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Assessment of agromorphological diversity of chickling-vetch (*Lathyrus cicera* L.) landraces in the traditional agroecosystems of Morocco

Salama El Fatehi[1,2]*, Younes Hmimsa[1,2], Mohammed Ater[2]

[1]Department of Life Sciences, Polydisciplinary Faculty (Abdelmalek Essaadi University), Larache, Morocco
[2]Applied Botany Laboratory, Agro-Biodiversity Team, Department of Biology, Faculty of Sciences (Abdelmalek Essaadi University), Tetouan, Morocco

***Correspondence author: elfatehisalama@gmail.com**

Abstract

Legumes are an essential component of human and animal food, particularly in the Mediterranean area. While some legumes are widely cultivated and consumed, others are neglected and underused. This is the case of an ancient Mediterranean legume, chickling-vetch (Lathyrus cicera L.), currently considered as a marginal crop. In Morocco, this crop persists in some traditional mountain agroecosystems in the Tadla-Azilal region. This study allowed to specify the cultivated area and the socio-economic characteristics. The estimation of local ecotypes diversity was carried out using agromorphological descriptors on a collection gathering 13 accessions. The used descriptors include germination, phenology, morphology, and production. The analysis of variability revealed the existence of a structured diversity based on ecotypes differentiation with significant geographical and altitudinal influences. The absence of dormancy, precocity, and a short vegetative lifecycle unveil an interesting adaptive potential to aridity. Regarding productivity, the obtained estimates are comparable or above those mentioned in the literature for other provenances. Our results therefore show that local ecotypes contain important genetic resources for conservation and development. This is particularly relevant considering the current context of climate change, where the search for alternative crops, adapted to fit the predicted harsh conditions, is a priority for global food security.

Keywords: agrodiversity, alternative culture, chickling-vetch, local ecotypes, neglected and underused crops, phenotypic diversity.

Introduction

Despite the importance of “Plant Genetic Resources for Food and Agriculture (PGRFA)” diversity (FAO 1997), the evolution of agricultural production systems and the globalization of the economy have led to a drastic reduction in the diversity of cultivated species. In fact, human food is based on a reduced number of species threatening not only food security but also the future of agriculture and agroecosystems. However, many minor/neglected species can contribute to the diversification of needs and resources (Grela et al., 2012; Mikić and Mihailović 2014). Hence the importance of agrobiodiversity to ensure food security worldwide (Zimmerer and De Hann 2017).

In the Mediterranean region, the regional climate scenarios predict an increase in temperature and a decrease in precipitation (Gibelin and Deque 2003; Driouech et al., 2010; IPCC 2014; Polade et al., 2017; Lionello and Scarascia 2018). In this context, the search for alternative crops and production system/model is an absolute priority. The answer to this challenge would be to promote species and varieties that are well adapted to low soil quality and harsh environmental conditions while having good nutritional values. It would not be appropriate to focus on the improvement and the selection of varieties and genotypes from major crops. However, to relay on the potential of PGRFA and nurture agrodiversity by rehabilitating marginalized minor crops.

In Morocco, the practice of subsistence farming within the agrosilvopastoral production systems is still well represented in pedoclimatic zones considered unfavorable to the development of (intensive) agriculture (Kradi 2012). In this context, traditional agroecosystems represent an important reservoir of agrobiodiversity and a refuge for marginalized crops as reported in mountain agroecosystems (Djé et al., 2004; Hmimsa and Ater 2008; Ater and Hmimsa 2008) and in oases traditional agrosystems (Houssni et al., 2020). For instance, *Vicia ervilia,* a minor and marginalized legume persisting in the

Rif's agroecosystems, has shown an important agro-morphological, genetic, and symbiotic diversity well sought to withstand climate change adverse such as resilience to drought (El Fatehi et al., 2014; 2016; 2017). *Lathyrus cicera* L. or chickling-vetch, another minor and neglected crop, is still persisting in traditional agroecosystems of Tadla-Azilal region, where it is locally referred as "*Ikiker"*.

Chickling-vetch has been cultivated throughout southwestern Europe. Nowadays, it is only cultivated in few isolated areas in Spain (Peña-Chocarro and Peña 1999). It is a legume native to the western Mediterranean, as it is believed to have been domesticated between 3000 and 4000 BC in the south of France and the Iberian Peninsula (Kislev 1989; Grela et al., 2012; Vaz Patto and Rubiales 2014; Ferreres et al., 2017; Adak et al., 2019). In Morocco, this species persisting in some refuge areas, with scarce data for its cultivation and its history. Archaeological data (Ballouche and Marinval 2003; Morales et al., 2013) confirmed the presence of pea in some Neolithic sites, without confirming whether it is *L. sativus* or *L. cicera*. On the other hand, although the cultivation, cropping, and uses of this species are relatively well described by Christian and Muslim authors during the medieval period in Spain (FAO 1997; Carabaza 1991; Garcia Sanchez 1992), the citations during the same period are rarer in Morocco (Ruas et al., 2011; Berque 1978; Rosenberger 1980). Overall, these references show that this cultivated species was used as both human diet and animal fodder.

