INNSPUB

International Journal of Biosciences | IJB |
ISSN: 2220-6655 (Print), 2222-5234 (Online)
http://www.innspub.net
Vol. 10, No. 4, p. 160-167, 2017

RESEARCH PAPER OPEN ACCESS

Influence of slopes on barley productivity in the Tessala mountains, (Western Algeria)

Berrahal-Belahcene Nadia[*1,2] , Megherbi-Benali Aicha[2], Labdi Mohamed[1], Zouaoui Sofiane[2], Toumi-Benali Fouzia[2]

[1]*National Institute of Agronomic Research (INRAA), Algeria*

[2]*Department of Environmental Sciences, University of Sidi Bel Abbes, Sidi Bel Abbes, Algeria*

Key words: Slope, Barley, Morphological parameters, Tessala, Western Algéria

http://dx.doi.org/10.12692/ijb/10.4.160-167 Article published on April 28, 2017

Abstract

Mountain ecosystems are almost all in a state of advanced degradation due to human pressure: deforestation, inadequate plowing on steep slopes. The classification of slopes in the mountains of Tessala reveals a rather undulating topography, frequently above 25%. In order to meet the needs of farmers and predict harvests. This study, based on the results of surveys carried out on farmers' fields and in the mountainous region of Tessala, describes the effect of the slope on the morpho-physiological parameters of the barley crop at three sites in the zone study. The results obtained from this study of the influence of the slope on the yield of the barley crop show that the soils with a steep slope have a negative effect on the behavior of the crops and their morphological parameters (height of plant, spike length, weight of spikes) and performance component (Number of grains/spike, weight of grain/spike, number of grains/m², weight of one thousand grains). The results obtained suggest the importance of adequate and rigorous choice of land in any development strategy in the study area where the terrain is particularly pronounced and sloping land (+ 12%) occupies almost 51% of the land area.

* **Corresponding Author:** Berrahal-Belahcene Nadia ✉ belahcene.nadia@yahoo.fr

Introduction

Algeria is one of the largest countries on the African continent with an area of 2,381,000 km². However, it is far from having all the advantages that its territorial dimension would suggest. Its natural assets are certainly significant, both in terms of surface resources and subsurface resources; But it is necessary to temper the simple quantitative estimates and the received ideas which have been founded upon them. In a vision of sustainable development, the resources of our country appear to be more limited when confronted with the population growth recorded since independence and that this comparison is complemented by the increasingly worrying threats posed to these resources , Their exploitation or improvident development (BNEDER, 1993).

The growing preoccupation with the sustainable management of the countryside requires a reasoned approach to agricultural activities. This leads to the search for the most influential characteristics of soil degradation through their identification, discrimination and impact (Sahli, 1991).

Overexploitation of these resources, coupled with the phenomenon of drought, inevitably leads to soil and water degradation, which results in problems of salinization, sodification and deterioration of soil structure (Bouklikha, 2001).

According to Benabdeli, 1993, mountain ecosystems are almost all in a state of advanced degradation due to human pressure: deforestation, inadequate plowing on steep slopes, overgrazing, and overexploitation of groundwater. We therefore found it useful to develop a research on the relationships between slopes and productivity so as to be able to respond to the needs of agricultural operators and crop prediction.

This study describes the slope-productivity relationship based on the results of surveys carried out on farmer fields and in the Tessala mountains region.

Zone and methods of study

Zone of study

The region of Tessala, Algerian western mountainous region, which has particular characteristics in terms of geographical isolation (Bouzidi, 2009).

