International Journal of Innovative Approaches in Agricultural Research
2018, Vol. 2 (2), 79-102
https://doi.org/10.29329/ijiaar.2018.141.2

Original article

Contribution to the Agro-Morphological Characterization of Three Vetch Species (Vicia Spp.) in the Setif Semi-Arid Region by Discriminant Factorial Analysis (ADF)

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Abstract

The issue of the sustainable development of livestock systems in Algeria is part of the way to resolve the issue of the growing gap between forage supply and the needs of a growing livestock herd.

The study undertaken is a contribution to the agro-morphological characterization of vetch and the determination of its place in the feeding of animals and also to highlighting the current situation of forage (cultivated and natural) - case of the vetch - in the semi-arid zone of Setif**.**

In this study where the general objective is to characterize agro-morphologically the species of vetch the same variables used were included for two statistical analysis approaches, the first descriptive and the second discriminant, which are Variance study and comparison of means and discriminate factor analysis (AFD) whose results corroborate. These analysis have detected significant differences of the input of the three species where the third one (*V. sativa*) which is obvious from all the variables by: Nr, Lrp, Ngrg, Ngrp, Pgrp and for the two sites involved (Northern and Centre of Setif). It is also clear from these analyzes that the variables that have the most weight or the most relevant in discriminating between the three species are Ngrp , Nfr, Lrp and Ngp. Variety evaluation allowed to see a lack of distinction between the varieties of the two introduced species 1 and 2 (*V. ervilia* and *V. narbonensis*); a difference of 70 % was found between the varieties of local specie 3 (*V. sativa)*. On the other hand, we can assume that these "emerging" varieties of species 3 (José, fig and even Baraka, 715 and 709) exhibit a fairly large phenotypic diversity that can provide a broad genetic base that can potentially serve in improvement programs.

In view of the great variability observed in many traits measured for the three vetches studied, this offers the possibility of choosing the species suitable for the development of the forage area in semi-arid zones, depending on the climatic characteristics and different production systems; especially if the introduced varieties do not meet the conditions of the region.

So we can infer that these three species have different uses for their agronomic traits related to biomass production and grain yield, they have considerable potential fodder, especially *V.sativa* which we can offer as complete feed for use on different forms.

Keywords: Agro-morphological characterization, Vetch, Forage, Semi-arid zones, Livestock systems.

Received: 28 February 2018 * **Accepted**: 19 May 2018 * **DOI**: https://doi.org/10.29329/ijiaar.2018.141.2

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INTRODUCTION

In what terms, the question about forage production in Algeria, is today:

* Structurally deficient supplies in relation to livestock needs?

* Availability of sole poorly distributed in space and time?

* The availability of a very narrow forage range?

Indeed, feeding cattle is based on common land (Dekhili et al., 2007) on the stubble grazing, vegetation land left fallow and hay associations vetch oats (Mebarkia, 2007). A such power source very shy, hardly allows an intensive breeding and rearing performant- which is an integral part of the production-systems; It exposes it rather to the vagaries of the climate and the chronic deficiencies in digestible nitrogen and metabolizable energy (Mébarkia, 2007).

This deficit can be compensated according to Abdelguerfi (1976), Leeuwrick (1976), Krauss et al. (1988) and Jones (1990), by developing forage legumes appropriately, and according to Abbas and Abdelguerfi (2005) considering the fallow as a component of Cereal/sheep production systems because it is a tool in the fight against the Climate hazard.

Pulse crops represent by their agronomic benefits as well as biological and other, forage that can be directly grazed by small ruminants, an appreciable nutritional supplement to fallow land (Oram, 1956).

As arable forage legumes, vetches are an excellent substitute feed for livestock (Laumont, 1950). They are generally used in combination with oats; in Switzerland for example, with their autumnal rye, Italian ryegrass and crimson clover (Kauter, 1947; Caputa, 1948; Lehman and Briner, 1975; quoted by Troxler, 1979), their pure culture, if all the favorable conditions are suitable, could give good results.

Before any initial action, it is imperative to proceed first with the characterization of these forage resources. Thus, it is in this context that our work integrates. It aims to characterize morphologically certain species of vetch in the semi-arid region of Setif, to identify the most discriminating variables and to find the most relevant and best-performing varieties to satisfy the food needs (Both quantitatively and qualitatively).

Material and Methods

The trial was carried out in the central zone of Sétif, at the experimental station of the Technical Institute of Great Cultures (ITGC), which is a site located to the southwest and at 5 km from the commune of Sétif whose lands are crossed by Oued Bousellem, by about 1081 m of altitude and characterized by a continental climate with strong thermal amplitudes, both annual and therefore daily, with very hot and dry summers and very severe winters with low and irregular rainfall-450 mm on average-(Seltzer, 1946).

Climatic conditions of the experiment

Table 1. Climatic conditions of the companion (2007-2008)

Months	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Total
Min. Temperature (C°)	35.80	28.10	20.20	15.80	18.20	21.20	21.10	19.25	32.49	39.56	39.20	/
Max	11.40	08.20	00.20	-2.40	-2.60	-1.44	-0.06	07.55	08.36	10.57	14.60	/
Rainfall (mm)	79.50	25.30	16.50	06.00	10.00	19.30	48.90	21.30	75.80	15.20	54.50	372.3

Table 1 shows that the year of experimentation (2007/2008) was dry, characterized by a small amount of rain (372.3 mm), which did not even reach the usual average of the region (450 mm) in addition to Poor distribution of precipitation.

In terms of temperature, lower temperatures are frequent in this season and most often coincide with the flowering stages of legumes where certain flowers are aborted (Mars, April and May). According to Mebarkia and *al.* (2007), if frost and sirocco occur in the first dekad of May, they can cause abortion of flowers (sirocco, which is likely to occur in early May, is the main cause of drying out reproductive organs).

The maximum temperatures are also very important, they occur at the end of the cycle of the legumes where they promote the fertility of the pods (their filling).

The data indicate that it was colder during the months of December (2007) and January (2008) with 6.7°C and 7.8°C respectively, where as for the other months the temperatures were relatively mild, August was the warmest with an average temperature of 28.2°C.

Tested vegetable material

The trial included three species of vetches (*Vicia sativa L.*, *Vicia ervilia L.* and *Vicia narbonenses L.*), each of them represented by six varieties supplied by the Setif ITGC station, as shown in Table 2.

Table 2. List of experiential species and varieties

Species / Varieties	Sp. 1 *Vicia ervilia L.*	Sp.2 *Vicia narbonensisL.*	Sp.3 *Vicia sativa L*
V1	IFVE 2799 Sel2510	2561-ICARDA	José (local)
V2	IFVE 2801 Sel2511	2580-ICARDA	Fig (//)
V3	IFVE 2801 Sel2512	2583-ICARDA	Baraka (//)
V4	IFVE 2801 Sel2513	2588-ICARDA	715 (//)
V5	IFVE 2801 Sel2515	2590-ICARDA	709 (//)
V6	IFVE 2801 Sel2516	2591-ICARDA	Hifa (//)

Experimental protocol and conduct of the experiment

The test was established according to an experimental block protocol which follows a complete randomization (Fig. 1).

