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Correlation of Quantitative Traits with some Physiological traits in Common Bean under Water Deficit Stress

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ABSTRACT: To evaluate effects of water deficit on quantitative traits and some physiological traits, two experiments based on completely randomized design were carried out under field conditions. In experiment 1, plants irrigation cycle was each 5 days (normal condition) whereas in other experiment, was each 10 days. In both experiments, 22 genotypes of common beans were studied. Relative water content (RWC) and stomatal resistance were studied as physiological characteristics. number of pods per plant, seed per pods, weight of 100 seeds and seed yield of each plant were measured. There was significant differences in quantitative and physiological traits between all genotypes of bean in both irrigation conditions, which is it indicate to high level of genetic variation in bean. Under water deficit condition ,the fallowing traits: seed yield of each plant , number of pods per plant and weight of 100 seeds decrease respectively compared to normal condition. RWC showed relative decrement in normal condition compared to stress. Stomatal resistance was increased significantly during the stress condition. A positive significant correlation detected in number of pods per plant and yield of each plant with stomatal resistance, likewise there was positive correlation in weight of hundred seeds with RWC in normal irrigation condition. A negative significant correlation observed between weight of hundred seeds and RWC, and positive correlation in number of pods per plant and yield of each plant with stomatal resistance, and between seeds per pods with RWC in water deficit condition.

Key words: Common bean, Physiological traits, Quantitative traits, Water deficit stress.

INTRODUCTION

Annual production of common bean is approximately 230 million tons. It is one of the best crop product and allocated 1st place among the legumes (Emeterio Payro *et al.,* 2004). One of the greatest challenges of 21 century is to use lesser water for crop products (Bastiiaanssen and Makin, 2003). In the arid and semi-arid regions of the world water crisis is serious (FAO, 2000). Water deficiency leads to decrease plant yield via biomass and/or distribution of dry matter in different parts of plant. This phenomenon depends on duration and tension of drought stress especially in last stages of growth (Winkel *et al.,* 1997). During the growth, plants face different kind of biotic and abiotic stresses. Among them, drought is much more harmful than other environmental stress, (Hasegawa *et al.,* 2000; Yamaguchi-Shinozaki *et al.,* 2002). Beans are sensitive to drought stress in farm, where in hot conditions high levels of water evaporation leads to closure of leaf stomata and minimize the performance of plant (Chaves *et al.,* 2002). Number of seeds and podes in plant are most crutial traits of plant yield (Stoilova *et al.,* 2005). Seed formation is the most sensitive stage to water deficiencies (Nilsen and Nelson, 1998). As well, floweing time, duration of fully seed formation and maturation time are prominent aspects for phenologic traits. Flowering time is equilibrium of vegetative and reproductive period. Each trait has direct or indirect effect on seed yield. In addition, Sadeghipour (2008) reported lack of irrigation decrease nutrient availibility to seeds and their weights, in mung bean.

Plant's life depends on its stomatal activities (Kudoyarova *et al.,* 2007). Photosynthesis and transpiration are dependent to stomata. It is reported that high performance beans has much more stomata on their leaves (Yusufzai *et al.,* 2009). It is demonstrated that thick and waxy leaves has much more resistance to water lose (Singh *et al.,* 1999).

Also, RWC is a factor for resistance to drought not a mechanism drought escape, so, the much more resistance the highest RWC be when stress signals receives to the leaves, stomata closure happens and water content remains constant in plant. In this regard, plant controls water content by regulation of closure of the stomata. This phenomenon diminishes CO_2 levels and decrease photosynthesis and increase reactive oxygen species in plant subjected to water stress (Mittler, 2002).

MATERIALS AND METHODS

This experiment was performed using 23 genotypes of common bean in Agricultural Research Farm, University of Tabriz during 2012 (Table 1). Experimental design was based on randomized complete block design (RCBD) using three replications. One experiment performed on normal condition (control) and second on water stress condition. All experimental plots were irrigated for two months. Then to induce water deficiency in summer, in control condition, plants irrigated once in a period of five days while in stress condition, irrigation cycle was each 10 days. Number of pods per plant, seed per pods, weight of 100 seeds and seed yield of each plant were measured in at least five plants of each plot during experiments.

To determine relative water content of leaves, some discs from leaves prepared and were weighted using sensitive scale (0.0001 g) and allocated into de-ionized water for 24 h. Then, they were dried with Whatman paper and weighted (saturated weight). Leaves were dried in oven at 75ºC for 24 h and weighted (dry weight) and relative water content was estimated by fallowing equation:

Relative water content (RWC, %) = (wet weight - dry weight)/(saturated weight - dry weight) × 100

Also, stomatal resistance was calculated using a leaf porometer (Delta-T Devices UK) instrument in both conditions.

Table 1: Numbers and codes of common bean genotypes.

