ISSN : 1812-5379 (Print)
ISSN : 1812-5417 (Online)
http://ansijournals.com/ja

JOURNAL OF AGRONOMY

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Journal of Agronomy 9 (3): 75-81, 2010
ISSN 1812-5379

Phenology and Agronomic Performances of the Species *Vicia narbonensis* L. in the Semi-arid Region of Sétif

[1]A. Mebarkia, [2]K. Abbas and [3]A. Abdelguerfi
[1]Department of Agronomy, Faculty of Sciences, Ferhat Abbas, University, Setif, Algeria
[2]INRAA, Setif Research Unit, Algeria
[3]INA, El Harrach, Algeria

Abstract: The experiment was conducted during two cropping seasons (2001/2002 and 2002/2003), with the objective to study the Phenology and agronomic performances of the fifteen ecotypes of the species (*Vicia narbonensis* L.) under the agro-climatic conditions of the semi-arid region of Setif. The various phenological stages of the plant, the fodder and grains yields and several characters relating to the quality of seeds were measured. The results obtained show large diversity among phenological ecotypes of *Vicia narbonensis* L. The ecotype 2466 is very early for the beginning of flowering, for full flowering, for the beginning of pods formation and for complete maturity. In contrast, ecotype 2390 is the latest for all the phonological stages measured. Concerning forage and grain production, the statistical analysis showed highly significant differences between ecotypes. The best fodder and grain productions are reported for the late flowering ecotypes. Ecotype 2390 produced average values of 2.5 ton dry matter ha^{-1} of fodder and 16.9 quintals ha^{-1} of grains. The fodder and grain yields were correlated positively ($p<0.05$) with the number of days to the full flowering, which guides the selection towards the late ecotypes. Highly significant differences were observed for total nitrogen and fat contents of seeds ($p<0.01$). Ecotypes 2393 and 2467 produced the highest concentrations in fat (1.2%) and the ecotype 2462 produced 33.6% in total nitrogen.

Key words: *Vicia* sp., yield, quality, drought, flowering date

INTRODUCTION

In semi-arid regions of Algeria, agriculture is dominated by field crops associated with the breeding of ruminants. The low rainfall levels (average 400 mm $year^{-1}$) and the low use of irrigation have resulted in an extensive conduct livestock. This is indeed carried out mainly on poor food resources. These resources consist mainly of by-products (bran, straw and stubble), grazing on plants spontaneous fallow and rarely growing vetch, oats and barley (CIHEAM, 2006). Recently, production systems have undergone profound changes. Indeed, the speculative nature of the meat market (Bahhady *et al*., 1988; Mebarkia and Abdelguerfi, 2007) whose prices can make the most of the live animal and animal fat-based food induced a rapid increase in the number of animals.

Besides this phenomenon, recent developments of grasslands mentioned by Abbas and Abdelguerfi (2005), Abbas *et al*. (2005), show a decline of fallow pasture, native grasslands and rangelands because of the multiple factors including public aid for the development of cereal without considering the whole production system which is also based on livestock (FAO, 1987; Cooper *et al*., 1987).

The limited grasslands are familiar with this sharp deterioration due to a high animal stocking. The lack of fodder and pastoral agriculture leads to a disproportionate use of concentrated feed causing an imbalance in the supply of livestock (Cocks *et al*., 1986). Given this situation, the development of grasslands for forage crops is an important developmental field to support sustainable mixed grain and livestock systems.

For this purpose, species of forage legumes are well-known for their potential to produce more food on land left fallow (Abd-El-Moneim *et al*., 1988; Abd-El-Moneim *et al*., 1990) and are also directly paturable by small ruminants. Furthermore, by avoiding monoculture, these species facilitate the control of root diseases and nematodes in cereals (Masson and Gintzburger, 2000; Bahhady *et al*., 1995); they can fight against erosion and improve soil structure as well. Based on work done by ICARDA, the production of dry matter and protein obtained in the biennial rotation cereal-legume forage is important.

