



The effect of different levels of auxin hormone at different irrigation intervals on yield components of broad bean

Seyed Adel Mavali Zade*, Tayeb Saki Nejad, Mani Mojadam

Department of Agronomy, Ahwaz Branch, Islamic Azad University, Ahwaz, Iran

Article published on November 23, 2014

Key words: Broad bean, Auxin hormone, Irrigation interval, Yield.

Abstract

In order to study the effect of irrigation periods and different levels of auxin hormone on quantitative and qualitative yield of broad bean in weather conditions of Shadegan, a split plot experiment in the form of randomized complete block design with four replications was carried out in a field in Darkhovein region in the autumn of 2011. The main plots included three levels of irrigation (8, 14, and 20 days) during the growth stage and sub plots included three levels of auxin hormone (0, 100ppm, 200ppm). Data analysis showed that application of auxin hormone and the decrease of irrigation interval had a significant effect on grain yield, biological yield, 100-grain weight, number of pods per plant, pod weight, stalk weight, pod length, number of grains per pod, plant height, harvest index, number of fertile sub branches, leaf area index, and leaf area so that the maximum grain yield was obtained at irrigation interval of 8 days and application of 100ppm auxin (246.35 g/m²) and the minimum grain yield was obtained at irrigation interval of 20 days and control treatment without application of auxin (134.15 g/m²). The results of this experiment showed that in Shadegan weather conditions the use of treatment with 100ppm auxin and irrigation interval of 8 days would be recommended for obtaining an optimal yield.

*Corresponding Author: Adel Mavali Zade ✉ lmavalizadeh@yahoo.com

Introduction

Daily increase of population growth and consequently increase of food demand have made further production of agricultural products necessary in order to supply the required food for the growing population. Although grain plays the main role in this regard, because of low percentage of grain protein and the restrictions for providing animal proteins, public attention nowadays is drawn to application of legumes as an important source of protein needed for human being. The average daily need of human being to energy is 2800 calories. In developed countries the daily use of energy is 3500 calories and in the third world countries it decreases to 2200 calories for each individual (Majnoon Hosseini,1993). To enhance the yield in area unit which is one of the major obstacles to production increase and planting development of broad bean within the province and country, and also to prevent excessive consumption of chemical fertilizers more research needs to be done about the effect of auxin hormone on broad bean in the region. Furthermore, investigations among the farmers of the province showed that broad bean farms are unfortunately irrigated excessively. Planning and regulating irrigation intervals at different growth stages of broad bean can lead to the application of this valuable blessing (water) for cultivating larger amounts of this crop. Moreover, the proper use of auxin hormone with regard to its effect on growth and yield components as well as investigating the interactive effect of auxin and intake of water make it necessary to carry out this experiment and these two factors are expected to increase water use efficiency (WUE) which is about 600 in Iran, but in the U.S. it is over 2000 g product per cubic meter of water (KazemiArbat H,RahimZadehKhovi F,Moghadam M,Banaei K,2000). Furthermore, Wester *et al* (1990) stated that shortage of water is one of the factors restricting plant growth and development which not only reduces the produced dry matter but also impairs carbohydrates share in grains and consequently decrease the harvest index (Masjedi ShokoohFar A,Alavi Fazeli,2009).Reduction of photosynthesis rate due to stomata closure and decrease of plant growth, shortage of assimilates for

filling the grains and decrease of grain filling period are the most important effects of drought on plants (Reddy, 2004). Moreover, water stress increases peroxidation reactions and oxidation of fatty acids of cell membrane and consequently disintegrates it (Jian Y and Hing B, 2001).

The results of the research conducted by Gosh and Basu (1999) showed that the effect of auxin hormone on grain yield, harvest index, and 100-grain weight was statistically significant at 1% level. The use of further growth hormone increased the grain yield due to production of more sub branches and consequently more pods and grains in each plant, and ultimately more grains were produced and grain yield increased. The effect of auxin hormone on biological yield at different periods of time was significant (Haniri,2012). (Leopard, 1964)In higher concentrations, auxin prevents the growth (KouchakiA, SarmadniaG,1990). (Renik and Bandroski, 1987). Auxin is degraded by two light and enzymatic oxidation processes (MoorT, 1982). Auxin regulator enhances antioxidant enzyme system in plant and makes the plant more tolerant of stress conditions such as water deficit stress (Zand, Soroushzade, 2009).

