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Agronomic performance of some perennial grass cultivars in Algerian semi arid conditions

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Abstract. Selection of perennial forage grasses is aimed at improving the sustainability of cropping. Tolerance to drought conditions, persistence and high forage yields are the major traits that determine the adaptability of the tested genotypes. This study was conducted at the experimental site of the ITGC institute in Sétif during the cropping season 2008/2009 with the objective of evaluating the performance of 13 varieties of perennial grasses, belonging to two species: *Festuca arundinacea* Schreb. and *Dactylis glomerata* L. in a semi arid region. Cultivar characterization focused on various agronomic traits in order to assess their adaptability to drought prone environments. The results showed the existence of a wide range of variability between cultivars, particularly regarding biomass production, production cycle and persistence. These results showed high potential for the selection of a plant material adapted to the specific conditions of the semi-arid areas of the Algerian high plains. Indeed, this study allowed us to select the most adapted varieties such as Flecha, Fraydo and Kasbah.

Keywords. *Festuca arundinacea* – *Dactylis glomerata* – Tolerance to drought – Persistence – Adaptability.

Performance agronomique de quelques cultivars de graminées pérennes sous conditions semi-arides en Algérie

Résumé. *La sélection des graminées fourragères pérennes vise à améliorer la durabilité du système de production. La tolérance à la sécheresse, la persistance ainsi que la production de la biomasse sont les principaux caractères qui déterminent la capacité d'adaptation des génotypes. Cette étude a été réalisée dans une région semi-aride, au niveau de ITGC de Sétif durant la campagne 2008/2009 avec l'objectif d'évaluer la performance de 13 variétés de graminées pérennes appartenant à deux espèces :* Festuca arundinacea Schreb. *et* Dactylis glomerata *L. La caractérisation a porté sur différents traits agronomiques afin d'évaluer la capacité d'adaptation des différents cultivars aux conditions de stress hydrique. Les résultats ont montré l'existence d'une grande variabilité entre les variétés évaluées, en particulier en ce qui concerne la production de biomasse, le cycle de production ainsi que la persistance. Ces résultats suggèrent l'existence d'un potentiel génétique pour la sélection d'un matériel végétal adapté aux conditions spécifiques des zones semi-arides algériennes. En effet, cette étude nous a permis de sélectionner les variétés les plus adaptées, à savoir Flecha, Fraydo et Kasbah.*

Mots-clés. Festuca arundinacea – Dactylis glomerata – *Tolérance à la sécheresse – Persistance – Adaptation.*

I – Introduction

Forage and turf grasses are the backbone of sustainable agriculture and contribute extensively to the world economy. They play a major role in providing high quality and economical meat, milk, and fibber products and are important in soil conservation, environmental protection, and outdoor recreation (Wang *et al.,* 2001). In the Mediterranean environment, the possibility of grasses to survive water stress during summer depends on their ability to reduce the vegetative phase to a dormant phase, and become active again under the first autumn rains (Laude, 1953). Stress-tolerant forage resources are increasingly needed for the environmental and economic sustainability of extensive Mediterranean livestock systems. In this context, perennial forages can be a valuable

alternative to annuals, if they can survive across successive summer droughts. Poor persistence of sown perennial pasture grasses is a problem in the Mediterranean regions all-over the World where the most stressful, life-threatening season is a summer characterised by long and often severe droughts with high temperatures. Among the perennial grass species of common interest across the Mediterranean basin, tall fescue (*Festuca arundinacea* Schreb.) and orchardgrass (*Dactylis glomerata* L.) are of paramount importance (Ghesquière and Jadas-Hécart, 1995).

The objective of this study was to characterize variation for dry matter yield, forage maturity, plant height, and persistence among cool-season perennial grass varieties evaluated under semi arid conditions of the eastern high plains of Algeria.

II – Materials and methods

Thirteen perennial forage grass varieties were implanted, among which seven varieties of *Festuca arundinacea* Schreb. and six varieties of *Dactylis glomerata* L. (Table 1). The plant material was obtained by PERMED project (INCO-CT-2004-509140). The field study was conducted during the 2008/09 cropping season at Sétif Agricultural Experimental Station (36°12'N, 5°24'E, 1023 m asl). The long term annual mean precipitation of the experimental site is 396.0 mm, occurring mainly in November to March with a winter mean temperature of 6.6°C and a spring mean temperature of 12.5°C. The climate is temperate continental, varying from arid to semi-arid. Season 2008/09 was characterized by a cold rainy winter and a warm spring with a rainfall peak in April, followed by a dry and hot summer. The soil is loamy clay, with a bulk density of 1.35 g cm^{-3}.

Each grass variety was sown on 10 row-plot 2.5 m long and 0.20 m row spacing. The 6 inner rows were harvested in November 2008 and April 2009 by clipping mechanically at a height of 7.0 cm. Fresh plant material samples, of varying size (100-500 g), were dried at 70°C for 48 h at each harvest for dry matter determination. Defoliation was initiated in the autumn before the onset of kill frost and in the spring season when inflorescence emerged in at least 4 varieties. Heading date was recorded, on the outer rows, as the number of Julian days from January 1st to the date when 50% panicles fully emerged. Plant height was determined as an average of three measurements taken per plot from the soil surface to the highest point of the vegetation just before the harvest. Variation in the ground cover was used as a measure of persistence.