In the Mediterranean area and especially in North Africa, production systems are commonly affected by the scarcity of water resources. This constraint will worsen in the current context of climate change (Nefzaoui et al., 2012; Hopkins 2012; Norton and Volaire 2012). Therefore, it is important to seek alternative crops in forage legumes capable of ensuring a qualitative and quantitative satisfactory production under an arid environment. Hence the interest in the rehabilitation of an ancient legumes, currently neglected and marginalized (López-i-Gelats and Bartolomé 2012; Enneking and Miller 2014). The example of chickling-vetch local ecotypes, still cultivated in Morocco, represents a good opportunity where the conservation of scarce genetic resources coincides with the search for alternative crops as response to global changes.

Therefore, it was in the context of prospecting and recognizing neglected cultures with a view to their rehabilitation that this study was carried out. We ourselves set the following objectives: i) delimit the cultivation area of chickling-vetch in Morocco and describe the characteristics and traditional practices of this culture; ii) assess the diversity and polymorphism of local ecotypes using agro-morphological markers.

Results

Characterization of L. cicera agroecosystems and traditional practices

The cultivation of chikling-vetch is in decline although it is regularly practiced in the study area. Actually, the surveys carried out in the prospected sites have shown decreasing number of farmers practicing this crop annually. In fact, our results show that this number does not exceed 10 farmers per village. We have noticed that this crop has been abandoned in some douars close to urban areas such as Demnate and Kelaât Sraghna. However, and despite its abandonment, various traditional uses by local populations maintain its commercialization in the local markets and mills.

Agriculture in this region is rainfed, practiced under unfavorable conditions with poor soils and dependent on climatic hazards with recurrent droughts (Taibi et al., 2015). It is mainly characterized by the practice of food polycultures (cereals, legumes, market gardeners and fruit trees), a small agricultural plot, and the dominance of microfundia (micro-ownership with plots of less than five ha). Our surveys have shown that the average size of chickling-vetch plots is 0.7 ha and varies between 0.01 ha and two ha. Field management is not mechanized and agricultural work is carried out according to traditional local practices: plowing by animal, broadcast sowing, manual harvesting and threshing (Fig. 1 Supplementary). Chickling-vetch is cultivated in plots where cereals and legumes alternate. This is typically an organic agriculture without any chemical fertilizer inputs. Yields are relatively low, with an average of 8.5 qx / ha, ranged from a minimum of 3 qx / ha and a maximum of 13 qx / ha. The harvesting yield is sold to local stores at rural markets "*souks*" or few cereal mills in closest urban centers, hence, the marketing circuit is simple and closed. The market value varies between 550 to 850 Dh per qx. But it is generally sold in small quantities according to local units "*Aabra"* equivalent to 12-13 Kg. With such low profitability, it is maintained mainly for its domestic use or as an additional income.

The sowing seeds are exclusively of local origin. Farmers do not differentiate between varieties and call it by a single name "*ikiker*". It is for this reason that we prefer to speak for sampled accessions of ecotypes rather than local varieties. Typically, farmers take part of the crop to use as seed. Otherwise, they will borrow the seeds from other farmers or buy them at the weekly rural markets "souks". In neighboring regions where cultivation has been abandoned, the chickling-vetch is present in agroecosystems in a spontaneous form, forming part of the weed flora. Thus, alongside cultivated ecotypes, we can speak of spontaneous populations escaped from cultivated forms.

Evaluation of agro-morphological characters

Seed quality

The seeds of different ecotypes have excellent germination power (Table 1). The germination rate varies between 90 for *Bernat*-2 and *Tamarzokat*, and 100% for *Ouaoula*, *Ikharkhoud*, *Ait Ali-o-Mhand* and *Iaamouman*. The average germination observed for all populations is 96.41% with a low level of variation (CV less than 4%). Regarding precocity (PR), the seeds germinate from the first day and did not show any signe of dormancy. The total time to germination (GT) is short and varies between 2 and 3 days. Overall, the various parameters related to germination show a low level of variation between ecotypes and have relatively homogeneous characteristics.

