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RESEARCH NOTES

Forage Production of Eight Annual Medic Cultivars under Rainfed Conditions of Golestan Province

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ABSTRACT

Medics are native to semi-arid areas around the Mediterranean Sea and have long been used in degraded pastures in the region. Annual medics are now widely distributed throughout the world, largely in areas with mild, rainy winters and alkaline soils. This study was conducted at a site located in the north east of Golestan Province (55° 57´ E, 37° 48´ N), on a silty clay loam soil in 2002 and 2003. The experimental design was a randomized complete block with four replications. Cultivars were seven annual medics (including: *Medicago truncatula* cv. Caliph, Mogul; *M. scutellata* cv. Sava, Robinson; *M. polymorpha* cv. Spineless; *M. litoralis* cv. Herald; *M. sphaerocarpas* cv. Orion) in addition to the indigenous annual medic *M. minima*. Results showed significant differences among cultivars ($P<0.01$) in terms of forage and protein production. Average forage production ranged between 216 kg ha^{-1} in the first year and 1,179 kg ha^{-1} in the second year. Average seed production ranged between 26 kg ha^{-1} in the first year and 890 kg ha^{-1} in the second year. The amount of protein production per unit was very low in some cultivars for both years. The results of this experiment suggest that Robinson and Sava might be recommended for cultivation in the region.

Keyword: Annual medic, Forage production, Golestan Province.

INTRODUCTION

Medics are native to semi-arid areas around the Mediterranean Sea and have long been used in degraded pastures in the region. Medics are now widely distributed throughout the world, largely in areas with mild, rainy winters and alkaline soils. Medics do have potential uses in sustainable agriculture systems, however, and additional research is needed to discover their niche (Bauchan, 1999). Annual medic (*Medicago* spp.) pastures that produce high levels of good quality forage are well suited to grazing and are used extensively throughout the dryland farming regions of the world (Walsh *et al*., 2001). Annual *Medicago* species are excellent candidates for use in sustainable agriculture systems such as pastures and cover crops.

Forage legumes have provided the foundation for dairy and meat production for centuries (Russelle**,** 2001). They are rich sources of protein, fiber, and energy. Even in intensive animal and milk production, where grain crops are major feed sources, forage legumes are required to maintain animal health (Wattiaux and Howard, 2001). Australian-bred cultivars of annual medics have been introduced back to the countries of origin of the species (Piano and Talamucci**,** 1996).

Medicago scutellata (L.) Mill. cv. Robinson has the ability to produce the high numbers of seeds. It establishes relatively easily but its early growth in autumn is rapid and

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erect making it susceptible to overgrazing (William *et al.*, 1964).

M. scutellata (L.) Mill. cv. Sava can increase water infiltration into the soil, thus improving the soil structure and protecting the soil surface (Smeltekop *et al*., 2002). *Medicago truncatula* Gaertn is indigenous to the Mediterranean Basin countries, especially in Western Asia (Lesins and Lesins**,** 1979). The barrel medic is adapted to different soil texture types, from sandy to clayey, and particularly to well drained neutral to alkaline soils with a pH of 6 to 8 (Evans *et al*., 1990); it is suited to warm temperate conditions, especially Mediterranean-type climates, 250–600 mm annual rainfall with dry hot summers and mild moist winters, and is intolerant of winter frosts (Brandsaeter *et al*., 2002). It has poor regrowth for a second harvest (Shrestha *et al***.,** 1998), but has a good ability to self-regenerate from seeds present in the soil seed bank.

The research reported in this paper was initiated in order to identify annual medics with improved forage production and seed yields for rainfed farming in Golestan Province, Iran.