Auxin as a growth regulator changes the grain into a strong reservoir by stimulating cell division and growth, and consequently by accepting more assimilates, more dry matter is stored in it(Zand and Soroushzade,2009). Pseudomonas strains which are able to produce auxin enhance the plant height from 4.1 to 5.3 cm and this increase leads to better absorption of water and soil nutrition by the plant (Bani Hashem F,*et al.*,2010). The highest contribution of assimilates mobilization into grain occurs in milky stage which accounts for 50% of total dry matter of the grain and the rate of auxin hormone in this stage is maximum (Kpuchaki A,Banaian Aval M,1994).The use of 10ppm auxin has increased total dry matter, leaf area index, growth rate, net assimilation rate, grain yield, and protein percentage of wheat (Haniri,2012).Application of different compounds of zinc and growth regulator (auxin)

activates antioxidant enzymes of the plant and makes the plant more tolerant of stress conditions such as water deficit stress (Ghanati and Moradi,2010). (Beles, 1992) The use of ethylene-releasing compounds or auxin which stimulated ethylene production will accelerate flowering. (Osborne DJ, 1989) The decrease of endogenous levels of auxin in leaves and other plant organs (fruit and flower) will absolutely lead to the loss. South wick, S.M. and Poovaiah, B.W. (1987) stated that endosperm and embryo produce auxin in grain which moves outward and stimulates endosperm growth. Vaaidia and Live (1972) stated that the effect of auxins depends on their concentration(MoorT, 1982).

The volume flow of materials from the phloem towards the growing fruits is done by the auxin that is made in grains. They have also stated that the maximum activity of this hormone occurs when the rate of dry matter density of grain is maximized that is when the rate of reservoir activity and phloem discharge is maximized (Horst Maraschino).

Brenner, M. L. (1987) said that indolacetic acid (IAA) is known as accelerating stomatal opening, rubisco enzyme activity, sucrose phosphate synthase, assimilate accumulation in phloem, assimilate mobilization in phloem, and physiological purposes activity. Borzenkova, R.A. (1976) stated that when IAA is applied as a foliar spray, it has a stimulatory effect on photosynthetic activities in a number of different plant species such as beans. The volume flow of materials from the phloem towards the growing fruits is done by the auxin that is made in grains. He has also stated that the maximum activity of this hormone occurs when the rate of dry matter density is maximized that is when the rate of reservoir activity and phloem discharge is maximized (Horst Maraschino). Water deficit has different effects on plants and basically, water stress prevents the cell enlargement before the cell division and actually limits the plant growth through inhibiting different physiological and metabolic stages of nutrients and hormones. In other words, the most sensitive physiological stage to drought is the cell growth and

development as a result of reduction in turgor pressure. Cells can develop only when turgor pressure exceeds the threshold of cell water (Zand and Sorushzade,2009). Yan-tun (2006) reported that water stress significantly reduced grain yield, biological yield, and harvest index of spring wheat. Wester *et al* (1990) stated that shortage of water is one of the factors restricting plant growth and development which not only reduce the produced dry matter but also impair carbohydrates share in grains and consequently decrease the harvest index(Masjedi ShokoohFar A,Alavi Fazeli,2009).

Pandey (2000) stated that harvest index reduction in severe drought stress conditions was due to more sensitivity of reproductive growth rather than vegetative growth to inappropriate conditions. Rezeyan Zadeh E, (2008) has stated that when the moisture is accessible, reproductive growth stage and the rate of current photosynthesis will increase and will lead to the formation of more flowers in plant which in turn affects the formation of fertile pods and production.

The most critical periods of water shortage during the growth stage are flowering stage and grain filling stage in which the needed water of crops should be fully provided. Flowers and pods might fall due to irrigation after severe water deficit stress at flowering stage. For filling the pods and producing a high yield not more than 50% of usable water of soil should be drained during flowering and grain filling stages. In end-of-season drought conditions, that is grain filling stage, an effective physiological trait in increasing the efficiency of dry matter distribution towards grain was high potential of plant for storing non-structural carbohydrates in vegetative organs and using them to support growing grains (Naderi *et al.*,2009).In areas where corns with limited growth and different types of soybeans with unlimited growth are planted if drought occurs during the pollination stage, the corn is usually more damaged and its grain yield will severely decrease (KouchakiA,SarmadniaG,1990). Cell growth in plant is an activity which is very sensitive to lack of water. Water potential reduction

in meristematic tissues during the day often leads to depletion of potential pressure less than the amount that is necessary for the cell enlargement. This event, in turn, leads to the decrease of protein or cell wall synthesis and cell enlargement (Boyer J S, 1968). The effect of drought stress duration is more than its severity and increasing the irrigation interval is one of the most important methods to practice deficit irrigation technique and is suggested as a method to increase water consumption efficiency (Soleimani H,2012). Ahmadi A and Baiker DR (2001) reported that during the grain filling stage in water stress treatments, the current photosynthesis of plant decreased; moreover, water stress led to the decrease of 1000-grain weight via decreasing grain filling period and declining the rate of assimilates mobilization to the grains and this reduction was attributed to grain filling process not to cell division. Phoris RP and King RW (1995) realized that the decrease of harvest index in severe drought stress conditions was due to more sensitivity of reproductive growth rather than vegetative growth to inappropriate conditions.