Despite the diversity of legume species available in Algeria, very few have been used specifically as a food source for livestock. Among the annual forage legumes grown on fallow *Vicia narbonensis* L. species is one of

Corresponding Author: A. Mebarkia, Department of Agronomy, Faculty of Sciences, Ferhat Abbas, University, Setif, Algeria

the most interesting. In fact, several studies conducted by ICARDA on the agronomic potential of *Vicia narbonenis* L. in arid and semi-arid indicate that this species is the most productive grain and straw (2.1 t ha^{-1} grain yield, 1 , 4 t ha^{-1} straw and 6.4 t ha^{-1} dry matter) (ICARDA, 2002) and fits very well in these regions. The research conducted in Turkey also shows that this species is very promising in rotation with wheat crop (Durutan *et al*., 1990).

The species *Vicia narbonenis* L. product yields higher thrust-germs; cold tolerant and resistant to major diseases and parasites (Abd-El-Moneim *et al*., 1988; Castleman, 1994).

In Algeria, a little scientific information is available on this species of forage legumes and this article proposes to study its agronomic performance in the semi-arid region of Setif during two crop years.

MATERIALS AND METHODS

Trials description: The tests were conducted during two consecutives growing seasons, from 2001/2002 to 2002/2003 at Agricultural Experimental Station of the Field Crop Institute (ITGC) of Setif, located on the eastern high plateaus of Algeria (1081 m asl., 5°21' E, 36°9'N). This area is under the dominance of a continental climate with high temperature ranges, both annual and daily. Thus, according to data, winter is known by its temperatures which fall below 0°C and during summer, these temperatures reached peaks above 40°C. In addition, temperature differences between night and day sometimes reaching 20°C in winter and spring cause the phenomena of freezing and thawing which they very limitative to plant growth (Bouzerzour and Benmahammed, 1994).

The average annual rainfall is about 450 mm (Seltzer, 1947). However, there occurs variations intra- and inter-annual that are very important. Periods of drought including spring were numerous over the last 20 years. Thus, there is a continuous variation of annual rainfall levels has been observed especially during the spring which is a key period for cereal and forage cultivation (Bahlouli *et al*., 2008).

Thus, if there weather events occur in the first decade of May, they will be responsible for flower abortion. The soil of the experimental site belongs to the group of steppe soils (Perrier and Soyer, 1970). The physico-chemical composition shows a texture for all plots, clay loam, a lumpy structure at pH alkaline water (8,07-8,50) and high in calcium total 33,5 to 35,0%. The content of soil with organic matter varies from 0.08 to 2.69%, the phosphorus content ranges from 17.2 to 36.0 ppm, the nitrogen content (0.07%) is low.

Table 1: Meteorological data at Setif for 2001-2002 and 2002-2003 growing season

	Seasons					
	2001-2002			2002-2003		
	Temperatures (°C)			Temperatures (°C)		
Month	Mean Min.	Mean Max.	Rainfall (mm)	Mean Min.	Mean Max.	Rainfall (mm)
09	7.2	36.7	47.2	2.6	38.3	4.3
10	4.5	36.1	14.4	2.6	33.0	10.1
11	-2.0	28.3	37.1	1.3	23.7	100.1
12	-7.4	22.0	8.4	5.6	19.0	67.4
01	-6.0	26.1	22.7	-4.1	20.3	115.6
02	-4.8	25.5	24.0	-8.9	21.6	29.0
03	-4.0	30.2	29.5	-2.9	27.5	37.6
04	1.0	35.2	8.8	-3.3	34.2	63.2
05	0.0	40.8	24.2	-0.0	40.2	43.6
06	4.6	44.5	1.5	7.2	46.3	59.4
07	6.0	45.0	44.3	10.8	48.5	13.7
08	7.0	42.2	33.8	10.5	45.8	22.4
Total rainfall		295.9				566.4

The climatic conditions of the two campaigns are presented in Table 1. Accumulated rainfall total is clearly important in 2003 compared to 2002 (566.4 vs. 295.9 mm). Rainfall unregistered between October to March (winter rainfall) is 63% for the year 2003 and 46% for 2002. The monthly temperature ranges are higher during the first growing season.