MATERIALS AND METHODS

The research was conducted in 2002 and 2003 at a site located in the north east of Golestan Province (55° 57′ E, 37° 48′ N), on a silty clay loam soil. The experimental design was a randomized complete block with four replications. The cultivars used were seven annual medics (including: *Medicago truncatula* cv. Caliph and Mogul; *M. scutellata* cv. Sava and Robinson*; M. polymorpha* cv. Spineless*; M. litoralis* cv. Herald*; M. sphaerocarpas* cv. Orion) in addition to the indigenous annual medic *Medicago minima*. Based on the soil farm characteristics (Ec= 0.8 (dS/m), PH= 7.8, OC%= 0.7, K (ppm)= 290, P (ppm)= 6)**,** all plots were fertilized with amonium phosphate 75 kg ha^{-1}. The cultivars were selected from the improved annual medics which were obtained by the Forest and Rangeland Research Institute of Iran. Viable scarified seeds were sown at 25 kg ha^{-1} in 5 m by 2 m plots on 15 December in 2002 and 2003 after rainfall sufficient for adequate germination. Hand weeding was conducted on 6 March. Dry matter (DM) production was measured by cuts taken after 10% flowering from randomly placed 1 m^2 quadrates per plot. Forage was cut to ground level by hand. Harvested plants were dried at 70°C for 24 hours, weighed, and the protein content was determined in the laboratory. Ten Seedlings were randomly selected from each cultivar; for measuring leaf to stem ratio (LSR), the means of leaf weight and stem cultivars were used separately. Data were analyzed using an analysis of variance procedure. For comparing means, a Duncan test was used.

The monthly maximum and minimum temperatures and rainfall for each month were measured at weather stations located near the site (Table 2).

RESULTS AND DISCUSSION

Precipitation

The long-term average of precipitation is in the region 320 mm. Precipitation levels for the mid-December to May growing season were 151 and 251 mm for 2002 and 2003, respectively (Table 1). The growing season precipitation in 2002 was 47.2%, the long term average for precipitation, but in 2003 was 78.31%. The total monthly precipitation levels were highly variable, with large differences between these values for each of the two growing seasons. Total rainfall variations were ≈100 mm between seasons (Table 1). These variations in precipitation levels indicate that there would have been large differences in the amount of moisture available for plant growth in these two seasons. In general, the rainfall days in the 2003 season (53 days) have a better distribution than in the 2002 season (43 days), and that would have provided increased soil moisture levels for longer periods compared with the 2002 growing season.

Table 1. Monthly precipitation (mm) and maximum and minimum temperatures (°C) in the growing season.

Year	2002			2003		
Growing Months	Temperature (°C)		Precipitation (mm)	Temperature (°C)		Precipitation (mm)
	Mean max.	Mean min.		Mean max.	Mean min.	
Mid. Dec.	13.6	7.3	34.1	16.6	6.2	43.8
Jan.	14.6	6.7	9.9	14	6	42.7
Feb	9.6	2	19.7	12	3	37.7
Mar.	18.8	8.1	41.2	16	7	22.5
Apr.	22.1	11.3	38	20	10.9	62.7
May	28.1	16.3	8.2	20.6	11.9	41.2
Total Rainfall			151.1			250.6
Rainfall days			43			53

Table 2. Forage, protein and seed production for eight annual medic cultivars in 2002 and 2003.

Year	2002			2003		
Cultivars	Forage kg DM ha^{-1}	Seed Kg ha^{-1}	Crude protein gr m^{-2}	Forage kg DM ha^{-1}	Seed Kg ha^{-1}	Crude protein gr m^{-2}
Spineless	216d*	26d	4d	125d	254cd	2d
Orion	343c	99c	4d	517c	465b	7c
Herald	400bc	30d	7bcd	451c	464b	9c
Robinson	764a	175b	14a	735b	890a	15ab
Sava	616ab	221a	10ab	777b	843a	13b
Mogul	324c	100c	5cd	1179a	551b	19a
Caliph	558b	162b	11ab	743b	222d	14b
M. minima	554b	112c	9bc	540c	323c	8c

*Means by same letter are not statistically different (p<0.05) in columns.