Jiang Y and Hung B (2001) reported the increase of peroxidation reactions and oxidation of fatty acids of cell membrane and consequently the decrease of cell membrane stability and its disintegration in beans under water stress conditions.

Clappertonetal (1997) stated that biological yield in the treatment without drought stress was more than the treatments with drought stress. Pandey *et al.*, (1983) stated that the number of grains in pod among the cultivar is more affected by genetic factors. Goksoy *et al.*, (2004) reported that grain yield significantly decreased as irrigation volume and frequency decreased. According to Ghanbari and Taheri Mazandarani (2004) although the decrease of grain yield under drought stress conditions at reproductive stage results from more sensitivity of plant to drought stress at this stage, the disruption of plant metabolism results in grain yield reduction in such conditions. Moreover, assimilate mobilization reduction due to water scarcity is one of the factors

that lead to the decrease of grain yield under water stress conditions (Emadi N *et al.*,2010). In addition to dry matter accumulation, the distribution of assimilates between different organs of plan is important, too. In drought stress treatment, the major part of produced assimilates at vegetative stage has been devoted to the roots to provide more water for the plant; therefore, the harvest index reduces in such conditions.

Drought stress causes the decrease of 100-grain weight which could be due to the decrease of effective period of grain filling stage and the decrease of synthesis and mobilization of assimilates to grains due to drought stress (Mahlouji M, Mousavizadeh S F and Karimi H, 2001).

Drought stress due to the effect of chlorophyllase, peroxidase, and phenolic compounds leads to chlorophyll content of the leaf which is a key factor in determining the rate of photosynthesis and dry matter production will decrease significantly (Ghosh,2004).

According to Ahmadi A and ceiocemardeh A, (2004) chlorophyll content of the leaf is a key factor in determining the rate of photosynthesis and dry matter accumulation. Drought stress at vegetative and reproductive stages led to the decrease of wax bean height in all densities. Water scarcity caused the decrease of photosynthesis, leaf area and lack of formation of new branches and also the decrease of number of pods per plant and number of grains per pod and 1000-grain weight (Emadi N *et al.*,2010). The decrease of irrigation intervals had a very positive effect on grain yield and biological yield. The increase of drought stress caused the decrease of grain yield by 24% and biological yield by 26%, and in such circumstances due to more reduction of biological yield rather than grain yield, the harvest index increased (Masjedi ShokoohFar A,Alavi Fazeli,2009). Among the yield componetes, number of pods per plant is the most important trait in determining the yield of bean and has the highest correlation with it (Bayat,2010). Water deficit stress has led to the

decrease of plant growth and dry matter yield in corn (Tavakoli H, karimi M, Mousavi SF,1989). The objectives of this paper were to study the effect of irrigation intervals and different levels of auxin hormone on throughput and yield components of broad bean and finally determination the most proper irrigation interval and the concentration of auxin hormone to produce to produce the most yield.

Materials and methods

This research was carried out in 2011 in a field in Darkhovein region in Shadegan located in the south of Khuzestan.

Experiment method

This research was carried out as a split plot experiment in the form of randomized complete block design with four replications and 9 treatments (Figure 3-3). Each experimental plot included 7 lines spaced 60 cm from each other and each line was as long as 6 m.

Experimental treatments

In this experiment, irrigation interval was considered as the main plot with three levels including 8 days irrigations (D_1), 14 days irrigation (D_2), 20 days irrigation (D_3) during the growth, and the sub plot included three levels of auxin hormone as A_0 : without auxin (control treatment), A_1 : 100ppm, A_2 : 200ppm auxin during the flowering stage.

Different stages of experiment

Land preparation and implementing the project plan, Preparing fertilizer and seeds.

Data analysis method

Analysis of variance was done in the form of split plot design by Minitab and Excel 2007 software and Duncan's test was used to compare the means.

Results and discussion

The effect of different levels of auxin hormone on total dry weight at different irrigation intervals

The ANOVA results (Table 1) showed that different levels of auxin hormone influenced the biological yield and caused a significant difference at 1% level, so that the mean comparison results (Table 2) showed that the use of 100ppm and 200ppm auxin increased the biological yield as much as 607.52 and 603.63 g/m² respectively. The results were significantly different at 5% level in comparison to the treatment without application of auxin which reduced the biological yield by 530.57 g/m². The results showed that the effect of applied auxin on grain yield, harvest index and 100-grain weight was statistically significant at 1% level. Due to consumption of more auxin hormone, the biological yield increased because of producing more sub branches and naturally producing more pods and grains per plant which ultimately led to producing more grains and higher grain yield (Ghosh & Basu).