The seeding was carried out manually on 25/12/2007 at a depth of 2-3 cm, on a plot with a cereal as a preliminary crop and on which different cultivation work was carried out (Table 3).

This main plot is divided into elementary plots spaced 80 cm apart and divided into three repetitions. Each of these elementary parcels is represented by two lines 2.5 m long and spaced 60 cm apart; 15 seeds were sown per line.

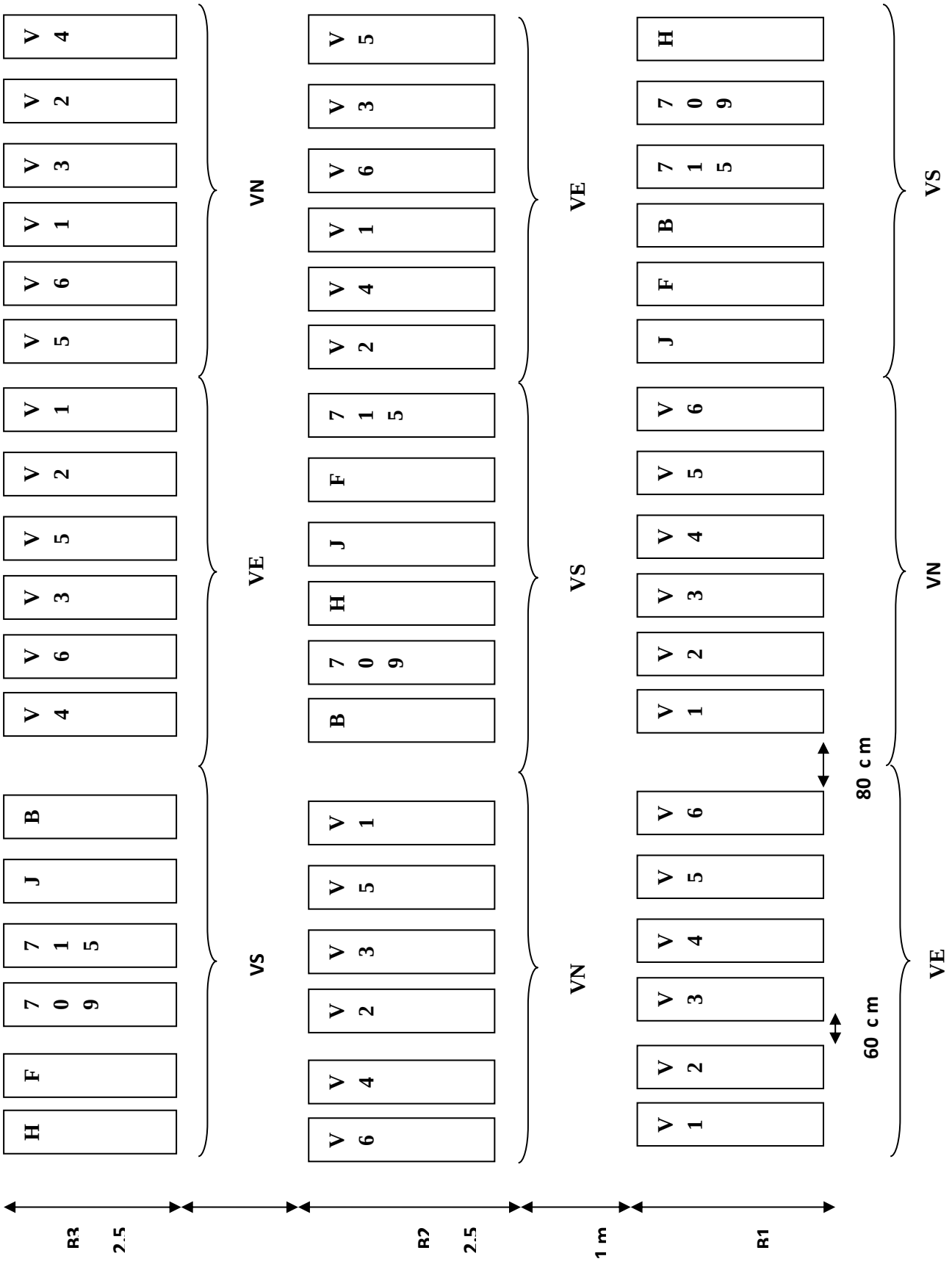

Figure 1. Experimental protocol

Conduct of culture and maintenance

Soil preparation according to Table 3, and throughout the crop, weeding was done manually on a regular basis to avoid competition by weeds.

No significant diseases or accidents have been observed in all species of *Vicia sp*. during the year of the experiment. However, we can record the appearance of black aphids on some plants but without causing significant damage.

Table 3. Cultural practices carried out on the experimental plot

Date	Cultural practices
Early September	Deep plowing 25 cm
End of September	Tillage
End of September	Spreading of background fertilization (TSP100 Kg / ha)
Novembre	Tillage and harrowing before sowing and weeding by Tréflon near-sowing in 2 l/ha

Data collection and analysis

The measurements and ratings were carried out on the field and in the laboratory for each species and at different periods of the vegetative cycle.

Ten variables were selected for measurement. They relate to biometric characteristics and performance components. These are all continuous or quantitative variables (Table 4).

Table 4. List of measured variables

Variables	Notation
Number of branches Nr	Nr
Length of main axis	Lrp
Number of sheets on main axis	Nfe
Number of flowers	Nfr
Number of pods / plant	Ngp
Weight of pods / plant	Pgp
Number of seeds / pod	Ngrg
Number of seeds / plant	Ngrp
Seed weight / plant	Pgrp
Yield	Rdt

The analysis program used for the statistical processing (of the collected data) is SPSS STATISTICS, version 17.0.0 (23 August 2008).

Treatment of data of two sites by statistical approaches (univariate and multivariate approaches)

The data generated from this experiment were subjected to the univariate (inter and intra-specific) descriptive analysis, allowing first to test the differences between the three species studied and secondly to obtain the descriptive results. Then, a DUNCAN test was used to obtain homogeneous groups.Once the first approach was completed, discriminate factor analysis was performed (AFD); The importance of the discriminating functions was judged according to the eigenvalues associated with them, the canonical correlations and the khi-2 transform of the Wilks Lamda statistic.

Results and discussion

Descriptive analysis

Species Factor Results (Site 1 Center)

The general mean and the least squares are shown in Table 5. According to these results, *Vicia ervilia* has the highest averages for four variables (Nfe, Nfr, Ngp and Ngrp). It resembles to the species 3 (*Vicia.sativa*) by three variables (Pgp, Pgrp and Rdt) which constitute variables common to these two species at site 1 (Center). However, this same species is different from the two others by seven variables (Nfe, Nfr, Ngp, Ngrg, Nr, Lrp and Ngrp) or a distinction of 70%.