Phenology

Regarding the phenology, the obtained results (Table 2) show a short cycle. Indeed, the appearance of the first flowers (FDF) takes place on average after about 50 days (49.54) and maximum flowering (BLO) is reached on average after 53 days (52.79). For pod formation (FDPO) and maturity (MAT) we observed early production and rapid ripening. Indeed, the first pods are observed from 72 days and the maximum maturity on average was observed on average at the 73rd days (73.25).

As for germination characteristics, we observed a low level of variability for phenology parameters with relatively narrow differences between different ecotypes. Thus, the maximum variation in flowering observed is 5 days and in maturity it is only 1 to 2 days. However, the analysis of variance (Table 2) showed that the differences between ecotypes are significant for both maximum flowering (BLO) and pod maturity (MAT). On the other hand, the multiple comparison of means reveals subgroups for these two characters (Table 2), thus showing a slight variation between ecotypes for flowering and maturity.

Morphology

The variability analysis of morphological characters includes plant height, diameter, and internodes, leaf length and width, and pod length and width. The results show a relatively low level of variability, which differs according to the studied characters (Table 1 supplementary). Generally, table 5 shows weak correlation between morphological characters. Even though, there are some cases of significant correlation between plant height (PLH) and leaf number (NLPL), and pod length (POL) and pod width (POW).

Despite the observed differences, the plant characteristics do not show any significant variations. In fact, only the length of the first internode (LFI) shows a significant inter-ecotype difference ranged from 19.62 mm in the *Bernat2* ecotype and 31.31 mm in *Ait Halwan*. However, multiple comparisons show the existence of groups differentiated by height (PLH) with a minimum height in *Bernat2* (572 mm) and maximum in *Ait Ali-o-Mhand* (730 mm). While the leaf width (LW) show significant variations between ecotypes ranged from 10.22 mm in *Iaamouman* and 20.35 mm in *Tamarzoukat*. Although the number of leaves (NLPL) and the leaf length (LL) show notable variations, the ecotype effect is not significant. However, the multiple comparison test of means still shows a differentiation of subgroups.

Regarding pod size, although the means by ecotype show a wide range of variability for length (POL) or width (POW), analysis of variance does not show an inter-effect. significant ecotypes even if multiple comparison of means shows the existence of subgroups.

In general, even if the variance analysis does not show any inter-ecotype differentiation by size, we can still consider the existence of significant size gradients for the plant, the leaf and the pod as shown in the multiple comparison test.

Production

For the evaluation of these traits, *Bernat2* ecotypes was excluded because they did not produce seeds. The analysis of variance shows no significant variation between ecotypes for traits related to biomass yield (BY), grain (SY) and the Harvest Index (HI) (Table 2 Supplementary). Furthermore, the biomass of ecotypes (BY) shows low CVs. However, SY and HI show slight variations in the ecotypes average values, without any significant inter-ecotype differences. This is due to the importance of the intra-ecotype variation. Furthermore, the pod weight (POY) is the only character that shows a significant difference between ecotypes according to ANOVA. For all ecotypes, POY shows an average value of 0.10 g with a minimum value of 0.04 g recorded for *Bernat3* and 0.22 g for *Ait Halwan*. Likewise, for the weight of 100 seeds (HSW), we observed a significant variation between a minimum of 5.61 g for *Bernat3* and a maximum of 8.45 g for *Ait Halwan*. For other parameters, even if the ANOVA was not significant, the observed differences between the ecotypes mean values are large enough to identify subgroups (Table 2 Supplementary).

Structuring variability

To get an idea on how this variability is structured, we carried out a principal component analysis (PCA) using characters related to phenology, morphometry, and production. In this analysis, we have excluded both the characters related to germination because they are homogeneous and do not vary significantly, and the *Bernat2* ecotype because they did not produce seeds. The first 3 components explain 70% of variability (Table 4). The first two components CP1 and CP2 explain about 60% of the variation. The projection of the populations on the plane (1 & 2) (Fig.1) shows a clear gradient structured along the axis 1. The CP1 is explained by the characteristics related to the pod (POY, POL, POW) in its positive side and characteristics related to production such as (HSW and HI) and phenological characteristics (FDF and BLO) for its negative part. In fact, the size and production traits are negatively correlated with the phenological traits (Table 3). Thus, the ecotypes with large pods and higher production have the lowest values for flowering, which means they are earlier. The main component 1 allows to classify the ecotypes according to the production and the phenology and discriminate the early flowering ecotypes (with large pods and more productive found in *Aït Halwan, Aît Ali-o-Mhand, Ikharkhoud,* and *Aït* Aarfa) from the late flowering ecotypes (with smaller pods and lower production found in *Tissa*, *Bernat3* and *Souk Nouzdir*). The remaining ecotypes have characteristics intermediate between the two groups. The *Tamarzoukat* ecotype is isolated by the 2nd main component, which discriminate according to the foliar characters (LL, LW). Thought, it is difficult to relate this gradient neatly to a geographic distance or an altitudinal gradient, we can still perceive that some opposing ecotypes on CP1 correspond to geographic and altitudinal isolations. In fact, if we take the *Aït-Ali-o-Mhand* and *Bernat3* ecotypes, they represent two poles opposed by geography and altitude. The first ecotype is located north of the cultivation area at a low altitude and the second is located on the south side at a higher altitude.

