EFFECTS OF IRRIGATION AND NITROGEN ON YIELD AND WATER PRODUCTIVITY IN COMMON BEAN (*PHASEOLUS VULGARIS* L.) AND COWPEA (*VIGNA UNGUICULATA* L.) IN NORTH OF IRAN

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Abstract. Water is known as a critical and rare source that humans and ecological systems depend on. With growing population and developing technologies in many countries, availability to this critical source has been decreased. This research was conducted in a split plot experiment in a randomized complete block design with 3 replications in Iran (the north of Iran, Astaneh-ye-Ashrafiyeh). The main treatments were irrigation with 40, 60, 80 and 100% water requirement using water balance and direct method and the second treatments were 0 and 30, 60 and 90 kg N ha^{-1}, and two bean cultivars were tested (local Dehsari and Cowpea). Seed yield in 2016 and 2017, in the case of irrigation with100% water requirement and 60 kg N ha^{-1} was higher in common bean cultivar than in Cowpea and yields were 3486 and 3646 kg ha^{-1}, respectively. The highest water use productivity in seed yield in 2016 and 2017 was in common bean cultivar, and in the case of irrigation with 100% water requirement and 60 kg N ha^{-1} fertilizer added, levels were 0.70 and 0.69 kg m^{-3}, respectively.
Keywords: *fertilizer, plant production, water requirements, water productivity, yield component*

Introduction

Agricultural sections, known as the largest consumers of water, create many challenges in producing foods with less consumed water. In recent years, competitions for getting more water sources among industry, agriculture and urban sections have increased, therefore, the optimum water consumption is a priority for the agricultural industry. Legumes, after cereals, are the second main food. The protein content in legumes is two or three times higher than in cereals and Iran is the second largest producer of legumes. Cowpeas are summer crops which grow in African tropical and subtropical regions (Jean-Martial et al., 2013). Cowpea is cultivated in north of Mexico and south-west of America and since they are resistant to high temperature, they have known as an important crop for hot regions (Jean-Martial et al., 2013; Singh, 2004; Hall et al., 2003; Clavel et al., 2005; Shardendu et al., 2011). Common bean contains 20-25% protein and 50-56% carbohydrate, and comparing to cereal and starch crops, it contains 2-3 and 10-20 times more protein, respectively (Carmona-Garcia et al., 2007). Water is a critical parameter which influences these crops significantly (Kotchoni and Bartels, 2003). Drought stress is known as one of the main reasons for crop loss which leads to 50% decrease in efficiency (Singh, 2007). Water shortage stress resulted in the decrease of growth of the crops and decreased the efficiency (Korir et al., 2006). About 60% of beans experienced alternative droughts and/or droughts for the end of the season (Beebe et al., 2008). The vegetative growth period of crops is an important and long period in crop cultivation (Baker and Rosenqvist, 2004). The decrease of this period in beans resulted in significant changes in growth and biological functions (Baker and Rosenqvist, 2004). Nitrogen is a critical element and is involved in producing the chlorophyll molecule that plays an important role in photosynthesis (Fageria and Santos, 2008). One-third of the world's most cultivated lands faces a shortage of water for agriculture, which is characterized by climate change and the increasing population will make this problem more serious in the future. Understanding the detrimental effects of drought on plant processes and mechanisms of drought tolerance in crop species, particularly those adapted to dry conditions will help to improve their agronomic performance by incorporating the superior traits into new species or cultivars (Clavel et al., 2005; Shardendu et al., 2011). Therefore, identification of plants resistant to dryness or dehydrated condition with proper performance and their resistance mechanisms is one of the most important solutions to combat drought stress. Due to limited water resources and low rainfall in the Country, the prospect is uncertain for agricultural production. According to forecasts, with the warming of the Earth's crust in the Future, the water requirement of plants will increase and the use of water resources will be very limited. Increasing competition for obtaining water and supplying water needs for growth of products should be done with regular irrigation to prevent irrigation from drought and flooding, and provide a basis for optimizing water use (Aujla et al., 2005).

Water productivity is defined as the ratio of dry matter production to water use (Anyia and Herzog, 2004). water productivity might not provide much information about the competitive or yield advantage of one particular species over another because improved water productivity may actually restrict growth. However, it is one trait that has been studied a great deal because it can give an idea of the variation amongst genotypes in ability where water is limited. Nitrogen plays a critical role in synthesis of proteins and nucleic acids and the shortage of nitrogen is easily seen in old leaves (Fageria and Santos, 2008). This research aims to evaluate the effect of nitrogen and water requirement on bean crops in the region of the study.

Materials and methods

This study was conducted in north of Iran (Astaneh-ye-Ashrafiyeh) located in latitude 37 and 29 min and longitude 49 and 95 53 min, 3 m below sea level on average in 2016 and 2017. In 2016 and 2017 rainfall was 65.7 and 76 mm, respectively. The meteorology and soil physicochemical traits are shown in *Table 1* and *2*. This research was implemented in split plot and random complete block in Astaneh-ye-Ashrafiyeh and all experiments were repeated 3 times. The main variables were irrigation with 40, 60, 80 and 100% water requirement, 0, 30, 60 and 90 kg nitrogen added per hectare and two bean varieties were tested (local Dehsari and Cowpea). In a plot, two rows were omitted and 12 crops were chosen randomly to evaluate the seed yield. The beans were removed and dried in oven with 70 °C for 48 h. After drying, the samples were weighed with precision of 0.01 and converted to kg ha^{-1}. Cowpea was harvested in several turns and the average of 6 turns was evaluated. The drainage of soil moisture was considered as irrigation variable and the water requirement was considered to be 100% of

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irrigation. Other variables were calculated based on irrigation value. In order to achieve 100% irrigation, the soil moisture near crops root was calculated using *Equation 1*.

$$d_n = (\theta_{Fc} - \theta_i)\ \rho_{b.} D_r \qquad \text{(Eq.1)}$$

The soil moisture to height of root showed the farm capacity. The duration of irrigation was calculated based on receiving moisture by soil. The θ_{Fc} is moisture percent of cultivation (%w), θ_i is soil moisture (%w), ρ_b is density (gr cm^{-3}) and D_r is effective root height (cm). The efficiency of water was determined by dividing seed yield on consuming water (Passioura, 2006). The irrigation and consumed water in each sample during growing phase is shown in *Table 3*.

Water productivity (WP; *Eq. 2*) is the seed yield (kg) per water use (m^3):

$$WP\ (kg\ m^{-3}) = \frac{\text{seed yield (kg)}}{\text{water use } (m^3)} \qquad \text{(Eq.2)}$$

Variance analysis and average comparison were conducted by MSTATC software (Duncan test 5%) and all figures were drawn in Excel software.