Plant material: The experiment was carried on 15 ecotypes of the species *Vicia narbonenis* L. from Syria, Lebanon and/or Turkey and made available by ICARDA (International Center of Agricultural Research in Dry Area).

Setting up the experiment: A set of cultural practices have been made for the establishment of the experiment. Immediately after the first rains of autumn (September and October), deep ploughing (25 centimeter) was performed using a disc plough. An intake of 100 kg ha^{-1} of phosphate fertilizer (superphosphate 46%) was made before sowing. Two passages cover crop crusaders aimed to reduce infestation by weeds and get a good bed for seeds. During the two test campaigns and immediately before planting, chemical weed control was applied using the Terbutryn herbicide (active ingredient) at 1.5 L in 300 L of water per hectare. The planting was made from the same batch of seeds on the first of December for the year 2001/2002 and December 12th for the year 2002/2003. Planting was done manually by a device completely blocks-randomized with 3 replicates per block in a plot with previous crop as grain (durum wheat). Each elementary plot consisted of 4 rows of 4 m long, 30 cm apart. Two hundred seeds of each ecotype of *Vicia narbonenis* L. were sown in each of the plots.

Parameters measured and statistical processing: Half of the elementary plot was used to assess the potential forage production and a set of agronomic traits; the other half was used to measure grain yield and to assess the quality of seeds produced. The stage of full flowering to early pod was taken to evaluate the forage yield. The phenological stages were observed:

- The date of the beginning of flowering (EF) - number of days from the date of exercise until the release of the first inflorescence
- The date of full Flowering (FFR) - number of days from the date of exercise until the onset of the maximum of flowers
- The early date of the pod's formation (EPF) - number of days since the lifting juice-only the appearance of fruit
- The date of full maturity (FM) - number of days from emergence to the date of hardening of the seed
- Ratings have also increased the total number of flowers per plant (NFP) and the number of grains per pod (NGP)

The measured yields are the total dry matter (DM) and grain yield (GY). We have made hay on a 1 m^2 per plot in the elementary stage of full bloom and we immediately weighted the sample to determine the amount of the produced green material. The dry matter production was estimated from a sample of 200 g of green matter placed in an oven at 105°C for 24 h. The grain yield was determined for each ecotype and by basic plot of harvested 1 m^2 then proceeds to the fixed combine. Finally, we determined the parameters of quality seeds of each ecotype produced during the first cropping season (2001/2002). The chemical analyses of seeds carried on crude protein (CP), fat (FAT), crude fiber (CF) and minerals (MI).

The underwent data analysis of variance using the software StatItcf ® to study the variability of measured parameters as a result of controlled factors. The relationship between pairs of measured variables are described and analyzed by the calculation of phenotypic correlations based on the genotype averages.

RESULTS

Variability in phenological development and production: Analysis of variance indicates that the effects of ecotype, of both the year and interaction ecotype x year were highly significant ($p<0.05$) for all traits measured (Table 2). This highlights the wide phenotypic variability observed for all measured parameters. Also, great phenological diversity was observed among ecotypes of *Vicia narbonenis* L.; ecotype 2466 is the earliest for early flowering to full flowering, for the beginning of pod formation and for full maturity; 64, 76, 84 and 131 days, respectively.

Table 2: Analysis of variance of the characters measured on the 15 ecotypes of *Vicia narbonensis* L. during the two experimental years

Sources of variation	Total	Ecotypes	Year	Interaction (ecotypes × year)
Df	89.00	14.00	1.00	14.00
EF	398.25	75.79**	435.60*	2274.39**
FFR	381.41	77.67**	589.36*	2145.24**
EPF	533.39	214.29**	210173*	2810.99**
FM	475.85	102.26**	4.45ns	2690.23*
TDM	106.95	88.06**	38.92**	569.93**
GY	44.77	3.38**	1.67**	276.15**
NGP	0.51	0.64*	0.17ns	1.33*
NFP	32.91	20.58**	3.10ns	180.14**

ns, *, **: Effect non significant and significant at 5 and 1% level, respectively. Df: Date of flowering, EF: Early flowering, FFR: Full Flowering, EPF: Early pod's formation, FM: Full maturity, TDM: Total dry matter, GY: Grain yield, NGP: No. of grains per pod, NFP: No. of flowers per plant