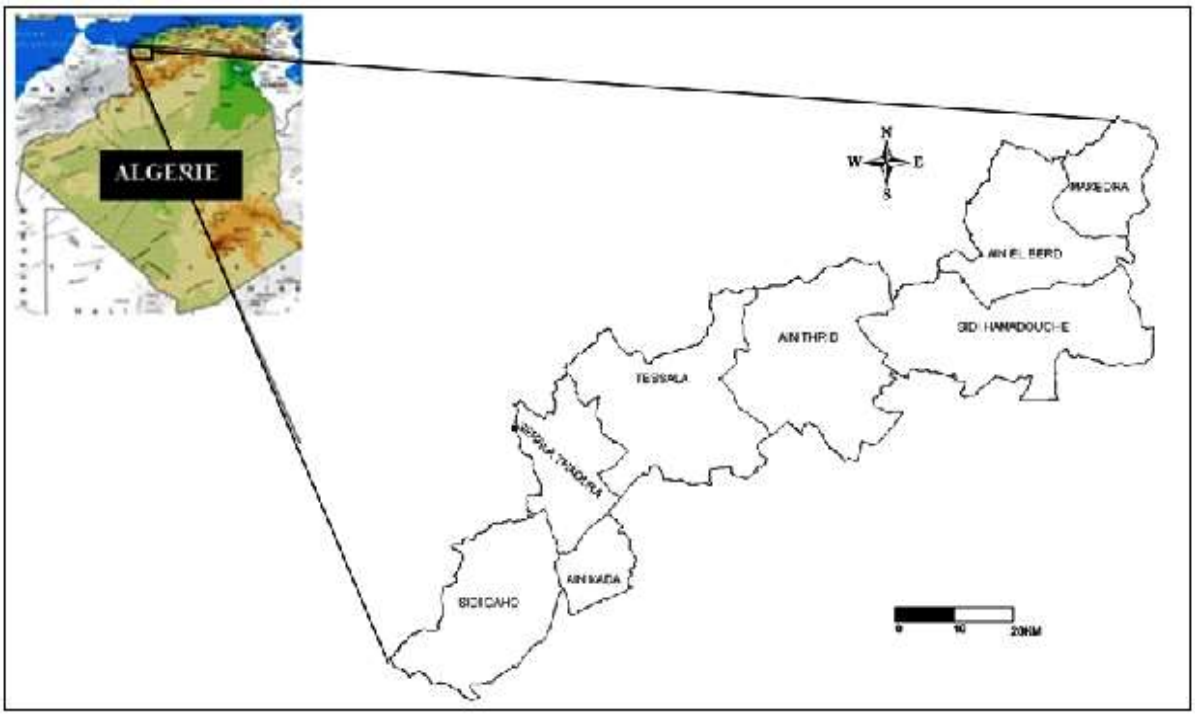

Fig. 1. Location of study area.

From the Mediterranean Atlas, it is the most lowered link, it is one of the elements More characteristic of the face of the western Tell with the mountains of Beni chougrane to the east, it is an integral part of this set, it forms the northern border for the plains of Tlemcen and Sidi Bel Abbes (Bneder 1993).

Limited to the north by the plain of Mléta and the Sebkha of Oran and to the south by the plain of Sidi Bel Abbes and the wadi El Mebtouh, the Tessala Mountains have an average altitude of 800m. It culminates at the summit of Djebel Tessala at 1061m, it decreases towards the East until reaching 600m in Mekedra (in the South-West of the agglomeration of Zahana) (Fg. 1).

The general orientation of these mounts is South-West / North East. The northern slope with a fairly steep slope is in direct contact with the plain of the Mléta, whereas the steeper south slopes steeply and slowly towards the Sidi Bel Abbes plain (ENSID, 2003).

The mountains of Tessala show a clear topographic dissymmetry, the southern slope Appearing less steep than the northern slope. However, below the summits the valleys encircle very strongly downstream and erosion phenomena (ravines in particular) affect many slopes (Pouquet, 1952).

The slope classification reveals a rather hilly topography, the slopes have steep slopes frequently above 25% (BNEDER, 1990), and a relief ranging from hills of average altitude of 500 meters in the southwestern part of The zone with a flat relief with softened slopes in contact with the plain of Sidi Bel Abbes. The Tessala mountains are characterized by very poor, rocky soils, of shallow depth and heavy texture predominantly clayey, subject to threatening erosion. (Benyahia *et al*., 2001).

Groundwater resources are very limited in the area. This weakness may constitute a constraint severely limiting any program for the recovery and development of the area. (Bouklikha, 2001).