Discussions

The Tadla-Azilal region is considered as a refuge site where the cultivation of “species” has been preserved in the Moroccan mountain agroecosystems. Usually, mountainous areas have geographic and ecological aspects that promote agrodiversity (Zimmer et al., 2016). The characteristics of this type of agroecosystem such as isolation, local knowledge, traditional practices, hardy local varieties adapted to difficult conditions, and short circuits between producer and consumers explain the conservation of agro-diversity.

Field surveys and observations have shown a declining trend for this crop, whether by the number of farmers who still practice this crop or by the cultivated area. Certainly, low yields, prices, and market demand are not in favor of maintaining this crop. Therefore, self-consumption is the main current market. This evolution could also be explained

Table 1: The main parameters related to the germination of 13 ecotypes of *Lathyrus cicera.*

	Mean ± SD	Min.	Max.	CV (%)
GT (Days)	2.15±0.38	2	3	17
PR (Days)	1±0	1	1	0
PG (%)	96.41±0.034	90	100	4

SD: Standard deviation, Min: Observed minimal value, Max: Observed maximal value, CV: Coefficient of variation, GT: Germination time (Days), PR: Precocity (Days), PG: Percentage of germination (%).

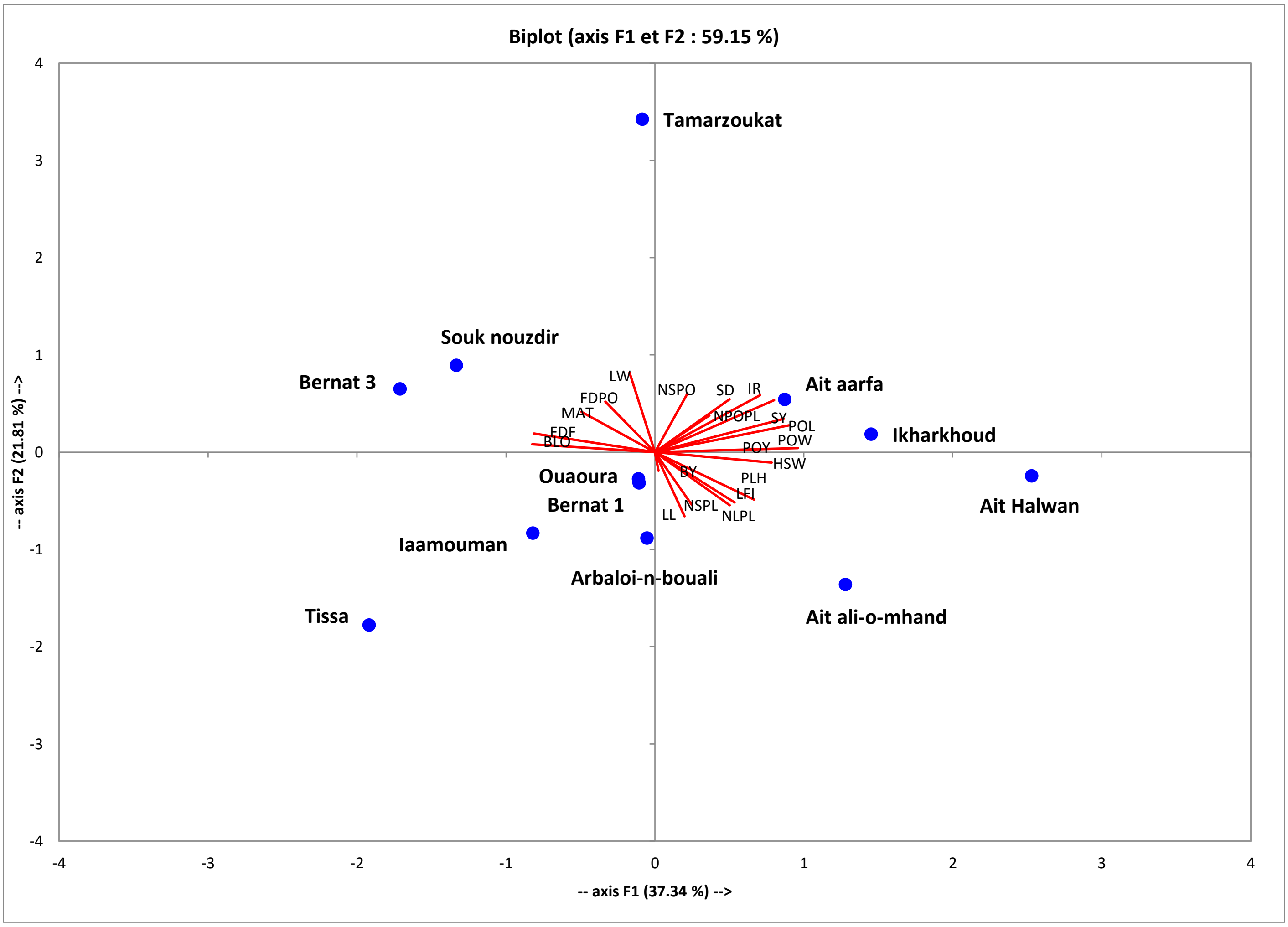

Fig 1. Projection of the plan [1, 2] of the principal component analysis (PCA). The blue dots represent the studied accessions. The red lines represent the projection of the measured characters. The corresponding codes are given in Table 4 Supplementary.

Table 2. The main parameters related to phenology of 13 ecotypes of *Lathyrus cicera*.

	Mean ± SD	Min.	Max.	CV (%)	F
DF (Days)	49.54±1.71	47	52	3.46	
BLO (Days)	52.79±1.56	50	55	2.96	3,274***
DPOM (Days)	72.31±0.48	72	73	0.66	
MAT (Days)	73.25±0.38	72.5	73.88	0.52	2,623**