Table 3: Phenological stages and productions observed in 15 ecotypes of *Vicia narbonensis* L. during the two experimental years

	Phenological stages				Productions			
Ecotypes	EF	FFR	EPF	FM	TDM	GY	NGP	NFP
2561	70	85	95	141	12.95	15.59	3.55	13.78
2380	70	85	92	141	18.59	16.03	3.99	13.23
2383	69	83	95	137	10.04	16.05	3.48	08.71
2388	72	84	106	144	18.21	17.04	3.13	12.37
2390	79	92	101	140	25.00	16.89	3.90	13.03
2391	73	82	91	140	20.32	16.14	2.90	11.17
2392	74	86	95	143	20.59	16.75	2.94	11.40
2393	75	82	107	134	19.72	15.85	3.34	11.90
2461	75	87	97	138	17.26	15.84	3.16	09.28
2462	75	87	97	141	19.75	16.70	3.61	13.23
2464	75	88	96	135	18.96	15.49	2.96	08.20
2465	70	83	92	136	15.35	16.28	3.34	12.17
2466	64	76	84	130	14.92	14.77	3.20	11.97
2467	70	81	92	130	18.81	14.35	3.50	13.64
2468	71	82	90	139	23.63	16.38	3.55	14.10
Mean	72	84.40	95.59	138.09	18.27	16.01	3.36	11.88
SD	5.86	5.67	6.14	6.97	2.11	1.06	0.55	1.41

EF: Early flowering, FFR: Full Flowering, EPF: Early pod's formation, FM: Full maturity, TDM: Total dry matter, GY: Grain yield; NGP: No. of grains per pod's, NFP: No. of flowers

In contrast, the ecotype 2390 is the latest with 79, 92, 101 and 141 days for the same phenological stages, respectively (Table 3). The year effect is significant ($p<0.05$) for all of the analyzed phenologicaly variables except for full maturity. This indicates that the characteristics of ecotypes of the species *Vicia narbonenis* L. tested in semi-arid region are strongly affected by inter-annual variations. A significant interaction ecotypes x year ($p<0.01$) indicates that the ecotypes are not stable for the parameters measured from one year to another.

For the production of forage and grain, analysis shows highly significant differences ($p<0.01$) between all ecotypes. The best forage production and grain are obtained for the ecotypes with late flowering. For example, the ecotype in 2390 showed average values of

Table 4: Mean square in the analysis of variance of the chemical composition parameters measured on the 15 ecotypes of the species *Vicia narbonensis* L. in the year 2001/2002

		Characters			
Sources of variance	Df	FAT	MAT	MI	CF
Total of variation	44	0.14	91.26	0.55	10.40
Ecotypes	14	0.29**	224.37**	0.07ns	2.14ns
Overall average		0.61	16.97	3.19	9.96

ns, *, **: Effect non significant and significant at 5 and 1% level, respectively. Df: FAT (%MS), Crude Protein: CP (%MS), MI: Minerals (%MS)/, CF: Crude fiber (%MS)

Table 5: Average values of grain chemical composition of the *Vicia narbonensis* L. species

Ecotypes	FAT (%DM)	MAT (%DM)	MI (%DM)	CF (%DM)
2561	0.4b	8.3c	3.2	11.0
2380	0.8ab	17.9bc	3.1	11.0
2383	0.5ab	18.1bc	3.0	10.2
2388	0.4b	6.5c	3.0	9.6
2390	0.4b	17.4bc	3.2	10.1
2391	0.8ab	18.9bc	3.0	10.6
2392	0.9ab	29.4ab	3.4	10.7
2393	1.2a	8.1c	3.2	10.1
2461	0.3b	20.4bc	3.2	9.5
2462	0.2b	33.6a	3.4	11.2
2464	0.6ab	10.0c	3.5	8.7
2465	0.4b	30.9ab	3.0	8.7
2466	0.6ab	10.2c	3.0	9.5
2467	1.2a	14.1c	3.2	9.1
2468	0.4b	10.8c	3.2	9.3
Grand mean	0.6	12.4	3.2	9.9