Table 1. *Information on meteorological data*

During growth	Maximum temperature (°C)		Minimum temperature (°C)		Average humidity (%)		Rain (mm)	
	2016	2017	2016	2017	2016	2017	2016	2017
June	27.3	28.4	17.3	18.4	70.1	59.8	11.3	12.5
July	41.9	31.9	20	19	52.3	50	30.7	33.2
August	29.5	28.9	18.8	20.2	67.9	62.3	0	6.3
September	28.4	27.3	18.5	19.2	66.7	64.1	23.7	24

Table 2. *Characteristics of soil in the study area*

Soil depths (cm)	Particle size distribution (%)				EC (%)	Total nitrogen (%)
	Sand	Silt	Clay	Organic carbon		
0-20	47	32	21	0.65	0.646	27.1
20-40	46	34	20	0.71	0.653	28.5

Table 3. *The amount of water use in each treatment in 2016 and 2017*

Year	2016	2017	2016	2017
Water requirements	Amount of irrigation (mm)		Amount of water use (mm)	
40%	162	175	366.7	251
60%	243	262.5	308.7	338.5
80%	324	350	389.7	426
100%	403.1	436.2	468.8	512.2

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Results

Seed yield

The relations between bean crops and nitrogen fertilizer in seed yield in 2016 and 2017 were significant in level 5% and other changes were observed in level 1% (*Tables 4* and *5*). The highest seed yield in two bean species in 100% water requirements and in 2016 and 2017, were 1700 and 1776 kg ha^{-1} (*Fig. 1*). The highest seed yield in 30 and 60 kg N ha^{-1} fertilizer in 2016 was 1076 and 1173 kg ha^{-1} (*Fig. 2*). The highest seed yield in 30 and 60 kg N ha^{-1} fertilizers in 2017 were 1107 and 1209 kg ha^{-1} (*Fig. 3*). The interaction between bean crops and fertilizer in normal beans and in 60 kg N ha^{-1} fertilizer were 2400 and 2512 kg ha^{-1} (*Fig. 4*). The highest seed yield in 2016 and 2017 in 100% water requirements and 60 kg N ha^{-1} fertilizers were 2169 and 2253 kg ha^{-1} (*Fig. 5*). The highest seed yield in 2016 and 2017 in 100% water requirements and 60 kg N ha^{-1} fertilizers for common bean were 3486 and 3646 kg ha^{-1} (*Table 6*).

Table 4. *Mean squares form the combined ANOVA for agronomic traits*

Source	df	Seed yield (kg ha^{-1})		100-seed weight (g)		Number of pods per shrub	
		2016	2017	2016	2017	2016	2017
Replication	2	143677^{ns}	130645^{ns}	197^{ns}	190.1^{ns}	1.57^{ns}	2.26^{ns}
Water requirements	1	2240842^{ns}	3135651^{ns}	4067*	3390^{ns}	19579	18984^{ns}
Error	2	277146	291045	173	167.6	1.91	2.09
Nitrogen	3	8182123**	9159561**	885**	880**	195	318.6**
Water requirements×nitrogen	3	3206147**	3390614**	702.8*	556	20.6**	5.41**
Varieties	3	855459**	924025**	37.29*	35.26	16.1**	16.9**
Water requirements×varieties	3	136747*	159486*	70.49	68.3**	7.68**	9.91**
Nitrogen×varieties	9	389196**	425595**	64.94**	66.1**	5.32**	7.02**
Water requirements×nitrogen×varieties	9	199775**	213990**	31.46**	31.2*	3.14**	2.74**
Error	60	41673	42530	12.72	13.58	0.562	0.699
CV (%)		12.4	12.6	12.1	12.8	2.19	3.32

ns = non-significant; * and ** = significant at 5% and 1% probability level, respectively

Table 5. *Mean squares form the combined ANOVA for agronomic traits*

Source	df	Plant height (cm)		Water productivity on seed yield (kg m^{-3})	
		2016	2017	2016	2017
Replication	2	3082.4^{ns}	2986.1^{ns}	0.013^{ns}	0.010^{ns}
Water requirements	1	56654*	56197.4*	0.008^{ns}	0.038^{ns}
Error	2	2884.9	2731.9	0.024	0.020
Nitrogen	3	2661.9**	3768.6**	0.15**	0.158**
Water requirements×nitrogen	3	403.23**	98.09**	0.205**	0.184**
Varieties	3	232.01**	204.33**	0.051**	0.046**
Water requirements varieties	3	116.64**	122.59**	0.003^{ns}	0.004^{ns}
Nitrogen×varieties	9	55.21**	64.85**	0.015**	0.014**
Water requirements×nitrogen×varieties	9	51.78**	52.77**	0.010**	0.010**
Error	60	6.92	7.51	0.002	0.002
CV (%)			3.93	6.7	6.6

ns = non-significant; * and ** = significant at 5% and 1% probability level, respectively

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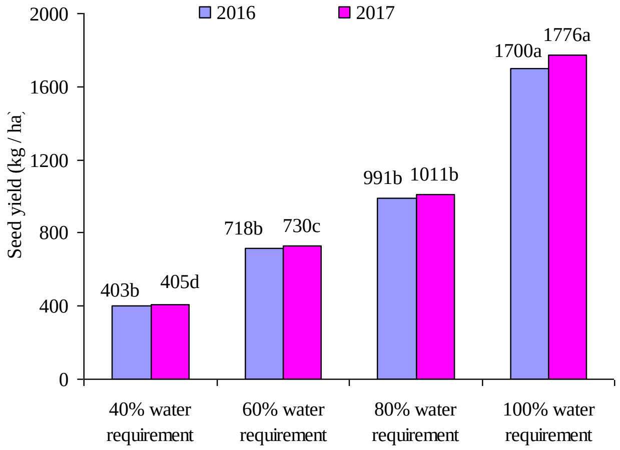

Figure 1. *Effect of irrigation on seed yield in bean cultivars in 2016 and 2017*

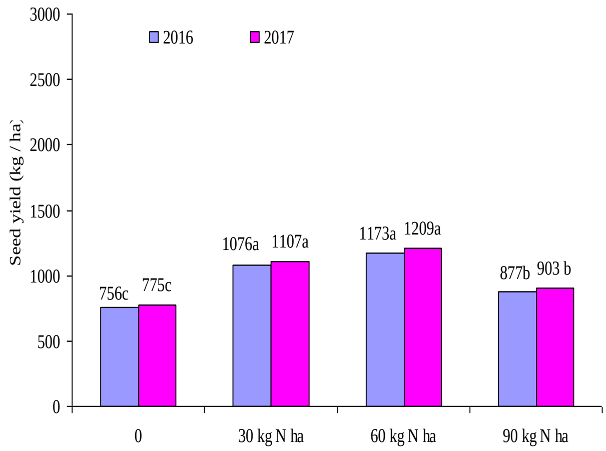

Figure 2. *Effect of nitrogen on seed yield in bean cultivars in 2016 and 2017*

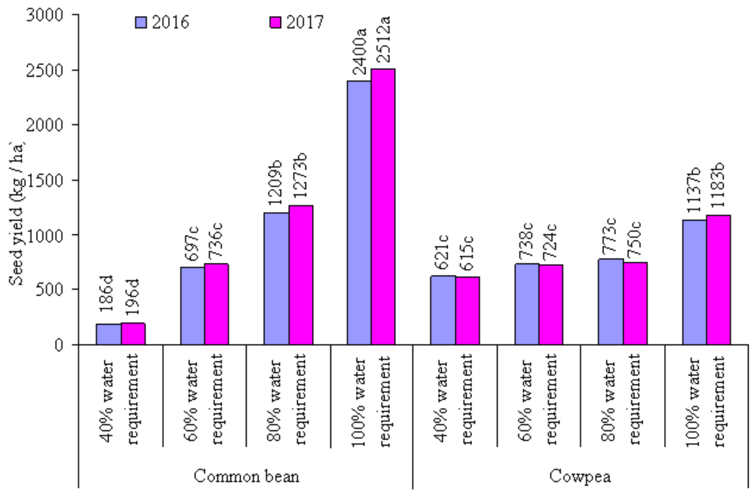

Figure 3. *Interaction of bean cultivars and irrigation on seed yield in bean cultivars in 2016 and 2017*