Table 5. General averages with their standard error (S.E.), coefficient of variation (CV) and LSM for each species, analyzed for each of the variables studied (Site Center)

Variables	General average	C.V.	*Vicia Ervilia* (LSM and S.E.)	*V.Narbonensis* (LSM and S.E.)	*Vicia sativa* (LSM and S.E.)
Nr	3.6±1.52	65.04	$4.02^{a} \pm 0.17$	$2.33^{b} \pm 0.18$	$4.45^{a} \pm 0.19$
Lpr	27.9±3.21	36.32	$20.45^{c} \pm 0.77$	$30.37^{b} \pm 0.80$	$33.8^{a} \pm 0.83$
Nfe	22.58±3.6	57.54	$27.9^{a} \pm 0.99$	$20.00^{b} \pm 1.02$	$19.18^{b} \pm 1.07$
Nfr	31.87±5.63	99.42	$50.67^{a} \pm 2.42$	$14.45^{c} \pm 2.52$	$28.72^{b} \pm 2.61$
Ngp	24.79±5.34	114.94	$41.83^{a} \pm 2.17$	$10.48^{c} \pm 2.25$	$20.55^{b} \pm 2.35$
Pgp	7.09±2.78	99.78	$6.13^{b} \pm 0.50$	$9.07^{a} \pm 0.56$	$6.05^{b} \pm 0.58$
Ngrg	3.90±1.00	25.80	$3.16^{c} \pm 0.08$	$3.97^{b} \pm 0.08$	$4.69^{a} \pm 0.08$
Ngrp	69.98±8.48	102.82	$95.6^{a} \pm 5.50$	$35.55^{c} \pm 5.68$	$77.66^{b} \pm 5.93$
Pgrp	5.28 ± 2.35	104.98	$5.02^{b} \pm 0.42$	$6.69^{a} \pm 0.44$	$4.08^{b} \pm 0.46$
Rdt	3.20 ± 1.91	114.37	$2.73^{b} \pm 0.28$	$4.15^{a} \pm 0.20$	$2.70^{b} \pm 0.30$

Variables: Nr= Number of sprouts; Lrp=Length of the main branch ; Nfe=Number of leaves; Nfr= Number of blossom; Ngp=Numbre of pods per plant; Pgp= weight of the pods per plant; Ngrg= Number of seeds per pod ; Ngrp= Number of seeds per plant; Pgrp= Weight of the seeds per plant ; Rdt= Yield.

a-c :Values connected with different letters differ significantly ($P<0.05$)

C.V: coefficient of variation; LSM: least squares means; S.E. :Standard error

Species Factor Results (Site 2 North)

The data for site 2 (North) (general averages and the least squares) are shown in Table 16. These results show that species 3 (*V. sativa*) has the highest values ($p < 0.05$) for 9 variables species, that is to say 90% in relation to the two other species; according to Table 17, it resembles to species 2 (*V. narbonensis*) only by a single variable (Pgp) and to species 1 (*V. ervilia*) by two characters (Nfe and Pgp); But at the same time it differs from the two by eight variables, that is to say 80% of distinction.

Species 1 (*V.ervilia*) holds the highest averages for all variables (100%) compared to species 2 (*V. narbonensis*); It resembles two variables (Lrp and Pgp) and resembles species 3 (*V.sativa*) by (Nfe and Pgp) but differs from these two species by seven variables (Nr, Nfr, Ngp, Ngrg, Ngrp, Pgrp, Rdt) or 70% distinction.

For *Vicia narbonensis*, its averages remain the lowest of the three species for all characters; It resembles to the other two species by the characters: Lrp, Nfe and Pgp and is distinguished by the remaining variables (Nr, Nfr, Ngp, Ngrg, Ngrp, Pgrp and Rdt).

This reflects a highly significant distinction between the three species; And among the 10 quantitative descriptors measured, the most discriminating ones are the variables: Nr, Nfr, Ngp, Ngrg, Ngrp, Pgrp and Rdt; However, the weight of pods per plant (Pgp) is considered to be the most important variable of similarity.

The clear fluctuation of the coefficient of variation from 33.8 to 124.22 reflects a wide variability between the three species studied in accordance with the results of the averages comparison.

Table 6. General averages with their standard error (S.E.), coefficient of variation (CV) and LSM for each species, analyzed for each of the variables studied (Site North)

Variables	General average	CV	V.*ervilia* (LSM and S.E.)	V.*narbonensis* (LSM and S.E.)	*V.sativa* (LSM and S.E.)
Nr	2.66±0.09	65.07	2.99^{b}±0.12	1.15^{c}±0.03	4.05^{a} ±0.22
Lpr	256.76±5.72	33.80	201.89^{b}±3.99	194.43^{b}±4.7	398.73^{a}±11.29
Nfe	22.34±1.31	124.22	29.18^{a}±3.38	11.84^{b}±0.21	26.42^{a} ±1.09
Nfr	20.67±0.97	78.16	27.57^{b}±1.35	2.00^{c} ±0.10	34.40^{a} ±1.89
Ngp	15.81±0.77	83.83	20.87^{b}±1.15	1.45^{c}±0.06	26.07^{a} ±1.49
Pgp	19.47±15.22	1716.51	3.42^{a}±0.19	0.71^{a}±0.04	61.63^{a} ± 52.12
Ngrg	3.42±0.09	45.12	3.42^{b}±0.17	2.00^{c}±0.07	5.10^{a} ±0.08
Ngrp	49.79±2.93	95.12	44.67^{b}±2.18	2.85^{c}±0.17	112.03^{a} ±6.87
Pgrp	2.80±0.15	97.91	2.86^{b}±0.16	0.47^{c}±0.03	5.49^{a} ±0.37
Rdt	22.66±1.26	99.6233.	23.21^{b}±1.32	3.93^{c}±0.24	44.62^{a} ±3.14

Variables: Nr= Number of sprouts; Lrp=Length of the main branch ; Nfe=Number of leaves; Nfr= Number of blossom; Ngp=Numbre of pods per plant; Pgp= weight of the pods per plant; Ngrg= Number of seeds per pod ; Ngrp= Number of seeds per plant; Pgrp= Weight of the seeds per plant ; Rdt= Yield.

a-c :Values connected with different letters differ significantly ($P<0.05$) ;

C.V: coefficient of variation; LSM: least squares means; S.E. :Standard error

Table 7. List of variables of resemblance and distinction between species (Site North)

Combination between species	Variables of similarity	Variables of distinction	% of distinction
Sp.1 * Sp. 2	Lrp, Pgp	Nr,Nfe,Nfr, Ngp, Ngrg,Ngrp, Pgrp Rdt	80 %
Sp.1 * Sp. 3	Nfe, Pgp	Nr, Lrp,Nfr,Ngp, Ngrg,Ngrp,Pgrp, Rdt	80 %
Sp.2 * Sp. 3	Pgp	Nr,Lrp,Nfe, Nfr,Ngp,Ngrg, Ngrp, Pgrp, Rdt	90 %

Species Factor Results (Center + North Sites)

The combined analysis of the results of the two sites (Center + North) was carried out according to the same approaches as previously and Table 24 presents the general averages and the least squares mean that, on the one hand, species 3 (*V.sativa*) showed the best means compared to the two other species (*V.ervilia* and *V. narbonensis*) for 7 variables (Nr, Lpr, Pgp, Ngrg, Ngrp, Pgrp and Rdt) or 70%; According to Table 25, it is 90% distinct from each of the other two species by the same variables (Nr, Lrp, Nfe, Nfr, Ngp, Ngrg, Ngrp, Pgrp, Rdt), But there is a single variable common to all species witch is Pgp, as a similarity variable. On the other hand species 1 (*V.cia ervilia*) holds 80% of the highest averages compared to species 2 (*V. narbonensis*). It resembles it by three variables (Lrp, Pgp and Pgrp) and is distinguished from it by seven variables (Nr, Nfe, Nfr, Ngp, Ngrg, Ngrp, Rdt). This allows us to declare that the three species are divergent with a rate of 70%. We also note that the common discriminating variables are Nr, Nfe, Nfr, Ngp, Ngrg, Ngrp, Rdt and here again the variable Pgp behaves as the most important similarity variable.

