditions. The resistance of a plant to an inimical factor of the medium is its faculty to develop itself in unfavourable conditions, generated by this factor. The resistance to the cold weather has been appreciated by the plant kinetic growths in height during the coldest month (January) and the resumption of vegetation in the spring (March). Indeed, the wintry growth is 27, 27 and 24 cm/month for respectively, the red canary grass, the tall fescue and the rye-grass against 40, 48 and 37 cm/month in the order of the same species for the spring growth. In a global way, the studied ecotypes seem to present the same resistance to cold weather; it can be explained by the fact that the climate of this region is characterized by generally soft winter. Concerning the resistance to the laying down of crop by the wind, it appears that only the rye-grass was especially sensitive when it did not undergo any cuts and that it arrives to the epiaison stage.

However, the aptitude for the remontaison is the capacity which has some species to produce other vegetative stems after a cut[17]. All the studied species, present a good faculty to the remontaison. The measure of the vegetation heights (non presented data) to the second and third cut showed an important development with an average of 65 cm.

Finally, the precocity is defined of two manners, on the one hand, by the median date of epiaison and on the other hand, by the date where the size reaches 10cm to which we can make a first exploitation in pasture[11]. It did not show notable differences between the various species. However, the gap to the epiaison between the three species was 7 days.

DISCUSSION

The phenologic statements, i.e., the various phase of vegetation which goes from sowing to harvest, show that the best germinative faculty is obtained by *P. arundinacea* and that as a whole the remain two species of *F. arundinacea* and *L. multiflorum* present a faculty superior to 70%. According to OSTREM[18], this weakness of germination comes certainly from the dormancy of certain seeds, because generally the spontaneous species present this phenomenon. Otherwise, at the time of the progress of the seedling-lifting phase, several factors interfere, notably the physiological maturity, the physical and sanitary state of the seeds[12]. In the same way, the temperature and the availability of soil water play a very significant role during the germination process. According to SIMON[19,20], the speed of seed's imbibitions increases with constant temperatures. The optimum of germination and lifting is approximately 20 to 25% and that the minimum rate of moisture, so that the occurrence of lifting is slightly higher to the point of permanent watering of 10%. According to this same author, the temperature of soil in non limiting water conditions is the explanatory factor of fluctuations observed of the seedling-lifting phase.

With regard to the evolution of the phenologic stages (from seedling-lifting until flowering), it is noted that *L. Lamk multiflorum* and *F. arundinacea* have similar chronological evolution, contrary to *P. arundinacea,* which spent more time to raise and tillering and in spite of that, it flowers one week before the two other species. The daily temperature higher than 0°C showed that the raised stage has been reached at an accumulated temperature of 219, 298 and 345°C for respectively, the rye-grass, the red canary grass and the tall fescue. However, for the tillering, the red canary grass needs 690°C, whereas the need of the tall fescue and the rye-grass were 445, 740, 2203 and 2309°C for the respective stages of tillering, montaison, epiaison and flowering. The red canary grass is relatively more heat demanding for the realization of these phenologic periods, except for flowering. Certainly, it needs more time to raise, tillering and to achieve the other stages, but it flowered one week before the two other species, an indication of accumulated temperature of 2192°C.

The notation of the agronomic characters shows that the rye-grass is vulnerable to the laying down, especially at the montaison stage; the tall fescue is less vigorous

during the winter, but according to our personal observations, it is only sensitive to the climatic conditions during the first year of sowing. In the following years, it reacts better to the cold weather, to the drought and to the flooding. On the other hand, the red canary grass is slightly sensitive to the diseases represented by rust and odium, when the soil conditions of humidity and temperature are favourable.

CONCLUSION

This study has permitted to investigate the phenologic evolution of three species descended from Annaba's region. The phenologic evolution was on an average of the same speed with a light advantage for the tall fescue and the rye-grass.

To the same date, the difference of stages between precocious and belated year is not very significant, where the gap is lower to 10 days.

The inter-annual phenologic variations explain themselves in part, by the temperature differences during the months of March to May.

The average epiaison stage is reached after 2203°C for the rye grass and tall fescue and 2040°C for red canary grass. However, in Fetzara station, these values varied slightly from one year to another. In any case, the calculation of the sum temperatures index did not permit to estimate with precision the exact stage of "full epiaison", nevertheless it permits to be used like a bioclimatic model for the different ecological surroundings.

The agronomic characterization noted that the rye-grass is vulnerable to rainfall at the montaison stage, the tall fescue is less vigorous in the first year of sowing and the red canary grass is slightly sensitive to the fungal diseases when the conditions of the medium are favourable. In a general way, these ecotypes seem to have as whole a rather good rusticity.

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