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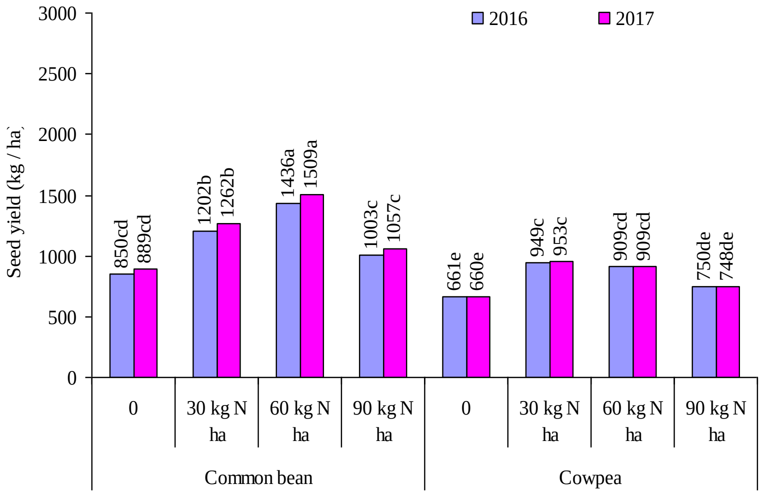

Figure 4. *Interaction of nitrogen and cultivars on seed yield in 2016 and 2017*

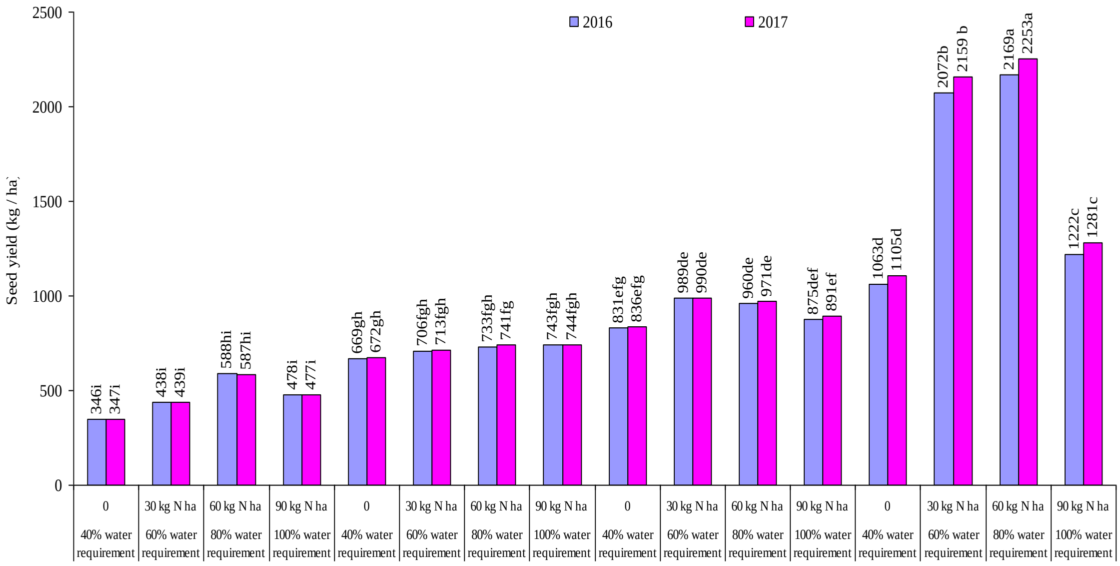

Figure 5. *Interaction of nitrogen fertilizer and irrigation on seed yield in 2016 and 2017*

Weight of 100 seeds

The total weight of 100 seeds in 2016 and 2017 were significant in 5% and other variables were significant in 1% (*Table 4*). The weight of 100 seeds in 2016 and 2017 were 34.7 and 36.1 g (*Fig. 6*). The highest weight of 100 seeds in 100% water requirement were 37.4 and 36.7 g in 2016 and 2017 (*Fig. 7*). The highest weight of 100 seeds in 2016 and 2017 with 100% water requirement were normal (*Fig. 8*). The highest weight of 100 seeds in 2016 and 2017 in 60 kg N ha^{-1} fertilizer were 31.1 and 30.2 g (*Fig. 9*). The highest Weight of 100 seeds, considering species and Nitrogen fertilizer, in 2016 and 2017 were 40.2 and 36.6 g in 60 kg N ha^{-1} (*Fig. 10*). The highest weight of 100 seeds in 100% water requirement and 60 kg N ha^{-1} fertilizer in common bean in 2016 and 2017 were 64.2 and 66.7 g (*Table 6*).

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Table 6. *Mean squares form the combined ANOVA for agronomic traits*