The large variation of the coefficient of variation (39.09% -160.09%) confirms the result of the comparison of the averages, and reflects the great variability of the species studied.

Table 8. General averages with their standard error (S.E.), coefficient of variation (CV) and LSM for each species, analyzed for each of the variables studied (Center + North sites)

Variables	General average	CV	Sp.1	Sp.2	Sp.3
Nr	3.12±0.07	67.40	3.50[b]±	1.72[c]±	4.25[a]±
Lpr	142.93±4.46	96.67	111.97[b]±	114.40[b]±	212.49[a]±
Nfe	22.46±0.70	97.49	28.55[a]±	15.82[c]±	22.73[b]±
Nfr	26.23±0.85	100.26	39.02[a]±	8.03[c]±	31.50[b]±
Ngp	20.28±0.75	114.60	31.26[a]±	5.85[c]±	23.55[b]±
Pgp	13.31±7.66	1781.16	4.76[a]±	4.79[a]±	33.26[a]±
Ngrg	3.66±0.04	39.09	3.29[b]±	2.96[c]±	4.89[a]±
Ngrp	59.83±2.07	107.08	69.91[b]±	18.80[c]±	94.48[a]±
Pgrp	4.03±0.15	118.53	3.93[b]±	3.49[b]±	4.77[a]±
Rdt	12.96±0.67	160.09	13.06[b]±	4.04[c]±	23.08[a]±

Table 9. List of variables resemblance and distinction between species (Center + North Sites)

Combination between species	Variables of similarity	Variables of distinction	% of distinction
*Sp.1 *Sp. 2*	*Lrp, Pgp,Pgrp*	*Nr,Nfe,Nfr,Ngp,Ngrg,Ngrp,Rdt*	*70 %*
*Sp.1 *Sp. 3*	*Pgp*	*Nr, Lrp,Nfe, Nfr, Ngp, Ngrg, Ngrp, Pgrp, Rdt*	*90 %*
*Sp.2 *Sp. 3*	*Pgp*	*Nr,Lrp,Nfe Nfr,Ngp,Ngrg, Ngrp, Pgrp, Rdt*	*90 %*

Discriminant factorial analysis

This analysis studies data from groups known a priori, it has two main goals (Anonymous, S.D.):

i-Description: Among the known groups, what are the main differences that can be determined using the variables measured?

ii-Ranking: Can the group of belonging of a new observation be determined only from the measured variables?

By its objectives, it is also related to neural networks, a subject very fashionable in computer research (Anonymous, S.D.).

According to DesBois (2003) and Anonymous (S.D.), this analysis can be carried out according to two different approaches: the first with a descriptive orientation, centered on the decomposition of the variance, based on geometric notions. The second decision-oriented approach focuses on the risk of error by using probabilistic (simplified) modeling.

Results of the statistical test of equality of groups averages (sites 1+2):

Table 10. Test of equality of groups averages

Parameters	Lamda de Wilks		F		ddl1		ddl2		Significance	
	Site 1	Site 2	Site 1	Site 2	Site 1	Site 2	Site 1	Site 2	Site 1	Site 2
Nr	0.798	0,680	120.059	112.967	2	2	955	479	0.000	0.000
Lrp	0.904	0.476	50.904	263.972	2	2	955	479	0.000	0.000
Nfe	0.944	0.927	28.356	18.732	2	2	955	479	0.000	0.000
Nfr	0.793	0.574	124.410	177.847	2	2	955	479	0.000	0.000
Ngp	0.820	0.598	1.501	160.822	2	2	955	479	0.000	0.000
Pgp	**0.997**		**1.457**		2		955		**0.235NS**	
Ngrg	0.752	0.606	157.567	155.520	2	2	955	479	0.000	0.000
Ngrp	0.808	0.540	113.322	203.812	2	2	955	479	0.000	0.000
Pgrp	0.988		5.643		2				0.004	
Rdt	0.991		4.097		2				0.017	
					2					

NS: Not significant (P> 0.05); P<0.00 high significant difference

According to Table 10 for all values of F of site 1 which vary between 1.454 and 157.567 (for a risk of error P<0.0005), we are required to reject the null hypothesis (H0) of equality of group averages (species) for all the variables (Nr, Lpr, Nfe, Nfr, Ngp, Ngrp, Ngrg, Pgrp and Rdt) except for the variable Pgp which holds the lowest value of F (F = 1.457 with P> 0.05). Regarding the site 2, the null hypothesis (H0) of equality of the group averages was also rejected for values of F which vary between 18.732 and 263.972 for all values retained for this study (Nr, Nfe, Nfr, Ngp, Ngrg, Ngrp).This proves that the three species are clearly different at the two sites. However, according to Wilks' Lamda values, a number of overlaps exist between the three species for measurements performed for both sites (except for Pgp for site 1).

Box test for equality of local variance-covariance matrices:

For this test, only 7 to 8 variables were retained. The logarithm values of the determinants of the variance-covariance matrices (Table 11) reflect the variability of the species as a function of the explanatory variables of dimension 8 for the site 1 and 7 for the site 2; Thus, for both sites, species 1 (Vicia ervilia) with a determinant log. of 37.590 and 32.487 respectively, appears to be the species with the most variability with respect to these 8 measurements for site 1 (Nr, Lrp, Nfe, Nfr, Ngp, Ngrp, Ngrg, and Pgrp) and 7 measurements for site 2 (Lrp, Nr, Nfe, Nfr, Ngp, Ngrg, Ngrp); it is therefore the most heterogeneous, followed by species 3 (Vicia sativa) with a determinant log of 36.226 for site 1 and 32.424 for site 2, which gives it a very acceptable heterogeneity rate, while Vicia narbonensis (species 2) appears to be the most homogeneous (log.determinant = 25.043 for site 1 and 7.426 for site 2).

From these results, we are led to reject the null hypothesis of equality of the variance-covariance matrices between the three species of vetch for site 1 as well as for site 2 and to consider them as different. However, according to DesBois (2003) the Box test is considered sensitive to the lack of multinormality, so we must remain cautious about the conclusion of the test.

