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Investigate the effect of drought stress and different amount of chemical fertilizers on some physiological characteristics of coriander (Coriandrum sativum L.)

Mohammad Mahdi Jamali

Ph.D student of agronomy- National Agrarian University of Armenia

Corresponding author: Mohammad Mahdi Jamali

ABSTRACT: In order to investigate the effect of water deficit and application of different fertilizers on some physiological characteristics of coriander, an experiment was conducted at research field at Khorramabad-Lorestan, Iran in 2009-2011. Field experiment was carried out by split factorial design with 3 replications. The factors studied included two levels of irrigation, irrigation after 30 mm evaporation from evaporation pan (without drought stress condition) and irrigation after 70 mm evaporation from evaporation pan (drought stress condition). Nitrogen levels were N_0, N_{60}, $N_{90,}$ N_{120} kg/ha and phosphorus levels were P_0, P_{80}, P_{100}, P_{120} kg/ha. The result showed that irrigation after 30 mm evaporation (without stress condition) and application of 120 kg/ha nitrogen and phosphorus increased crop growth rate, leaf area index, whereas irrigation after 30 mm evaporation and application of 90 kg/ha nitrogen and 100 kg/ha increased net assimilation rate. The highest crop growth rate, leaf area index was obtained from $I_{30}N_{120}P_{120}$, and highest net assimilation rate was obtained from $I_{30}N_{90}P_{100}$.

Keywords**:** water deficit, fertilizers, physiological characteristics, coriander

INTRODUCTION

Coriander is an annual plant with scientific name Coriandrum sativum L. from Apiaceae family and with height of 20 to 40 cm. The goal of analysis the growth physiological indices is response of plant spices to definite environmental conditions. Environmental conditions are variable in a year and also during the years (Lebaschi and Sharifabadi, 2004). In this regard, medicinal plant of coriander has importance in pharmacy industry, food, cosmetics and health (Volatile, 2000). In stress condition, less leaf area is produced in coriander in comparison with without stress condition (Drunasky and Struve, 2005). This event decreased relative growth rate, crop growth rate and net assimilation rate. (Maurya, 1989) in his studies on coriander concluded that phosphorus caused to increase of leaf area index. So increasing leaf area index caused to increase of crop growth rate. Increase in production and achieving self-reliance and self-sufficience in production of medicinal plants in the country require proper planning and necessary investment in research and particularly applied studies in agriculture. Genotype, environment and crop management are key determinant factors of the final product. Important factors effective on the growth and development of plants are irrigation and chemical fertilizers, especially nitrogen and phosphorus fertilizers, which especially affect the growth of coriander seed and its variants. This research has been conducted with a focus on the abovementioned issue.

MATERIALS AND METHODS

This test was conducted in research field in Khorramabad-Lorestan in 2009-2011. Field experiment was carried out by a split factorial design with 3 replications. The factors studied included two levels of irrigation, irrigation after 30 mm evaporation from evaporation pan (without drought stress condition) and irrigation after 70 mm evaporation from evaporation pan (drought stress condition), nitrogen levels were N_0, N_{60}, N_{90}, N_{120} kg/ha and phosphorus levels were P_0, P_{80}, P_{100}, P_{120} kg/ha. The seeds were planted in May month. Shrub distance on the row was 10 cm. at first seeds were disinfected with Vitavax fungicide and then they were cultivated in furrow to a depth of 2 cm. at planting time, phosphorus fertilizer was distributed to land in the form of strip and land was irrigated after planting of seeds. Nitrogen fertilizer in determinate quantities was given to two equal parts in 4 to 6 leaf-shaped stages and starting of making stem. So they were blended with rake. Growth indexes were set considering growth degree days (GDD = Growth Degree Day) and the base temperature for coriander was considered 7 ° C. Growing degree days was calculated by the following formula and its accumulation was determined for different times of the sampling

$$\text{Growth degree days} = \frac{\text{Daily maximum temperature} + \text{daily minimum temperature}}{2} - \text{Base temperature}$$

To calculate the daily growing degree days, temperatures less than 7 and above 29 degrees Celsius in order of 7 and 29 degrees were applied respectively. The turnover of DM (Dry Matter) and LAI (Leaf Area Index) produced as the dependent variable and GDD as independent variables were determined by following formula after calculating the corresponding coefficient.