Table 1. The ANOVA of biological yield, number of fertile branches per plant, number of grains per pod, 100-grain weight, and harvest index of broad bean at different irrigation intervals and different levels of auxin hormone.

Variation sources	Degree of freedom	Mean of squares					
		Biological yield (g/m ²)	Number of fertile branches in each plant	Number of grains per pod	Harvest index	100-grain weight (g)	grain yield (g/m ²)
Replication	3	737.26	0.06	0.027	0.14	101.1	125.59
Irrigation interval	2	146176.78**	2.39**	0.034ns	331.56**	33757.7**	67318.23**
Main plots error	6	56.92	0.02	0.057	0.37	53.9	37.19
Auxin hormone	2	22550.24**	1.24**	0.513**	58.38**	1687.3**	10712.37**
Irrigation interval x auxin hormone	4	432.81**	0.01ns	0.127**	10.50**	187.6*	393.54**
Sub plot error	18	75.74	0.06	0.009	0.58	57.7	72.78
Coefficient of variations(CV%)		1.50	9.84	2.64	1.80	2.48	3.42

ns, *, ** respectively indicate non-significant difference, and significant difference at 5% and 1% levels.

The ANOVA results (Table 1) showed that different irrigation intervals affected the biological yield and caused a significant difference at 1% level. According to mean comparison results (Table 2), the decrease of irrigation interval to 8 and 14 days increased biological yield by 682.49 and 595.87 g/m² and the increase of irrigation interval to 20 days reduced biological yield by 463.35 g/m². The results were significantly different at 5% level. In-end-of-season

drought conditions, that is grain filling stage, a biological trait was

effective in efficiency of dry matter distribution towards grain, high plant potential for storing non-structural carbohydrates in vegetative organs and using them to support the growing grains (Naderi *et al.*,2009).

Table 2. The mean comparison of simple effects positive effect on grain yield and biological yield (25) of different levels of irrigation intervals and auxin hormone on biological yield, number of fertile branches in each plant, number of grains per pod, harvest index, and 100-grain weight in broad bean.

Treatments	Traits mea						
Irrigation levels	Biological yield (g/m ²)	Number of fertile branches in each plant	Number of grains per pod	Harvest index	100-grain weight (g)	grain yield (g/m ²)	
8-day interval	682.49 a	2.92 a	3.68 a	46.45 a	112.2837 a	317.69 a	
14-day interval	595.87 b	2.50 b	3.66 a	43.86 b	98.811 b	261.73 b	
20-day interval	463.35 c	2.02 c	3.57 a	36.34 c	78.943 c	169.37c	
Auxin hormone levels							
0ppm auxin	530.57 b	2.12 b	3.45 c	39.69 b	92.372 b	215.10b	
10ppm auxin	607.52 a	2.75 a	3.88 a	43.22 a	99.214 a	267.05a	
20ppm auxin	603.63 a	2.57 a	3.61 b	43.75 a	98.451 a	266.65a	

The mean of treatments with similar letters are not significantly different from each other at 5% level according to Duncan's multi range test.

Clapperton (1997) stated that biological yield in the treatment without drought stress was more than the treatments with drought stress.

The decrease of irrigation intervals had a very positive effect on grain yield and biological yield (Moor, T.1982).

The results of Table (1) showed that the interactive effect of different levels of auxin hormone at different irrigation intervals was significant at 1% level. According to mean comparison results (Table 3), the highest grain yield by 719.05 g/m² belonged to the treatment with application of 100ppm auxin at 8-day irrigation interval and the lowest grain yield by 417.95 belonged to the treatment without the use of auxin at 20-day irrigation interval.

The effect of different levels of auxin hormone on grain dry weight at different irrigation intervals

The ANOVA results (Table 1) showed that different levels of auxin hormone affected the grain yield and caused a significant difference at 1% level, so that the mean comparison results (Table 2) showed that the use of 100ppm and 200ppm auxin increased the grain yield by 267.05 and 266.65 g/m² which showed no significant difference at 5% level. The treatment without the use of auxin decreased the grain yield by 215.1 g/m² which was significantly different from the two mentioned treatments at 5% level.

The ANOVA results (Table 1) showed that different irrigation intervals affected the grain yield and caused a significant difference at 1% level. Mean comparison result of the yield (Table 2) showed that the treatments with different irrigation intervals were significantly different at 5% level, so that 8-day irrigation interval increased the grain yield by 317.69 g/m² and 14-day and 20-day irrigation intervals decreased the grain yield by 261.73 and 169.37 g/m².