Table 11. Logarithms of determinants

Species	Rang		Log. determinant	
	Site1	Site2	Site1	Site2
1	8	7	37.590	32.487
2	8	7	25.043	7.426
3	8	7	36.226	32.424
Within group	8	7	37.517	32.435

Step by step statistics of species

Table 12. Statistics step by step[a, b, c, d] (Site1)

Step	Variable	.Lamda de Wilks							
		Statist.	ddl1	ddl2	ddl3	F.exact			
						Statist.	ddl1	ddl2	Signi
1	Ngrg	0.752	1	2	955	157.567	2	955	.000
2	Nfr	0.610	2	2	955	133.737	4	1908	.000
3	Pgrp	0.546	3	2	955	112.227	6	1906	.000
4	Ngrp	0.474	4	2	955	107.762	8	1904	.000
5	Nr	0.442	5	2	955	95.756	10	1902	.000
6	Lrp	0.422	6	2	955	85.281	12	1900	.000
7	Ngp	0.407	7	2	955	76.857	14	1898	.000
8	Nfe	0.398	8	2	955	69.442	16	1896	.000

At each step, the variable that minimizes the largest number of Wilks L. is entered.

a: the maximum step is 20

b: the partial minimum F to be entered is 3.84

c: the partial maximum F to be entered is 2.71

d: F tolerance level, or VIN insufficient for further computation

Table 13. Statistics step by step[a, b, c, d] (Site2)

Step	Variables	Lamda de Wlks							
		Statistique	ddl1	ddl2	ddl3	F. exact			
						Statist.	ddl1	ddl2	Signi.
1	Lrp	0.476	1	2	479	263.972	2	479	0.000
2	Nfr	0.313	2	2	479	188.429	4	956	0.000
3	Ngrg	0.256	3	2	479	155.143	6	954	0.000
4	Ngrp	0.234	4	2	479	127.101	8	952	0.000
5	Ngp	0.225	5	2	479	105.366	10	950	0.000
6	Nr	0.217	6	2	479	90.598	12	948	0.000
7	Nfe	0.209	7	2	479	80.244	14	946	0.000

At each step, the variable that minimizes the largest number of Wilks L. is entered.

a: the maximum step is 20

b: the partial minimum F to be entered is 3.84

c: the partial maximum F to be entered is 2.71

d: F tolerance level, or VIN insufficient for further computation

The results shown in Tables 12 and 13 are obtained after completion of eight steps for site 1 and 7 steps for site 2 with the introduction of a new variable each time (step) and the selected variables (inputs) show a great significance as to the difference between the species; they have proven to be highly discriminatory; these are: Ngrg, Nfr, Pgrp, Ngrp, Nr, Lrp, Ngp and Nfe (plus Pgrp for site 2).

Comparison between groups in pairs

Table 14. Comparison between groups

Site 1					**Site 2**				
		1	2	3			1	2	3
1	F		**51.875**	**64.670**	1	F		**52.660**	**89.658**
	Sig.		0.000	0.000		Sig.		0.000	0.000
2	F			**100.841**	2	F			**114.163**
	Sig.			0.000		Sig.			0.000
3	F				3	F			
	Sig.					Sig.			

Table 14 reflects only the results of the 8th (site 1) and 7th (site 2) and last step of the inter-group comparison according to which we observe that species 2 (*V.narbonensis*) is more correlated with the species 3 (*V.sativa*) with r=100.841 (Site 1) and r = 114.163 (site 2) than at species 1 (*V. ervilia*) where

r = 51.87 and r = 52.660 (site 1, site 2, respectively) ; moreover, these coefficients give us information on the high rate of distinction between the three species.

Canonical discriminant analysis

This analysis makes it possible to judge the discriminating power of the linear functions produced and to which are associated the eigenvalues.

Table 15. Eigenvalues associated with linear discriminant functions (site 1+2):

	Eigenvalues					**Wilks Lamda**			
Site1	**Functions**	**Values**	**% variance**	**% cumulative**	**Canonical correlation**	**Wilks Lamda**	**Ki 2**	**Ddl**	**Sign**
	1(1 to 2)	0.856[a]	70.6	70.6	0.679	0.398	877.706	13	.00
	2	0.356[a]	29.4	100.0	0.512	0.738	289.522	7	.000
Site 2	**Functions**	**Values**	**% variance**	**% cumulative**	**Canonical correlation**	**Wilks Lamda**	**Ki 2**	**Ddl**	**Sign**
	1(1 to 2)	1.768[a]	70.8	70.8	0.799	0.209	745.209	14	0.000
	2	0.729[a]	29.2	100.00	0.649	0.579	260.519	6	0.000

According to Desbois (2003), each eigenvalue $\boldsymbol{\mu h}$ of rank h is equal to the interclass variance of the linear discriminant function of the same rank.

Indeed, the analysis of the data by the discriminant approach, revealed two discriminating functions For both site 1 and site 2 with a rate of variation of 70.6% (site1) and 70.8% (site2) for the first function and a eigenvalue equal to $\mu 1$ = 0.856 (site1) and $\mu 1$ =1.768 (site2). For both sites, a percentage of the intergroup variance of 29.4% for the second function with an eigenvalue equal to $\mu 2$ = 0.356 (site1) and $\mu 2$ = 0.729 (site2); this reflects a total rate of variation of 100% absorbed or explained. This high percentage of inertia indicates a good quality of the distribution of the two axes. The Ki2 test indicates that these two components contribute significantly to discrimination and are therefore of great discriminating importance. The Wilks Lamda are weak with higher canonical correlations (0.679 for site1 and 0.799 for site2) indicating that the three groups are distinct.

Standardized canonical discriminant functions

Using the step-by-step method to minimize the global Wilks Lamda, only eight of the ten variables analyzed (Table 16).

Table 16. Standardized coefficients of linear discriminant functions

Parameters	Site1		Parameters	Site2	
	Functions			Functions	
	1	2		1	2
Nr	0.410	0.111	Nr	0.170	0.288
Lpr	0.265	-0.221	Lrp	**0.572***	**-0.628***
Nfe	-0.001	0.311	Nfe	-0.028	0.300
Nfr	**0.607***	**0.670***	Nfr	0.241	**0.648***
Ngp	**-0.886***	**0.746***	Ngp	**-0.534***	**0.571***
Ngrp	**0.648***	-0.179	Ngrg	**0.474***	0.279
Ngrg	**0.911***	**-0.618***	Ngrp	**0.511***	**-0.668***
Pgrp	**-0.716***	-0.482			

*: significant correlations

Regarding site1, for the first discriminant function, five variables on the eight retained (Ngrg, Ngp, Pgrp, Ngrp and Nfr with 0.911, -0.886, 0.716, 0.648 and 0.607 respectively) have the highest weights in the prediction of this function, allows them to constitute very important variables in the discrimination between the three species.

For the second linear function, only three variables contribute greatly to the definition of this function (Ngp, Nfr, and Ngrg) with respectively (-0.746, 0.670 and -0.618) which makes them variables of high discriminating power. We note that these three variables are common in the prediction of the two functions, which confirms their great involvement in the distinction between the species studied.

According to Figure 2, for the first function, the variable Ngrg opposes the variable Ngp on one side and the variable Pgrp opposes the other two variables (Nfr and Ngrp) on the other side. With regard to the second function, the variable Ngrg opposes the two variables Ngp and Nfr. We find that the variables Ngp, Ngrg and Nfr are common discriminant variables to the two linear discriminant functions, which gives them a high discriminating power.