$TDM = EXP (a+bgdd+cgdd^2)$

$$LAI = \frac{LA1+LA2}{2}$$

CGR was calculated by multiplying the estimated amount of dry matter by the relative growth rate according to the following formula:

$CGR = TDM \times RGR$

Net assimilation rate (NAR = Net Assimilation Rate) is a standard model of the photosynthetic efficiency of leaves in a plant community and the scale is grams per square meter in the growing degree days (g/m2.gdd) is. Net assimilation rate is obtained from the following formula:

$$NAR = \frac{CGR}{LAI}$$

RESULTS AND DISCUSSION

Total dry matter

Drought stress caused to decreasing accumulation of total dry matter in plant. Main reason of decreasing accumulation of total dry matter in stress condition was decrease the leaf area index and as result decrease of plant photosynthetic area. The highest total dry matter was obtained (with 576.3 g/m^2.gdd) from irrigation after 30 mm evaporation from evaporation pan and application of 120 kg/h nitrogen with receiving 1040 growing degree days. Total dry matter in irrigation treatment after 70 mm evaporation from evaporation pan and application of 120 kg/h nitrogen was 468.3 g/m^2.gdd and it was obtained from 1040 growing days (figure 1). Total dry matter in different levels of non application, 60 and 100 kg/ha nitrogen was respectively 517.3, 547.5 and 562.4 g/m^2.gdd with receiving 1040 growing days (figure 1). Also phosphorus caused to increase of total dry matter, so the highest total dry matter was obtained (with 582.2 g/m^2.gdd) from irrigation after 30 mm evaporation from evaporation pan and application of 120 kg/ha phosphorus with receiving 1040 growing degree day. Total dry matter in different levels of non application, 80 and 100 kg/ha phosphorus was respectively 467.1, 556.2 and 573.6 g/m^2.gdd with receiving 1040 growing degree days (figure 2).

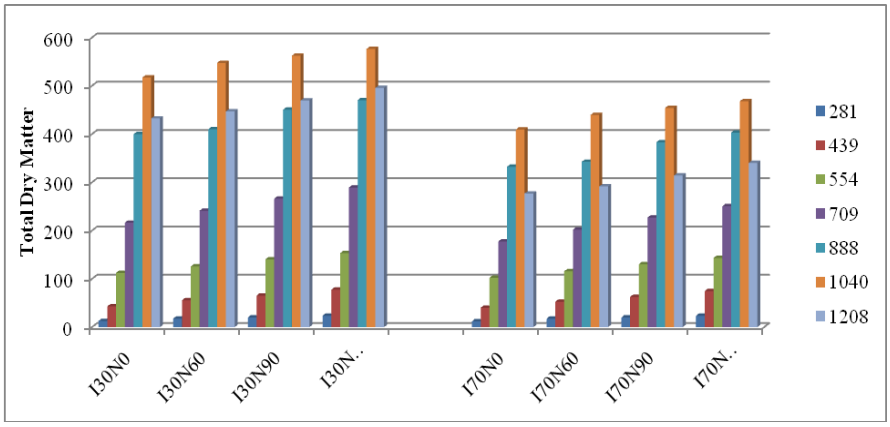

Figure 1. Changes process of total dry matter in different levels of irrigation and nitrogen

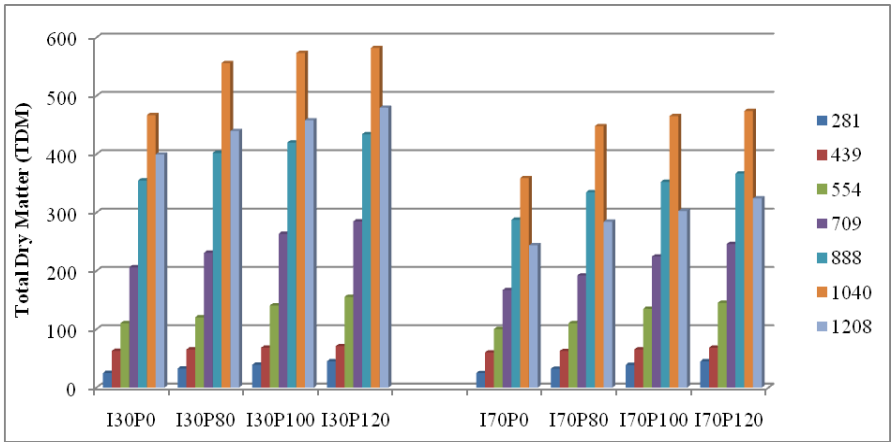

Figure 2. Changes process of total dry matter in different levels of irrigation and phosphorus

