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EFFECTS OF DROUGHT STRESS ON PLANT GROWTH PARAMETERS, MEMBRANE DAMAGE INDEX AND NUTRIENT CONTENT IN COMMON BEAN GENOTYPES

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ABSTRACT

Common bean (*Phaseolus vulgaris* L.) is an important crop in both Turkey and the world. Drought is one of the important abiotic stress factors limiting the quality and quantity of common bean. This study was conducted to determine the drought-tolerant and susceptible common bean genotypes in Lake Van Basin of Turkey. Total 48 bean genotypes consisted of 40 genotypes from Lake Van Basin, 6 from different parts of Turkey and 1 drought susceptible variety-Zulbiye and 1 drought tolerant variety-Yakutiye. The drought experiment was designed as completely randomized plot with 4 replicates in plastic greenhouse conditions. The four-week-old bean seedlings were subjected to drought stress by completely stopping irrigation for 8 days compared to control seedlings. The investigated traits were growth rate, fresh and dry shoot weights, fresh and dry root weights, stem diameter, area and number of leaves, leaf relative water content (LRWC), membrane damage index (MDI), and ion contents (K, Ca and Na) beside the 0-5 visual scale assessment of drought. At the end of the study, it was determined that plant growth and development of the bean genotypes were negatively affected by drought; however, the studied bean genotypes reacted variously to this stress factors. The genotypes V7, V15, V33, V82, V89 and V-A1 were found to be drought sensitive as the variety Yakutiye, while the genotypes V21, V62, V69, V71, V86, V95 and T7 were found to be drought tolerant as the variety Zulbiye.

Key words: Drought stress, *Phaseolus vulgaris,* Tolerance, Lake Van Basin.

INTRODUCTION

Common bean is one of the widely produced crops in the world, and Turkey is also one of the leading countries in common bean production (FAOSTAT, 2013). Lake Van Basin is located in the eastern part of Turkey, and there is a wide genetic diversity in common bean germplasm in the basin (Ekincialp and Sensoy, 2013; Erdinc *et al*., 2013). Beside biotic stress conditions, abiotic ones, especially drought, have caused crop yield losses as well as the significant effect on plant growth and crop quality in recent years (Kacar *et al*., 2006; Ozen and Onay, 2007; Saleem *et al*., 2015).

In drought stress, cell growth is adversely affected by the water loss, and this causes the cells to remain small (Zlatev and Lidon, 2012). Moreover, reduction in cell growth leads to a decrease in cell wall synthesis and many plants accumulate some solutes in the cell in response to drought stress (Mahajan and Tuteja, 2005; Assaha *et al*., 2016; Saravia *et al*., 2016). The increase in the amount of intracellular solutes is very important in keeping cell water. Sugars, amino acids and many ions especially K^+ are considered as solutes effective in osmotic adjustment (Kacar *et al*., 2006; Ozen and Onay, 2007).

Nutrition performances of drought resistant varieties (N, P, K, Ca, Mg, Fe, Zn, Mn and B) have also been determined and a significant correlation has been determined between nutrient use efficiency and tolerance to drought (Gunes *et al*., 2007). Sodium causes an increase in Na/Ca ratio of the apoplast by replacing Ca in the cell membrane, and the physiological and functional structure of the membrane is disrupted and the Ca balance of the cells is disrupted (Reid and Smith, 2000). High Na concentration causes an increase in free Ca in cells by freeing Ca bound in cell's internal membrane structures and discharging internal Ca stores (Kaya and Tuna, 2010). Potassium (K) is an essential nutrient for plants and is usually the most abundant cation in plants. However, sodium (Na) may be toxic even at the minimum level for the plants. It has been also reported that excessive sodium ion in the plant causes symptoms such as necrotic spots on the shoots and leaves starting from the older leaves (Aktas, 2002).

Water stress causes severe problems in vegetable crops, but tolerant genotypes give hopeful results. Water stress in tomatoes causes the decrease in the yield and fruit quality; however, the leaf relative water content was comparatively well in tolerant genotypes (Sanchez *et al*., 2010). It has been stated that there is an increase in the stomatal conductance and the activity of transpiration of bean plants under extreme drought (Rosales *et al*., 2005). Water stress adversely affects development of sensitive bean varieties, but the developments of tolerant ones close to results the control plants (Gonzalez and Pastenes, 2012).