In terms of climate, the study area is subject to semi-arid conditions under Mediterranean influence (Bachir Bouiadjra *et al*, 2011). The southern slope of the Tessala Mountains is characterized by prolonged drought and soil Relatively degraded with a dominance of clay soils. The northern slopes benefit from more mild climatic and edaphic conditions: a softening sea breeze in summer, with low evaporation and interesting rainfall (Ferka Zazou, 2006).

The dominant economic activity in the study area is based on agriculture which occupies nearly 80% of the population. Population growth leads to a demand for arable land, which leads to decreased soil fertility (ENSID, 2003).

In the lower foothills of Tessala, the soils are of the calcimagnesic type of medium depth, of alluvial intake of the type little evolved, moderately deep and of fine texture (Charif, 2001).

For an area of 58744.68 ha, the useful agricultural area is 54038.8 ha or 87.11%. It is strongly influenced by the diversity of terrain, land tenure, soil, cropping practices and production systems. Forest area and rangelands occupied respectively 6.78 and 9.51%.

Vegetal materials

To conduct this study, we examined the behavior of the barley crop, Rihane 03 variety (Pedigree: AS 46/AVT11ATHS 2L-1AP-3AP-OAP).

Method of study

The study consists in determining the effect of the slope on the components of barley yields , three sites were selected in the study area, which is located in the lower semi-arid area in the cooler winter, where the dry season is pronounced, and spreads out over about five and a half months from the end of the month, April to mid-October (Benseddik & Benabdelli, 2000).

Precipitation, poorly distributed in space and time, ranges between 200 and 400 mm/year (Mohammedi, 1997), often result in a large water deficit.

The selected sites are: The site of Ain Kada (south-west zone), Ain Trid (center of the zone) and Ain El Berd for the northeast part; And two groups of slopes, the first grouping the slopes of -10% and the second those of + 10% (Figure 2), whose characteristics are given in the table below (Table 1).

A cumulative rainfall of 342 mm (average Seltzer: 325 mm) was recorded. In addition, the number of winter frost days was significant in December (15 days), March and April (18 days), with both periods coinciding with the settlement and tillering phases. The soils of the experimental sites Ain El Berd and Aïn Trid are heavy, with a high retention capacity.