DM: dry matter; FAT (%DM), Crude Protein: CP (%DM), MI: Minerals (%DM), CF: Crude fiber (%DM)

Table 6: Correlations between grain yields and phenological characters and Dry matter of the *Vicia narbonensis* l. species during the two experimental years

	EF	FFR	EPF	FM	TDM	NGP
Grain yield of *Vicia narbonensis* L.	0.54*	0.48*	0.85*	0.37ns	-0.16ns	0.51*

ns. *. **: Effect non significant and significant at 5 and 1% level. respectively. EF: Early flowering. FFR: Full Flowering. EPF: Early pod's formation. FM: Full maturity. TDM: Total dry matter. NGP: No. of grains per pod's

25 quintals ha^{-1} of dry fodder and 16.90 quintals ha^{-1} of grain, respectively (Table 3).

Chemical composition of seeds: Significant differences were observed for the chemical composition of seeds especially for fat and for crude protein ($p<0.01$) and no significant effect for crude fiber and minerals ($p>0.05$) (Table 4). The ecotypes 2393 and 2467 produce seeds with higher levels of fat (1.20%) and in total nitrogen (33.59%) for the ecotype 2462. (Table 5). The grain yield was positively correlated (r = 0.54*) with the number of days needed to reach the beginning of flowering, full flowering (r = 0.48*), early pod formation (r = 0.85*) and insignificant for the full maturity (r = 0.37 ns). However, it is negatively correlated (but not significantly) with the number of grains per pod (Table 6).

The study of correlations between the date of flowering, fertility (number of flowers per plant), grain yield and forage among ecotypes of *Vicia narbonenis* L. is presented in Fig. 1. It appears that there are positive and significant relationships (r = 0.54*) between flowering date and grain yield (Fig. 1a) on the one hand and between flowering date and forage yield (r = 0.38*) (Fig. 1b) on the other. Both positive relationships suggest that ecotypes with a long flowering period will give the best yields and fodder grain. We also did find a negative relationship (r = -0,11) but an insignificant one between the flowering date and the number of flowers per plant (Fig. 1c). This relationship shows that the altitude area or the low temperatures are frequent, that late ecotypes in flowering reduce their fertility and therefore reduce grain yield.

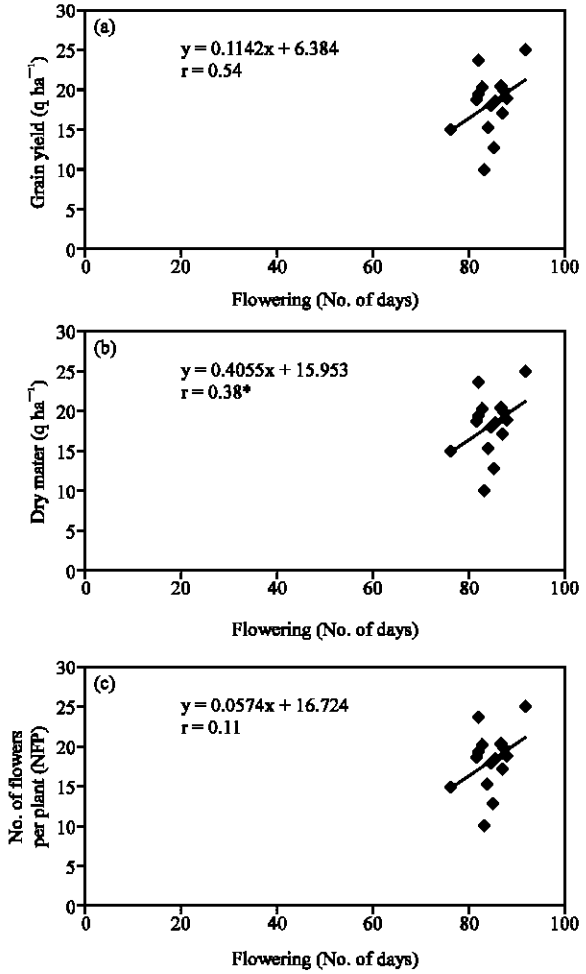

Fig. 1: Correlation between flowering and agronomic characters among 15 ecotypes of the species *Vicia narbonensis* L.: (a) date of flowering (DF) and grain yield (GY); (b) date of flowering (DF) and Dry matter (DM) and (c) date of flowering (DF) and number of flowers per plant (NFP)