That is, the minimum grain yield belonged to 20-day irrigation interval and the maximum grain yield belonged to 8-day irrigation interval. The effect of drought stress duration is more important than drought stress severity and stress severity has fewer effects (Soleimani H,2012). Pandey (2000) stated that harvest index reduction in severe drought stress conditions was due to more sensitivity of reproductive growth rather than vegetative growth to inappropriate conditions. Rezeyan Zadeh E, (2008) has stated that when the moisture is accessible, reproductive growth stage and the rate of current photosynthesis will increase and will lead to the formation of more flowers in plant which in turn affects the formation of

fertile pods and production. Ghanbari AM and Taheri Mazandarani A. (2004) believe that although the decrease of grain yield under drought stress conditions at reproductive stage results from more sensitivity of plant to drought stress at this stage, the disruption of plant metabolism results in grain yield reduction in such conditions. Moreover, assimilate mobilization reduction due to water scarcity is one of the factors that lead to the decrease of grain yield under water stress conditions. The decrease of irrigation intervals had a very positive effect on grain yield and biological yield. The increase of stress reduced the yield by 24% (Masjedi ShokoohFar A,Alavi Fazeli,2009).

Table 3. The mean comparison of interactive effects of different levels of irrigation intervals and auxin hormone on biological yield, number of fertile branches in each plant, number of grains per pod, harvest index, and 100-grain weight in broad bean.

Treatment		Trains mean						
Irrigation levels	Auxin hormone levels	Biological yield (g/m ²)	Number of fertile branches in each plant	Number of grains per pod	Harvest index	100-grain weight (g)	grain yield (g/m ²)	
8-day irrigation	0ppm auxin	622.67 c	2.52 cd	3.4 c	44.59 c	105.661 b	277.62 c	
	100ppm auxin	719.05 a	3.22 a	4.0 a	48.15 a	115.118 a	346.35 a	
	200ppm auxin	705.75 b	3.00 ab	3.7 b	46.63 b	116.072 a	329.10 b	
14-day irrigation	0ppm auxin	551.07 d	2.15 e	3.4 c	42.38 d	96.054 d	233.52 d	
	100ppm auxin	623.97 c	2.80 bc	3.6 bc	44.24 c	101.075 c	276.12 c	
	200ppm auxin	612.57 c	2.55 cd	3.5 bc	44.93 c	99.304 cd	277.55 c	
20-day irrigation	0ppm auxin	417.95 g	1.70 f	3.3 c	36.39 f	75.401 f	134.15g	
	100ppm auxin	479.52 f	2.22 de	3.5 bc	37.25 f	81.450 e	178.67f	
	200ppm auxin	492.57 e	2.15 e	3.6 bc	39.65 e	79.978 e	195.30e	

The mean of treatments with similar letters are not significantly different from each other at 5% level according to Duncan's multi range test.

The ANOVA results of Table (1) showed that the interactive effect of application of different levels of auxin hormone at different irrigation intervals was significant at 1% level. The mean comparison results (Table 3) showed that the highest grain yield by 346.35 g/m² belonged to the treatment with application of 100ppm auxin at 8-day irrigation interval and the lowest grain yield by 134.15 g/m² belonged to the treatment without application of auxin at 20-day irrigation interval. In treatments with application of 100ppm and 200ppm auxin at 14-day irrigation interval and also the treatment without application of auxin at 8-day irrigation interval, there was no significant difference between gain yield means at 5% level.

A large amount of current and stored assimilates is used for increasing the weight of grains and grains dry weight will increase in a certain rate and then the increase of grains dry weight inclines exponentially to reach a steady state. Grain yield at different levels of auxin hormone is maximized 130 days after emergence. At this stage, maximum dry weight of grain at different irrigation intervals belongs to treatments with application of 100ppm and 200ppm auxin by 270 g/m² and minimum dry weight of grain belongs to treatment without application of auxin by 233 g/m². Auxin changes the grain into a strong reservoir by stimulating cell division and growth, and consequently by accepting more assimilates, more dry matter is stored in it (Tavakoli H, Karimi M, Mousavi

SF,1989).

Vaaidia and Live (1972) stated that the effect of auxins depends on their concentration (MoorT,1982). South wick, S M and Poovaiah BW, (1987) stated that endosperm and embryo produce auxin in grain which moves outward and stimulates endosperm growth. The volume flow of materials from the phloem towards the growing fruits is done by the auxin that is made in grains. They have also stated that the maximum activity of this hormone occurs when the rate of dry matter density of grain is maximized that is when the rate of reservoir activity and phloem discharge is maximized (Horst Maraschino).