In the selection of tolerant chickpea genotypes to drought, yield and yield components, drought sensitivity index, capacity of leaf water retention capacity, leaf relative water content, and membrane permeability could be important parameters and it has reported that relative moisture content decreased parameters due to the drought under greenhouse conditions (Guneri Bagci, 2010; Suzuki *et al*., 2014) Increases in the growth parameters, leaf water potential, leaf stomata conductivity in drought tolerant bean cultivars were reported to be higher when compared with other susceptible cultivars (Terzi *et al*., 2010). Drought stress conditions negatively affects the growth parameters in melons such as 0-5 visual scale assessment, leaf relative water content, membrane damage index and shoot and root in K and Ca ions, plant height, stem diameter, number of leaves, and leaf area; however, the stress tolerance levels for the genotypes absorbing more K and Ca ions increases substantially (Kusvuran, 2010; Kabay and Sensoy, 2016).

Based on the scientific studies, drought stress leads to serious loss of yield and quality in bean. The relatively broad genetic diversity in common bean genotypes has been determined in Turkey and in especially Lake Van Basin (Ekincialp and Sensoy, 2013; Erdinc *et al*., 2013). However, little information has been reported about the mechanism of drought resistance in this germplasm. Therefore, the present study aimed to determine the drought tolerance levels of bean genotypes collected from Lake Van Basin of Turkey.

MATERIALS AND METHODS

The 48 different bean genotypes collected from Van Lake Basin were employed in the present study to determine their drought tolerance levels (Table 1). These genotypes consisted of 40 genotypes from Lake Van Basin, 6 from different parts of Turkey and 1 drought susceptible variety-Zulbiye and 1 drought tolerant variety-Yakutiye.

The plants were grown in a plastic greenhouse with day and night temperatures of approximately 26 and 12°C, respectively and relative humidity remained approximately 40 to 80%, respectively. Bean seeds were germinated in a mixture of peat: perlite at a 2:1 ratio in the 2L plastic pots. The drought experiment was designed as completely randomized plot with 4 replicates each has 9 seedlings. The four-week-old bean seedlings were subjected to drought stress by completely stopping irrigation for 8 days compared to control seedlings.

Evaluation with a 0 – 5 scale: Bean genotypes were rated for their drought tolerance on a 0-5 scale compared to check plants: 0 = healthy plants with no visible symptoms of drought stress; 1 = decrease in development; 2 = slight wilting in older leaves; 3 = moderate curling and wilting in upper leaves; 4 = leaves yellow-brown with severe wilting; and 5 = Wilted plants and dried lower leaves (Koc, 2005; Guneri Bagci, 2010; Kusvuran, 2010).

Determination of fresh and dry weights: All plants were weighed on a precision scale (±0.1g). Then, the samples were open air dried one day, and oven dried for 48 hours at 65 ° C till reach a constant weight, and the dried samples were weighed on a precision scale (±0.1g).

Determination of the plant height and diameter: The stem lengths in bean plants were measured with a ruler (±0.1 cm), and their stem diameters were measured with a digital display caliper (±0.1 mm).

Determination of the number of leaves and leaf area: At the end of the drought experiment, the number of leaves was counted and the leaf areas were determined as cm^2 with a planimeter in all bean genotypes.

Determination of the leaf relative water content (LRWC): At the end of the drought experiment, fresh leaf samples were sampled, weighted (FW) and kept in distilled water for four hours to calculate their turgor weights (TW). Then, the samples were kept in an oven (65 °C) for 48 hours and weighted (DW). The below formula was used in order to calculate the relative water content of the bean genotypes (Kusvuran, 2010)

$$LRWC = \frac{(FW-DW)}{(TW-DW)} \times 100$$

Determination of relative growth rate (g fresh weight day^{-1}): Before and after drought stress applications, the plants were weighed and the difference between the two measurements was divided by the number of days (Kusvuran, 2010)

Determination of the membrane damages in the leaf cells: Membrane Damage Index (MDI) in bean leaves was calculated by measuring the electrolyte out of the cell. The 17 mm diameter discs taken from the bottom 3 leaves were incubated for 5 hours in 10 ml distilled water, and their EC values were measured. The same disc samples were kept at 100 °C for 10 minutes, and their EC values were measured again. Membrane Damage Index (MDI) was calculated by the following formula (Kusvuran, 2010)

$$MDI = \frac{Lt-Lc}{1 - Lc} \times 100$$

Lt: The first EC value of drought stressed leaf disk samples / The second EC value of drought stressed leaf disc samples kept at 100 ° C for 10 minutes