DISCUSSION

Our results confirm those obtained in other studies indicating that the species *Vicia narbonenis* L. has good adaptation and having a good level of potential to Mediterranean regions where rainfall does not exceed 350 mm. In particular, the work of Abd-El-Moneim *et al.* (1988) and Abd-El-Moneim *et al.* (1990) which have shown that grain yields of *Vicia narbonensis* L.vary from 0.47 to 1.40 t ha^{-1} for rainfall 195 to 245 mm only. Also, Siddique *et al.* (1996), have reported that grain yield is equivalent to *Vicia faba* and the pea and most important to other species of vetch. This is why the possibility that this species could be used as a grain legume in semi-arid especially as food for livestock and, possibly, after selecting a greater appetite.

In our study and according to visual observations, we found that most ecotypes of *Vicia narbonenis* L. tested retain most of their leaves at maturity which gives them a provision to produce an interesting biomass. Similar observations were reported by Siddique *et al.* (1996) on the same species. Therefore, we have shown that this species could be used as fodder as well as a legume seed.

The great variability observed in phenological parameters evaluated for the 15 ecotypes of *Vicia narbonensis* L. gives the opportunity to make a selection, to choose the appropriate ecotype, to consider its inclusion as an element of recovery of fallow and this is according to climatic characteristics and nutritional needs of different systems of production (resources forage or food grains).

The semi arid Setif is characterized by low temperatures (below 4°C). These temperatures affect in most cases vetches fertility by inducing a reduction in the number of flowers per plant and consequently the decrease in grain yield (Baldy, 1974). The study of Ridge and Pye (2003) on pea cultivation in the Mediterranean climate of Australia have shown that yield reduction is due to extreme negative temperatures at the flowering stage.

Our results show a negative insignificant relationship between the period of flowering emergence and fertility (Fig. 1c). Thus, the later this stage is, the higher its fertility (number of grains per pod).

This is explained by a probable reduction in the number of flowers in late ecotypes in flowering. The works of Estelle (2008) indeed show that peas are resistant to frost the earliest at flowering (stage of floral initiation) and are therefore more fertile. These correlations between fertility and the period of flowering's emergence are confirmed by Pasquale (1998) both in legumes than in grasses.

Besides these aspects, the significant positive relationships that we have highlighted between characters including phenological stages of early flowering, full flowering, early pod maturity and complete maturity and forage yield, on the other hand, with grain yield (Table 4) show that the late ecotypes of *Vicia narbonenis* L. provide the best grain yields while avoiding frost.

In addition, these ecotypes are early enough to escape the summer drought stress. This increases grain yield coinciding with the decline in fertility can be explained by compensation of the low number of seeds by the elevation of the specific weight there after the very common late rain in the region of study (May-June). Present results are similar to those of Abd-El-Moneim (1992) and Siddique *et al.* (1996) who obtained a negative correlation between grain yield and flowering in *Vicia narbonensis* L. The same results were found by Mebarkia and Abdelguerfi (2007), on cultures of *Vicia ervilia*, *Vicia sativa* L. and *Vicia dasycarpa* in semi-arid.

These findings provide prima board to the possibility of direct selection on grain yield for late ecotypes to produce a food rich in nitrogen and seed. Concerning the ecotypes in early flowering and maturity, they can be used as grazing resources. In addition, the late ecotypes are most suitable for grazing because of their long flowering period and their good forage production.