SD: Standard deviation, Min: Observed minimal value, Max: Observed maximal value, CV: Coefficient of variation, F: Report of variance of the effect ecotype, ** Significant at $P < 0.01$, *** Significant at $P < 0.001$, FDF: First days to flowering (Days), BLO: Blooming (Days), FDPO: First days to pod maturity (Days), MAT: Maturity (Days).

Table 3: Correlation matrix. in bold the significant correlations at P <0.05

	PLH	SD	FI	NLPL	LL	LW	POL	POW	BY	SY	IR	NSPL	NPOPL	POY	NSPO	HSW	FDF	BLO	FDPO	MAT
PLH	1																			
SD	-0.187	1																		
LFI	0.514	0.122	1																	
NLPL	**0.672**	-0.156	0.426	1																
LL	0.483	-0.434	0.500	0.336	1															
LW	-0.386	0.363	0.422	-0.490	-0.516	1														
POL	0.549	0.523	.390	0.411	0.025	0.129	1													
POW	0.524	0.543	0.348	0.311	-0.038	0.169	**0.983**	1												
BY	0.191	-0.089	0.159	0.081	-0.025	-0.036	0.015	-0.037	1											
SY	0.112	**0.618**	0.045	-0.005	-0.148	0.278	**0.768**	**0.753**	0.033	1										
IR	0.214	**0.667**	0.111	0.126	-0.077	0.276	**0.857**	**0.837**	-0.116	**0.963**	1									
NSPL	0.075	0.134	0.498	0.551	0.213	-0.572	-0.007	-0.117	0.028	-0.164	-0.072	1								
NPOPL	-0.112	0.438	0.307	0.038	-0.235	0.088	0.306	0.312	0.084	**0.658**	0.571	0.015	1							
POY	**0.582**	0.517	0.539	0.447	0.260	-0.164	**0.886**	**0.846**	-0.114	**0.704**	**0.821**	0.253	0.247	1						
NSPO	-0.021	0.332	0.256	-0.070	-0.475	0.492	0.340	0.391	-0.216	0.318	0.389	-0.112	0.187	0.229	1					
HSW	0.490	0.330	0.466	0.375	0.203	-0.271	0.528	0.475	-0.151	0.471	0.572	0.467	0.246	**0.771**	0.367	1				
FDF	**-0.610**	-0.374	**0.783**	-0.331	-0.259	0.347	**-0.660**	**-0.686**	0.228	-0.360	-0.477	-0.239	-0.127	**-0.767**	-0.047	**-0.665**	1			
BLO	**-0.735**	-0.244	0.425	-0.344	-0.233	0.111	**-0.743**	**-0.690**	-0.345	**-0.596**	**-0.615**	-0.005	-0.088	**-0.770**	-0.016	**-0.621**	**0.597**	1		
FDPO	-0.437	-0.160	0.281	-0.469	-0.199	0.296	-0.051	0.007	-0.421	0.099	0.045	-0.485	-0.220	-0.177	0.221	-0.326	0.249	0.301	1	
MAT	-0.532	-0.085	0.092	-0.395	-0.186	**0.587**	-0.208	-0.206	-0.408	-0.205	-0.155	-0.258	-0.474	-0.351	0.186	-0.394	0.405	0.444	**0.681**	1