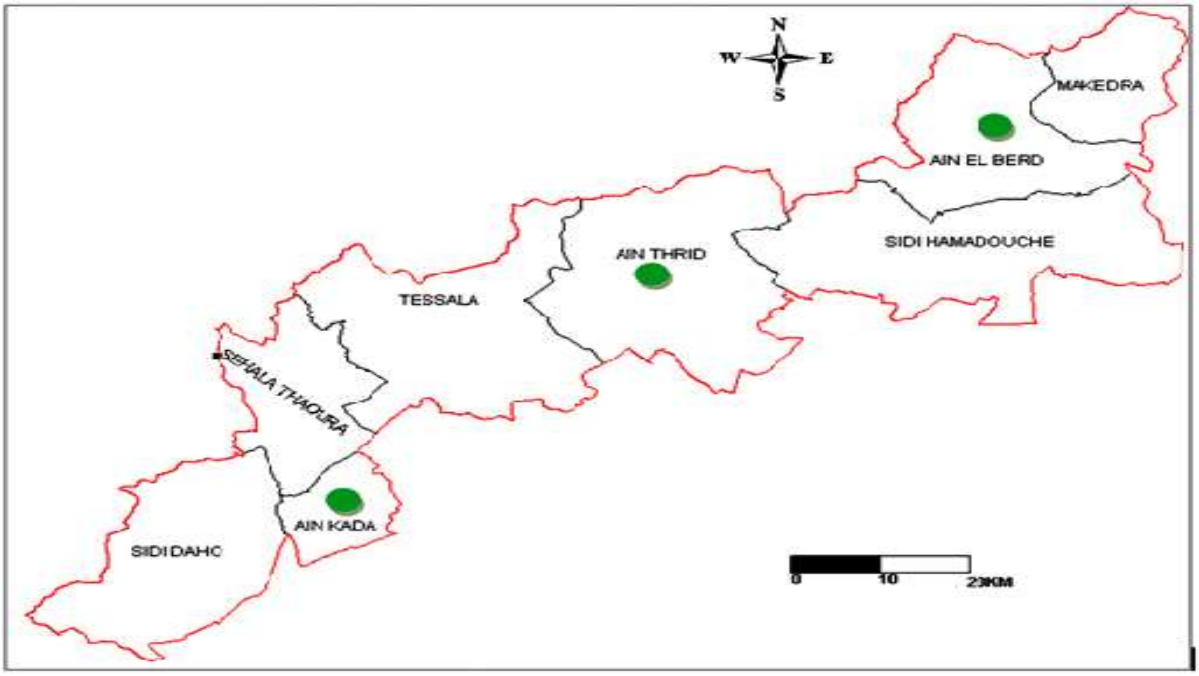

Fig. 2. Location of the sampled stations.

They are vertisols characterized by vertical cracking; The site Ain Kada is predominantly loamy and therefore has a sensitivity to compaction and accentuation (Mourret *et al.*, 1990). The soils of all the experimental sites are non-saline and alkaline pH.

Experimental plan

The experimental plan consist s of complete random blocks with three replicates. The sites were chosen to represent the study area from southwest to northeast. The Ain Kada site represents the south-west zone, Ain Trid for the central part of the study area and Ain El Berd for the northeast part of the study area.

Two slopes were chosen according to two groups, one grouping the slopes of -10% and the second + 10%.

The morpho-physiological parameters measured on each plot and for each slope group are as follows:

Height plant (HP): average height in centimeters of plants, measured from the ground to the top of the spikes (barbs not included),

Spike Length (SL),

Spike Weight /m² (SW),

Number of grains/ spike (N. G),

Grains Weight /m² (GW ,

Spike Number /m² (S.N),

Weight of one thousand grains in grams (PMG),

Data processing

The relationships between the different components as well as the variations due to the soil characteristics of the selected sites and the slope interaction x experimental sites were analyzed by variance analysis and by a multi-varied analysis (correlations) by The statistical software STATBOX.

Results and discussion

Monitoring of plots

Analysis of relative variance on grain yield and its components

The analysis of variance, with 2 classification criteria, revealed significant site effects for height, weight and number of grains/m²; And a sloping effect not significant for the length of the spike, the weight of the grains/m² and the PMG. The interaction sites x slopes is not significant for the length of the ear and the PMG. (Table 2).

The correlations

Interpretation of the correlations is made by graphic representation; A vector connects the center of the circle to the different points representing the variables.

Table 1. Physico-chemical characteristics of the soils of the experimental sites.

Parametres	Experimental sites		
	Aïn El Berd	Aïn Trid	Aïn Kada
Texture	C	C	S
Organic carbon (%)	0.40	1.52	1.65
Total nitrogen (%)	0.12	0.15	0.13
C / N Report	10.17	9.98	12.69
Phosphorus (ppm)	25.00	10.50	29.00
Total limestone (%)	0.53	3.22	06.45
Active limestone (%)	00	00	04.50
PH (H2O)	8.07	8.04	8.92
Organic material	1.96	2.62	2.84
Electrical conductivity	0.085	0.110	0.100
(Mmhos /cm)			

C: Clay texture , S: Silty texture.

The study of the representation of the main components (Figure 4) shows that four of the variables studied are well represented (r> 0.6) and correlated positively with respect to axis 1 and which are the length of plant, Number of grains/spikes, grain weight/m² and number of spikes/m² with respective correlation coefficients of 0.683, 0.773, 0.617 and 0.716.

Table 2. The analysis of variance of the measured parameters. (P <0.05).