Crop growth rate

Crop growth rate represents the increase in plant dry matter per unit surface in unit of time and its scale is grams per square meter of growing degree days (g/m2.gdd). A large amount of solar radiation is not absorbed by plant coverage in the beginning of growth period for the reason that plant does not have appropriate coverage and crop growth rate is low but crop growth rate increases with increasing of leaf area and it reaches to its maximum amount in flowering stage. After this stage, crop growth rate decreases because plant proceeds to material transfer instead of new material production and leaves yellow and fall in ripening stage which this event causes to photosynthesis destruction and decrease of crop growth rate. Crop growth rate showed decreasing trend in the range of 1040 to 1208 growing degree days in different treatments of irrigation. Figure 3 shows the changes process of crop growth rate in different levels irrigation and nitrogen. The highest crop growth rate was obtained (28.0 g/m^2.gdd) from irrigation after 30 mm evaporation from evaporation pan and application 0f 120 kg/ha nitrogen with 1040 growing degree days. Crop growth rate in levels of non application, 60 and 90 kg/ha was respectively 20.6, 24.1 and 27.3 g/m^2.gdd. Figure 4 shows the changes process of crop growth rate in different levels of phosphorus. According to figure 4, we can conclude that increasing phosphorus causes to increasing the crop growth rate. Because phosphorus causes to increase of leaf area and as a result increase of photosynthesis. The highest crop growth rate was obtained (with 28.2 g/m^2.gdd) from irrigation after 30 mm evaporation from evaporation pan and application of 120 kg/ha phosphorus with 1040 growing degree days. Crop growth rate in levels of non application, 80 and 100 kg/ha was respectively 20.7, 24.3 and 27.5 g/m^2.gdd.

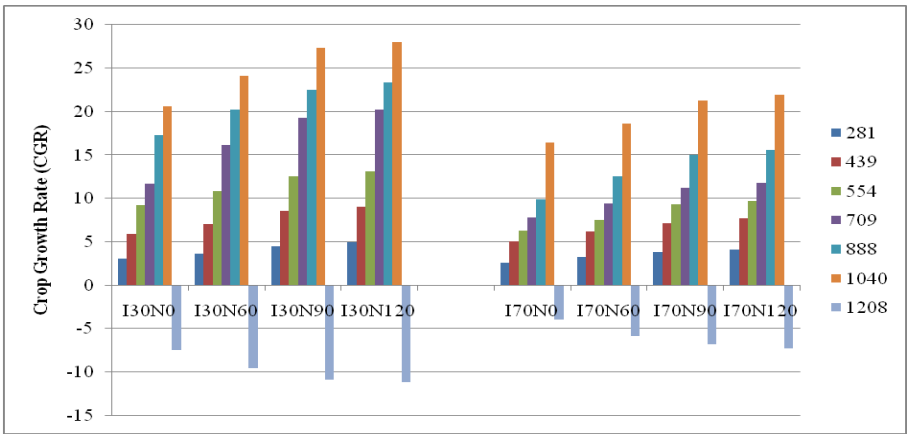

Figure 3. Changes process of crop growth rate in different levels of irrigation and nitrogen