The effect of different levels of auxin hormone on 100-grain weight at different irrigation intervals

The ANOVA results (Table 1) show that application of different levels of auxin has affected 100-grain weight and has caused a significant difference at 1% level, so that the mean comparison (Table 2) shows that application of 100ppm and 200ppm auxin has increased 100-grain weight 99.21 and 98.45 g respectively while in the treatment without application of auxin hormone, 100-grain weight has decreased 92.372 g.

Auxin hormone changes the grain into a strong reservoir by stimulating cell division and growth, and consequently by accepting more assimilates, more dry matter is stored in it (Zand and Sorushzade,2009).

The highest contribution of assimilates mobilization into grain occurs in milky stage which accounts for 50% of total dry matter of the grain and the rate of auxin hormone in this stage is maximum (South wick, S.M. and Poovaiah, B.W. (1987) stated that endosperm and embryo produce auxin in grain which moves outward and stimulates endosperm growth. Brenner, M. L. (1987) said that indolacetic acid (IAA) is known as accelerating stomatal opening, rubisco enzyme activity, sucrose phosphate synthase, assimilate accumulation in phloem, assimilate mobilization in phloem, and physiological purposes activity. The volume flow of materials from the

phloem towards the growing fruits is done by the auxin that is made in grains. He has also stated that the maximum activity of this hormone occurs when the rate of dry matter density is maximized that is when the rate of reservoir activity and phloem discharge is maximized (Horst Maraschino). There is evidence that the increase of auxin output in phloem from the growing fruits into the leaves of the source might act as a retroviral command (Horst Maraschino). The average weight of wheat grain depends on the number of spikes per area unit to total yield (KouchakiA,SarmadniaG,1990). In general, the factors with interfere at the beginning of growth season are more effective in the number of grains while the size of grain is mainly determined by the factors that will affect grains after pollination. The rate of available assimilates for mobilization to spike is determined between pollination and maturity stages (KouchakiA,SarmadniaG,1990).The ANOVA results (Table 1) shows that different irrigation intervals have affected 100-grain weight and have caused a significant difference at 1% level, so that according to mean comparison results (Table 2) the reduction of interval up to 8 days has increased the weight of 100-grain by 112.28 and the increase of irrigation interval up to 14 and 20 days has increased the weight of 100-grain by 98.81 and 78.94 g respectively. The results of the table show that the mean comparisons of 100-grain weight are significantly different at 5% level in different treatments. The most sensitive periods of water scarcity during the growth stage are flowering stage and grain filling stage when the needed water of plant should be supplied completely (Ghanbari AM and Taheri Mazandarani A,2004). Ahmadi A and Baiker D R (2001) reported that during the grain filling stage in water stress treatments, the current photosynthesis of plant decreased; moreover, water stress led to the decrease of 1000-grain weight via decreasing grain filling period and declining the rate of assimilates mobilization to the grains. Wester *et al* (1990) stated that shortage of water is one of the factors restricting plant growth and development which not only reduces the produced dry matter but also impairs carbohydrates share in grains (Kazemi Arbat

H, Rahim Zadeh Khovi F, Moghadam M and Banaei K, 2000). Pandey (2000) stated that the decrease of harvest index in severe drought stress conditions was due to more sensitivity of reproductive growth rather than vegetative growth to inappropriate conditions. Rezeyan Zadeh E, (2008) stated that as more assimilates mobilize from greens organs of plant to the grain, the share of grain weight from the total plant will increase. Ahmadi A and ceiocemardeh A, (2004) said that chlorophyll content of the leaf which is a key factor in determining the rate of photosynthesis and dry matter accumulation decreases significantly. Taleie (2000) stated that the capacity of some reservoirs would be emptied as the source decreased. Mahlouji (2001) has reported that drought stress causes the decrease of 100-grain weight which could be due to the decrease of effective period of grain filling stage and the decrease of synthesis and mobilization of assimilates to grains due to drought stress. Water scarcity has caused the decrease of photosynthesis, lack of formation of new branches and also the decrease of yield components such as 100-grain weight (Emadi N *et al.*, 2010). Reddy (2004) has reported that reduction of photosynthesis rate due to stomata closure and decrease of plant growth, shortage of assimilates for filling the grains and decrease of grain filling period are the most important effects of drought on plants). The results of Table (1) showed that the interactive effect of application of different levels of auxin at different irrigation intervals was significant at 5% level. The mean comparison results (Table 3) showed that the highest weight of 100-grain belonged to the treatment with application of 100ppm auxin hormone at 8-day irrigation interval by 115.11 g and the lowest weight of 100-grain belonged to the treatment without application of auxin at 20-day irrigation interval by 79.97 g. 100-grain weight is a yield component which is affected by genetic and agro-technical factors. Any factor which leads to increase of 100-grain weight, will lead to increase of grain yield, too. Changes of 100-grain weight in relation to the number of grains per pod can be a reaction to adjust the reservoir or source.