Source de variation	Ddl	HP	S.L	S.W	N. G	G.W	S.N	PMG
Total	17	20.70	0.31	690.43	14.91	4490.99	2085.79	7.17
Locations	2	11.61	0.68	1367.86	16.32	1610.03	7375.06	12.37
Slopes	1	118.43	0.31	3055.54	72.0	1008.60	8624.22	5.24
Interaction. (Sites x Slopes)	2	4.37	0.09	394.47	2.77	8.76	1723.39	3.75
Residual	12	16.79	0.29	429.76	11.93	341.76	719.78	7.03
Average test		45.42	5.70	202.02	29.38	173.49	199.44	40.27
C.V (%)		9.0	9.4	10.3	11.8	10.7	13.5	6.5
SD		4.10	0.54	20.73	3.45	18.49	26.83	2.65
Area effect		S	NS	NS	NS	S	S	*NS*
Slope effect		S	NS	S	S	NS	S	*NS*
Interaction effect (area x slope)		S	NS	S	S	S	S	*NS*

ddl : degrés de liberté ; *S* : significatif ; *NS* : non significatif.

The length of the spikes which is positively correlated to axis 2 (r = 0.764) and the weight of the grains negatively with respect to axis 2 (r = -0.643).

These variables depend much more on the variety than on the environment (Megherbi *et al.*, 2016). The PMG is very weakly correlated with respect to axis 1 (r = 0.054), and strongly correlated with axis 3 (r = 0.908).

Study variables

The diagonalization results show that the percentage of the information given by each axis is: axis 1 = 36.32%, axis 2 = 25.59%, axis 3 = 17.23% and axis 4 = 10.35%. The first two main axes account for 61.91% of the information (Table 3).

Table 3. Total Variance Explained.

Component	HP	SL	NG	SW	GW	SN	PMG
Eigen value	2,543	1,791	1,206	0,725	0,333	0,248	0,154
% of Variance	36,322	25,592	17,234	10,350	4,750	3,548	2,203
Cumulative (%)	36,322	61,914	79,148	89,499	94,249	97,797	100,000

For the contribution of the observations (Figure 3), the diagonalization results show that the effect of the slopes and of the different sites on the morphological characteristics and the yield components have no influence on the culture of Barley except for the weight of the grains and the number of spikes/m2 where the site of Ain El Berd has positively influenced these two characteristics and this may be due to the climatic conditions of this site which benefits from a rate of rainfall more Important compared to the other two stations.

Discussion

Slopes have a negative influence on morphological characteristics (Height plant and weight of spikes) and yield components (number of grains/spike, number and weight of grains/m2).

These slopes of more than 10% are affected by high erosion, which according to Boli *et al.* (1994) has a negative impact on crop yields and loss of fertility factors (nutriments, organic matter and clay). More the slope and the length of ground are important, more the risk of erosion will be severe because the runoff takes seeds, plants, fertilizers and fine particles.

For Giasson, 2000, the zones with the highest slopes are also those which, in addition to the problem of erosion, suffer from a lower agricultural potential; Erosion is very intense on the central part of the south-eastern slope of the Tessala mountains, but, it is less strong on the southern slope, where conditions are more favorable: soils developed on a resistant substrate and less pronounced relief (Bachir Bouidjra *et al.,* 2011).

In addition to environmental characteristics as topography aspects, limiting factors must be taken into account when assessing the agricultural suitability of an area.

Soil depth insufficient characteristic sign of soils in the region limits root development and availability of water and nutrients for plants, resulting in declining production and soil fragility (Mrabet, 1993).

Conclusion

The results obtained from this study of the influence of the slope on the yield of the barley crop show that the soils with a steep slope have a negative effect on the behavior of the crops and their morphological parameters (height of plant, spike length, weight of spikes) and performance component (Number of grains/spike, weight of grain/spike, number of grains/m², weight of one thousand grains).

The results obtained suggest the importance of adequate and rigorous choice of land in any development strategy in the study area where the terrain is particularly pronounced and sloping land (+ 12%) occupies almost 51% of the land area.

References

Bachir Bouiadjra S, El Zerey W, Benabdelli K. 2011. Diachronic study of changes in vegetation cover in a mountainous ecosystem by remote sensing in space: Case of the Tessala mountains (western Algeria) Physio-Geo - Physical and Environmental Geography, 2011, volume V p211-225.

Benabdeli K. 1993. Agriculture, food and the environment: a trilogy in imbalance. Ecosystems, n ° 1, Ed Djillali University LiabesSBA 70-74.