Lc: The first EC value of control leaf disk samples / The second EC value of control disk samples kept at 100 ° C for 10 minutes

Mineral element analysis: At the end of the drought experiment, the shoot and root samples from stressed and control plants were dried in an oven at 65 ºC until reach a constant weight. Then the dry samples (200 mg) were grounded, pre-lit by ethyl alcohol, and lit till ash formation at 550 °C. The ash samples were dissolved with a 3.3 % HCl solution, filtered with a blue-band filter paper, and Na, K, and Ca was determined in an atomic absorption device (Thermo trade brand serial no: ice3000 series aa spectrometer) (Kusvuran, 2010; Guneri Bagci 2010; Kabay and Sensoy, 2016).

The statistical analysis: Analysis of Variances based on general linear models (Yesilova and Denizhan, 2016) carried out by SAS 9.4.1 statistical program was used. Duncan multiple Comparison tests was used to measure the statistical differences between genotype.

RESULTS AND DISCUSSION

The Membrane Damage Index (MDI) and the 0-5 scale were the important indicators of drought stress in plants (Kusvuran, 2010) In the present study, we have determined some drought tolerant bean genotypes (V7, V15, V33, V82, V89, and Va-1 beside Yakutiye) having relatively lower MDI and 0-5 scale values after comparing their stressed and control samples (Table 1). The relatively little slowdown in growth (their 0-5 scale value was 1.25) and very slight yellowing symptoms on the lower leaves were observed in these tolerant genotypes. On the other hand, we have also determined some drought susceptible bean genotypes (V21, V62, V69, V71, V86, V95, and T7 beside Zulbiye) having relatively higher MDI and 0-5 scale values after subjected to drought stress (Table 1). The relatively high slowdown in growth (their 0-5 scale value was 4.75) and wilted plants and drying at lower leaves were observed in these susceptible genotypes. The MDI values in these susceptible genotypes ranged from 65.70% to 64.77%, while the MDI values in the above mentioned tolerant genotypes varied from 22.23% to 23.93% (Table 1). The relative plant growth rate loss of the studied bean genotypes subjected to drought stress ranged from 27.80% to 83.06% (in Yakutiye and T7, respectively) (Table 1). The relative leaf water content of the studied bean genotypes subjected to drought stress varied from 7.99% to 36.32% (in V89 and V69, respectively) (Table 1).

Drought stress can affect cell growth in a negative manner and causes the cells to remain small. Decrease in cell growth also causes a decrease in cell wall synthesis in (Kacar *et al*., 2006; Ozen and Onay, 2007). Therefore, the plant growth parameters are negatively affected by drought stress. In the present study, the decrease in fresh shoot weights in the susceptible genotypes ranged from 77.03% to 73.61%, while the decrease in fresh shoot weights in the tolerant genotypes varied only from 27.59% to 33.30% (Table 2). The decrease in dry shoot weights in the susceptible genotypes ranged from 13.03% to 14.73%, while the decrease in dry shoot weights in the tolerant genotypes varied from 71.47% to 76.32% (Table 2). The decrease in fresh root weights in the susceptible genotypes ranged from 70.03% to 75.32%, while the decrease in fresh root weights in the tolerant genotypes varied from 4.78% to 6.98% (Table 2). The decrease in dry root weights in the tolerant genotypes ranged from 5.61% to 8.65%, while the decrease in dry root weights in the susceptible genotypes varied from 71.13% to 78.87% (Table 2). As it seen from the results, the shoot parts of the bean genotypes have suffered more from the drought stress compared to root parts (Table 3). Gonzalez and Pastenes (2012) also stated that water stress has adversely affected plant growth parameters in sensitive bean varieties compared to the tolerant ones.

The significant differences were observed in stem diameters, leaf numbers, shoot lengths, and leaf areas between tolerant and susceptible genotypes subjected to drought stress (Table 3,4). The reduction in stem diameter was approximately 8.11% in tolerant genotypes, whereas this value was 40.19% in susceptible ones. The reduction in leaf number was approximately 8.77% in tolerant genotypes, while this value was 65.22% in susceptible ones. The reduction in stem shoot length was approximately 10.15% in tolerant genotypes, whereas this value was 70.17% in susceptible ones. The reduction in leaf area was approximately 26.64% in tolerant genotypes, while this value was 68.88% in susceptible ones.

