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# Response Of Lentils (*Lens culinaris* medik.) To Zinc And Manganese Soil Intake In The Dryland Rainfed Farming Of Abda Plains, Morocco.

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**Abstract**— The lentil *(Lens culinaris* Medik.) plays an important role in the cropping systems of semi-arid areas of Morocco particularly in Abda plain areas. Yields of this crop are very low due to rainfall and soil constraints. For the latest, lentil crop doesn't benefit from fertilizer input in addition to the low Zinc and Manganese availabilities which limits crop performance in this area. The main objective is to examine the effect of soil application of zinc and manganese on agronomic traits and development of lentil. A "Latin Square" experimental design was applied with treatments that consisted of applying an amount of 15 kg/ha/150L $H_2O$ of zinc sulfate and/or manganese sulfate at budding stage. Under water stress, lentil crop growth was slowed by Mn treatment, alone or in combination with the Zn. In the opposite biological yield was enhanced by Zn application either alone or combined with Mn. The pods number was increased by 11; 14; and 11 pods/plant, respectively by Zn, Mn, and Zn+Mn applications. For the seed number/plant, it was increased by 48; 72; and 52 %, respectively by Zn, Mn, and Zn+Mn applications. The highest harvest index was obtained from Mn treatment (25%) while the other treatments gave lower rates. However the overall average of grain yield was significantly improved by Zn (21%) and Mn (19%) treatments when applied separately. We conclude that under dryland farming, applying zinc and manganese fertilization alone or combined could improve lentil productivity through the increase of yield components, harvest index, biological and grain yields.

**Index Terms**— Lentil, Semi-arid, Zinc, Manganese, Morocco, Yield, Fertilisation



## 1 INTRODUCTION

The lentil (Lens culinaris Medik) is a legume crop that plays an important role in the cropping systems of the rainfed semi-arid areas of Morocco. It is ranked as the fourth cultivated crop legume with only 10% of the total cultivated area of grain legumes [1]. This area is in continuous decrease since the 1980's, indeed, it went from 87.000 ha in 1985-87 to 60,000 ha in 1988-1990 and is about 43000 ha with an average annual production of 31,497 tons [2] mostly in Zaer-Zemmour, Chaouia and Abda semi arid areas [3].

Previous soil explorations of Abda area showed a start of soil deficiency of some micro-nutrients such as Zinc (Zn) and Manganese (Mn) [4]. This is a problem mostly found in areas where soil pH and $CaCO_3$ content are high and soil organic matter content is low as in Abda area case [5]. The application of Zn results in the enrichment of seeds in this element while Mn improved synthesis of chlorophyll and several enzymes in the plant, and water absorption by the plants [6]. The needs for these two elements differ from one plant to another.

This element is easily retained by the alkaline soils. Therefore Manganese deficiency is possible even if the soil is rich in this element [7].As a consequence, absorption of these micronutrients at amounts adequate for better crop production and higher grain mineral concentrations are significantly depressed. Thus, replenishment of Zn and Mn is needed not only for improving Zn concentrations of edible parts of plants, but also for sustaining high yields [8,9]. There are several examples demonstrating that applying Zn and Mn fertilizers to cereal crops improve not only grain Zn and Mn concentration of plants, but also their productivity [10]. Zinc is more mobile in acidic soils than in alkaline ones. Normal concentrations in plants are between 125 and 150 ppm. Zinc deficiency causes troubles by destroying auxin (growth factor), which would explain the lack of elongation of internodes.

The application of Zn and/or Mn is not only necessary to improve concentrations in small grains, cereals and legumes, but also to improve and maintain high yields. There are several examples demonstrating that the application of Zn and Mn fertilizers on cereal crops not only improves the concentration of small grain crops Zn and Mn, but it also increases their productivity [8,9].In Morocco, rare are studies that investigate the effect of Zn and Mn application on grain legumes such as lentil in the rain-fed areas.

The objective of this study is to examine the effect of foliar application of zinc and manganese on agronomic traits and development of lentil.

## 2 MATERIALS AND METHODS

### 2.1 Site Location

The experimental site is located at the National Institute of Agricultural Research (INRA) experiment station of Jemâa Shaïm, 12km North-east of the city of Jamâa Shaïm, Province of Safi. Jemâa Shaïm station is at 32°24' N latitude and 08°47' W longitude, and is 176 m above sea level. The soil of Jemâa Shaïm Agricultural Research Station is classified as Vertisol, well developed deep clay soil with little or no slope, typical of semi-arid

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Morocco.