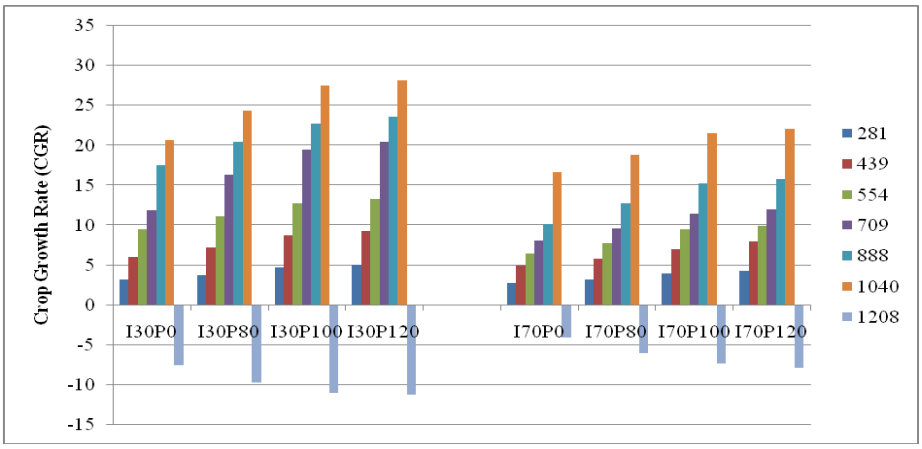

Figure 4. Changes process of crop growth rate in different levels of irrigation and phosphorus

Leaf area index

Leaves take into consideration as factor that have much role in yield formation, since green leaves are considered as important producer organs of photosynthetic material for plants growth. Plant must reach to desirable amount of leaf area index for absorbing the radiation which its amount is dependent to kind of plant and environment conditions. As regard rate of increase of leaf area is definitive of rate of increase the photosynthetic capacity in plant, calculate the increase of leaf area has especial importance. Results showed that drought stress caused to decrease of leaf area index. The highest leaf area index was obtained (with 6.8) from irrigation after 30 mm evaporation from evaporation pan and application of 120 kg/h nitrogen with 1040 growing degree days (figure 5). Leaf area index in drought stress treatment was 5.9 and it was obtained from 1040 growing degree days (figure 5). Leaf area index in levels of non application of nitrogen, 60 and 90 kg/ha was respectively 5.7, 6.0, 6.3 and it was obtained from 1040 growing degree days. Also highest leaf area index in levels of non application of phosphorus, 60, 90 and 120 kg/ha was 5.9, 6.3, 6.7 and 7.1 with receiving 1040 growing degree days (figure 6).

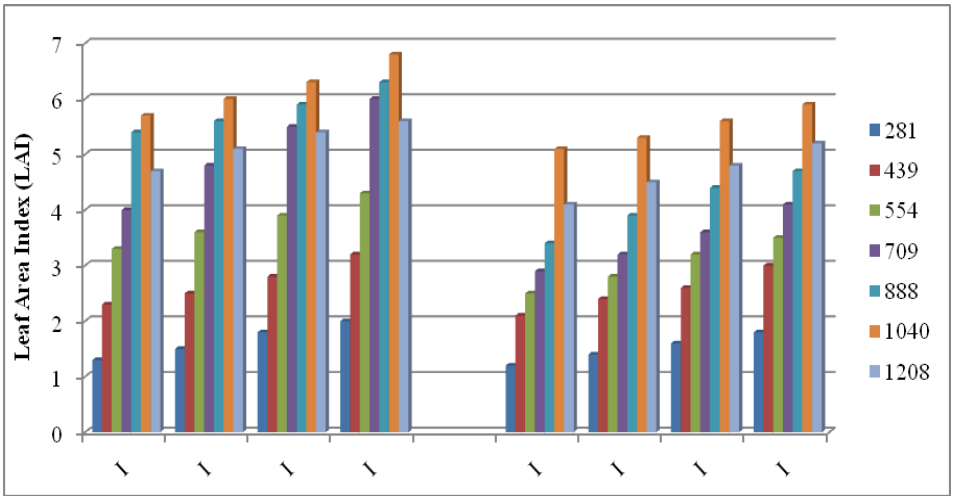

Figure 5. Changes process of leaf area index in different levels of irrigation and nitrogen

