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Agricultural capability and soil fertility in the region of Djebel El Ouahch, Constantine, Algeria

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Abstract

This work, entitled "agricultural capability and soil fertility in the region of Djebel El ouahch", describes the work carried out and the results obtained after a soil study carried out in the context of the agro-soil study project in the region of Djebel El Ouahch, Constantine. The purpose of this project was to undertake a study to determine soil resources for use in agricultural development. Soil mapping has shown the existence of three types of soils: calcimagnesic, brown, and isohumic. Dry cultivation was indicated for each type of soil. More than 80% of the soils are suitable for cereal and fodder crops. Tree crops are to be excluded except for rustic trees adopted with fine texture.

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Introduction

The present study deals with the evaluation of edaphic potentials of Djebel El Ouahch region in order to contribute to the knowledge of the region's soils in order to remedy their deficit both in terms of Physical, biological and chemical Anthropogenic and natural In order to do this, a prospecting mission on the ground, with Surveys and soil sampling. The Samples were subjected to physical, chemical and In the INSID laboratory. The interpretation of the results allowed the development of documents Mapping (soil and cultural suitability maps) and Provide advice and recommendations on farm.

Geographical situation of the study area

The massif of Djebel El Ouahch is located to the east of the city of Constantine. This massif is part of the series of small Numidian chains or Constantine (BOUDY, 1955). It is individualized of the surrounding limestone mountains by its blunted appearance under the effect of a very important erosive action that Sandstone and weak substratum has strongly favored, as a result of deforestation, fires and pastoral overload, which has led to forest degradation. It is an area that is located straddling two bioclimatic floors, the semi-arid and the subhumid.

The depressed southern environment belongs to the semi-arid stage (precipitation: 500-600 mm/year), the fresh south-eastern semi-arid corresponds to the large erosion glacier of the El Haria depression where (The communes of Ain Abid in the south, Didouche Mourad and Zighoud Youcef in the North, and Constantine in the West). The northern, mountainous environment (1100 to 1300m of altitude) belongs to the subhumid stage (precipitation: ...); It corresponds to the region of the cork oak, a homogeneous medium from the edaphic (Numidian sandstone) and forest Fig. 1. (ANONYME, 1977).

Physical environment

The high slope of more than 50% incineration that materializes the mountain slopes covers 1584.82 ha of the study area.

As for the class of gentle slopes, it occupies the last place with a surface close to the previous class 1266.26 ha and occupying mainly the Southwest of the study area (El Haria depression). The relief is composed of five classes of slopes (Table 1):

Climate

Numerous works have been carried out for the evaluation of correction gradients. The table below summarizes the main gradients of correction proposed by its authors. The climatic synthesis is spread over the period 1987 – 2016 (Table2).

Precipitations

The average annual rainfall over the period (1987-2015) is 707 mm. 47% of the rainfall is recorded during the winter season (387 mm) and the remaining 53% is distributed regularly between the spring (174 mm) and fall (157 mm) seasons. The rainiest month is January with 128 mm. The driest month is the month of July with 3 mm of rain (Table 3).

Température

The months of January and February are the coldest months with a minimum average of 7.17 ° C. The absolute minimum temperature recorded during this period is 1.1 ° C. It is recorded during the month of February 2015. The month of August represents the warmest month with a maximum average of 31,9 ° C. In August 2015, an absolute maximum temperature of 34.29 ° C was observed (Table4).

Humidity

The following (table 5) shows that the maximum humidity is observed in January and December (79%) and the minimum in July (50%).

Insolation

For the region of Djebel El ouach, Constantine near the data of the station of Ain El Bey during the period (1987-2015) is reported in the following (table 6):

The table above shows that the duration of sunshine reaches its maximum value in July (338 hours); By January and December reaches its minimum value (153 hours).

The wind

The following (table 7) shows the monthly average (m/s) recorded at Ain El Bey station for the period (1987-2015) or the maximum wind speed recorded in April and December (2.8m/s) and the speed Minimum in October and September (2.1m/s).

Evapotranspiration

It is the transformation of a liquid into a vapor; It is expressed in (mm). And for the region of Djebel El Ouahch, Constantine, the maximum evaporation is recorded in July (188mm), and the minimum in December (43mm) (Table 8).

The sirocco

This hot wind has negative effects mainly on young plants of natural regeneration or young reforestation by the phenomenon of drying caused by excessive evaporation (Table 9).

White frost

It is harmful to the vegetation cover and especially during the flowering period (Table 10).

Storms

This phenomenon is quite frequent in the study area and appears during all months of the year but increases from July to August, with a peak in September (6.4 days) are generally stormy (table11)

Bioclimatic classification of the Djebel El Ouahch region.

To characterize the climate of watershed studied we use the climagram of Emberger Fig. 2. Fig. 3. Fig. 4. Fig. 5., Fig. 6., Fig. 7., Fig. 8. (Table 12) which allowed the bioclimatic stage of the station to be defined.

Q2 = 2000p / M2-m2

Water balance

$$P = E.R.T + R + I + Wa$$

From where:

P: précipitation (mm).

E.T.R: evapotranspiration; (mm).

R: runoff (mm).

Wa: Reserve variation

Evapotranspiration

It results from the combination of two phenomena that transform water into steam by a specifically physical process.

Actual evapotranspiration (E.T.R) or flow deficit (De) is the amount of water actually evaporated and transpired. Several methods are proposed to calculate E.T.R; among them that of TURC where (Table 13):

$$E.T.R = \frac{P}{\sqrt{0.9 + \left(\frac{P^2}{l^2}\right)}}$$

$$L = 300 + 25T + 0.05T^3$$

T: Temperatures (°C)

E.T.R: evapotranspiration actual; (mm).

P: précipitation (mm).

L: A parameter depends on the temperature

Surface runoff (R):

This is a very important parameter; It is evaluated from the formula of Tixeront Berkaloff. From where:

A: refers to surface runoff; Expressed in (mm).

P: means the annual average precipitation; Expressed in mm.

E.T.P: means potential evapotranspiration; Expressed in mm.

At the level of the Jebel El Ouahch region: P = 642 mm; E.T.P = 879.63mm So: R = 178.90 mm or 23.98% precipitation.

Infiltration (I): Infiltration is the passage of water through the surface of the soil, called: penetration into the soil; It is calculated by the following formula

$$I = P - (E.T.R + R)$$

From where:

P: means the annual average precipitation; Expressed in (mm)

A: refers to the surface runoff; Expressed in mm.

E.T.R: refers to actual evapotranspiration; Expressed in mm.

At the level of the Djebel El Ouahch region:

P = 746.07 mm

E.T.R = 59.26 mm
R = 178.90 mm
So:
I = 461.8mm or 61.90% precipitation.
Wa = P - E.R.T - R - I / Wa = 418.78 mm

Culture and climate

The wind, the sirocco and the storms in Djebel El Ouahch do not represent a threat to the majority of speculation. On the other hand, the rainfall that seems important during the winter season having a long period during the months of March to October.