These low-wind directions can be supported by the results obtained by Angelo (1987) who argue that the species *Vicia narbonenis* L. is ranked among the best species of the genus *Vicia* sp. due to its tolerance to cold and drought and its high production of fodder and grain. In terms of quality seeds, the results indicate a wide variability within ecotypes; the high total nitrogen content in narbon vetch grains could be a source of supplementary animal feed in the semi-arid and arid areas. Our results are similar to those obtained by Abd-El-Moneim (1992), Mihailovic *et al.* (2007) and Seymour *et al.* (2006), which were found in the same species of protein levels ranging from 23 to 28%. Others studies have reported that *Vicia narbonenis* L. provides high forage protein including the composition of amino acids which is similar to pea (Eason *et al.*, 1987; Petterson *et al.*, 1997) and its seed contains a good amount of sulfur in relation to other legume seeds (Enneking, 1995).

Compared with other species of vetch, *Vicia narbonensis* L. is well suited to seed production because it does not shatter (Angelova, 2007) when ripe and has an upright allowing mechanical harvesting (Abd-El-Moneim, 1992; Siddique *et al.*, 1996).

CONCLUSIONS

The obtained results show that the species *Vicia narbonensis* L. produces interesting grain, forage yield in semi arid regions in which the average annual rainfall do not exceed 350 mm. Wealth in total nitrogen of the seed can also be used as a component of feed concentrate. Some criteria are interesting for the selection of appropriate ecotypes in semi arid regions including the earliness to flowering and the number of grains per pod to overcome the decline in fertility among late ecotypes.

However, it has been established within the studied ecotypes that the best production of grain and dry matter is obtained by the late ecotypes in flowering and complete maturity because of the favourable rainfall conditions in late season.

This suggests a possible use of these ecotypes. Indeed, the great phenological variability found among 15 ecotypes of the studied *Vicia narbonenis* L gives the possibility to choose the appropriate ecotype in order to consider its inclusion as part of fallow recovery according to climatic characteristics and the specificities of different production systems.

REFERENCES

Abbas, K. and A. Abdelguerfi, 2005. Perspectives d'avenir de la jachère pâturée dans les zones céréalières semi-arides. Fourrages, 184: 533-546.

Abbas, K., M. Abdelguerfi-Laouar, T. Madani, A. Mebarkia and A. Abdelguerfi, 2005. Rôle et usage des prairies naturelles en zone semi-aride d'altitude en Algérie. Fourrages, 183: 475-479.

Abd-El-Moneim, A.M., P.S. Cocks and Y. Swedan, 1988. Yield stability of selected forage vetches (*Vicia* sp.) under rainfed conditions in west Asia. J. Agric. Sci., 111: 295-301.

Abd El-Moneim, A.M., M.A. Khair and P.S. Cocks, 1990. Growth analysis, herbage and seed yield of certain forage legume species under rainfed conditions. J. Agron. Sci., 164: 34-41.

Abd-El-Moneim, A.M., 1992. Agronomic potential of three vetches (*Vicia* spp.) under rainfed conditions. J. Agron. Crop Sci., 170: 113-120.

Angelova, G.Y.S., 2007. Study on the Productive Potential of Some *Vicia* L. Species. Plant Genetic Resources, Sadovo, Bulgaria, pp: 97-102.

Bahhady, F., E.F. Thomson and M. Boulad, 1988. Red meat production, marketing and trade in Syria. http://ressources.ciheam.org/om/pdf/a35/98606220.pdf.

Bahhady, F., S. Christiansen, H.C. Harris and E.F. Thomson, 1995. Performance of Awassi lambs grazing common vetch in on-farm and on-station trials. Regional Symposium on Integrated Crop-Livestock Systems in the Dry Areas of West Asia and North Africa, Amman (Jordan), Nov. 6-8. http://agris.fao.org/agris-search/search/display.do?f=1996/v2220/QV9600004.xml;QV9600004

Bahlouli, F., H. Bouzerzour and A. Benmahammed, 2008. Effets de la vitesse et de la duree du remplissage du grain ainsi que de l'accumulation des assimilats de la tige dans l'elaboration du rendement du ble dur (*Triticum durum* Desf.) dans les conditions de culture des hautes plaines orientales d'Algerie. Biotechnol. Agron. Soc. Environ., 12: 31-39.

Baldy, C., 1974. Contribution à l'étude fréquentielle des conditions climatiques. Leur Influence Sur la Production des Principales Zones Céréalières en Algérie, INRA-ITGC, pp: 152.