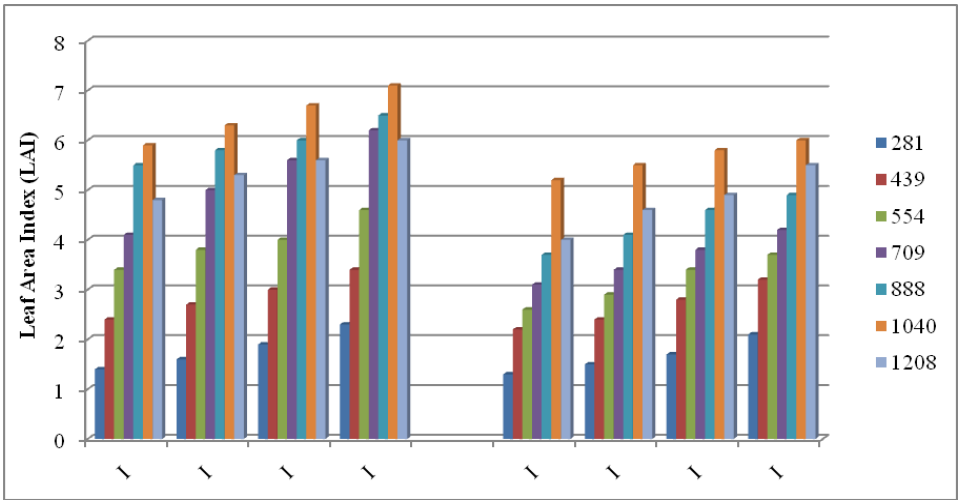

Figure 6. Changes process of leaf area index in different levels of irrigation and phosphorus Net assimilation rate (NAR)

Net assimilation rate is intensity average of leaves photosynthesis in a plant community and it reaches to its maximum when the all leaves are in expose to the sunlight and this condition occurs when the plant is in primary stages of growth and leaves are extent that none of them are in the shadow. Net assimilation rate in stress and without stress condition and application of 90 kg/h nitrogen was respectively 4.3 and 3.8 g/m^2.gdd and it was obtained from 1040 growing degree days (figure 7). The lowest net assimilation net was obtained (with -1.8 g/m^2.gdd) from irrigation after 30 mm evaporation from evaporation pan and application of 120 kg/h nitrogen with receiving 1208 growing degree days. Net assimilation rate in levels of non application, 60 and 120 kg/ha phosphorus was respectively 3.5, 3.8 and 3.9 g/m^2.gdd.

Also highest net assimilation rate was obtained (with 4.1 g/m^2.gdd) from application of 100 kg/ha phosphorus with receiving 1040 growing degree days. Phosphorus caused to increase of net assimilation rate with increase of leaf area (figure 8).

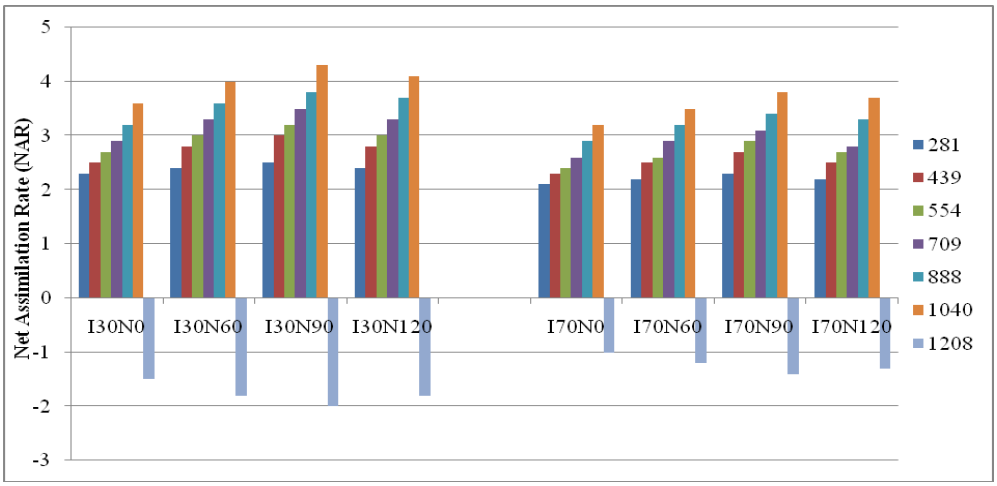

Figure 7. Changes process of net assimilation rate in different levels of irrigation and nitrogen