The moderately high humidity in Djebel El Ouahch is (50%), it plays a very important role in the hydrological cycle because it not only indicates the more or less close to the condensation of the atmosphere but also Controls the rate of soil evaporation and coverage. The following diagram shows the different crops that existed in the area according to its average annual temperatures fig.9.

Températures °C 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35

Methodology

Recommendations that derive from both descriptive information and analytical information are intended to contribute to enhancing the physical, chemical and biological potential of soils in the region. They are the result of a logical process that requires a synchronization of the following stages: - the field phase (recognition and prospecting), - analysis of the samples in the laboratory, - interpretation of the analytical results themselves, - recommendations and advice for Cultural practices.

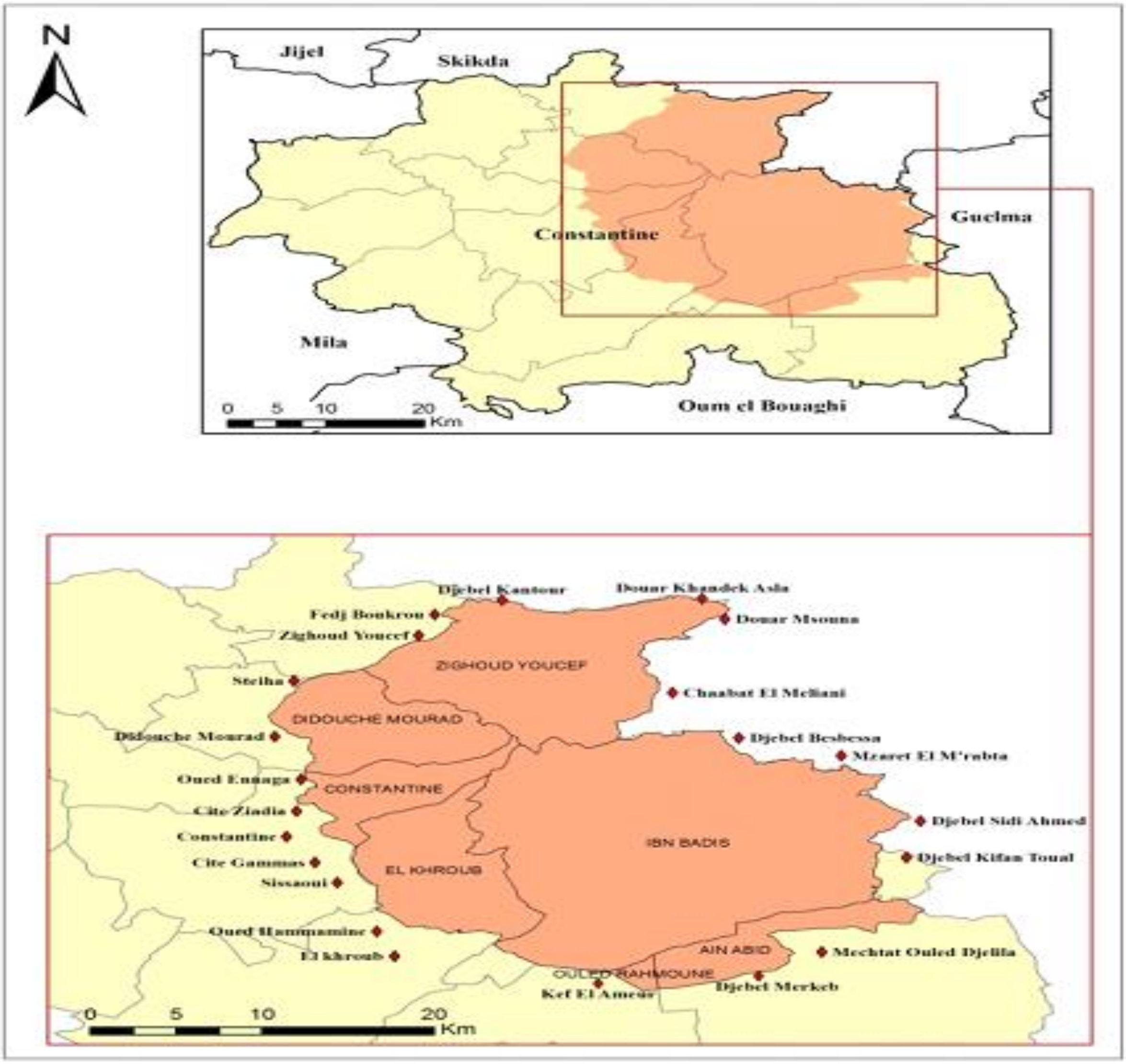

Fig. 1. Geographical location of the study area.

The soil profiles with reference to the two mapping units are thoroughly diagnosed in order to establish a state of physical, chemical and biological fertility of the soils of the study area. Field observations (profile descriptions) and soil test results are the key to this diagnosis. The observations drawn from the description of the profiles provide information on the advantages and soil stresses that may negatively or positively influence the development of the root crop system. It is also information that reveals the state of the soil and its behavior under the influence of natural and anthropogenic factors.

Physical fertility of soils

The granulometric composition represents the proportions of clay, silt and soil sand. These fractions predict the predisposition of the soil to settlement, referring to the triangle of Rémy and Mathieu (1972).The optimum time to work the soil while avoiding composting it is expressed by the optimum "Proctor". The latter is estimated by a function which takes into account the soil content of organic matter and clay. The Optimum "Proctor" reflects an optimum humidity level for tillage.

The ability to bend is also a consequence of this granulometric composition. It is deduced from the index of battance (IB) determined from the results of soil analyzes (silt, clay, MO and pH water).

The adhesion limit (Atterberg limits) of the soils of the region is also determined to moisture content for which the soil begins to adhere to the metal of a tool (plow and spade). All these data are therefore likely to provide information on the fragility of soils and the greater or lesser ease of working them by providing additional information on their mechanical reactions to agricultural implements.

The state of the soil drainage is directly deduced from the observations of the profiles. It implies the compactness of the soil at depth, its texture, the difference in the textural composition between underlying and overlying horizons), its permeability and finally the presence or absence of hydromorphic indicators (oxidoreduct spots).

Soil structure is also an indicator of the physical state of the soil. The shape of the aggregates, their size, their arrangement and the volume of the voids (pores) of these aggregates are all parameters that describe the structure of a soil. It gives information on the state of stability of the aggregates and on the conditions of development of the root system of plants.

Chemical fertility

Many parameters were determined in the laboratory to assess the level of soil fertility in the region. These are CEC (cation exchange capacity), EC (electrical conductivity), saturated pulp extract, P (total phosphorus), K (total potassium), $CaCO_3$ (total limestone), pH water).

Soil biological fertility

The level of decomposition of the organic matter (MO) of the soils of the region is evaluated by the ratio C / N (Boyer, 1982). The MO content is assessed in relation to the clay content in the soil. (IOBC: International Organization for Biological Control).

Cultivation of soils

The key parameters indicating the soil requirements of the main crops are: - soil depth, - soil texture, - coarse content (%), - hydromorphy, - soil structure, - electrical conductivity, - the total limestone content.