Benseddik M, Benabdelli K. 2000. Impact of climatic risk on the yield of durum wheat (*Triticum durum*, Desf) in semi-arid zone: eco-physiological approach. Drought 1. **Vol 11**, 45-51.

Benyahia M, Benabdeli K, Moueddene K. 2001. Geology, Pedology and Ecosystem Ed University Djillali Liabes SBA & INRA SBA p 70-75.

BNEDER.1990. Development of mountain areas in the Wilaya of Sidi Bel Abbés: prospects for the development of agricultural holdings zone North. Report 63 p.

BNEDER. 1993. Study of development and development of the mountain areas of the wilaya of Sidi Bel Abbes phase III. Development Program. 103p.

Boli Z, Bep Aziem B, Roose E. 1994. Erosion impact on crop productivity on sandy soils of Northem Cameroon. Com ISCO 8, Delhi, **1,** 80-89. Editors L. S.Bushan, LP: Abrol, M.S. Mohan Rao, Indian Assoc., S, W Cons., Dehra Dun, India, 1684 p.

Bouklikha M. 2001. Test of soil improvement in clay soils for optimal occupation (case of the southern slope of Tessala Sidi Bel Abbes) Memory of magister University Djillali Liabes department of environmental sciences 125 p

Bouzidi M, Latrèche A, Attaoui I, Mehdadi Z, Benyahia M. 2009. characterization of matorrals and garrigues in *Urginea pancration* (Steinh) Phil. In the djebel Tessala (Western Algeria) Physio-Geo -Geography Physics and Environment, volume **3,** 133-149.

Charif K. 2001. Contribution to an agro-forestry development approach of the municipality of Tessala Sidi Bel Abbes memory of magister, Univ Djillali Liabes Sidi Bel Abbes, Algeria .115p.

ENSID. 2003. The physical environment and constraints to agricultural development in Algeria. Part 1: the North West region. 126p ENSID: National Institute of Soils of Irrigation and Drainage and their effects on the soil-plant system. Al Awamia **80,** 3-38.

Ferka Zazou N. 2006. Impact of spacio-temporal occupation of spaces on the conservation of the forest ecosystem. Case of the commune of Tessala, Wilaya of Sidi Bel Abbes. Memory of magister University Abou Bakr Belkaïd. Tlemcen 147p.

Giasson. 2000. Handbook of integrated soil management and conservation practices **8,** of FAO Land and Water Bulletins, ISSN 1607-808X; Food and Agriculture Org., 49-52; 208p.

Megherbi-Benali A, Toumi-Benali F, Zouaoui S, Hamel L, Benyahia M. 2016 Impact of environmental conditions on the yield variability of durum wheat (*Triticum durum*. Desf) and its associated characters at Algerian semi-arid areas. International Journal of Agronomy and Agricultural Research (IJAAR) **8(2),** 64-74 P.

Mohammedi H. 1997. Ecological diagnosis of productive space in the face of food needs: case of the cereals sector in the Sidi Bel-Abbes region. Thesis of Magister, Djilali Liabès University, Sidi Bel-Abbes, 111 p.

Mourret JC, Conesa A, Bouchier A, Ould Sadd M, Gaîd M. 1990. Identification of the factors of variability of durum wheat under limiting water conditions in the Sidi Bel region -Abbes. Cereal farming, 23, 1-10.

National Office of Meteorology (Algeria). - Data 2015.

Mrabet R. 1993. Bibliographic review on plowing systems for water conservation.

Pouquet J. 1952. The mountains of Tessala (South-Tellian chains of Oranie), essay Morphogenetic. Edict. SEDES, Paris, 351 p.

Sahli Z. 1991. Ecosystems in crisis, risks and security in Mediterranean agriculture The case of the semi-arid zone of Sersou (Tiaret, Algeria) CIHEAM Mediterranean Options, Series A l no 21, 1991.

Seltzer P. 1946. Climate of Algeria Works of the Institute of meteorology and physics of the globe of Algeria, excluding ser, University of Algiers. Edit. The Typo-litho & J. Carbonel, 219P.