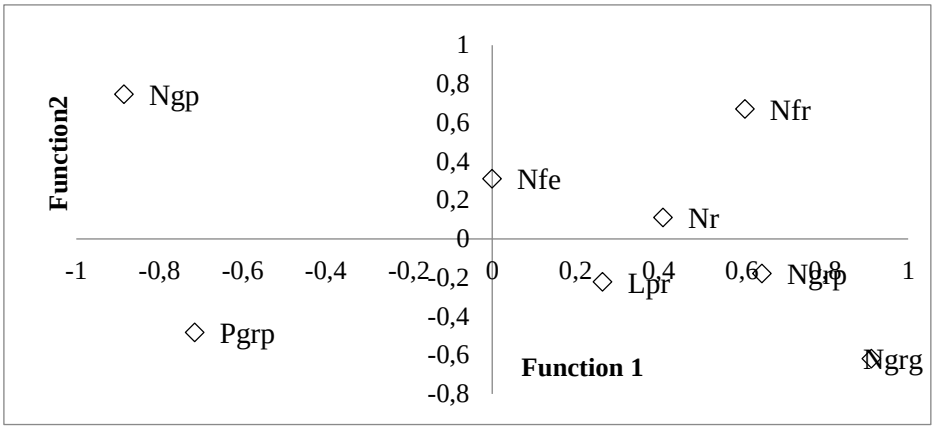

Figure 2. Two-dimentional distribution of the measured variables according to the canonical discriminant functions F1 and F2

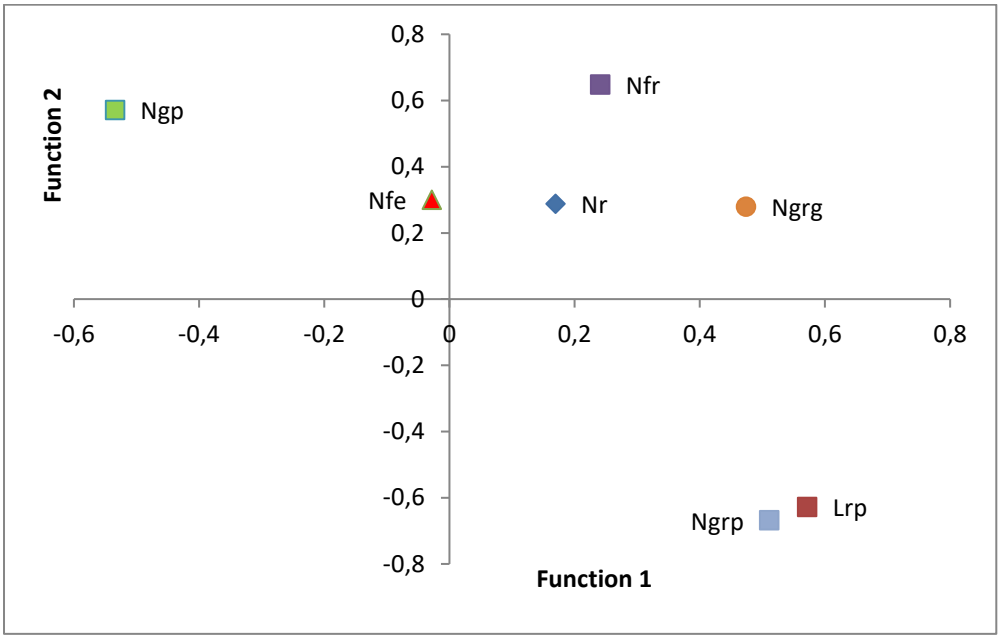

Figure 3. Distribution of predictive discriminant variables in relation to linear discriminant functions

Regarding site 2, for the first discriminant function, only the three variables Lrp, Ngp and Ngrp with respectively 0.572, -0.534, and 0.511 have the most important weights in the prediction of this function followed by Ngrg with a lesser degree (r = 0.474), their contribution allows them also to constitute very important variables in the discrimination between the three species.

For the second linear function, four variables contribute greatly to the definition of this function (Ngrp, Nfr, Lrp and Ngp) with respectively (-0.668, 0.648, -0.628 and 0.571) which makes them high discriminant variables.

According to Figure 3, for the first function, the variable Ngp opposes the other two variables (Lrp and Ngrp); for the second function, Ngp and also Nfr oppose the same variables (Ngrp and Lrp). We note that Lrp, Ngp and Ngrp are common variables for the prediction of the two discriminant functions, indicating that these are high discriminant variables.

Correlation between predictive variables and linear discriminant functions

Another way of interpreting the contributions of predictive variables to discriminant linear functions is the study of the structural matrix giving the combined intragroup correlations between the explanatory variables and discriminating functions.

Table 17. Structure matrix

Site1			Site2		
Parameters	**Function 1**	**Function 2**	**Parameters**	**Function 1**	**Function 2**
Ngrg	0.602*	-0.236	Lrp	0.776**	-0.230
Nr	0.506*	0.302	Ngrp	0.681**	0.207
Ngrp	0.496*	0.274	Ngrg	0.582*	0.261
Lpr	0.319	-0.235	Nr	0.456*	0.377
Pgrp	0.117	-0.006	Nfr	0.510*	0.622**
Nfr	0.345	0.667*	Ngp	0.496*	0.571*
Ngp	0.293	0.639*	Nfe	0.112	0.277
Nfe	0.114	0.369			

Combined intra-group correlations between discriminant variables and standardized canonical discriminant function variables are ordered by absolute sizes of the correlations within the function.

*: Highest absolute correlation between each variable and any discriminant function

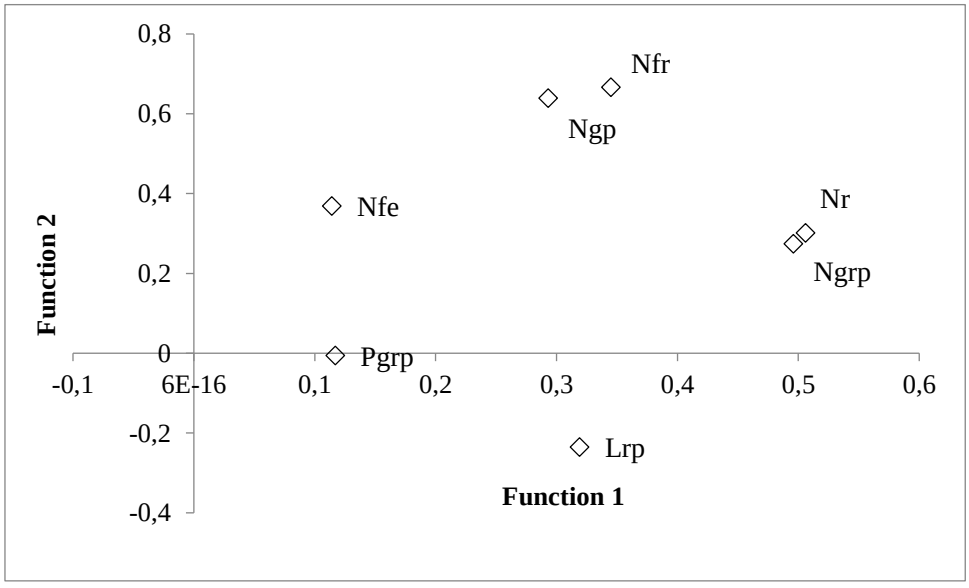

Figure 4. Two-dimensional distribution of predictor variables according to their correlation with linear discriminant functions (F1and F2)

According to Table 17, for the first discriminant linear function, the contribution of the variable Ngrp with 0.602 (site1) and Lrp with 0.776 (site2), is the largest, followed by Nr (site1, 0.506) and Ngrp (site2, 0.681); Nfe contributes the lowest for both sites (0.114, 0.112 respectively). Site1 as well as site2, the second discriminant linear function shows that Nfr has the largest correlation (0.667, 0.622 respectively) followed by Ngp (0.639, 0.571) the rest of the variables contribute very weakly in the prediction

Figure 4 illustrates the dispersion of the predictive variables as a function of their correlation with F1, F2; in fact in relation to the first function, there is no opposition between the variables. Also for the second function, the most correlated variables show no opposition.