WP (kg m^{-3})		Number of pods per plant		Plant height (cm)		Weight of 100 seed (g)		Seed yield (kg/ha)		Nitrogen (kg ha^{-1})	Water requirement (%)	
2017	2016	2017	2016	2017	2016	2017	2016	2017	2016			
0.06o	0.06l	8s	7r	32.8q	37.1p	31.5d	32.2d	155l	146j	0	40%	Common bean
0.08o	0.08l	8qrs	8pqr	37.0opq	38.9op	27.3d-j	28.1d-h	205l	195j	30		
0.08no	0.08l	8rs	8qr	36.0pq	38.5op	31.3de	32.0d	204l	193j	60		
0.08no	0.09l	8qrs	8qr	37.3opq	39.0op	26.1d-k	27.1d-i	218l	209j	90		
0.19j-m	0.20jk	8pqrs	8n-r	38.3n-q	40.6nop	29.9def	31.3def	670ijk	635hi	0	60%	
0.22h-m	0.22h-k	9opqr	9m-q	39.5m-p	41.8mno	28.8d-g	29.9def	758ijk	718hi	30		
0.23g-l	0.23g-k	9op-s	8m-r	39.3m-p	42.0l-o	29.6def	31.3def	800ij	753hi	60		
0.20i-m	0.21h-k	9opqr	8m-r	40.5mno	42.6l-o	28.0d-h	29.0d-g	715 ijk	683hi	90		
0.27e-i	0.27fgh	9opq	9l-p	42.4mn	44.1lmn	29.4def	30.4def	1170fgh	1125fg	0	80%	
0.30d-g	0.30efg	10nop	9k-o	42.6mn	44.7lmn	30.6de	31.6de	1299ef	1240ef	30		
0.31c-f	0.32def	10nop	9k-n	42.9m	45.5lm	29.4def	30.6def	1385def	1313def	60		
0.28d-h	0.28fgh	10mno	9k-n	43.0m	46.2l	29.4def	30.7def	1237efg	1156fg	90		
0.29d-g	0.30efg	12hij	11hi	60.0l	62.6k	43.2c	45.7c	1561de	1495de	0	100%	
0.52b	0.54b	12hij	11hi	60.9l	64.1k	49.5b	52.3b	2784b	2657b	30		
0.69a	**0.70a**	15c	14cd	75.2jk	78.9i	**64.2a**	**66.7a**	**3646a**	**3486a**	60		
0.39c	0.40c	13ghi	12gh	60.1l	63.3k	47.1bc	48.6bc	2058c	1963c	90		
0.19klm	0.21h-k	8qrs	8o-r	71.3k	72.7j	25.8d-l	26.0e-j	457kl	462ij	0	40%	Cowpea
0.23g-l	0.27f-i	10mno	9klm	88.6gh	91.8fg	19.3m	19.7k	573jk	579hi	30		
0.34cd	0.38cd	11klm	10jk	84.1i	88.5g	21.1klm	21.7ijk	825ij	834gh	60		
0.25f-k	0.28fgh	10lmn	10kl	77.8j	83.2h	22.8h-m	23.7g-k	604ijk	610hi	90		
0.21i-m	0.24g-k	11jkl	11ij	88.8g	91.0fg	25.4e-l	25.7f-j	683ijk	697hi	0	60%	
0.23g-l	0.26f-j	12ijk	11hij	92.4fg	96.2de	20.4klm	20.8jk	739ijk	754hi	30		
0.22h-m	0.25f-j	12g-j	12ghi	89.5g	94.8ef	21.1klm	21.7ijk	713ijk	728hi	60		
0.23g-l	0.26f-i	12hij	12ghi	84.1hi	90.4g	21.8i-m	22.7h-k	760ijk	775hi	90		
0.15mn	0.17k	14cde	14de	98.3de	101.4c	20.7klm	20.9jk	625ijk	644hi	0	80%	
0.21i-m	0.24g-k	14def	14def	97.0de	101.6c	27.4d-i	27.9d-h	857hij	884gh	30		
0.19i-m	0.22h-k	13efg	13fg	95.8def	101.9c	20.4klm	21.1jk	802ij	827gh	60		
0.17lm	0.20ijk	13efg	13fg	94.0ef	101.7c	20.2lm	21.0jk	714ijk	736hi	90		
0.18klm	0.19jk	13fgh	13ef	98.2d	95.3ef	21.5j-m	21.2jk	875hij	841gh	0	100%	
0.33cde	0.35cde	**19a**	**20a**	**122.3a**	**116.5a**	30.0def	29.4def	1643d	1580d	30		
0.26e-j	0.28fgh	17b	18b	113.2b	106.3b	24.2f-m	23.5g-k	1296ef	1246ef	60		
0.18klm	0.20ijk	15cd	15c	108.3c	100.3cd	23.0g-m	22.2ijk	916ghi	881gh	90		

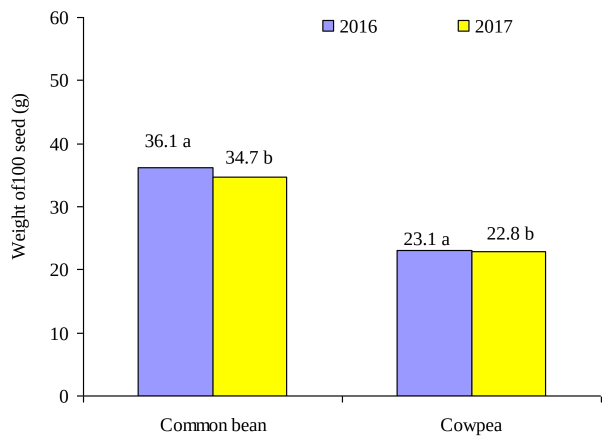

Figure 6. *Weight of 100 seed in bean cultivars in 2016 and 2017*

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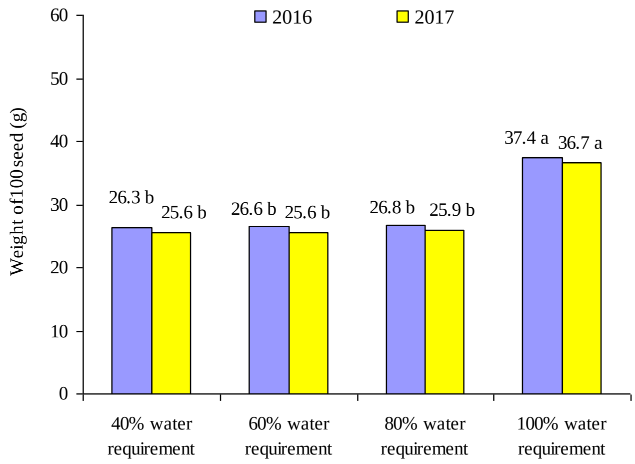

Figure 7. *Effect of irrigation on weight of 100 seed cultivars in 2016 and 2017*

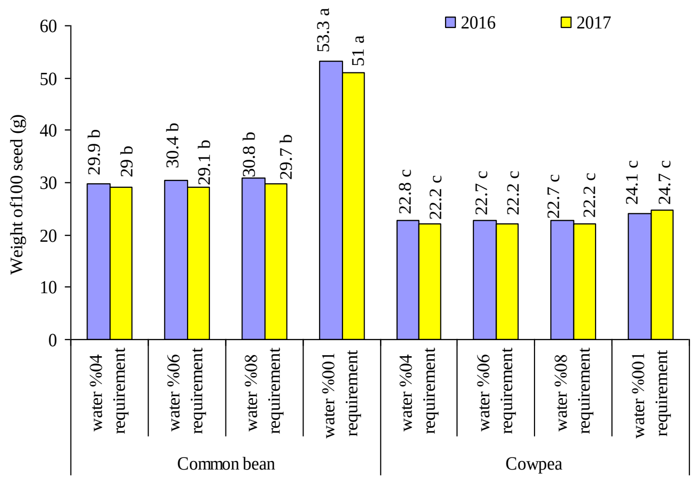

Figure 8. *Interaction of nitrogen and cultivars on weight of 100 seed in 2016 and 2017*