All data collected were analysed as a randomized complete block design using GenStat (Discovery Ed.). Differences among the means were tested using the least significant difference (LSD) test at the 0.05 probability level.

III – Results and discussion

Mean plant height, averaged over cultivars, varied from 20.0 cm to 40.2 cm with significant differences between seasons (P <0.001) (Table 1). The *Dactylis* Delta-1 was the shortest variety with a mean of 20 cm and Lutine and Fraydo fescues were the tallest among the evaluated entries with 34.2 cm and 40.2 cm respectively (Table 1). Dry matter yields over cultivars were relatively low during autumn as compared to spring harvests (Table 1), with an average dry matter yield of 0.43 t ha^{-1} for the autumn harvest and 0.84 t ha^{-1} for the spring harvest, which allowed better expression of the yielding ability of the different varieties. The analysis of variance of the autumn dry matter yield indicated that the Kasbah cocksfoot and the tall fescue varieties Fraydo and Centurion were the top yielding with an average dry matter yield of 0.69 t ha^{-1}, while the lowest dry matter yield was recorded with Medly with an average of 0.16 t ha^{-1}. Concerning the spring dry matter yield, Anova showed significant differences (P = 0.014) (Table 1) among treatments, the mean values ranging from 0.47 t ha^{-1} (Lutine) to 1.35 t ha^{-1} (Flecha).

Plant height at the defoliation period was directly correlated to the production level of each variety. The sward elongation was slow at the beginning of the cycle (autumn), when the differences between species were very small. The elongation became higher at the end of the cycle when tall fescue varieties exhibited a better response to the environmental conditions than *Dactylis* varieties. Volaire (1991) suggested the existence of a strong correlation between vegetation height, vigour, and recovery. Concerning the dry matter production, crops were harvested twice, in autumn and spring when significant differences were noted between varieties (Table 1). The poor autumn production could be explained by the low level of soil moisture available for growth; autumn rains usually arrive very late, and in summer there is a complete absence of rain resulting in gradual dormancy of the different varieties, which reduced their dry matter production.

Row cover and the number of days to heading showed significant differences between cultivars (Table 1). Thus, sward persistence as expressed by final row cover ranged from 31.0% (Lutine) to 78.7% (Kasbah) in autumn and from 28.7% (Lutine) to 69.8% (E542) in spring (Table 1). Regarding the number of days to heading, Flecha exhibited the earliest heading date (114.7 and 120.7 days, respectively), while *Dactylis* varieties Delta1 and Jana were the latest to head (133.5 and 135 days, respectively) (Table 1).

Table 1. Description of the studied varieties an d genotypic means during the fourth production year

Name	Origin	PHT	DM1	DM2	Rec1	Rec2	DHE
Cocksfoot							
Jana	Italy X north Africa	25.7	0.3	0.6	54.8	46.5	135.0
Medly	Mediterranean	22.6	0.2	0.6	44.6	38.4	121.3
Kasbah	South Morocco	26.8	0.7	1.2	78.7	59.7	129.7
Delta-1	France	20.0	0.3	0.5	61.6	53.4	133.3
Currie	Algeria	22.7	0.4	0.7	61.2	45.1	127.7
Ottava	Sardinia	25.8	0.4	0.6	51.2	42.9	129.7
Tall fescue							
Tanit	Italia X Morocco	32.2	0.5	1.2	64.0	55.2	125.3
Sisa	Sardinia	31.2	0.4	0.9	47.6	42.3	125.3
E-542†	France X Tunisia	29.7	0.4	0.7	70.7	69.8	122.7
Centurion	Italia X Tunisia	31.4	0.7	1.2	66.7	64.7	124.7
Flecha	France X Tunisia	28.7	0.5	1.3	75.8	65.4	114.7
Lutine	Temperate X Mediterranean types	34.2	0.2	0.5	31.0	28.7	129.0
Fraydo	Israel	40.2	0.7	1.0	56.3	40.7	120.7
LSD (0.05)	–	5.28	0.26	0.53	9.06	13.35	6.74

† E-542 = Flecha tall fescue infected with the non toxic AR5421 strain of *Neotyphodium Coenophyialum.* Plant height (PHT, cm), Autumn dry matter yield (DM1, t ha^{-1}), Spring dry matter yield (DM2, t ha^{-1}), Plant recovery (REC1,2,%), Number of days to heading (DHE, days).

The lower persistence of continental *Dactylis glomerata* cultivars in comparison with the Mediterranean ones can be ascribed to their difficulty in developing a deep root system and extracting water under conditions of limited water availability (Volaire and Lelièvre, 2001). The widespread yield advantage of *Festuca* over *Dactylis* may largely derive from greater growth across autumn and winter (Lelièvre *et al.*, 2011). Kasbah maximized the drought tolerance and persistence through its complete dormancy trait. The high level of persistence attained by Flecha arose from survival mech-

anisms other than complete dormancy, such as the deep root system (Lelièvre *et al*., 2011) and the development of an extensive collar of senescent leaf sheaths around its young tillers in summer which could increase tiller survival by reducing transpiration losses (Norton *et al.*, 2006).

IV – Conclusion

These results showed the possibility to select an adapted material of *Dactylis glomerata* and *Festuca arundinacea* to the specific conditions of the semi-arid areas of the Algerian high plains, where annual rainfalls rarely exceed 400 mm per year. Flecha, Fraydo and Kasbah showed superior adaption for the measured traits. There was some evidence for better drought tolerance of earlier-heading varieties.

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