Fig. 5 representing the distribution of the variables on the axes (F1, F2) for the site2, shows the opposition of certain variables such as Lrp with Nfr, Ngp and all other variables for the second function.

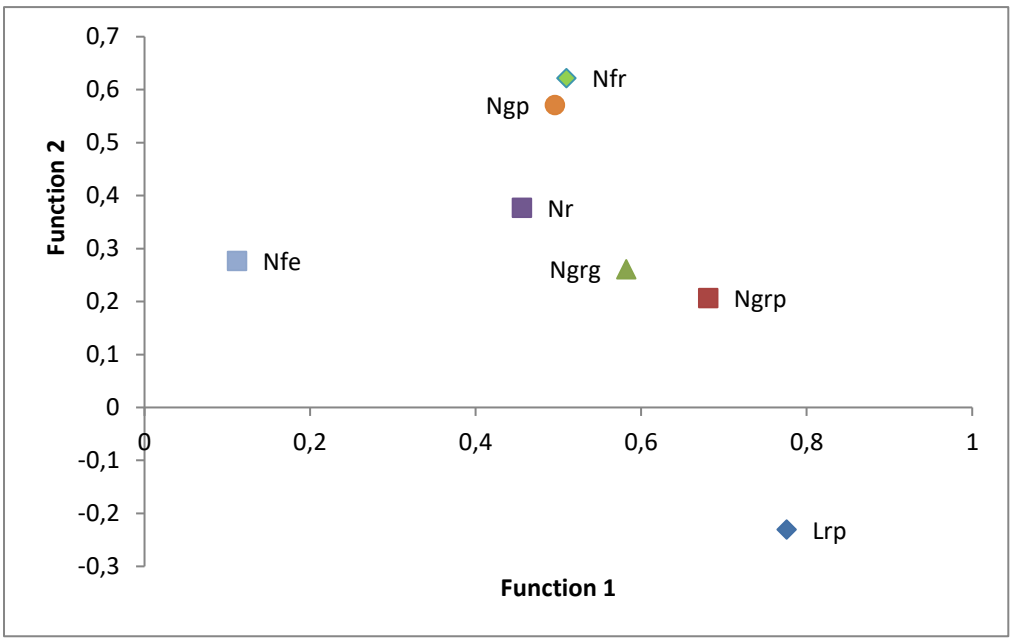

Figure 5. Distributions bidimensionnelle des variables prédictives selon corrélation avec les fonctions linéaires discriminantes (F1et F2)

Estimated average group values

The factorial coordinates of the barycenters of groups on the discriminant axes are evaluated as mean values of the groups.

Table 18. Functions at group barycenters

Species	Site1		Site2	
	Function1	**Function2**	**Function1**	**Function2**
1	-0.117	0.790	-0.486	1.088
2	-1.012	-0.511	-1.181	-0.882
3	1.291	-0.369	2.021	-0.294

Based on the values of the first discriminant function estimated at the barycenters of each species for both site 1 and 2 (Table 33): the projection of individuals of species 1 with the lowest score (site1 -0.117, site2 -0.486), classifies them among individuals of species 3, which opposes the other two species (1 and 2) by the common variables Nfr, Ngrg and Ngrp; in contrast for the second function, species 1 with the highest score (site1 0.790, site2 1.088) receives the projections of the other species (2 and 3) and opposes them by the common variables Nfr and Ngp (Fig. 6 and 7).

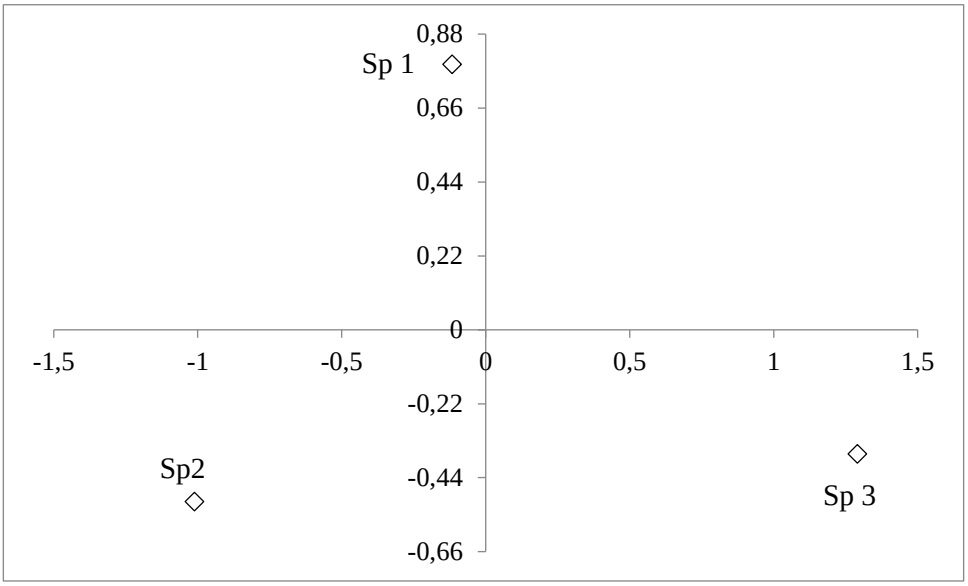

Figure 6. Two-dimentional distribution of the studied species on the axes discrimanators according to the barycentres (site1)

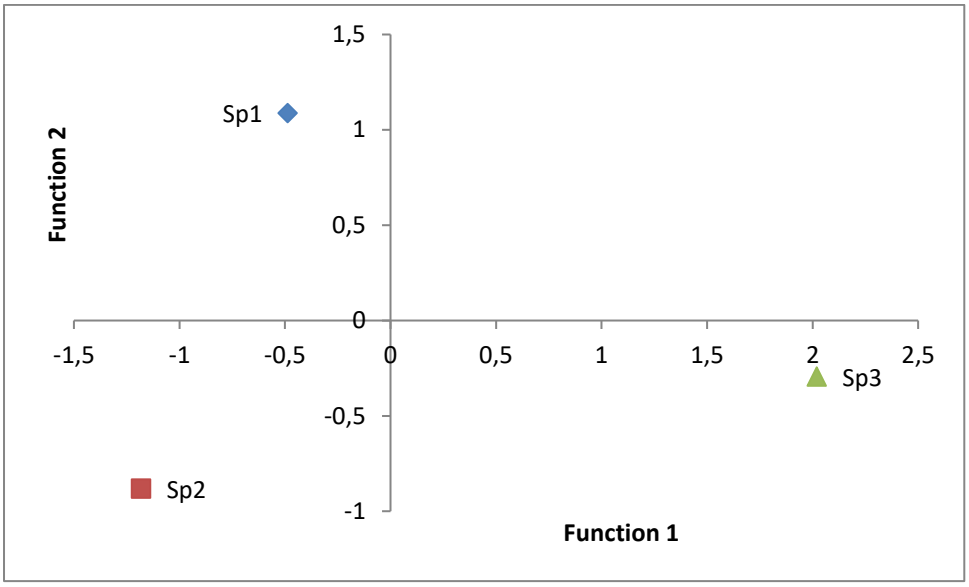

Figure 7. Two-dimentional distribution of the studied species on the axes discrimanators according to the barycentres (site 2)

Percentage of well-classified

There are several ways to check the quality of a discriminant analysis. Some use probabilistic hypotheses, others do not. In our case we chose the percentage of well-classified: it is the most used statistic and also the "speaking" while being the simplest. The idea is this: we have a classification procedure so why not apply it to the observations of which we know the real group and to check if one makes a good classification.