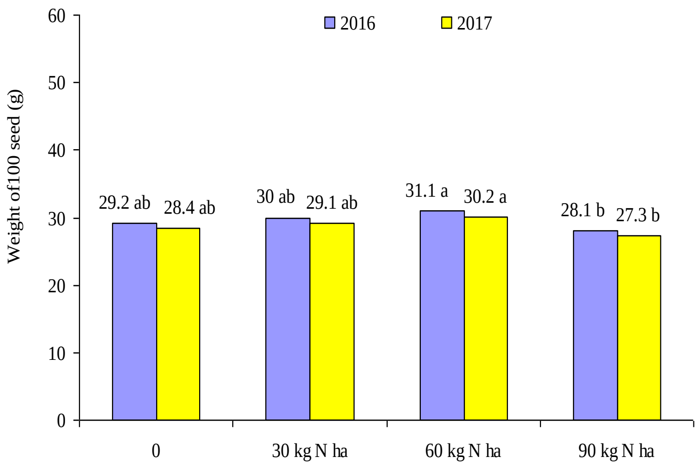

Figure 9. *Effect of nitrogen on weight of 100 seed in bean. cultivars in 2016 and 2017*

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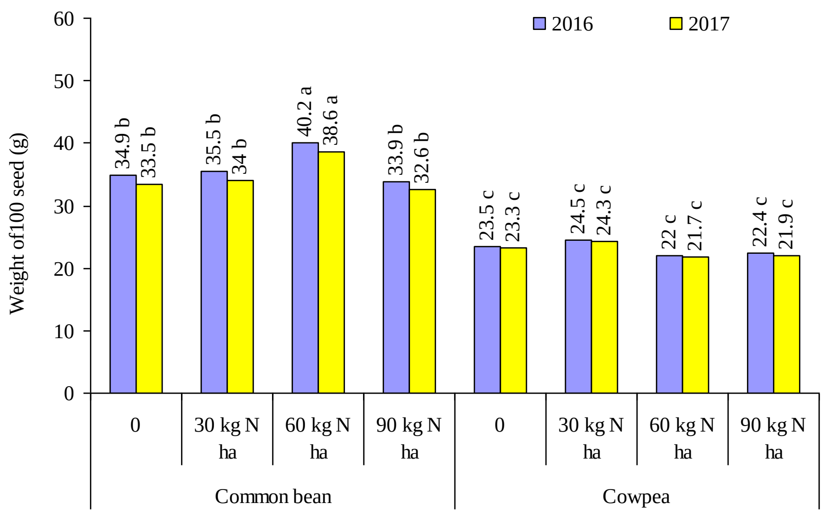

Figure 10. *Interaction of nitrogen fertilizer and cultivars on weight of 100 seed in 2016 and 2017*

Number of pods per plant

The effect of varieties was not significant during two years but in other references it was 1% (*Table 4*). The highest Number of pods per plant varieties in 100% water requirement in 2016 and 2017 were 31 and 32 (*Fig. 11*). The highest number of pods in 2016 and 2017, in 100% water requirement for Cowpea were 43 and 45 (*Fig. 12*). The highest number of pods in 2016 and 2017, in 30 kg N ha^{-1} were 27 and 26 (*Fig. 13*). The highest number of pods in reaction of varieties and Nitrogen fertilizer in 2016 and 2017 were 42 and 41 in Cowpea and in 30 kg N ha^{-1} (*Fig. 14*). The highest number of pods in 2016, in 60% and 80% water requirement and 30 and 60 kg N ha^{-1} were 36 and 35 (*Fig. 15*). The highest number of pods in 2017, in 60% and 80% water requirement and 30 and 60 kg N ha^{-1} in Cowpea were 37 and 36 (*Fig. 15*).

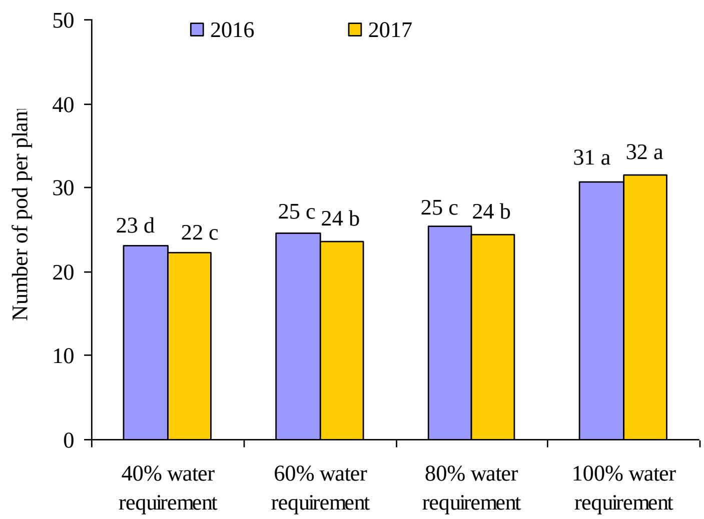

Figure 11. *Effect of irrigation on number of pods per plant in bean*

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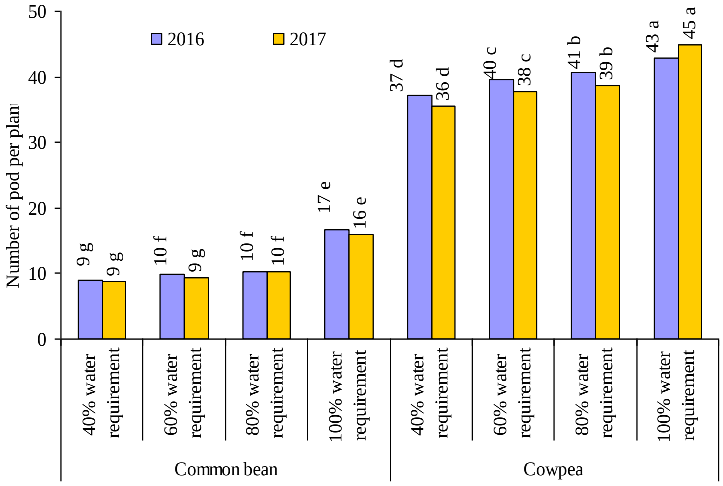

Figure 12. *Interaction of irrigation and cultivars on number of pods per plant in 2016 and 2017*

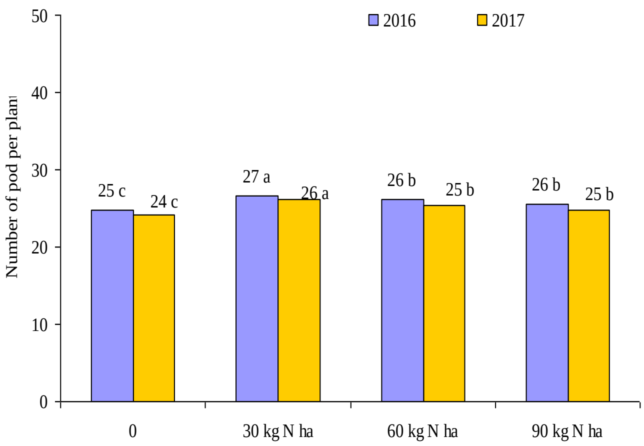

Figure 13. *Effect of nitrogen fertilizer on number of pods per plant in bean*

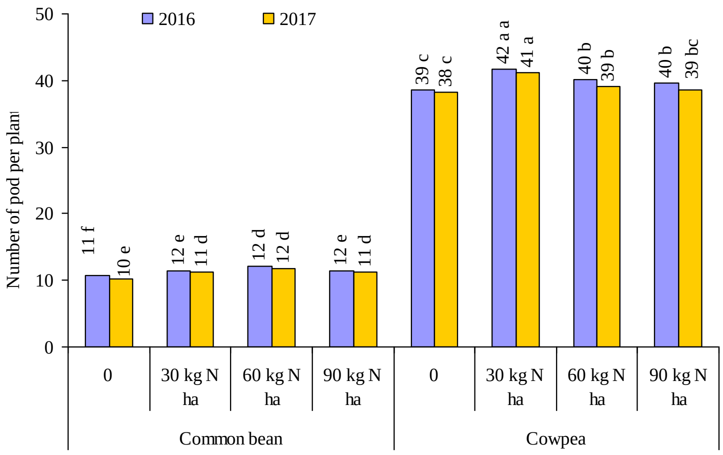

Figure 14. *Interaction of nitrogen fertilizer and cultivars on number of pods per plant in 2016 and 2017*

