

Characterization of a Leguminous Plant (Green pea: *Pisum sativum* L.) and It's Impact in the Improvement of Soil's Fertility in an Arid Area in the Centre of Tunisia

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Abstract: In the region of Haddej Bouhedma, leguminous plants are cultivated in “jessers” where the rainwater is recovered and exploited during the rainy years. The emphasis of this paper is to characterize the Green pea which is lately introduced to this region and to demonstrate it's impact in the improvement of the soil's fertility of the region. For that an in situ investigation and observations on open field have been achieved. Results indicate that this crop allows the production and offers an interesting fresh biomass rich on dry matter and nitrogen. Also roots are lined with nodules which are advantageous for soil fertility.

Key words: Fertility, Green pea, Haddej Bouhedma, Soil

1. Introduction

In the south and the centre of Tunisia, agriculture is closely related to the availability of water. It is localized in oases (around 40 000 ha), some irrigated perimeters, and in the traditional hydraulic constructions called locally “Tabias and Jessers”. The region of Haddej-Bouhedma is located in the central of Tunisia where *Acacia raddiana* is very common (Fig. 1). In this area, agriculture is among the main economic activities. Thanks to traditional water management rainwater is collected and used for different plantations like legumes.

The leguminous plants have a high nutritional value due to their richness on protein, minerals, essential vitamins, carbohydrates and fibre. Legume seeds contain 17% to 40% of proteins, while cereals do contain 7 to 13%, which equates to the content of the meat on protein 18 to 25% (Genovese and Lajolo, 2001). In addition, species belonging to this family improve the soil structure because they fix atmospheric nitrogen which reduces the use of chemical fertilizers and avoids the groundwater's pollution by nitrate.

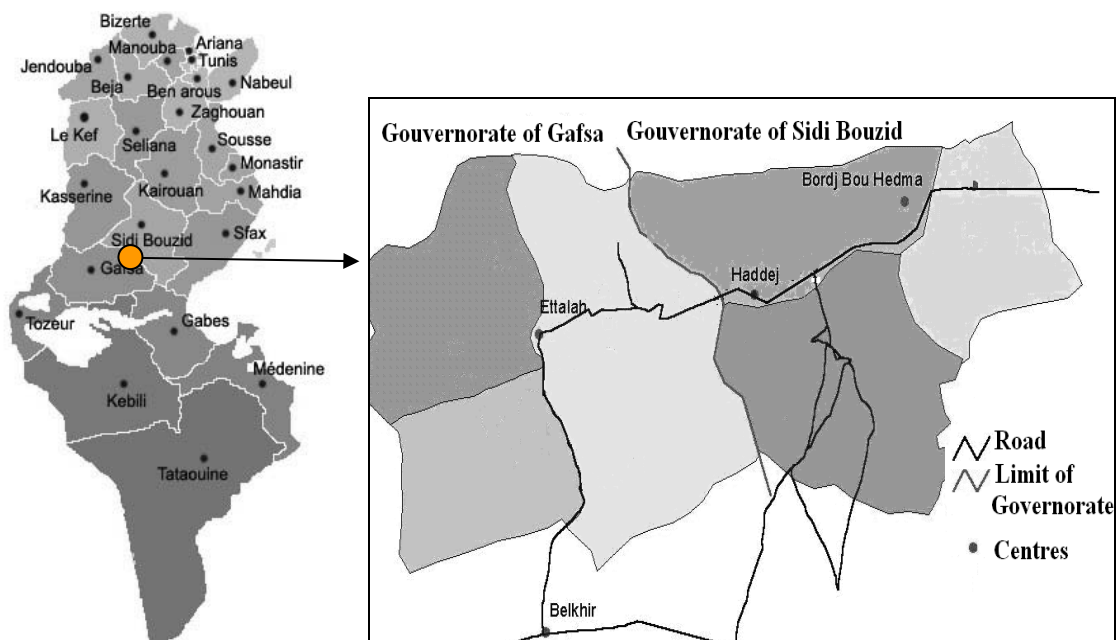


Fig. 1. Localisation of the region of Haddej Bouhedma.

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For the last two decades the pea is the most practiced crop in this region. In addition to its high yield, it is also used for livestock due to its high concentration on proteins (Oelke *et al.*, 1991). Auld *et al.* (1982) and Oelke *et al.* (1991) indicate that this crop can be used as green manure to restore the soil organic matter which provides more than 28 kg / ha of nitrogen to the soil. The purpose of this study is to determine the main steps of the technical itinerary of the pea's cultivation in this region and its impact on the soil fertility expressed by the nitrogen content.