Well-ranked rates are an immediate measure of the performance of the classification rule (RO) developed. Better results than those produced by a random rule are expected, for three groups over 33%**.**

Table 19. Percentage of well-classified and validation

			Species	Predicted classes			
				1	2	3	Total
Site1	Original	Number	1	248	81	16	345
			2	15	298	13	326
			3	30	35	222	287
		%	1	**71.9**	23.5	4.6	100.0
			2	4.6	**91.4**	4.0	100.0
			3	10.5	12.2	**77.4**	100.0
Site2	Original	Number	1	142	31	1	174
			2	2	166	0	168
			3	20	9	111	140
		%	1	**81.6**	17.8	0.6	100.0
			2	1.2	**98.8**	0.0	100.0
			3	14.3	6.4	**79.3**	100.0

The results of the classification (Table 19), performed by SPSS's Discrim (1994, 1999) procedure for both sites (1 and 2), show a fairly high overall well-classified apparent rate (site1 80.23%, site2 86.9%); the weighted average of the apparent well-classified rate for each species that varies from 91.4% (site1) to 98.8% (site2) for species 2 (*V.narbonensis*) to approximately 72% (site1) and 79.3% site2) for species 3 *V.ervilia* with the most assignment error. This leads us to declare that species 1 and 3 have the lowest well-classified rates (71.9% and 77.4% respectively for site1 and 81.6% and 79.3% for site2), as heterogeneous species; in contrast to species 2 considered to be very homogeneous.

This result is predictable and corroborates the results obtained in Table 11 (Box Test) and Table 16 (standardized coefficients of discriminating canonical functions).

It is therefore clear that among all the variables analyzed, five of these variables have a great deal of weight in the discrimination between the species of vetch studied and are classified as relevant variables; they are: Nfr, Ngp and optionally Ngrp, which represent variables common to both sites; and with Ngrg for site1, Lrp for site2.

The results of the descriptive analysis of sites 1 and 2 individually for the species factor revealed that the behavior of the three species remained virtually the same; they are very significantly different at site 1 as well as at site 2 and with almost equal rates of distinction. This assumes that the environment has not influenced species behavior.

On the other hand, if we want to compare the behavior of the species one by one on the two sites, we will see that for species 1 (*V.ervilia*) it has remained distinct from the other two species with very high discrimination rates (80% and 100% respectively) on both sites. Between species 2 (*V. narbonensis*) and 3 (V. sativa), there was 90% discrimination both at site 1 and site 2. The most discriminating variables common to both sites are Nr, Nfr, Ngp, Ngrg, and Ngrp; Pgp remains for both sites the most interesting character of common similarity. The difference demonstrated by univariate analysis is an indication of a genetic constitution inherent to each species (Dekhili et al., 2013).

The results of the combined analysis (Sites Center + North) corroborate those of the analyze of Site 1 (Center) and Site 2 (North). Indeed the species are distinct very significantly and the common responsibility for this distinction is attributed for the three levels of analysis to 50% of the analyzed variables Nr, Nfr, Ngp, Ngrg, and Ngrp,

Regarding to the variety effect, it appears from the examination of the results of the two sites (results not published) that for species 1 (*V.ervilia*) we find that the varieties revealed themselves to be similar to a high degree (70%) as well On site 1 and on site 2 and by almost the same variables (Nr, Lrp, Pgp, Ngrg, Ngrp and Pgrp) their difference is due to only two common variables: Nfe and Nfr. In species 2 (*V. narbonensis*), the varieties show a somewhat higher similarity at site 1 Center (70%) than at site 2 North (60%) and the resemblance common variables to both sites are: Nr, Ngp, Pgp, Ngrp and Pgrp. A single variable common to both sites (Nfr) is responsible for distinguishing between varieties of this species. Finally, for species 3 (*V.sativa*), the varieties are significantly different at Site 1 (Center) and Site 2 (North), but their discriminating variables are not common at both sites.

This factorial analysis discriminating with all its tests revealed a very significant difference between the three species and that species 3 distinguished clearly from the other two species for a good number of variables (Nr, Lrp, Ngrg, Ngrp, Pgrp and Rdt) and is therefore the most productive for parameters related to green biomass (Nr and Lrp) and also for parameters related to grain yield (Ngrg, Ngrp, Pgrp and Rdt); that means a large production in green biomass and grains.

Conclusion

The results of the descriptive analysis revealed that, with the majority of the analyzed parameters, a significant difference was observed between the three species of vetch (1 *V.ervilia*, 2 *V.narbonensis*, 3 *V.sativa*). This analysis revealed the individualization of species 3 with its best performances compared to the other two species (1 and 2).

For its part, the factorial analysis discriminating with all the tests carried out revealed almost the same result, namely a great distinction between the three species and the individualization of the species 3 which proves to be the most productive in terms of the parameters related to the green biomass (Nr

and Lrp) and also for the parameters related to the grain yield (Ngrg, Ngrp, Pgrp and Rdt) or a production in green and in large grains.

Thus, its performance in Species 3, which is represented by local varieties, which might enable us to propose it as a complete forage, ie, usable on different forms (green, straw, hay, grain or in concentrated addition) and this corroborates with the results of Mebarkia et al. (2007).

This indicates that the introduced species (*V.ervilia* and *V. narbonensis*) are less adapted to the environmental conditions of the Sétif region (semi-arid) due to their lesser performance.

On the other hand, we can assume that these "emerging" varieties of species 3 (José, fig and even Baraka, 715 and 709) exhibit a fairly large phenotypic diversity that can provide a broad genetic base that can potentially serve in improvement programs as highlighted by Mebarkia, (2007), given the large variability observed in many of the traits measured for the three vetches studied, this gives the possibility to choose the species suitable for the implementation value of the forage area in semi-arid zones and according to climatic characteristics and different production systems; especially if the introduced varieties do not meet the conditions of the region.

Several hazards of extinction threaten these traditional varieties, namely drought (and / or climate change), the progressive loss of traditional knowledge in relation to local genetic resources, traditional practices and uses, and the introduction of foreign varieties. The importance of this genetic richness for the development of varieties is indisputable and requires safeguarding actions to reduce the effects of genetic erosion (Pistrick et al., 1994; El Gazzah 1995; Loumerem et al., 1998; BenSadok, 2006).

Thus, it would be wise to continue the study on these species and varieties, for the production of grain and forage.

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