The lower yields in 2002 were associated with a reduction in vegetative growth because of low rainfall in winter and a warm, dry spring (Table 1). The variation in growing season (December-May) rainfall in 2003 relative to 2002 was associated with a variation in means for forage and seed production. Results showed that seed production as well as forage was affected by environmental variation, so that seed production in 2003 in some cultivars increased four or five times more than the previous year. Experimental means for forage production (Table 2) ranged from 216 kg DM ha^{-1} in 2002 to 1,179 kg DM ha^{-1} in 2003.

Averages for leaf:stem ratios (LSR) in cultivars were 1.83, 1.76, 1.69, 1.51, 1.5, 1.43, 1.3 and 1.25 for Robinson, Sava, Herald, *M. minima*, Caliph, Mogul, Orion and Spineless, respectively. These results show that some cultivars have greater LSR than others. In other words, some cultivars have higher leaf production than others and this is an advantage in forage plants. Hence Pinkerton (1997) and Jung (2005) reported that forage quality is directly related to the leaf:stem ratio, and clearly, the proportion of leaves in alfalfa when harvested is the dominant factor that determines the quality of this crop, both in terms of protein content and also the digestibility of its cell wall material.

Forage Production

The production of high levels of quality forage by some of the cultivars evaluated in this study indicates the potential for growing annual medic pastures in northeastern Golestan Province. Some cultivars of the annual medics were encouraging for the further development of this region.

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Korte *et al.* (1999) indicated that a variation in growing season rainfall caused variation in the means for forage production, with variations for forage production ranging from 600 to 4,920 kg DM ha^{-1}. The highest average yields of medic dry matter from this experiment (Table 2) was comparable to those reported by other researchers (Sanadgol and Kalate, 1991; Shababi Tabari, 1992) for annual medic production in dry land regions of Iran. Over two seasons, even with differences in precipitation levels, the Robinson cultivar consistently yielded ≈750 kg ha^{-1} dry matter; this flexibility further emphasizes the suitability of this cultivar for development. Therefore, *M. scutellata* cv. Robinson in general, was identified as having the greatest potential for development and use (among cultivars in this experiment) in northeastern Golestan. The dry matter yield potentials of some cultivars were generally limited by the short growing season in 2002. However, the extended growth and development periods in 2003 displayed by *M. truncatula* cv. Mogul significantly increased its potential for forage production above that of the other cultivars.

M. polymorpha cv. Spineless was one of cultivars that has no adaptability to the region's conditions. This cultivar had a very low forage production compared with other cultivars over the two years, resulting in low protein and seed production (Table 2). Some cultivars such as Robinson and Herald and also *M. minima* were a fairly persistent in forage production relative to other cultivars in both years (Table 2).

Results revealed that the *M. truncatula* cv. Mogul, produced the greatest level of dry matter in a high rainfall year. It is suggested that cultivars differed in their response to the environmental temperatures and suitable rainfall for seedling establishment (January-February) and rapid growth stage (April), so that, an increasing in rainfall relative to the previous year at same time, delayed onset of the flowering stage. Walsh *et al*. (2001) revealed that dry matter production was related to the period of growth and development, where higher yielding cultivars showed extended periods of vegetative growth.

Crude Protein

Medics are equal to alfalfa in forage quality with crude protein (CP) ranging from 11 to 26% (Pahlevanpur, 1997; Shrestha *et al*., 1998; Bauchan, 1999). In this study, also, the crude protein of cultivars ranged from 14 to 19%. These high nutritive value and intake characteristics lead to good animal performance. Although the amount of protein production per unit area was recorded as very low in some cultivars, the results for crude protein (Table 2) compared with other studies mentioned above suggest that some of the annual medic cultivars evaluated in this experiment would be highly suited to livestock production.