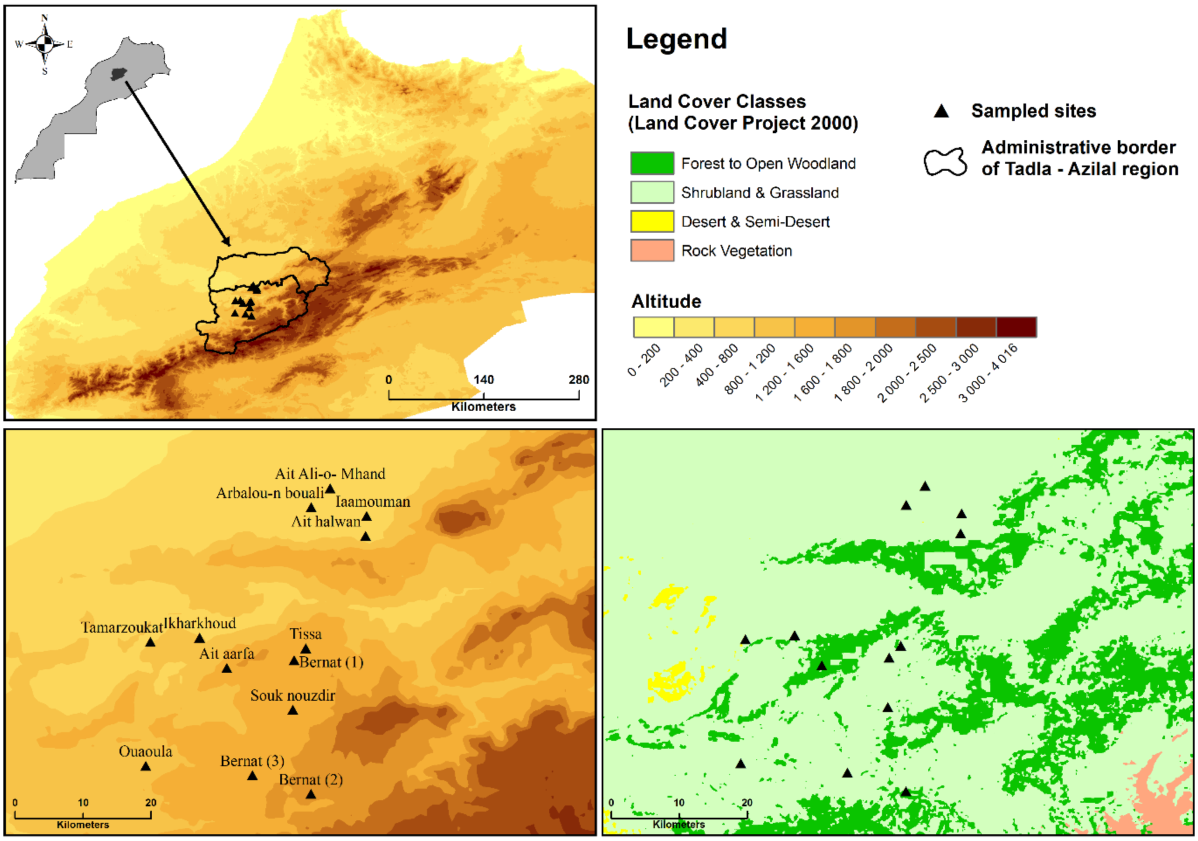

Fig 2. Maps showing the distribution area of the chickling-vetch crop and location of the sampled sites.

Table 4. Eigen values of the first three axis of the principal component analysis (PCA).