The soil of the experimental plot is a clay soil with a pH of 7.4, E.C. 0.13 mmhos/cm, organic matter 1.8%, available $P_2O_5$ 17 ppm and potash 497 ppm. Zinc status of soil was 0.48 ppm and manganese content of soil was 0.85 ppm. More characteristics of the soil are given in Table 1. The climate is semiarid with a winter rainfall pattern. The long-term average seasonal precipitation, over 30 years, has been 297 mm, most falling between November and April. The average rainfall from 1988 to 2004 is only 296 mm.

### 2.2 Plant Material

The variety of lentil "Hamria" used in this experiment was developed jointly by INRA and ICARDA. It is well adapted to semi-arid areas of North Africa and west Asia with a short-cycled with early maturity (not more than 150 days), high efficiency for grain filling and good grain quality, tolerant to diseases and suitable for mechanical harvesting. In addition to these characters this variety was chosen for this area for its positive soil water balance when used in rotation with wheat in the dry land area of Abda.

### 2.3 Crop Management

This trial was established on a clean fallow while applying no tillage system. Therefore direct seeding of lentil with an amount of 50 kg/ha. The fertilizer amount was 18-46-0 kg/ha of N-$P_2O_5$-$K_2O$, was applied early November of each year. The trial was harvested at the end of May or early June.

### 2.4 Treatments

The treatments consisted of foliar application of 15 Kg/ha/150 L $H_2O$ of Zinc sulfate (Zn $SO_4.7H_2O$) and/or Manganese sulfate ($MnSO_4.4H_2O$) at budding stage. The experimental design applied was Latin Square (4x4 blocks by 4 treatments).

### 2.5 Data Analysis

Each set of data that was registered on hard copies either in the field or in the lab, were put in excel files (worksheets) according to the suitable statistical analysis. For this case we applied the ANOVA (Analysis of Variance) for 4 blocks and for treatment in Latin Square model to detect any effects of individual or combined treatments. In case a significant difference was found, we proceeded to a comparison of means by using the Least Significant Difference (LSD (5%)).

## 3 Results and Discussions

### 3.1 Phenology

The growth cycle of Hamria variety lasted about 136 days in total with a 15% reduction of the normal cycle of the variety. The mid season drought affected significantly the phenological behavior of the used lentil by causing an early and short duration flowering of 30 days, and forcing the crop maturity without taking advantages of the spring rainfall. In fact during the rains of March, most of the plants were in the process of late stages of seed filling. The same observations were made by [11] where water stress reduced growth cycle at different lines of lentils, and resulted in a shortening of the ripening period. The treatments did not influence the different stages of development. The presence of elements have neither accelerated nor delayed the phenological stages.

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### 3.2 Crop Growth

At the 63rd day after emergence, the dry matter production of the different treatments was slightly higher than that of the control. Plant growth did not follow the same trend for all treatments (Fig.1). Indeed, plots treated with manganese alone or combined manganese with zinc, were most affected by the drought in mid-cycle stages. After the rains of March, there was a significant increase in the plots biomass treated with zinc and manganese at a time. The Zn treatment allowed having a consistent increase in biomass until the end of the cycle. Under water stress, crop growth was slowed by Mn treatment, alone or in combination with the Zn.

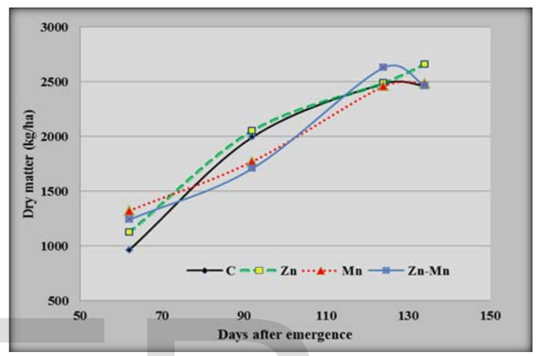


**Fig 1. Effect of Zn and Mn fertilization on lentil growth in the rainfed dry land of Abda plains.**

### 3.3 Biological yield, grain yield and harvest index

As reffered in the table below the biological yield was enhanced by Zn application either alone or when combined with Mn whereas no effect was shown for the grain yields that was very low (less than 700 kg/ha) compared to the potential of the variety (25 kg/ha). The literature reviews say that Zn and Mn, can significantly increase the yield of crop [12].The highest harvest index was obtained from Mn treatment (25%) while the other treatments gave lower rates. These results are similar to those of [13] on the chickpea; the application of zinc in soil allowed to improve performance. [14] reported that the response of lentil fertilization through soil zinc fertilization is extremely rare. This could be due to the fact that the lentil has a low efficiency of absorption of zinc in alkaline soils [15,16].