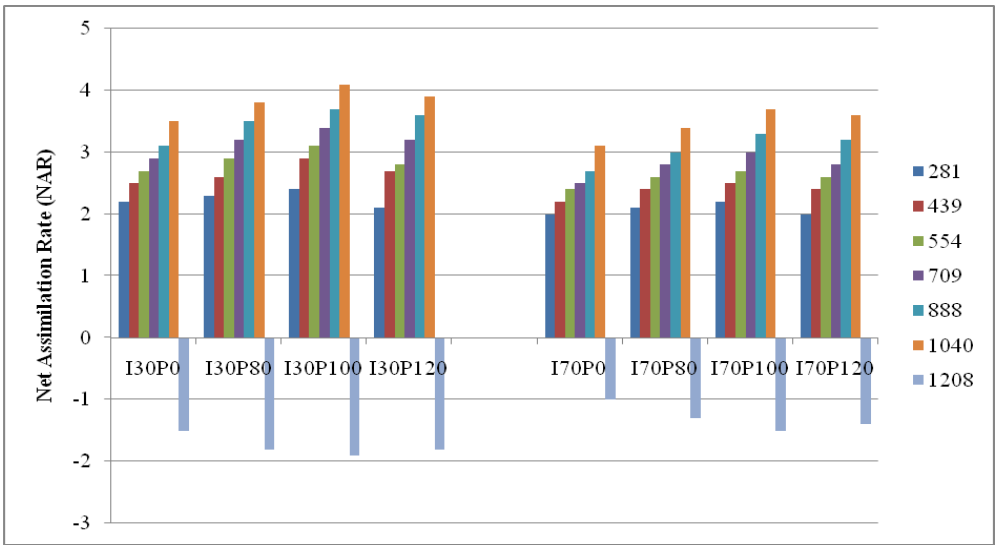

Figure 8. Changes process of net assimilation rate in different levels of irrigation and phosphorus

Amount of dry matter accumulation in drought stress condition started with receiving 281 growing degree days and it continued until about 1040 growing degree days then it began to decrease. This subject shows nonexistence of sufficient humidity in soil in order to growth supply of coriander. Studied showed that drought is main limitation in production of crop plant (Milburn, 1979; Blum and Sulivan, 1986). Plants have different sensitiveness to drought in growth stages and the effect of drought is different on their yield. In some plants, the first stage of growth is the most sensitive stage to drought (Lazaroff and Pitman, 1966; Nyeb and Tinker, 1977). This subject has been distinguished in connection with reducing rainfall or irrigation in different stages of plant cycle by (Hejnowicz and Sievers, 1995). Rapid inhibition of branch growth is the first symptom of drought stress in plant (Neumann, 2008). This phenomenon occurs with closing of stomata and as a result reducing evaporation and absorption of carbon dioxide. Drought stress causes to disorder in plant development, reproduction system, aging leaves, fade and plant death (Schulze, 1986; Hsaio, 1973). In this experiment, mentioned process had justification about leaf area index (figure 5 & 6). Drought stress is effective on plants access to nutrition. For example, absorption amount of soil nitrogen may be under effect of soil humidity in drought stress time (Barraclough et al., 1989). Phosphorus absorption is limited in drought stress time, not also by limited access but also by reason of reducing power the root

absorption (Dunham and Nye, 1979). Increase of nitrogen and phosphorus caused to increase of dry matter accumulation and delay in stopping the accumulation of total dry matter. Accumulation rate of dry matter, leaf area index, crop growth rate and net assimilation rate reached to maximum with normal irrigation and application of suitable fertilizer. Crop growth rate showed different process in drought stress treatment. Crop growth rate decreased in most treatments with receiving 1208 growing degree days. The highest crop growth rate was related to normal irrigation (irrigation after 30 mm evaporation from evaporation pan) and application 120 kg/ha nitrogen and 120 kg/ha phosphorus. Crop growth rate is decreased in drought stress condition because of increasing respiration intensity and decrease of photosynthesis (Goldani and Rezvani, 2007; Prasad et al., 1978). Crop growth rate decreased with approach to stage of plant maturity, because of stopping the vegetative growth, yellowing leaves, decrease of net assimilation rate and allocation of photosynthesis material to seed and finally crop growth rate was negative with drought and falling leaves. Increase of nitrogen consumption caused to increasing the crop growth rate by increasing leaf area index and received light. (Birch and colleague, 1998) reported that crop growth rate is result of light absorption by leaves, time period of light absorption and efficiency of light consumption. Increase of crop growth rate was because of positive effect of nitrogen consumption on leaf area index. Net assimilation rate decreased in drought stress condition because coriander plant has active growth and stress caused to its decreasing. Results showed that drought stress caused to significant decrease of leaf area index. So the highest leaf area index was obtained from normal irrigation and the lowest leaf area index was obtained from drought stress condition. Drought stress in during vegetative growth causes to shrinking leaves and acceleration in yellowing and leaves aging and as a result leaf area index and rate of light absorption is decreased. Humidity shortage is reduced leaf area index through decrease of growth and increasing leaves aging (Cakir, 2004). Use the nitrogen and phosphorus had effect on production and expansion of leaf area. (Connor and colleague, 1993) reported that leaf area index, leaf area duration and finally plant photosynthesis is increased by nitrogen consumption. Net assimilation rate did not remain constant with passing of time and with increasing of plant age showed a descending fall in growth and evolution, so dry weight is reduced when new leaves are added because of cast a shadow of leaves on each other. So we can concluded that irrigation after 30 mm evaporation from evaporation pan and application of 90 kg/ha nitrogen and 100 kg/ha phosphorus was effective for Khorramabad city-Lorestan province- Iran. Since production quantity is not important in production of medicinal plants, but also determines the effective material is important in each treatment.