Prospecting on ground

Sampling

The sampling adopted in this study consists of exploiting the main soils that characterize the Djebel El Ouahch (brown soils, isohumic soils and calcimagnesic soils). Each type of soil is represented by three representative profiles of the studied area. The choice of these profiles was based on the geological, geomorphological and topographical map, along a toposquence of the Djebel El Ouahch region.

Delimitation of cartographic units

Soil surveys carried out on a scale of 1/25,000 ths reveal two large map units in the study area, according to the CPCS (1967). This is the class of calcimagnesic soils and the class of isohumic soils.

The class of brown soils is dominant. It occupies the lower and central part of the study area. These soils are formed on Numidian sandstones not calcareous.

Description of dereference profiles

Profile N ° 1

Geographic coordinates: X: 36 ° 18 'E

Y: 6 ° 44 'N

Lithology: Tellian tablecloth marly formation Geomorphology: plateau Micro-relief: terassetes Slope: 0-1%

Aspect of surface: 1-3%, vegetation: plowed soil, external drainage: medium, internal drainage: mediocre.

Horizon H1 (0-40 cm)

Moist, brown, clayey-loamy, lumpy structure, organic matter, medium porous, organic debris galleries, significant biological activity, HCL effervescence, diffuse limestone, some roots perpendicular, friable diffuse.

Horizon H2 (40-80 cm)

Wet, dark brown, fine polyhydric structure, medium to moderately detectable organic matter, porous, medium biological activity, HCL effervescence, diffuse limestone, presence of whitish spots of moderately compact salt accumulation, diffuse transition.

Horizon H3: (80-120 cm)

Wet, brown, medium subangular polyhedral structure, effervescence with diffuse limestone HCL, presence of whitish spot of accumulation of salts, compact. Fig.10.

Three criteria in this type of soil attract our attention. A heavy texture in depth (clay predominates in deep horizons), a surface battance (the silt predominates in the surface horizon), a deep hydromorphism. The installation of drains is essential to remedy the problems of stagnation of the waters coming from the hills that border the zone. These soils are vulnerable to settlement problems. All the same, they remain fertile by their physical properties (high depth, texture and suitable structure in the first 30 cm). It would be reasonable to work them when they are dry to avoid the risk of settlement. The absence of limestone is advantageous for a good number of crops, especially those susceptible to ferric chlorosis. The compactness of these soils at depth would slow the growth of the root system and thus the development of fruit trees.

Profile N ° 2

Geographical coordinates: X: 36 ° 32 'E

Y: 6 ° 46 'N

Lithology: clay sand quatonary silt Geomorphology: flattened Micro-relief: depressions Slope: 0-1%

Aspect of surface: 1-3%, vegetation: fallow + forest, external drainage: medium, internal drainage: good.

Horizon H1 (0-40 cm)

Limono-argilo-sandy, coarse lump, organic matter (MO) detectable, porous, friable, no effervescence with HCl, sharp transition,

Horizon H2 (40-80 cm)

Clayey-silty, coarse angular polyhedral, presence of shiny sides, low MO content, low porosity, compact, no Hcl effervescence, sharp transition,

Horizon H3: (80-120 cm)

Clayey-silty, coarse angular polyhedral, non-detectable organic matter (MO), little porous, compact, no effervescence at Hcl. Fig. 11.

This type of soil is of a very heavy and very compact nature. It is vulnerable to settlement problems. It would be reasonable to work it when dry to avoid the risk of settlement. Its high clay content along the profile gives it a vertical character (large indentation slits in dry seasons). Arboriculture should be avoided in this type of soil.

The absence of limestone is advantageous for a good number of cereal and vegetable crops, especially those susceptible to ferric chlorosis. This type of soil also remains fertile because of its physical properties (high depth, good water retention)

Profile N ° 3

Geographical coordinates: X: 36 ° 24 'E

Y: 6 ° 43 'N

Lithology: Numidian sandstone, Geomorphology: hill

Micro-relief: terassetes Slope: 10%

Aspect of surface: 1-3%, vegetation: range + forest, external drainage: good, internal drainage: good.

0-40 cm

Argilo-Limoneux, fine angular polyhedric, organic matter (MO) detectable, little porous, compact, no effervescence at Hcl, sharp transition,

40-80cm

Clay, prismatic, massive, organic matter (MO) detectable, non-porous, compact, no effervescence with HCl.

80-120 cm

Clayey-silty, coarse angular polyhedral, non-detectable organic matter (MO), little porous, compact, no effervescence at Hcl. Its soils are permeable. The gradient of permeability is decreasing due to the nature of the material different in the two horizons (Sablo-silty/limono-sandy). However, drainage is not a constraint because the non-compact, low-clay C horizon acts as a natural drain. This type of soil is frequently encountered in hills. It is in these soils that the fruit trees succeed best. There is no risk of soil compaction due to its low clay contents.

Results

The results of the soil analyzes are:

(K2), and the oligoelements (Fe, Cu, Zin), the total weight of the particles, The calculated and deduced results: Biological activity and evolution of organic matter (C/N), benchmark index (IB), packability, texture, retention capacity (UK), Atterberg limits , Plasticity limit "LP", adhesion limit "LA", plasticity domain "DP"), minimum Proctor (mP), optimum Proctor (oP), saturation level in exchangeable bases (V%) Fig. 13.

Interpretation and Recommendation

Physical state of soil fertility

Physical properties and their effects on the mechanical behavior of soils

The physical properties of the soils of the region due to their very different granulometric nature make it possible to discuss their mechanical behavior. The ability to compaction, tenseness and adhesiveness are constraints that deserve to be raised.

A/Brown Soils

Granulometric analysis reveals a limono-sablo Argileuse (LSA) texture of the surface horizon H1 and the underlying horizon H3.

The ability to settle in the H1 surface horizon and is very important in the underlying horizon H3. The soil is already prone to settlement at water content below the wilting point.

This result is confirmed by the Minimum Proctor (7.88%) whose water content is lower than the water content of the soil at the wilting point (12.81%). The Optimum Proctor indicating a maximum soil settlement (6.01%) is greater than the soil moisture content at field capacity (14.64%). Ultimately, settlement covers the entire moisture field between the wilting point and the field capacity.

Table 1. Five classes of slopes.

Slope class (%)	Surface area (ha)	Area (%)	Type of relief
0-3	1266,26	1,90	Replat
03-12	15366,02	23,1	Bas piémont
12-25	28958,72	43,52	Collines
25-50	19358,03	29,09	Collines
>50	1584,82	2,38	Hauts piémonts

Table 2. Location of the main stations of Djebel El ouahch.