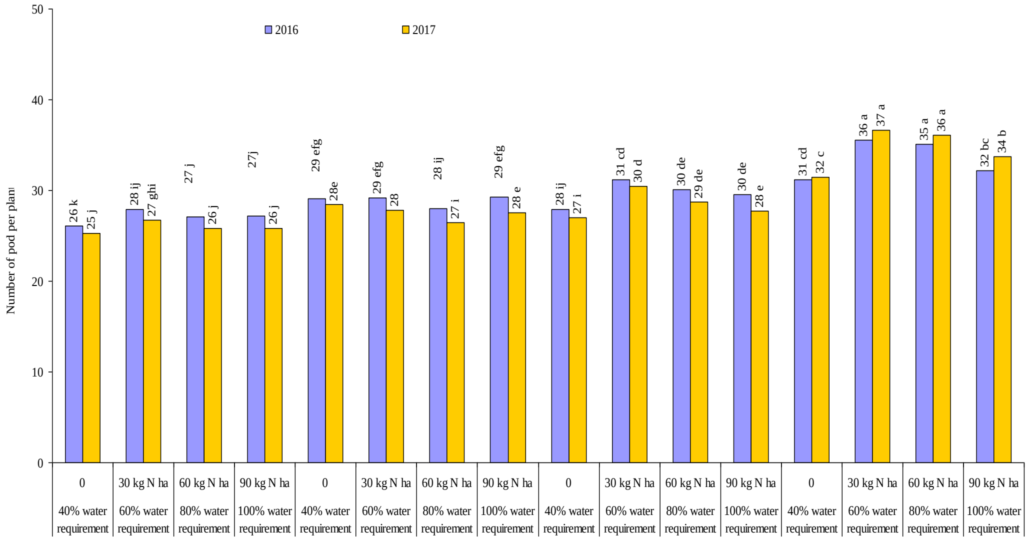

Figure 15. *Interaction of nitrogen fertilizer and irrigation on number of pods per plant in 2016 and 2017*

Plant height

Plant height was significant during 2 years in 5% and other changes were significant in 1% (*Table 5*). The maximum height of Cowpea plant in 2016 and 2017 were 95.8 and 94 cm (*Fig. 16*). The maximum Plant height in bean varieties in 100% water requirement were 87 and 88.9 cm in 2016 and 2017 (*Fig. 17*). Maximum plant height in bean varieties in 100% water requirement and Cowpea varieties were 104.6 and 110.6 cm in 2016 and 2017 (*Fig. 18*). The maximum plant height in 2016 in 30 and 60 kg N ha^{-1} was 74.5 cm (*Fig. 19*). The maximum plant height in 2016 in 30 and 60 kg N ha^{-1} fertilizer were 72 and 72.5 cm (*Fig. 19*). Maximum Plant height in relations of varieties and Nitrogen fertilizer during 2 years in 30 kg N ha^{-1} were 101.5 and 100.1 cm (*Fig. 20*). Maximum plant height in 2016 in 100% water requirement and in 30 and 60 kg N ha^{-1} were 98.2 and 95.7 cm (*Fig. 21*). Maximum plant height in 2017 in 100% water requirement and in 30 and 60 kg N ha^{-1} fertilizer were 100.9 and 99 cm (*Fig. 21*). Maximum plant height in 2016 and 2017 in 100% water requirement and 30 kg N ha^{-1} fertilizer were 116.3 and 122.2 cm for Cowpea (*Table 5*).

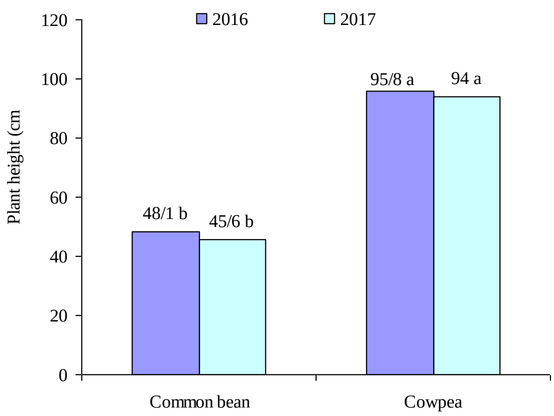

Figure 16. *Plant height in bean cultivars in 2016 and 2017*

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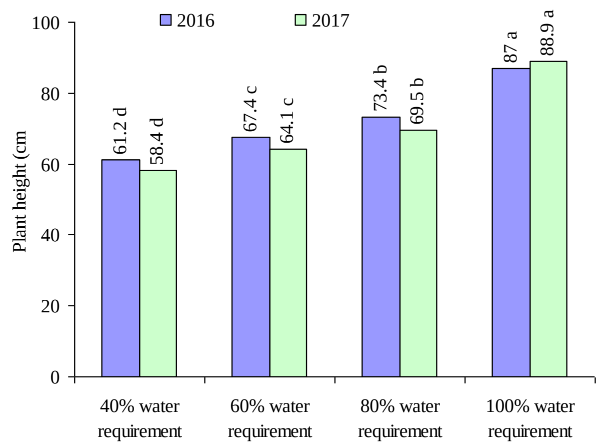

Figure 17. *Effect of irrigation on plant height in bean*

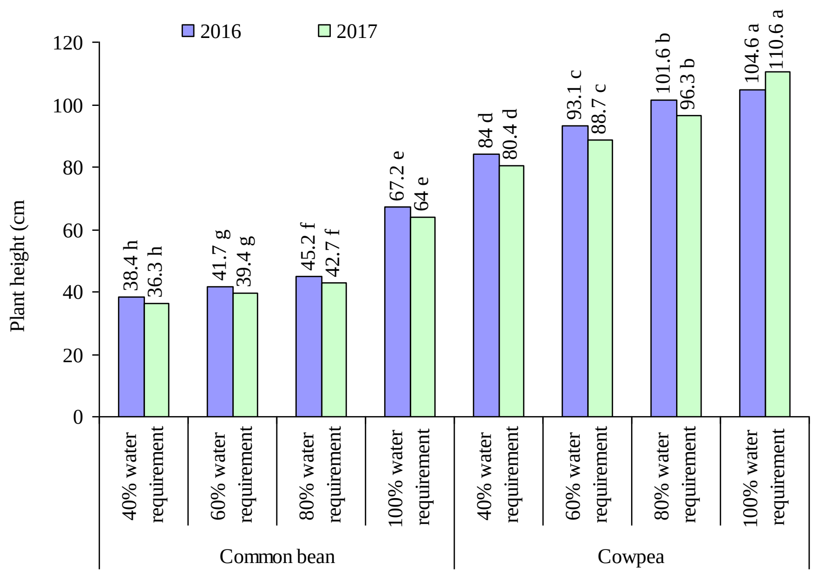

Figure 18. *Interaction of irrigation and cultivars on plant height in 2016 and 2017*