2. Materials and Methods

To carry out this work, 28 "jessers", chosen arbitrarily in two representative plains in this area (14 "jessers" at El Boua and 14 "jessers" at Hawel El Wad), were visited. In each "jesser" 10 plants were randomly collected. The biomass formed above and under the ground, nodule's number, leaf area (cm²) and the pod's number were observed. The envelopes and seeds, previously counted, were weighed. The taste of pea was determined both by a tasting panel formed by several people (to judge if the taste is very sweet, sweet, mildly sweet or unsweetened) and by determining the sugar content with a refractometer. Dry matter of the envelopes and seeds, were recorded and after drying in the oven, phosphorus, potassium and sodium content were determined by the conventional methods of analysis based on photometry and spectrophotometry. The nitrogen was analyzed by Kjeldahl method. The nitrogen's analysis in the soil (in a depth of 20 cm) was conducted in two different plains: El Boua and Hawel El Wed with three repetitions before and after cropping. Results were interpreted by the use of Student Newman and Keuls method.

3. Results and Discussion

3.1. Characterization of the pea grown at Haddej Bouhedma

3.1.1. Growth's assessment

The average values of the fresh aboveground and underground part's weight and the leaf surface of pea are grouped in **Table 1**. This table shows that the pea was developed in good conditions since the average size of a leaf was about 17 cm². This result explains the formation of an interesting above and under the ground biomasses having reached respectively 59 and 17 g / plant at El Boua.

The values of the aboveground and underground biomasses and leaf area recorded at Hawel El Wed's plain are statistically comparable to those recorded in El Boua although being slightly lower.

Table 1. Mean values per plant (10 repetitions) of the growth's assessment of the Green pea of the region of Haddej Bouhedma. Values assigned by the same index are not statistically different at the threshold of 5% by the Student Newman and Keuls test.

	El Bouaa	Hawel El Wed
Aboveground part's fresh weight (AP) : g/plant	58.71 a	49.80 a
Underground part's fresh weight (UP): g/plant	16.71 a	14.60 a
Leafy's surface cm²	17.40 a	16.70 a
Average number of nodules	21.52 a	17.80 a

3.1.2. Dry matter of aboveground (AP) and underground parts (UP)

The average values of the dry matter formed in above and under the ground parts are reflected in **Table 2**. In the two regions, the AP/UP was slightly higher than 1 (1.04 at el Bouaa and 1.19 at Hawel El Wed). This indicates that the plants were well watered due to the exceptional good distribution of rainfall during this season.

Furthermore, the average content of dry matter in the aboveground part (12.41% and 14.05%) recorded in the two plains showed that the fodder was rich on this matter. These percentages were quite near to those found in alfalfa fodder's (between 17 and 20%) grown in oasis of the South of Tunisia (Maalawi *et al.*, 2006).

3.1.3. Characterization of cloves

The average values of the characterization of pea's pods are grouped in **Table 3**. It shows that these pods had an average weight of 5.36 g, a length of 8.02 cm and contain 7.28 seeds. Our results were convenient with those mentioned by Oelke *et al.* (1991) who reported that the pea pods can reach a length of 7.6 cm and contain 4 to 9 seeds. The envelopes represent an average of 55% of the total weight of pods.

Table 2. Dry matter per plant (10 repetitions) of the aboveground (DMAP) and the underground (DMUP) parts and the value AP/UP of pea of Haddej Bouhedma. Results are expressed as a percentage by grams of the fresh weight of the plant. Values assigned by the same index are not statistically different at the threshold of 5% by the Student Newman and Keuls test.

Emplacement	DMAP		DMUP		AP/UP
	%	g/plant	%	g/plant	
El Bouaa	12.41	7.29 a	21.36	7.00 a	1.04
Hawel El Wed	14.05	3.57 a	20.54	3.00 a	1.19

Table 3. Characterization of pea (170 pods).

	Average	Standard deviation
Average weight of cloves (g)	5.36	1.79
Average length of cloves (cm)	8.02	1.06
Seeds's number	7.28	1.48
Seeds's average weight (g)	2.44	0.88
Envelopes's average weight (g)	2.93	1.67
Refractive index (%)	14.00	0.03

Table 4. Taste of Green pea (Average of 23 samples).