The effect of different levels of auxin hormone on harvest index at different irrigation intervals

The ANOVA results (table 1) show that different irrigation levels have affected harvest index and have caused a significant difference at 1% level. Mean comparison results (Table 2) show that application of 100ppm and 200ppm auxin hormone has increased the harvest index by 43.22 and 43.75% respectively. Gosh –Basu (1999) stated that the effect of consumed hormone on grain yield, harvest index, and 100-grain weight was statistically significant at 1% probability level. Auxin as a growth regulator changes the grain into a strong reservoir by stimulating cell division and growth, and consequently by accepting more assimilates, more dry matter is stored in it (Zand, Soroushzade, 2009). The ANOVA results (table 1) show that different irrigation intervals have affected harvest index and have caused a significant difference at 1% level. Mean comparison results (table 3) show that decrease of irrigation interval up to 8 days has led to increase of harvest index by 46.45% and increase of harvest index up to 14 and 20 days has led to decrease of harvest index by 43.86 and 36.34% respectively. Yan-tun (2006) reported that water stress significantly reduced grain yield, biological yield, and harvest index of spring wheat. Wester *et al* (1990) stated that shortage of water is one of the factors restricting plant growth and development which not only reduce the produced dry matter but also impair carbohydrates share in grains and consequently decrease the harvest index (Masjedi Shokooh Far A, Alavi Fazeli, 2009).

Rezeyan Zadeh E, (2008) stated that harvest index indicates the rate of assimilate mobilization which is made in source into the reservoir, and as more assimilates mobilize from greens organs of plant to the grain, the share of grain weight from the total plant will increase. Drought stress causes reduction of photosynthesis, leaf area, yield components, and harvest index (Emadi N *et al.*, 2010). Decrease of irrigation intervals had a positive effect on grain yield and biological yield (912). The ANOVA results (Table 1) showed that the interactive effect of application of different levels of auxin hormone at different

irrigation intervals on harvest index was significant at 1% level. According to mean comparison results (table 3), the interactive effect of application of different levels of auxin hormone at different irrigation intervals on harvest index was significant at 5% level and the highest harvest index belonged to the treatment with application of 100ppm auxin hormone at 8-day irrigation interval by 48.15% and the lowest harvest index belonged to the treatment without application of auxin at 20-day irrigation interval by 36.39%.

Conclusion

The results of this experiment showed that application of different levels of auxin hormone and also different irrigation intervals and their interactive effect on various traits of broad bean in weather conditions of Shadegan had different results. In general, however, application of 100ppm auxin at 8-day irrigation level showed the highest qualitative and quantitative yield and affected most yield components and improved them.

Considering the fact that the purpose of planting broad bean is to produce grain and to increase the rate of protein, different genetic and agro-technical factors are used to improve these two factors in area unit which is actually the same as the yield. The results of this research showed that application of 100ppm auxin hormone at 8-day irrigation interval led to highest qualitative and quantitative yield, therefore it is recommended to apply this treatment in Shadegan where the experiment was carried out after being confirmed by research centers.

Investigating the costs of application of auxin and its effects on increase of crop yield shows that its application in a large scale (in farms) is economically justified and if it's true application is spread among the farmers it can improve the grain yield and yield components of broad bean in the region. Moreover, with regard to the results of the research, application of auxin hormone can enhance plant's resistance to drought and compensate for the declining effect of water scarcity on crop yield significantly. The results

of the research displayed in different tables confirms this fact; therefore, it can be concluded that application of auxin hormone even in drought conditions can somewhat guarantee the crop yield.

References

Ahmadi A, ceiocemardeh A. 2004. Effect of drought stress on soluble carbohydrate and protine in four adopted wheat cuitivars with varous climat .Iranian Journal of.Agriculture Sciences **35**, 753-763.

Ahmadi A, Baiker DR. 2001. Stomatal and non stometal factors that restrcting photosynthesis in whiat under taought condition.Iranian Journal of.Agriculture Sciences **31(40)**, 813-825 (in Persian).

Bani Hashem F. 2010. The effect of Pseudomonas bacteria on the height of rice and its yield.

Bayat AA, Sephri A, Ahmad G, Dorri HR. 2010. Effect of water deficit stress on yield component of pinto bean. Iranian Journal of Crop Sciences**12**,42-45.