Station	Longitude	Latitude	Altitude
El Hambli	6°55'28,436"E	36°19'46,87"N	824m
Aioun Saad	6°42'24,787"E	36°30'2,78"N	582m
Sidi El Houas	6°45'51,174"E	36°31'56,021"N	540m
Ain Nahas	6°43'44,624"E	36°17'52,988"N	633m
Lambléche	6°42'42,383"E	36°20'35,837"N	620m
Kef Lakhal	6°47'30,438"E	36°24'26,206"N	1109m

The benchmark index equal to 0.93 bears witness to the nonbattance of the surface soil (Remy and Laflèche, 1974),

The interval between the adhesion limit and the wilting point is appreciable; In other words, at the point of wilting the adhesion to the tools does not take place.

It should also be noted that the water content at the field capacity is not a constraint for tillage. It remains below the limit of adhesiveness.

B/Calcagnaic Soils

The granulometry shows a clay texture of the surface H1 and very clayey (ALo) horizon of the underlying H2 and clay horizon of the H3 horizon.

Table 3. Corrected values of precipitation (mm/year) at different points of Djebel El Ouahche.

Stations	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Tot
Station AinEl Bey(583,1m)	71	56	51	55	43	21	7	10	37	37	52	76	516
Point El Hambli(642m)	102	77	63	52	59	29	7	11	34	50	65	93	642
Point Didouch mourad (582m)	112	85	71	59	56	25	6	11	35	58	79	107	704
PointZighoud Youcef(540m)	128	95	77	62	57	25	6	10	35	64	87	121	767
Point lambléche (620m)	93	71	62	54	56	26	7	11	34	51	67	88	620
Point Ain Nahas (633m)	82	63	57	50	53	26	7	10	32	46	60	75	561
Point Kef lakhal (1109m)	98	77	70	76	58	28	9	14	51	51	71	104	707

Table 4. Table of temperatures of Djebel El ouahch.

Month		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
stations	T°C												
Station AinEl Bey(583,1m)	M	11,98	13,26	16,15	19,06	24,83	30,44	34,24	34,29	29,15	24,06	17,04	12,98
	m	2,49	2,77	4,82	6,93	11,08	15,24	18,25	18,73	15,76	11,70	6,87	3,87
	T° mean	6,93	7,42	9,9	12,63	17,35	21,73	25,45	25,58	21,5	17,1	11,63	8
Point El Hambli(642m)	M	9,8	11,4	14,2	17,2	21,3	25,9	30,4	30,7	27,3	21,2	15,5	11,3
	m	1,1	2,0	3,6	5,3	8,6	12,2	14,9	15,8	14,3	9,7	5,7	2,8
	T°C	5,4	6,7	8,9	11,2	14,9	10,6	22,6	23,2	20 ,8	15,4	10,6	6,9
Point Didouch mourad (582m)	M	11,3	13,0	15,6	18,6	22,6	26,6	31,4	31,9	28,6	22,5	17	12,8
	m	3,2	4,2	5,8	7,5	11	14,8	17,7	18,7	16,8	11,8	7,7	4,6
	T°C	7,2	8,6	10,7	13,0	16,8	20,8	24,5	25,3	22,7	17,1	12,3	8,7
PointZighoud Youcef(540m)	M	11,5	13,0	15,6	18,5	22,3	26,6	31,0	31,6	28,4	22,4	17,1	13,1
	m	3,5	4,2	5,9	7,7	11,0	14,8	17,7	18,8	17	12,1	8,1	5,1
	T°C	7,5	8,6	10,7	13,1	16,6	20,7	24,3	25,2	22,7	17,3	12,6	9,1
Point lambléche (620m)	M	10,7	12,5	15,1	18,2	22,3	26,8	31,7	32,0	28,6	22,1	16,5	12,1
	m	2,4	3,3	4,9	6,7	10,1	4,0	16,9	17,8	15,9	10,8	6,7	3,5
	T°C	6,5	7,0	10,0	12,4	16,2	20,4	24,3	24,9	22,2	16,4	11,6	7,8
Point Ain Nahas (633m)	M	11,1	12,9	15,4	18,6	22,8	27,3	32,2	32,4	28,9	22,6	16,8	12,4
	m	2,4	3,6	5,1	6,9	10,4	14,4	17,3	18	16,2	11,2	6,9	3,7
	T°C	6,8	8,2	10,2	12,7	16,6	20,8	24,7	25,2	22,5	16,9	12,8	8,2
	M	9,6	10,9	12,9	16,7	22,3	26,7	31,3	31,3	26,4	21,3	15,3	10,7
Point Kef lakhal (1109m)	m	1,4	1,05	3,3	5,5	9,4	13,7	16,5	17,05	13,8	10,2	5,4	2,4
	T°C	5,28	5,77	8,25	10,9	15,7	20,0	23,8	23,9	19,8	15,4	9,9	6,3

The compaction capacity is fairly high in the surface horizon (H1), moderated in sub-surface H2 and large in the horizon of depth H3. The soil is subject to settlement at slightly higher water content than the wilting point. This result is confirmed by the Minimum Proctor (12.85%) whose water content is higher than the water content of the soil at the wilting point (11.35%). The Optimum proctor indicating a maximum soil settlement (19.38%) is greater than the soil water content at field capacity (18.06%).

Table 5. Humidity of the area of Djebel El ouahch.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Humidity	79	77	75	72	68	58	50	51	63	68	75	79

Table 6. Insolation of the area of Djebel El ouahch.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Insulation time	153	169	206	236	283	307	338	312	250	213	166	153

Table 7. Wind speed of the area of Djebel El ouahch.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average speed m/s	2,3	2,4	2,5	2,8	2,4	2,5	2,4	2,2	2,2	2,2	2,6	2,8
abs max speed m/s	28	30	25	24	23	23	27	25	33	35	28	27

Ultimately, settlement covers the entire moisture field between the wilting point and the field capacity.

The slope index equal to 0.64 bears witness to the non-surface tilt of the soil (Remy and Laflèche, 1974).

The interval between the tack limit and the wilting point is appreciable; In other words, at the point of wilting the adhesion to the tools does not take place. It should also be noted that the water content at the field capacity is not a constraint for tillage. It remains below the limit of adhesiveness.

Isohumic soils

Granulometric analysis reveals a Sablo-silty (SL) texture of the H1 surface and Limono-Sablo-Argileuse (LSA) surface of the underlying horizon H3.

Compaction capacity is very important in the surface (H1) and depth (H3) horizons. The soil is subject to settlement at slightly higher water content than the wilting point. This result is confirmed by the Minimum Proctor (6.68%) whose water content is greater than the water content of the soil at the wilting point (5.88%).

The Optimum Proctor indicating maximum soil settlement (16.01%) is greater than the soil moisture content at field capacity (14.64%). Ultimately, settlement covers the entire moisture field between the wilting point and the field capacity.

The benchmark index equal to 0.96 bears witness to the non-surface tilt of the soil (Remy and Laflèche, 1974).

The interval between the adhesion limit and the wilting point is appreciable; In other words, at the point of wilting the adhesion to the tools does not take place. It should also be noted that the water content at the field capacity is not a constraint for tillage. It remains below the limit of adhesiveness.