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REFERENCES

Barraclough PB, Kuhlmann B and Weir AB. 1989. The effects of prolonged drought and nitrogen'er iHzer on root and shoot growth and water uptake by winter wheat. Journal of Agronomy and Crop Science, 163: 352-360.

Birch CJ, Hammer GL and Rickert KG. 1998. Improved methods for predicating individual leaf area and leaf senescence in maize. Aust. J. Agric. Res. 49: 249-262.

Blum A and Sullivan E Y. 1986. The comparative drought resistance of landraces of sorghum and millet from dry and humid regions. Annals of Botany, 57: 835-846.

Cakir R. 2004. Effect of water stress at different development stages on vegetative and reproductive growth of corn. Field Crops Res. 89: 1-16.

Connor DJ , Hall AJ and Sadras VO. 1993. Effect of nitrogen content on the photosynthesis characteristics of sunflower leaves. Aust. J. Plant Physiol. 20: 251-263.

Drunasky N and Struve DK. 2005. Quercus macrocarpa and Q. Prinus physiological and morphological responses to drought stress on Coriandrum sativum L. Urban Forestry & Urban Greening, 4(1): 13-22.

Dunham RJ and Nye PH. 1979. The influence of soil water content on the uptake of ions by roots. III. Phosphate, potassium, calcium and magnesium uptake and concentration gradients. Journal of Applied Ecology, 13: 967-984.

Goldani M and Rezvani P. 2007. The effects of different irrigation regimes and planting dates on phenology and growth indices of three chickpea (Cicer arietinum L.) cultivars in mashhad. J. Agric. Sci.

Hejnowicz Z and Sievers A. 1995. Tissue stress in organs of herbaceous plants. Journal of Experimental Botany, 46: 1035-1043.

Hsaio TC. 1973. Plant responses to water stress. Annual Review of Plant Physiology, 24: 519-570.

Lazaroff N and Pitman MG. 1966. Calcium and magnesium uptake by barley seedlings. Australian Journal of Biological Science, 19: 991-1005.

Lebaschi MH and Sharifi Ashurabadi A. 2004. Growth indices of some medicinal plants in different levels of drought stress. Researches of medicinal and aromatic plants of Iran, 20(3): 249-261.
Maurya KR. 1989. Growth, yield and quality component in coriander genotypes. Indian Journal of Horticulture, 46(1): 107-110.
Milburn JA. 1979. Water Flozu in Plants.Longman, London, 230p.
Neumann PM. 2008. Coping mechanisms for crop plants in drought-prone environments. Annals of Botany, 101: 901-907.
Nye PH and Tinker PB. 1977. Solute Movement in the Soil-root System. Oxford: Blackwell Scientific publications, England, 342p.
Prasad VV, Pandey SRK and Saxena MC. 1978. Physiological analysis of yield variation in gram (Cicer arietinum) genotypes. Indian J. Plant Physiol. 21: 228-234.
Schulze ED. 1986. Carbon dioxide and water vapor exchange in response to drought in the atmosphere and in the soil. Annual Review of Plant Physiology, 37: 247-274.
Volatil O. 2000. Coriander (Coriandrum sativum L.). Plant Foods for Human Nutrition, 51(2): 167-172.