Seed Production

Variation in seed production range is very large between the two years and among the cultivars. Means for seed production ranged from 26 kg ha^{-1} in 2002 to 890 kg ha^{-1} in 2003 (Table 2). Korte *et al.* (1999) showed that variation in growing season rainfall caused variation in the means for seed production, so that, it ranged from 80 to1,210 kg ha^{-1}. The correlation between rainfall and medic seed production has been reported previously (Cocks, 1995). The level of seed production by the majority of the annual medic cultivars evaluated appeared to be adequate for the establishment of a viable seed bank that would allow regeneration at the start of subsequent pasture phases. Carter (1981) indicated 1,000 Kg ha^{-1} seed should be sufficient to ensure pasture regeneration for a number of years given typical levels of hardseededness and dormancy release.

The cultivars Robinson and Sava had a relatively high ranking for seed production. The high seed production level of Sava and Robinson of approximately 840-890 Kg ha^{-1} virtually guarantees the future establishment of productive medic pastures in 2003 (Table 2). The remaining cultivars in this experiment (apart from Mogul, Herald and Orion) produced approximately 200-300 kg ha^{-1}, which is the proposed minimum level for a viable annual medic seed bank (Carter, 1981). The reduced seed production by all cultivars in 2002 indicates that conditions in the late months of growth were not favorable for seed production. In general, the lower rainfall, and particularly dry conditions with below-average rainfall levels and increases in daily temperature means (Table 1) throughout flowering and seed formation, affected seed production in the 2002 season. Korte *et al.* (1999) and Cocks (1995) have reported the relationship between seed production and rainfall.

Forage production in some cultivars more was affected by the rainfall variations in growing season than in others. It is suggested that for harvesting a suitable forage production, a cultivar or cultivars should be selected with a stability in production for different conditions (wet or dry). Based on the results of this experiment, Robinson and Sava cultivars belonging to the *M. scutellata* species might be recommended for their forage production stability under different conditions. Since the Mogul cultivar belong to *M. truncatula* is able to produce high forage production in wetter year, if the probability of rainfall is equal to or higher than the long term average, this cultivar might also be recommended for the region.

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تولید علوفه هشت رقم یونجه یکساله در شرایط دیم استان گلستان

م. ع. دری

چکیده

یونجه های یکساله، بومی نواحی نیمه خشک مدیترانه هستند و استفاده از آنها در چراگاه ها و مراتع این مناطق سابقه طولانی دارند. این گیاهان بطور وسیعی در سرتاسر نقاط جهان که بارندگی ها غالبا در زمستان رخ می دهد ودارای دماهای معتدل هستند، گسترش یافته اند. این بررسی در ایستگاه تحقیقاتی واقع در شمال شرق استان گلستان (N ′۴۸ °۳۷ و E ′ ۵۷ ° ۵۵)، در خاک سیلتی کلی لوم طی دو سال زراعی ۱۳۸۲-۱۳۸۰ اجرا شد. ارقام با همکاری واحد مرتع موسسه تحقیقات جنگلها ومراتع تهیه شد. این ارقام عبارت بود از: *Medicago truncatula* cv. Caliph, cv.Mogul; *M. scutellata* cv. Sava, cv. Robinson; *polymorpha* cv. Spineless; *M. litoralis* cv. Herald; *M. sphaerocarpas* cv. Orion *M.* این ارقام به همراه یک گونه بومی *M. minima* (شاهد) در طرح بلوک کامل تصادفی در چهار تکرار کشت شدند. نتایج نشان می دهد که بین ارقام از لحاظ تولید علوفه و تولید پروتئین در واحد سطح اختلاف معنی‌داری ($P<0.01$) وجود دارد. در طول آزمایش حداقل تولید علوفه خشک ۲۱۶ کیلوگرم در هکتار در سال اول و حداکثر تولید علوفه خشک ۱۱۷۹ کیلوگرم در هکتار در سال دوم بدست آمد. همچنین کمترین تولید بذر در سال اول با ۲۶ کیلوگرم درهکتار برای رقم Spineless و بیشترین مقدار تولید بذر در سال دوم ۸۹۰ کیلوگرم در هکتار برای رقم Robinson بدست آمد. براساس نتایج این آزمایش رقم Robinson و Sava برای این منطقه مناسب هستند.

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