Choice of soil working tools according to the soil size of the region

The installation of crops generally requires changes in the surface horizon which allow the creation of an environment conducive to the installation and development of crop roots. Changes in this profile are made by the passage of agricultural tools driven by tractors. Minimum tillage is mostly necessary and the choice of soil preparation operations is therefore an essential element of the technical itinerary from which a reasoned choice of the tillage equipment for the two soil types in relation to their textures (board) (Table 14, 15) Effectiveness of tillage tools in relation to the objective and nature of the soil in the dry state.

Table 8. Evapotranspiration of the region of Djebel El Ouahch.

Month	Jan	Feb	Mar	Apr	Mai	Jun	Jul	Aug	Sep	Oct	Nov	Dec
evaporation	45	47	59	72	101	142	188	168	125	87	59	43

Table 9. The siroco of the area of Djebel El Ouahch.

Mois	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
The days of sirocco	0,0	0,0	0,0	0,0	0,2	0,6	0,9	0,8	0,1	0,1	0,0	0,1

Table 10. Number of days of frost.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jelly	10,6	6,3	4,3	1,4	0,0	0,0	0,0	0,0	0,0	0,0	1,3	7,9

State of soil biological fertility

The content of organic matter is expressed as a function of the clay content (O.I.L.B.). The (C/N) ratio expresses the biological activity in the soil (Boyer, 1982).

A. Brown Soils

The level of salinity expressed by the electrical conductivity (EC) is not a constraint for the crops, given the low EC values recorded along the profile (horizons H1, H2).

The EC values are equal to 0.15 and 0.28 dS/m (to the saturated pulp extract), respectively, • the pH of the soil is neutral along the profile. It is equal to 7.42 and 7.29 respectively for the horizon H1 and H3. It is a field of water pH favorable to the availability of nutrients for plants.

Table 11. Average number of storm days.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Orage	0,5	0,4	1,9	2,7	5,2	5,8	5,8	6,0	6,4	2,7	1,4	0,9

Table 12. Bioclimatic stage of the station.

Station	P (mm/an)	M°C	m°C	Q2	Stage bioclimatique
Ain El Bey	516	34,29	2,49	55,68	Stage semi-aride Hiver frais
El Hambli	642	30,7	1,1	75,07	Stage subhumide Hiver frais
Didouche Mourade	704	31,9	3,2	84,42	Stage subhumide Hiver tempéré
Zighoud Youcef	767	31,6	3,5	92,90	Stage subhumide Hiver tempéré
Lambléche	620	32	2,4	72,1	Stage subhumide Hiver frais
Ain Nehas	561	32,4	2,4	64,39	Stage semi-aride Hiver frais
Kef Lakhal	707	31,3	1,4	81,71	Stage subhumide Hiver frais

Table 13. Calculation of actual evapotranspiration according to C.W. Thornwaite (climate-data.org).

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
P (mm)	102	77	63	52	59	29	7	11	34	50	65	93
T°C	5,4	6,7	8,9	11,2	14,9	10,6	22,6	23,2	22,8	15,4	10,6	6,9
E.T.R	2,69	2,02	2,67	3,83	4,56	8,80	6,79	7,62	8,91	6,66	3,07	2,06

Table 14. Case of heavily textured soils (ALo * and A *).

Convenient Tool	Plowing	Preparation of the seedbed	Pseudo-plows	Superficial work	Unpacking
Heavy Cultivator			+	+	
Cultivator relative to horizontal axis		+		+	
Light Cultivator		-			
Cultivator relative to vertical axis		-		-	
Relative harrow					
Relative plow	-		-	-	
Plow plow					
Disc plow	-				
Disc harrow	+				
Shredder	- -			- -	
Plow sprayer				- -	
Lightweight subsoiler		- -		- -	
Power harrow	-		-		
Relative harrow	-				

- - not recommended

- not very effective or risky

+ Adopted

Alo: heavy clay

A *: clayey.

Total limestone has low values. This indicates that there is no risk of precipitation of the assimilable phosphorus ($H_2PO_4^-$, HPO_4^{2-}, PO_4^{3-}) or problems of antagonism and retrogradation of nutrients.

The exchangeable potassium (K^+) content is low in the surface horizon (0.117 g / kg) and very low in the sub-surface horizon (0.051 g / kg).

In this way, it is advisable to make inputs for straightening and then maintenance for crops.

Inputs of fertilizer are not necessary because of the high contents of exchangeable magnesium (Mg^{+2}) recorded along the profile.

It is equal to 0.783 and 0.285 g/kg respectively in the H1 and H3 horizons.

B. calimagnesic soils

The level of salinity expressed by the electrical conductivity (EC) is not a constraint for the crops, given the low EC values recorded along the profile (horizons H1 and H2).

The EC values are equal to 0.26 and 0.31 dS/m (to the saturated pulp extract), respectively.

The pH of the soil is basic along the profile. It is equal to 8.86 and 9.01 respectively for the horizon H1 and H2.

This is a pH domain that is favorable for plant nutrient availability.

Total limestone has low values.

This indicates that there is no risk of precipitation of the assimilable phosphorus ($H_2PO_4^-$, HPO_4^{-2}, PO_4^{-3}) or problems of antagonism and retrogradation of nutrients.

The exchangeable potassium (K^+) content is very low in the surface horizon (0.071 g/kg) as in the subsurface horizon (0.069 g/kg).

In this case, it is advisable to make rectification and maintenance contributions for crops.

Inputs of this fertilizer are not necessary given the high contents of exchangeable magnesium (Mg^{+2}) recorded along the profile.

They are equal to 1,076 and 1,108 g/kg respectively in the H1 and H2 horizons.

Table 15. Case of intermediate textured soils (LSA and SL)* .

Convenient Tool	Plowing	Preparation of the seedbed	Pseudo-plows	Superficial work	Unpacking
Heavy Cultivator			+	+	
Cultivator relative to horizontal axis		+		+	
Light Cultivator		-		-	
Cultivator relative to vertical axis		-		-	
Relative harrow					
Relative plow	-		-		
Plow plow	-				
Disc plow	-		-		
Disc harrow			-		
Shredder		-		-	
Plow sprayer				- -	
Lightweight subsoiler			-		-
Power harrow		-			
Relative harrow		+		+	

- - not recommended

- not very effective or risky

+ Adopted

LSA: limino-sandy-clay

SL: sandy-loamy

Annex

Laboratory analysis

Iso humic soils

	Depth (cm)	0-40	40-80	80-120
Granulometry (%)	Clay	25,30	18,60	15,10
	Silt	35,9	36,2	33,1
	Sand	38,8	45,2	51,8
Limestone %		3,33	2,59	1,85
Cation exchange capacity (meq/100g)		15,01	11,38	25,85
pH eau (1/5)		7,89	8,27	7,42
Conductivity(ds/m)		1,05	0,52	0,52
Carbon (%)		0,71	0,35	0,93
Organic material (%)		1,10	1,06	1,10
Azote (%)		7,1	5,83	9,13
C/N		6,82	4,90	10,42
Exchangeable bases (meq/100 g)	Ca++	3,38	3,76	6,45
	Mg++	2,72	1,93	5,77
	Na+	1,15	0,15	3,01
	K+	1,22	0,69	1,60
Assimilable phosphorus P(Pmm)		34,35	36,64	22,90