**Table: Effect of Zn and Mn fertilization on biological and grain yields, and harvest index of lentil grown under rainfed of Abda.**

| Treatments | Biological yield (Kg/ha) | Grain yield (Kg/ha) | Harvest index (%) |
|---|---|---|---|
| Control | **1655 $^{b}$** | **401 $^{a}$** | **19,9$^{b}$** |
| Zn | **1864 $^{a}$** | **485 $^{a}$** | **21,6$^{b}$** |
| Mn | **1660 $^{b}$** | **477 $^{a}$** | **25,0 $^{a}$** |
| Zn+Mn | **1704$^{ab}$** | **430 $^{a}$** | **19,8$^{b}$** |

Values followed by the same letter are not significantly different according to the statistical analysis.

### 3.4 Lentil pods and seeds number per plant

The number of pods per plant was improved in all treatments compared to the control which gave only 29 pods per plant (Fig.2). Manganese significantly improved pods number. This is consistent with what was found by [17]. Similarly to the previous yield component, applying manganese and zinc resulted in a higher seed number per plant (Fig.3). These results indicate an essential requirement of Zn and Mn for the function of pollen and fertilization. It seems imperative to ensure an adequate supply of Zn and Mn during the development of the reproductive system to overcome the constraint of seed yield of legumes [18].

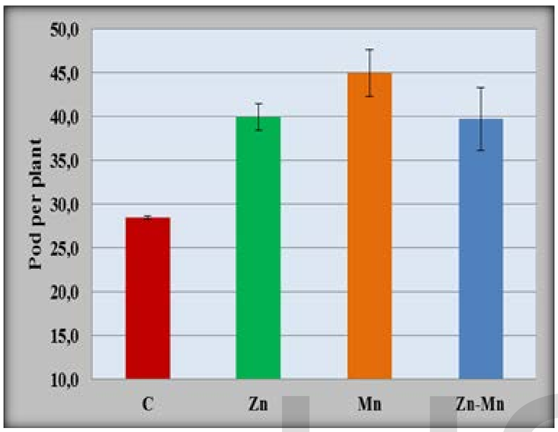


**Fig 2. Effect of Zn and Mn application on lentil pod's number in the rainfed dry land of Abda plains**

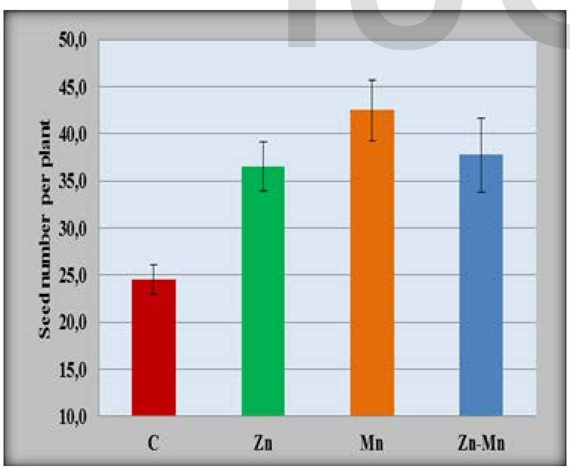


**Fig 3. Effect of Zn and Mn application on lentil seed's number in the rainfed dry land of Abda plains**



## 4 CONCLUSION

In this trial the midseason water stress influenced very significantly the lentil crop's performance. The lentil plant growth did not follow the same trend for all treatments that in plots treated with manganese alone or combined manganese with zinc, were most affected by the drought in mid-cycle stages. The plots that received zinc fertilizer were less sensitive to lack of water in the middle of the cycle. Even though, grain yield is very low compared to the potential of the variety Hamria, Zn and Mn gave good grain yields. The lowest harvest index was obtained from the control with 19.1%, followed by the combined Zn and Mn treatments (22.1%), Zn (27.3%) and Mn (29.6 %). Manganese and zinc resulted in a higher pods and seed numbers per plant compared with the control. The quality of seed was not affected by neither by treatments nor by water stress as the variety managed to produce fewer good size of grains rather than many small sized grains.

We conclude that under dryland farming, applying zinc and manganese fertilization separately or combined could improve lentil productivity through the increase of yield components, harvest index, biological and grain yields.

## 4 ACKNOWLEDGMENT

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