Bouzerzour, H. and A. Benmahammed, 1994. Environmental factors limiting barley grain yield in the high plateaus of Eastern Algeria. Rachis, 12: 11-14.

CIHEAM., 2006. Agriculture, pêche, alimentation et développement rural durable dans la région méditerranéenne. Annuel Rapport 2006, pp: 291-312.

Castleman, G.H., 1994. A Review of Narbon Bean (*Vicia narbonensis* L.). Victorian Institute of Dryland Agriculture, Mallee Research Station, Walpeup, Australia.

Cocks, P.S., E.F. Thomson, K. Somel and A.M. Abd-El-Moneim, 1986. Degradation and Rehabilitation of Agricultural Land in North Syria. ICARDA., Aleppo, Syria.

Cooper, P.J.M., P.J. Gregory, D. Tully and H.C. Harris, 1987. Improving water use efficiency of annual crops in the rainfed farming systems of West Asia and North Africa. Exp. Agric., 23: 113-158.

Durutan, N., K. Meyveci, M. Kraca and M. Avci, 1990. Annual Cropping Under Dryland Conditions in Turkey: A Case Study. In: The Role of Legumes in Farming Systems of the Mediterranean Areas, Osman, A.E., M.H. Ibrahim and M.A. Jones (Eds.). Kluwer Academic Press, Dordrecht, pp: 239-255.

Eason, P.J., R.J. Johnson and G.H. Castleman, 1987. Narbon bean a potential new grain legume for poultry. Proc. Nutr. Soc. Aust., 12: 119-119.

Enneking, D., 1995. The Toxicity of *Vicia* Species and Their Utilization as Grain Legumes. 2nd Edn., Centre for Legumes in Mediterranean Agriculture, University of Western, Perth, Australia.

Estelle, D., 2008. Tolérance au gel après acclimatation au froid chez le pois: Identification des protéines et cartographie PQL et QTL. Thèse de Doctorat Science, Lille I, 2008.

FAO., 1987. Agriculture Towards 2000. Food and Agriculture Organization of the United Nationals, Rome, Italy.

ICARDA., 2002. Annual Report for 2002. International Center for Agricultural Research in the Dry Areas, Aleppo.

Masson, P. and G. Gintzburger, 2000. Les legumineuses fourrageres dans les systemes de production mediterraneens: Utilisations alternatives. Proceedings of the Meeting of the Mediterranean Sub-Network of the FAO-CIHEAM Inter-Regional Cooperative Research and Development Network on Pastures and Fodder Crops, April 4-9, Sassari, Italy, pp: 395-406.

Mebarkia, A. and A. Abdelguerfi, 2007. Etude du potentiel agronomique de trios especes de vesces (*Vicia* sp.) et variabilite dans la region semi-aride de Setif (Algerien). Fourrages, 192: 495-504.

Mihailovic, V., A. Mikic and B. Cupina, 2007. Potential of annual legumes for utilisation in animal feeding. Biotechnol. Anim. Husbandry, 23: 573-581.

Pasquale, M., 1998. Influence of agronomic factors on the relation ship between forage production and seed yield in perennial forage grasses and legumes in a Mediterranean environment. Agronomie, 18: 591-601.

Petterson, D.S., J.B. Mackintosh and S. Sipsas, 1997. The Chemical Composition and Nutritive Value of Australian Pulses. Grains Research and Development Corporation, Barton.

Ridge, P.E. and D.L. Pye, 2003. The effects of temperature and frost at flowering on the yield of peas grown in a Mediterranean environment. Field Crops Res., 12: 339-346.

Seymour, M., K. Siddique, R. Jones and G. Riethmulle, 2006. Narbon Bean, a multi-purpose grain legume for the low cropping areas. Department of Agriculture and Food. Farmnote 23/2001.

Siddique, K.H.M., S.P. Loss and D. Enneking, 1996. Narbon bean (*Vicia narbonensis* L.): A promising grain legume for low rainfall areas of south-western Australia. Aust. J. Exp. Agric., 36: 53-62.