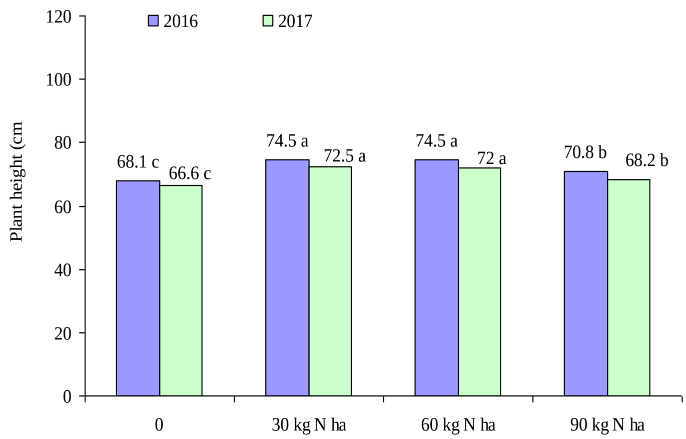

Figure 19. *Effect of nitrogen fertilizer on plant height in bean cultivars in 2016 and 2017*

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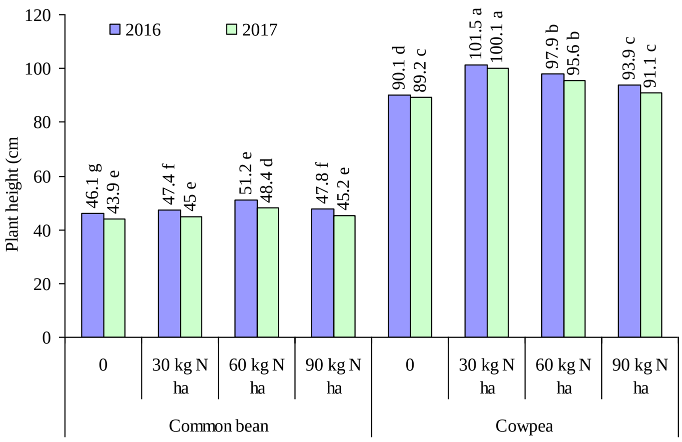

Figure 20. *Interaction of nitrogen fertilizer and cultivars on plant height in 2016 and 2017*

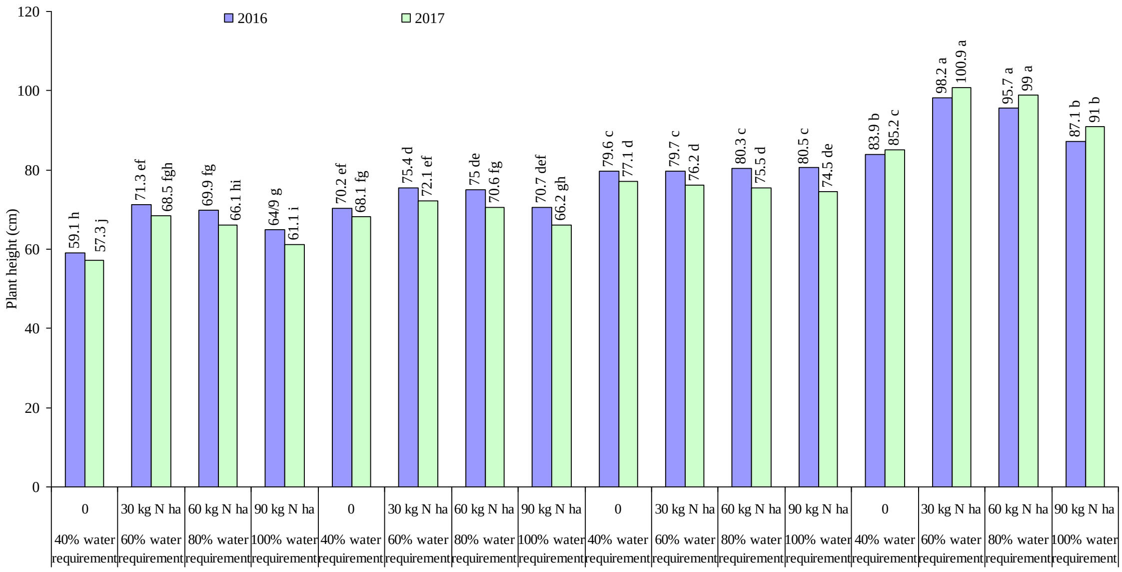

Figure 21. *Interaction of nitrogen fertilizer and irrigation on plant height in 2016 and 2017*

Water productivity (WP)

The Water productivity on seed yield regarding to bean varieties and interaction of varieties and fertilizer in 2016 and 2017 were not significant. However, the other sources were significant in 1% (*Table 5*). The highest efficiency of water consumption in 2016 and 2017 in 100% water requirements were 0.36 and 0.34 kg m^{-3} (*Fig. 22*). The highest efficiency of water consumption in 2016 and 2017 for normal beans in 100% water requirement were 0.48 and 0.47 kg m^{-3} (*Fig. 23*). The highest efficiency of water consumption in 2016 and 2017 in 60 kg N ha^{-1} fertilizer were 0.31 and 0.29 kg m^{-3} (*Fig. 24*). The highest efficiency of water consumption in 2016 and 2017 was observed in 30 and 60 kg N ha^{-1} fertilizer and 100% water requirement (*Fig. 25*). The highest Water productivity in 2016 and 2017 was observed in common bean, 100% water requirement and 60 kg N ha^{-1} fertilizer (*Table 6*).