	F1	F2	F3
Eigen values	7.468	4.362	2.127
% variance	37.340	21.811	10.633
% cumulate variance	37.340	59.151	69.785

by the recent changes that the region has experienced development in terms of infrastructure and modernization of agriculture in the neighboring plains. These changes directly threaten the conservation of these genetic resources. This risk is high especially since Morocco does not have a national program for the collection and conservation of genetic resources and the rare accessions preserved have been collected within the framework of international programs (Francis et al., 1994). On the other hand, the alternative would be *in situ* conservation by preserving this crop and the practices associated with it. We believe that this culture should be promoted as part of a concerted and participatory program involving the local populations. A great effort would also be needed to promote its uses beyond the only current use as animal feed. For example, traditional dietary uses still practiced in this region such as soups and porridge made from chickling-vetch flour, which are very popular and commonly advised for diabetics diets. promoting local gastronomy based on local crops may lead to their preservation as suggested by recent studies (Hammer et al., 2019).

The assessment of diversity and polymorphism in the sampled ecotypes, which is considered representative of the chickling-vetch cultivation area in Morocco, was carried out using agromorphological characters. Our results are a preliminary contribution as they result from an experiment with potted plants grown in greenhouses while awaiting field trials. However, they provide interesting data on chickling-vetch local ecotypes in Morocco. On the other hand, the fact that our cultures were carried out under the same conditions makes it possible to minimize the environmental effects and appreciate the veiling genetic diversity. In general, our results show a relatively high variability for some characters but without causing a clear differentiation between different local ecotypes. Indeed, some characters show a low level of variation and some homogeneity. This is the case with the quality of the seeds where the three measured parameters (GT, PR, PG) show no significant difference between different ecotypes. In fact, the germination power of seeds is high (96.4%) with a low coefficient of variation (4%). In addition, the seeds are characterized by rapid and grouped germination, these results are comparable to those obtained in local ecotypes of vetch (El Fatehi et al., 2014). Likewise, for phenological characters, local ecotypes are characterized by early flowering (50 days) and grouped together. The available data show some variability in phenology according to provenances. Indeed, Larbi et al., (2010) found that it takes an average of 84 days for the onset of flowering in accessions from Syria, while Grela et al. (2012) showed that the onset of flowering was shorter (between 63 and 61 days) for populations from Italy, Spain, and Greece. Local ecotypes also showed early production (72 days), which is normal given the early flowering. In comparison with the values observed in other studies, this precocity is relatively high. Indeed, in other studies, we noted a late production estimated at 130 days (Larbi et al., 2010), 144 days (Hanbury et al., 1999) and 161 days (Siddique et al., 1996). The importance of the difference in the obtained values from the literature can be explained in part by the difference in the experimental devices used. Nevertheless, for Moroccan local ecotypes, our results show a definite tendency towards precocity with short vegetative cycles. This is an important agro-climatic character, especially in the Mediterranean where the irregularity of climate and recurrent droughts are common. Regarding morphological characters, despite the observed variability in the size of the plant, leaf, and pod, there was not a clear differentiation between ecotypes. On the other hand, the average size observed in local ecotypes with 625.8 mm is significantly higher than that observed in Greece (453 mm) (Grela et al., 2012), Spain (492 mm), Italy (554 mm) or Turkey (451 mm) (Adak et al., 2019). However, the pod in local ecotypes appears to be shorter with an average length of only 22.05 mm compared to other studies (Zawieja et al., 2016; Adak et al., 2019). While the width remains appreciably equal to that observed in the provenances mentioned above. For traits related to productivity in local ecotypes, seed weight (SY), index (HI) or pod weight show some differentiation. The comparisons with seeds from other provenances should be considered as an indication and with caution given the difference in the experimental designs and the fact that some local ecotypes (e.g. *Bernat2*) have not been produced by any farmer. Thus, we can estimate that the biological yield (BY) and the seed yield (SY) of local ecotypes are lower than those observed by Adak et al., (2019) and Siddique et al. (1996). The estimated harvest index (HI) also appears to be lower than those obtained by Siddique et al. (1999), Larbi et al. (2010) and Adak et al. (2019). Likewise, seed production per pod is lower than that observed by Siddique et al. (1999), Grela et al. (2012) and Adak et al. (2019). However, the weight of 100 seeds in local ecotypes is of the same order as that obtained by Sammour et al., (2007), greater to that of Siddique et al. (1999) and lower than that observed by Grela et al. (2012) and Zawieja et al. (2016).