Beles FB, Morgan PW, Seltveit ME. 1992. Ethylene in plant.

Borzenkova RA. 1976. Effect of phytohormones on photosynthetic.

Boyer JS. 1968. Plant Physiol. **43**, 1056 – 62.

Brenner ML. 1987. The role of hormones in photosynthate partitioning.

Clappertion MI, Jansen HH, Johnston AM. 1997. Suppressions of WAM fungi and micronutrient uptake by low level p fertilization in long – tem wheat rotation. American Journal of Altemative Agriculture. **12**, 59 – 63.

Emadi N. 2010. The effect of drought stress and plant density on yield and yield components and morphological characteristics of wax beans in Yasuj.

- Ghanbari AM, Taheri Mazandarani A.** 2004. Effect of Sowing date. biomass of forage sorghum Var.speed-feed. Iranian Journal of Agriculture **1(3)**, 713-723.
- Ghosh AC, Basu PS.** 1999. Indole – acetic acid and its metabolism. **Kouchaki A, Sarmadnia G.** 1990. Physiology of crops yield. Jihad Daneshgahi Publications, Mashhad University.
- Ghosh PK, Ajay KK, Bandyopadhyay MC, Manna KG, Mandaly AK, Hati KM.** 2004. Compratire feffectivence of cattle manure, phosphocompost and fertilizer – N.P.K on trhee croppind system in vertisols of semi- aridtaopis. **Kpuchaki A, Banaian Aval M.** 1994. Physiology of crops yield. Jihad Daneshgahi Publications, Mashhad University.
- Ghanati, Moradi.** (2010). The effect of Application of elements and indole butyric acid onantioxidant enzyme activity in corn in water deficit conditions. **Mahlouji M, Mousavizadeh SF, Karimi H.** 2001. Effect of drought stress and sowing date on pinto bean grain yield components. Journal of Agriculture yield components. Journal of Agriculture and Natural Resources. Journal of Science and Technology **4**, 1.57-67.
- Goksoy AT, Demir AO, Turan ZM, Dagustu N.** 2004. Responses. **Majnoon Hosseini.** 1993. Legumes in Iran, Jihad Daneshgahi Publications, Mashhad.
- Hasan Zadeh Ghort Tapeh.** 2005. Investigating the yield and yield components of mungbeans in second cultivation dates and after the wheat harvest.1st national conference on legumes,Institute of Plant Science, Ferdowsi University of Mashhad, November 20-21. **Masjedi Shokooh Far A, Alavi Fazeli.** 2009. The effect of irrigation interval and level onyield of summer corn in Ahvaz weather conditions.
- Haniri.** 2012. The effect of different levels of auxin hormone on morpho-physiological characteristics and yield components of wheat at different growth stages. **Moor T.** 1982. Translated by Lahooti, M. PhD., Zare' Hasan Abadi M, Ahmadian R. Biochemistry and physiology of plant hormones.
- Horst Maraschino, Translated by Khaladbarin B, PhD, Eslam Zadeh T.** Mineral nutrition o f higher plants, Vol. I. **Naderi.** 2009. Evaluating advanced lines and cultivars of NAM wheat in yield comparison test in drought stress conditions in hot climate.
- Jiang Y, End B, Hung.** 2001. Droughtand heat. Stress intury to tow cool season turfgrasses in relation to antioxidant metabolism lipid peroxidation.. Journal of Agronomy and Crop Sciences **41**, 436 – 442. **Osborne DJ.** 1989. “Abscission” crit, Rev.Journal of Plant Sciences **8**, 103 – 129.
- Kazemi Arbat H, Rahim Zadeh Khovi F, Moghadam M, Banaei K.** 2000. The effect of different levels of nitrogen and phosphorus fertilizers and irrigation intervals on productive **Phoris RP, King RW.** 1985. Gibberettins and reproductive.
- Reddy AR, Chaitanya KV, vivekanenden M.**

2004. Drought induced of photosynthesis and anti oxidant metabolism in higher plants. Journal of plant physiology **161**, 1189 – 1255.

South Wick SM, Poovaiah BW. 1987. Auxin movement in.

Soleimani H. 2012. Journal of Agriculture, Economy, Livestock, p. 27.

Tavakoli H, Karimi M, Mousavi SF. 1989. The effect of different irrigation regimes on vegetative and

reproductive growth of corn. Iranian Journal of Agriculture **20(3, 4)**, 1-9.

Torabi Jefrodi A, Hasan Zade A. 2008. Effect of plant population on some morpho-physiological characteristics of two common beans cultivar.

Zand, Sorushzade. 2009. The effect of zinc foliar spray and auxin growth regulator on grain yield and yield components of grain corn in water deficit conditions.