Code	Number of genotype	Code	Number of genotype
1	41128	13	21471
2	41158	14	21177
3	41136	15	21528
4	41164	16	21249
5	41165	17	21366
6	41166	18	21158
7	41176	19	21170
8	41214	20	21538
9	41150	21	21154
10	41154	22	21153
11	41159	23	21152
12	21396		

RESULTS AND DISCUSSION

According to the Table 2, under water deficit condition, the fallowing traits: seed yield of each plant , number of pods per plant and weight of 100 seeds were decreased by 55%, 30.2% and 24.3% respectively compared to normal condition. Drought stress during flowering and seed formation stages decreased bean yield (Boutraa and Sanders, 2001). RWC showed relative decrement in normal condition compared to stress (Table 2). In a similar study, (Kumar *et al.,* 2006) it has been revealed that RWC in bean leaves was diminished from 29 to 33% under water deficit stress, which is concordant with our findings. In this study, stomatal resistance was increased during the stress condition. Increment levels Singh *et al.,* (1999) reported that thick and waxy leaves had much more resistance to water loose. This could confirm our results concerning stomatal resistance (Table 2).

Correlation between stomatal resistance and RWC showed that, there were a significant and negative correlations between them in both irrigation conditions (Tables 3 and 4). In normal condition, yield per plant showed most correlation with number of pod per plant and in water deficit stress with weight of hundred seeds and pod per plant (Tables 3 and 4). A negative significant correlation observed between weight of hundred seeds with pods per plant and seeds per pods in normal irrigation condition. A positive significant correlation detected in number of pods per plant and yield of each plant with stomatal resistance, likewise there was positive correlation in weight of hundred seeds with RWC in normal irrigation condition (Tables 3). A negative significant correlation observed between weight of hundred seeds and RWC, and positive correlation in number of pods per plant and yield of each plant with stomatal resistance, and between seeds per pods with RWC in water deficit condition (Tables 4).

Table 2: Percent of increase or decrease in quantitative and physiologic traits in different genotypes of common bean.

Pods per plant	yield of each plant	Weight of 100 seeds	Seeds per pods	Stomatal resistance	RWC	genotypes
30/6	56/2	19	8/1	9/5	9/4	1
34/7	62/3	25/3	22/4	16/9	7/3	2
26/3	54/6	21/3	19/1	9/9	6//6	3
26/6	46	14/9	14/9	15	8/4	4
41/6	65/8	22/9	18/8	4	7/4	5
20/9	50/9	17/4	26/4	32/3	9/9	6
17/2	59/5	37/8	17/6	28/5	7/5	7
42/3	62/3	21/5	24/3	28/7	10/7	8
51/2	67/4	9/2	23/8	10/3	9/2	9
42/2	65/7	32/4	21	34/6	9/2	10
16/3	36/1	15/5	9	58/7	5/3	11
17/5	36/9	18/1	11/4	14/6	6/9	12
16/2	45/6	17/3	18/5	46/1	14/2	13
6/4	53/7	40/5	19/5	19/9	8/2	14
27/5	52/4	18/2	11/3	16/8	8/3	15
20/3	53/5	34/1	16/5	11	8/5	16
36/1	56/4	27/1	6/8	18/9	9/6	17
25/3	41/7	15/4	10/4	6/9	5/5	18
12/3	55/1	25	30/6	29/2	7/4	19
27/1	54/3	19	18/3	7/8	8/8	20
33/6	56/4	16/2	16/4	15/5	7/5	21
30/1	50/2	15/2	11	22/2	7/3	22
23/1	51	30/6	8/1	10/8	5/5	23

Table 3: Correlation of evaluated traits in 23 genotypes of common beans under normal irrigation condition.

	Pods per plant	Seeds per pods	Weight of 100 seeds	RWC	Stomatal resistance
Seeds per pods	0.288				
Weight of 100 seeds	-0.696**	-0.663**			
RWC	-0.244	-0.240	0.615**		
Stomatal resistance	0.540*	-0.320	0.120	-0.91**	
yield of each plant	0.782**	0.349	0.406	-0.224	0.645**

Table 4: Correlation of evaluated traits in 23 genotypes of common beans under water deficit stress condition.

	Pods per plant	Seeds per pods	Weight of 100 seeds	RWC	Stomatal resistance
Seeds per pods	0.379				
Weight of 100 seeds	-0.328	-0.419			
RWC	0.260	-0.557**	- 0.636**		
Stomatal resistance	0.532*	-0.125	0.153	-0.95**	
yield of each plant	0.641**	0.362	0.651**	0.31	0.670**

According to the table 2, under water deficit condition, The least decrement in RWC, and the highest increment in stomata resistance were observed in 11th genotype. Likewise the least decrement in yield and yield component were observed in 11th and 12th genotypes. Therefore these genotypes had much more resistance during drought induced-stress.

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