Thus, the obtained data show that the observed variability exhibits some form of differentiation of ecotypes. In fact, the *Tamarzoukat* ecotype is clearly differentiated from other ecotypes by larger leaves. The other ecotypes can be arranged along an axis opposing two poles. Instead, more precocious and more productive ecotypes, on the other hand, less precocious and less productive ecotypes, and between the two, intermediate forms. This opposition could correspond to a form of adaptive response to an altitudinal gradient. The earlier forms are low altitude ecotypes like *Aït Ali-o-Mhand* located at 451 m altitude and the less early forms are high altitude ecotypes like *Bernat2* and *Bernat3* with respectively 1653 and 1407 m altitude. Despite this reservation made on comparisons with accessions from other provenances, the local ecotypes show interesting characteristics in terms of vegetative cycle and some components of productivity.

Material and methods

Surveys and sampling

Our visits to the regional agricultural services have identified the region where this crop persists. Field trips and surveys carried out in this region have made it possible to delimit the area where this culture is still practiced regularly. Geographically, it is located between Middle and High Atlas Mountains in the Tadla-Azilal region (Fig. 2). Out of the 42 rural communes of the province of Azilal, chickling-vetch is cultivated only in 16 communes (*Ouaouizerth, Aït Abbes, Ait M'hamed, Tilouguite, Ait Bou Oulli, Ouaoula, Tisqui, Taounza, Bin El Ouidane, Tamda Noumercid, Anergui, Tabaroucht, Ait Mazigh, Tanant,* and *Beni Ayat*). Thus, this region will constitute our study area where sampling, prospecting and surveys of farmers have been carried out. At the level of each commune, we interviewed an average of 5 farmers practicing this crop. The interviews were conducted using the technique of semi-structured surveys and based on pre-established questionnaires. This makes it possible to bring together two types of information: i) information of socio-economic aspects (the farmer, agricultural practices, land tenure, etc.) and ii) information concerning the cultivation of chickling-vetch (the origin seeds, field management, yields, prices, etc.).

Sampling was performing during spring when pods and seeds were mature, just before harvesting. Each accession is composed of 30 individuals sampled directly from the fields. The pods were sampled from individuals, randomly chosen along a diagonal line across the field. The plant material consists of 13 accessions collected in the unique growing area localized in Morocco for this culture, located in Tadla-Azilal region (Table 3 Supplementary), which is located at the southern end of the Middle Atlas and extending on the central High Atlas.

Evaluation of agromorphological characters

Germination

For each sampled ecotype, 30 seeds were used to carry out the germination test. After disinfection with a solution of sodium hypochlorite (5%) and rinsing with distilled water. The seeds were placed in Petri dishes on moistened filter paper and placed in the dark. Daily monitoring was adopted to evaluate the following parameters (Table 4 Supplementary): germination time (GT), precocity (PR) et percentage of germination (PG).

Greenhouse planting

After germination, 10 seedlings per ecotype were cultivated on potting soil in 1.5 L plastic pots. The pots were labeled and randomly placed in a greenhouse under natural light and temperature conditions. They were watered twice a week. From sowing to harvest, we adopted daily monitoring for the various measured parameters.

Agromorphological characterization

The monitoring of morpho-agronomic characters was based on 20 characters (Table 4 Supplementary): 4 for phenology, 8 for morphology (characterizing the size of the plant, leaves and pods) and 8 for productivity (characterizing the production and yield per plant). Each ecotype is represented by a repetition of 10 plants.

Statistics

Statistical analysis (descriptive statistics, analysis of variance (ANOVA) followed by multiple comparisons of means using Duncan's test, and principal component analysis (PCA)) were carried out using XLSTAT 13.1 and SPSS 17.0.

Conclusion

This work shows the lack of data on the current state of chickling-vetch cultivation in Morocco and shed light on this marginalized crop. It shows as well that this crop is a neglected and underused crop, but thanks to the persistence of traditional agricultural practices within mountain agroecosystems, its conservation is ensured. However, the decline in number of cultivated plot by this legume threaten its genetic resources and call for its urgent conservation. We believe that priority should be given to *in situ* conservation programs by supporting the persistence its culture and its recovery through the enhancement and diversification of its uses. The evaluation of diversity by agromorphological characters (germination, phenology, morphology and production) showed the existence of more or less variability depending on the considered character, which demonstrates some differentiation between the sampled ecotypes. Indeed, the limited connectivity between ecotypes has favored some differentiation through isolation. At the phenotypic level, there was a sufficient level of variability to differentiate the ecotypes suggesting the existence of significant genetic diversity. An approach using genetic markers would allow this hypothesis to be verified and this diversity to be measured. Agronomically and in relation to the adaptive potential for aridity, local ecotypes demonstrated interesting aptitudes for selection. In particular, characteristics related to vegetative cycle and some components of productivity. Given its potential for tolerance to aridity and its production capacity in difficult conditions, chickling-vetch represents an interesting alternative crop in the context of global changes.

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