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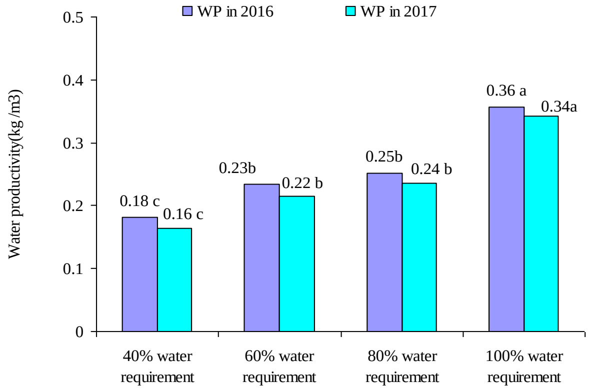

Figure 22. *Effect of irrigation on WP in 2016 and 2017*

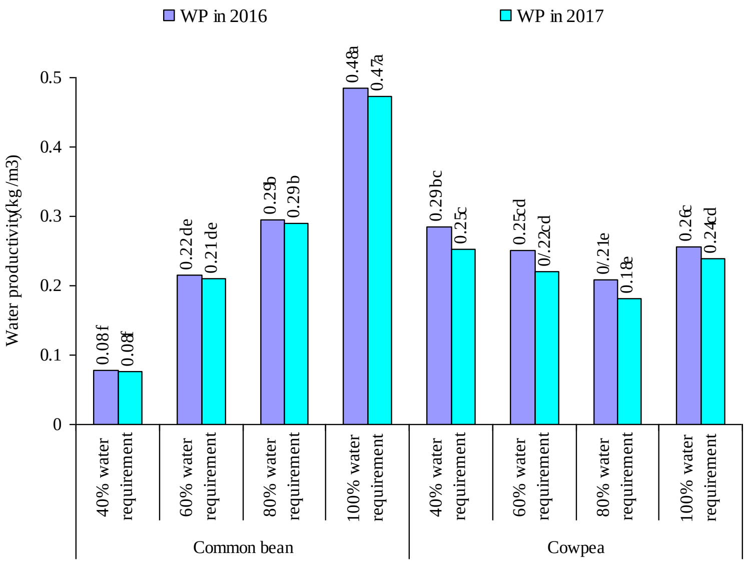

Figure 23. *Interaction of irrigation and cultivars on WP in 2016 and 2017*

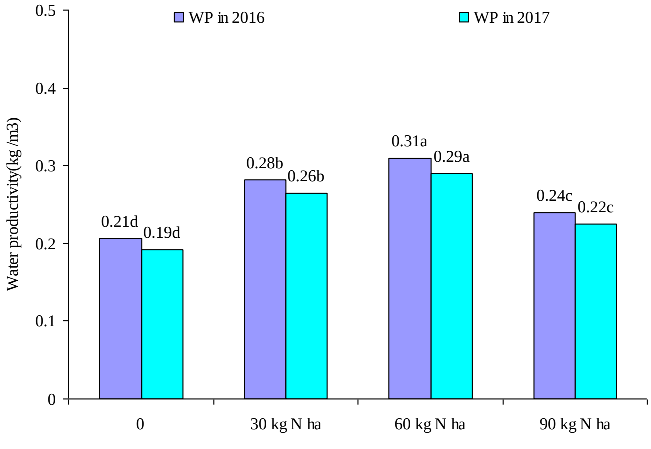

Figure 24. *Effect of nitrogen fertilizer on WP in 2016 and 2017*

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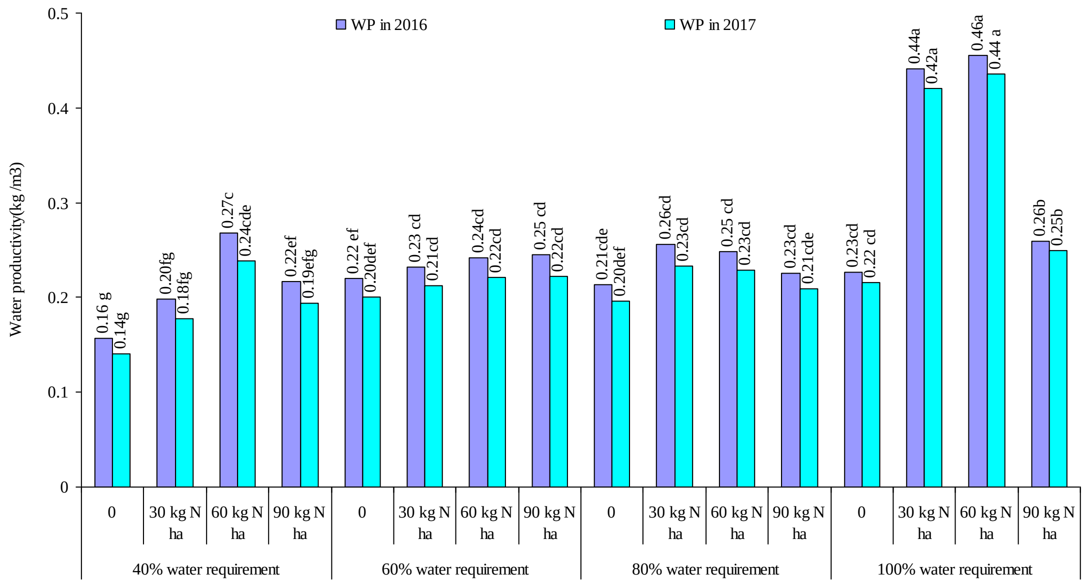

Figure 25. *Interaction of irrigation, nitrogen fertilizer and cultivars on WP in 2016 and 2017*

Discussion

Beans are sensitive to soil condition and drought damage and their water consumption increases with age. Irrigation is very important in water stress and showed direct effect on yield (Korir et al., 2006). Increase amount of Nitrogen to a determined level resulted in increase of yield (Singh, 2007). The results showed that moisture stress resulted in decrease of seed weight. Nitrogen influenced all elements of seeds such as number and weight. Shortage of Nitrogen in plants resulted in decrease of efficiency (Lawlor, 2001). According to Marschner (1995), high amount of Nitrogen in crops made them more sensitive to diseases.

Beans were sensitive to water shortage before and during flowering stage. In this step, shortage of water prevented the evolution of inflorescence and decreased the number of young pods and seeds (Singh, 2007; Lizana et al., 2006). High level of Nitrogen had no effect on number of pods. Authors reported the loss of legume yield in drought related to decrease of pods in crops (Singh, 2007). Long term water stress decreases the crop height. Availability of nitrogen influenced cell division and enlarged leaves (Singh, 2007). Water shortage is the most limiting factor in bean and Cowpea production, and improving agricultural Water productivity is essential for the increased leguminous demand. Conventional irrigation cannot be sustained in arid and semi-arid areas because of the rapid depletion of water resources. It is believed that conventional irrigation is a luxury use of water and can be reduced without much effect on economic yield. Methods that may cut down irrigation are of considerable interest and should be explored. Physiological water-saving irrigation strategies especially temporal and spatial deficit irrigation have great potential to practice in Leguminous production in arid and semiarid areas. It is well established that plant Seed production depends on the amount of water used for growth as well as on water productivity. The estimation of water productivity suggests that the amount of seed produced is equal to the water used during growth multiplied by Water productivity, which thus implies that the amount of Seed increases with increasing water productivity for constant water use. Therefore,

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Water productivity would be of particular interest in situations where growth is affected as a result of limiting water availability. The increased water productivity of bean and cowpea under water stress is attributed to seed production being reduced less by drought than water use.

Conclusion

The results showed that water shortage has negative influence on crop yield. The highest seed yield required 100% water and the lowest value was 40% in two varieties. The highest loss of seed yield in drought showed that supplying enough water is necessary to ensure photosynthetic elements to seeds by producing leaves and green coverage. The efficiency of water in common bean was more proper than in Cowpea. Finally based on results, it is suggested that normal beans are in priority of cultivation in studied region.

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