Calcimagnesic soils

	Depth (cm)	0-40	40-80	80-120
Granulometry (%)	Clay	32	38,5	42
	Silt	35,9	36,2	33,1
	Sand	32,5	25,3	24,9
Limestone %		12	12,93	9,25
Cation exchange capacity (meq/100g)		14,01	10,38	18,85
pH eau (1/5)		8,10	9,02	8,27
Conductivity(ds/m)		0,16	0,19	0,37
Carbon (%)		0,71	0,35	0,93
Organic material (%)		1,47	1,34	0,96
Azote (%)		0,97	0,68	0,44

C/N		0,73	0,51	2,11
Exchangeable bases (meq/100 g)	Ca++	2,38	2,76	4,45
	Mg++	1,72	1,93	5,77
	Na+	1,15	1,15	3,01
	K+	1,03	0,69	1,60
Assimilable phosphorus P(Pmm)		29,35	32,64	21,90

Brown soils

	Depth (cm)	0-40	40-80	80-120
Granulometry (%)	Clay	27	38,5	30
	Silt	40	43	44,2
	Sand	33	18,5	25,8
Limestone %		2,33	3,59	1,85
Cation exchange capacity (meq/100g)		10,01	9,38	9,85
pH eau (1/5)		7,89	7,27	7,42
Conductivity(ds/m)		0,14	0,15	0,52
Carbon (%)		0,71	0,35	0,93
Organic material (%)		2,25	1,10	1,0
Azote (%)		1,42	1,08	0,65
C/N		0,5	0,32	1,43
Exchangeable bases (meq/100 g)	Ca++	3,38	3,76	6,45
	Mg++	1,72	0,93	0,77
	Na+	1,15	1,15	3,01
	K+	0,22	0,69	1,60
Assimilable phosphorus P (Pmm)		19,35	22,64	20,90

C. isohumic soils

The level of salinity expressed by the electrical conductivity (EC) is not a constraint for the crops, given the low values of the EC recorded along the profile (horizons A, C).

The EC values are equal to 0.23 and 0.16 dS/m (to saturated pulp extract), respectively. The pH of the soil is basic in the surface horizon and neutral in the sub-surface horizon. It is equal to 7.75 and 7.06 respectively.

This pH domain remains favorable to the availability of nutrients for plants.

Total limestone shows low values. This indicates that there is no risk of precipitation of the assimilable phosphorus (H2PO4-, HP04- 2, PO4 - 3) or problems of antagonism and retrogradation of nutrients, exchangeable potassium content (K+) Is very low in the surface horizon (0.014 g / kg) as in the subsurface horizon (0.0007 g/kg).

In this case, it is advisable to make rectification and maintenance contributions for crops.

Fertilizer inputs are unnecessary given the high contents of exchangeable magnesium (Mg+2) recorded along the profile.

It is equal to 0.204 and 0.589 g/kg respectively in horizons A and C.

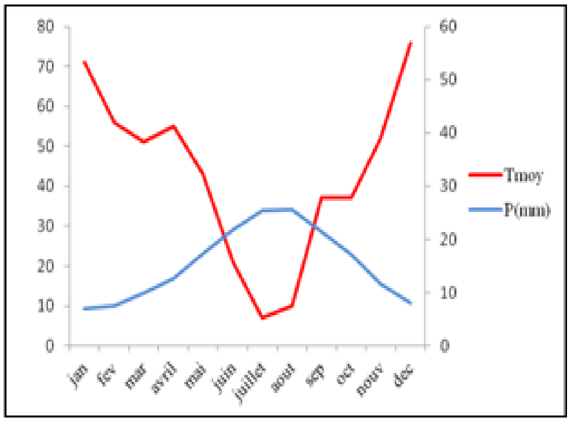

Fig. 2. Diagrame ombro-thermique of Ain El Bey.

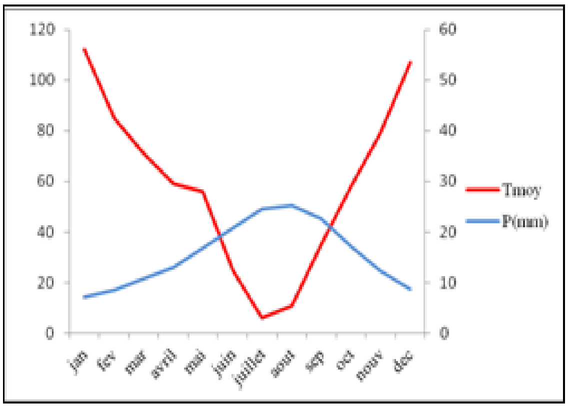

Fig. 3. Diagrame ombro-thermique of Didouche Mourad.

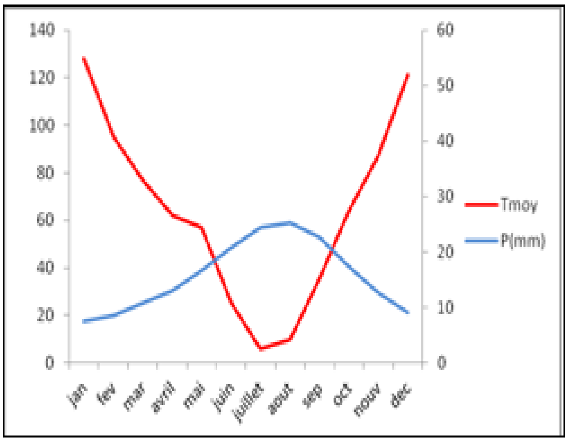

Fig. 4. Diagrame ombro-thermique of Zighoud Youcef.

Cultural suitability of the soils of Djebel El Ouahch

Total limestone and salinity are not a constraint for many crops; Vegetable, cereal, forage and arboriculture in both types of soils. The granulometric nature of the soils of the region, which is heavy for calcimagnesics and light for the less developed, will be selective as to the crop demands of the crops. for this purpose, crops adapted to light soils, taking into account the climatic conditions of the region, are as follows:

A. Vegetable crops

Tomato (*Solanum tuberosum*), onion (*Allium cepa*), garlic (*Allium sativum*), potato (*Solanum tuberosum*), bean (*Phaseolus vulgaris*), watermelon (*Cucumis lemo*), artichoke *Scolymus*), eggplant (*Solanum melagena*), strawberry (*Fragaria vesca* L)

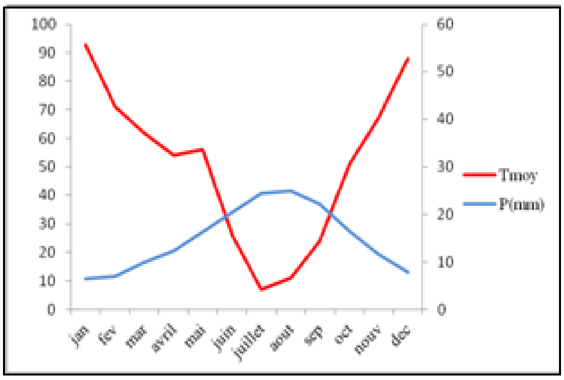

Fig. 5. Diagrame ombro-thermique of Lambléche.