Judgment	Very sweet	Sweet	Average sweetness	Non sweet
Percentage	13.04	39.13	34.78	13.04

Table 5. Average content on minerals in seeds and envelopes of pea (% of Dry Matter).

Plains	El Bouaa				Hawel El Wed			
	aboveground part	Underground part	Seeds	Envelopes	aboveground part	Underground part	Seeds	Envelopes
% Na ⁺	0.05	0.34	0.02	0.01	0.35	0.38	0.01	0.04
% K ⁺	1.00	2.60	3.00	3.00	1.30	1.50	3.00	3.00
% P	0.24	0.75	0.44	0.16	0.10	0.48	0.43	0.10
% N	3.92	1.94	3.30	2.64	2.52	1.92	3.41	2.14

The juice of freshly ground seeds had a refractive index of 14% indicating that the pea is rich on carbohydrates. The tasting test's results are presented in **Table 4**. It shows that the pea grown in the region of Haddej Bouhedma is sweet to mildly sweet which indicate it's valuable quality.

3.1.4. Analysis of major minerals

The average levels of phosphorus (P), potassium (K⁺), and sodium (Na⁺), and reduced nitrogen (N) on pea's seeds and envelopes from the two plains are reflected in **Table 5**. This table shows that the various organs of pea were filled with reduced nitrogen (especially in the seeds: 3.3 and 3.41% respectively for El Bouaa and Hawel El Wed). Black *et al.* (1998) and Wang and Daun (2004) found that the total protein's content of pea varies from 24.3% to 32.6%.

The levels of sodium, potassium and phosphorus are respectively between 0.01 and 0.38, 1 and 3 and 0.24 and 0.75%.

3.2. Nitrogen's Analysis in the soil before and after the pea's cultivation

The results of soil's analysis before and after cropping are illustrated in **Figure 2**. It shows the positive effect of this specie on the enrichment of soil on nitrogen both in the two plains. Indeed, the percentage of nitrogen in the soil increased from 0.02 mg/kg to 1.7 mg/kg in the plain of Hawel El Wed and from 0.2 mg/kg to 1.0 mg/kg in the El Bouaa's plain.

The differences between the test results obtained before sowing and those obtained after the harvest were respectively 1.68 mg/kg and 0.8 mg/kg. The nitrogen could be very useful for cereals which will be sowed in the coming season due to it's capacity to ameliorate the soil fertility and structure. This nitrogen fixed by the leguminous plant avoids the utilisation of fertilizers which will pollute the soil. In fact, Kaminski (1991) said that half of the biological nitrogen fixation, which is about 200 million tones per year, is coming from the symbiotic relation between leguminous plants and rhizobia. According to Elmerich (1993), this production represents two times the world production of nitrogen fertilizers.

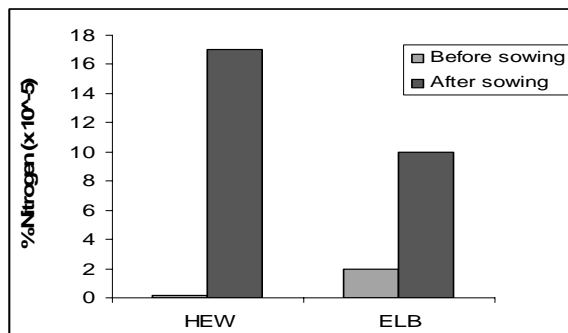


Fig. 2. Soil's analysis before and after the pea's cultivation in two plains in the region of Haddej Bouhedma (Caption: -HEW = Plain Hawel El Wed- -ELB = Plain of El Boua).

4. Conclusions

Cultivated legumes are increasingly occupying the sowed lands on Haddej Bouhedma's region. This work was focused on identifying the importance of Green pea and demonstrating its interests in the enrichment of soil on nitrogen.

The results showed that legumes are cultivated in the plains and behind the waterworks during rainy years. In addition to cereals, the most sowed legume is the Green pea. The crops are not watered; their fate in store depends on rainfall. The analysis of samples collected in this region have shown that the pea provide a fodder rich on nitrogen-material and develops a great production of dry matter in the aboveground and underground parts and a very high number of nodules. Moreover, it is advantageous in terms of soil's enrichment on nitrogen.

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