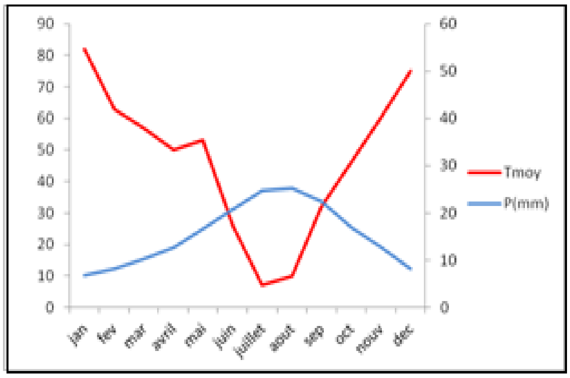

Fig. 6. Diagrame ombro-thermique of Ain Nehas.

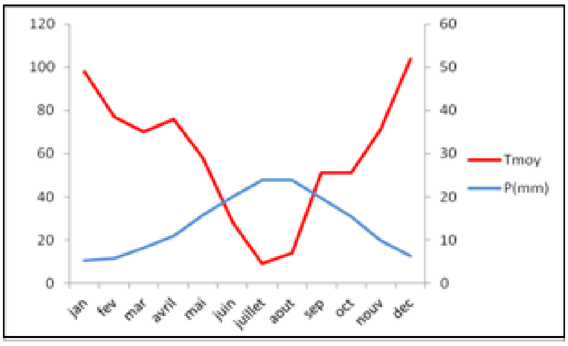

Fig. 7. Diagrame ombro-thermique of Kef Lakhal.

B. cereal crops

Wheat (*Triticum*), barley (*Hordeum vulgare*),

C. Forage crops: luzerne (*Medicago sativa*), bersim (Trifolium alexandrinum), ray-grass (*Lolium multifolium*),

D. Fruit trees

Cherry (*Prunus cerasus*), fig (*Ficus carica*), vine (*Vitis vinifera*), orange tree (*Citrus sinensis*), mandarin tree (*Citrus nobilis*), lemon tree (Citrus *limon*), bigaradier (*Citrus aurantium*), peach (*Prunus persica*). The crops adapted to heavy soils are as follows:

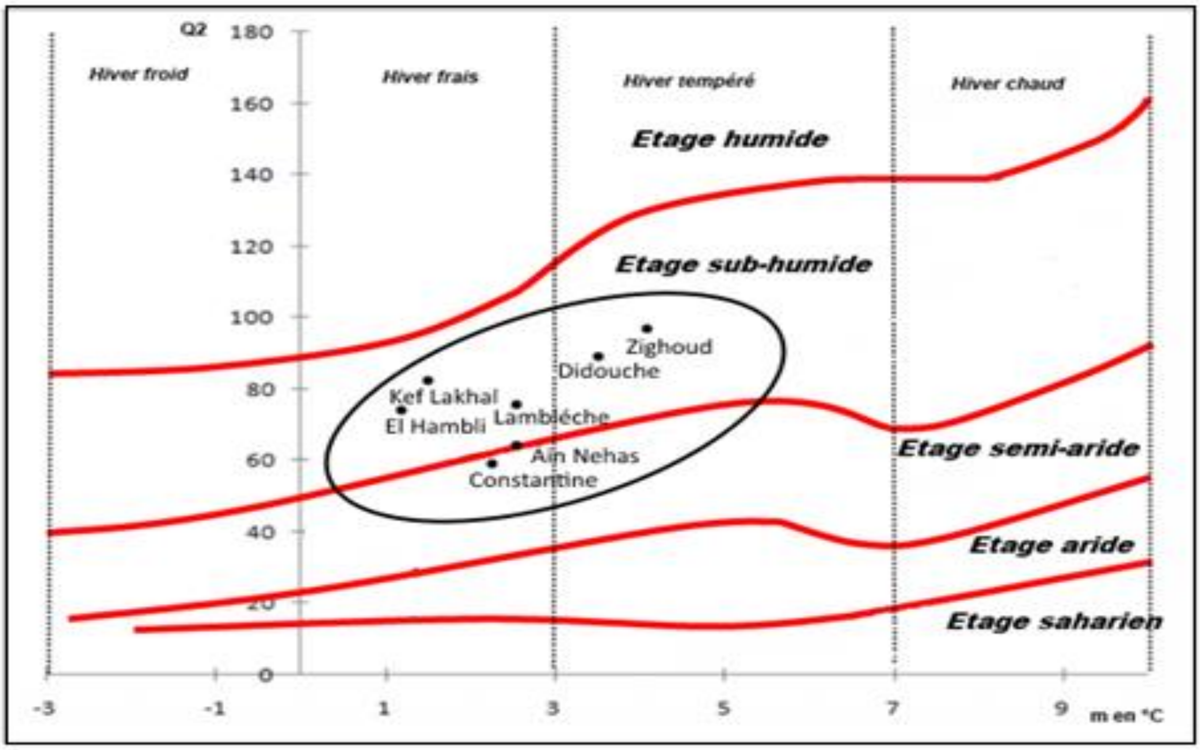

Fig. 8. The bioclimatic stage of the stations of the zone of Djele El Ouahch.

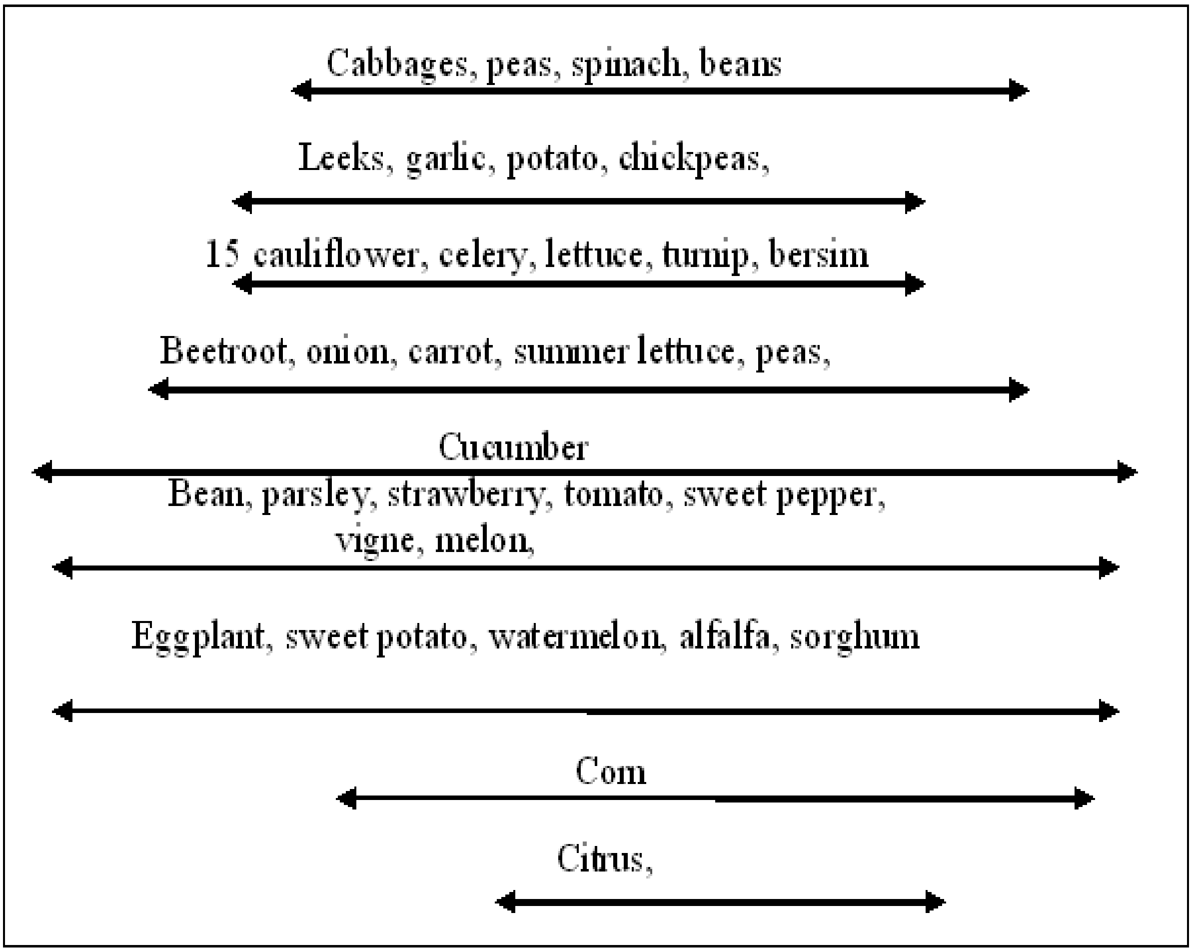

Fig. 9. Choice of some crops depending on the temperatures of the region.

E. Vegetable crops

Potato (*Solanum tuberosum*), bean (*Phaseolus vulgaris*), broad bean (*Visia fava*), artichoke (*cynara scolymus*), eggplant (*Solanum melangena*), spinach (*Spinacia oleracea*)

Fig. 10. Soil calcimagnic, moist, polyhedral (KEHAL L.2015).

Fig. 11. Isohumic soil, coarse, polyhedral (KEHAL L.2015).

F. Cereal crops:

Wheat (*Triticum*), barley (*Hordeum vulgare*),

G. Forage crops

Luzerne (*Medicago sativa*), bersim (*Trifolium alexandrium*), soja (Soja radiata), vesce (*Visia sativa* et *Visia faba*), ray-grass (Lolium multifolium)

H. Fruit tree

Fig (*Ficus carica*), hazel (*Eriobotrya japonico*), medlar (*Eribotrya japonica*), pear tree (*Piper nigrum*).

Fig. 12. Brown soil, coarse, polyhedral (KEHAL L.2015).

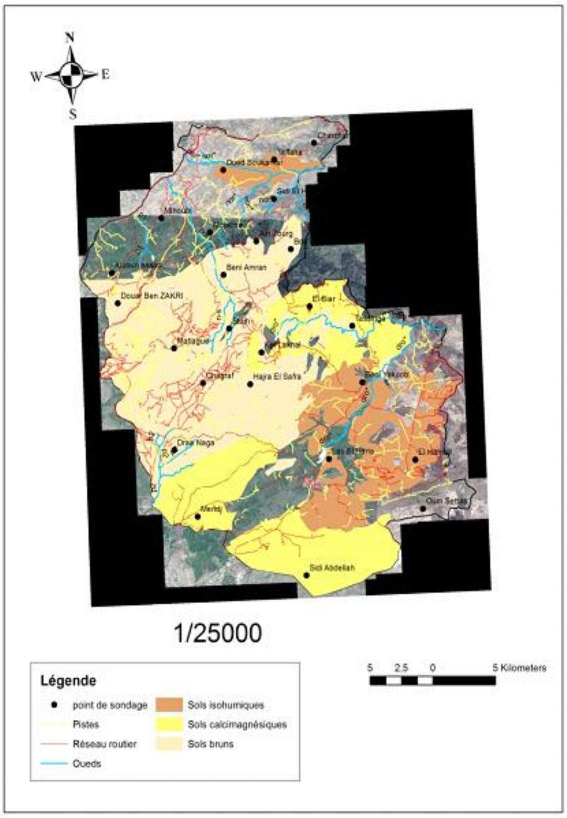

Fig. 13. The soils of the region of Djebel El Ouahch (city of Constantine, Algeria) (KEHAL L, 2015).

Conclusion

The evaluation of the soil fertility status of the study perimeter in the Jebel El Ouahch area is not limited to a simple description of climate and soil. It takes into account the contribution of factors that intervene in this environment and that directly influence crop development. These are the climatic, edaphic and anthropogenic factors most important in the region. his study highlighted that climate is suitable for a large number of market gardening, cereal, forage and tree crops. The good development of these remains nevertheless conditioned by reasoned irrigations during the spring, summer and autumn period. Soil surveys show two types of soils: heavy, deep, sometimes hydromorphic calcimagnetic soils, compact in depth and vulnerable to settlement, and brown, light, permeable, well ventilated soils, but also vulnerable to settlement. At the end of these descriptions, advice on the choice of agricultural practices and on crops is issued, namely: - the choice of working periods of the soil and of the tillage equipment, - the choice of species taking account of the The cultural suitability of these two types of soils. Particular attention should be paid to the loss of soils, particularly the isohumic soils eroded by river bank erosion found at Oued El Haria and its tributaries. To this end, a management program for the protection and conservation of soils is recommended. Physical analysis of these two types of soil shows that they do not risk adhering to the tillage material over a wide range of moisture ranging from Water content at the point of wilting to the water content at the field capacity. However, these soils remain vulnerable to settlement within this humidity range. This makes it possible to suggest the passage of agricultural machines when the latter are in the dry state in order to avoid compaction and caking. Inputs of organic matter are essential given the low levels recorded in the two types of soils. Soil salinity is not a constraint for crop development and growth due to its low level. The soil pH is slightly alkaline to alkaline. It is a favorable pH for nutrient availability for plants. The soil content of the region in total limestone is low, which reduces the risk of precipitation of the assimilable phosphorus and reduces the problems of downshifting and antagonism between the nutrients. The exchangeable potassium content is generally very low in the soils of the region. For this purpose, it is advisable to make provision for straightening and maintenance to prevent the deficiencies and the risks of leachings, especially in the less evolved soils. On the other hand, magnesium is present at high levels. Maintenance fertilizers are sufficient to keep this element at its optimum.

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