Guneri Bagci (2010) stated that parameters such as yield, yield components, drought sensitivity index, capacity of leaf water retention, leaf relative water content, and membrane permeability were important in selecting tolerant chickpea genotypes against drought stress. Kusvuran (2010) reported that drought stress conditions have negatively affected various parameters in melon: such as leaf relative water content, membrane damage index and K and Ca ion levels in shoots and roots, plant height, stem diameter, number of leaves, leaf area of the body, and 0-5 visual scale assessment. Kusvuran (2010) also stated that the genotypes absorbing more K and Ca has improved tolerance to stress conditions.

In the present study, the ion analysis data for Ca, K and Na are presented in Table 4-6. It has seen that the genotypes with little loss of K and Ca in the stress condition were more tolerant to drought stress, while the others with high loss of these ions were sensitive to drought. However, the certain levels of increases were observed in Na levels in shoot and root in reaction to drought stress. The shoot Ca reduction in the bean genotypes due to the drought stress ranged from 13.12% to 57.85%, and the reduction varied from 5.4% to 55.23% in the roots. Similarly, the shoot K reduction in the bean genotypes due to the drought stress ranged from 7.83% to

46.87%, and the reduction varied from 5.76% to 57.65% % in the roots. On the other hand, the shoot Na increase in the bean genotypes due to the drought stress ranged from 8.0% to 76.57%, and the reduction varied from 5.26% to 77.52% in the roots. The bean genotypes have comparatively higher Na level and lower K and Ca levels were more affected by drought stress as also seen from the Ca/Na and K/Na ratios. Potassium (K) is an essential nutrient for plants and is usually the most abundant ions in plants. However, sodium (Na) could be toxic at the minimum level for the plants. Potassium deficiency and toxicity of Na are common in the world and among the main problems that limit crop production (Aktas, 2002; Dasgan *et al*., 2006; Kabay and Sensoy, 2016; Assaha *et al*., 2016; Saravia *et al*., 2016). Na replaces with Ca in the cell membrane and causes an increase in Na/Ca ratio in the apoplast. In this case, the physiological and functional structure of the membrane is disrupted and the Ca balance of the cell is disrupted (Reid and Smith, 2000). High Na concentration leads to a discharge in internal Ca store and to an increase of the free Ca in the cell by freeing Ca ions bound to internal membrane structures of the cell (Kaya and Tuna, 2010). Gunes *et al*. (2007) have also reported that there has been a significant correlation between tolerance to drought and nutrient use efficiency.

In conclusion, the obvious differences for 0-5 scale values in tolerant and sensitive genotypes were observed among the drought stress applied 48 bean genotypes. The comparatively more negative impacts were also detected in drought sensitive bean genotypes for the parameters such as growth rate, shoot and root dry and fresh weights, shoot length, stem diameter, number of leaves, leaf area leaf relative water content and membrane damage index. On the other hand, the comparatively more positive impacts were noticed in drought tolerant bean genotypes for the ion parameters such as K, Ca, and Na. The drought tolerant genotypes have higher K/Na and Ca/Na ratios than the others. We concluded that the parameters we observed were the suitable ones for discriminating bean genotypes for drought stress.

Table 1. 0-5 scale value, membrane damage Index (MDI) (%), relative plant growth rate (RPGR) (%) and leaf relative water content (LRWC) (%) of the bean genotypes in drought stress study

Bean Genotype	0-5 scale in drought stress	MDI in drought stress	RPGR in control	RPGR in drought stress	LRWC in control	LRWC in drought stress
V5	3.250 d-f	43.313 i-m	0.279 v	0.119 w-y	73.804 m-s	58.047 h-j
V6	4.500 ab	55.777 a-h	0.684 e-i	0.135 t-x	80.879 l-h	54.117 j-n
V7	1.250 j	24.862 op	0.659 i-k	0.451 cd	60.857 x-z	52.781 k-o
V10	1.500 ij	25.549 op	0.514 s-u	0.283 ij	65.352 v-x	55.521 i-m
V12	1.500 ij	23.739 p	0.686 e-h	0.486 ab	59.176 z	53.677 j-o
V14	4.250 a-c	54.690 a-i	0.606 m-o	0.161 s-u	78.731 e-l	57.986 h-j
V15	1.250 j	23.933 p	0.485 u	0.332 gh	74.627 k-r	67.657 c-e
V21	4.750 a	61.207 a-d	0.736 b	0.179 p-s	86.454 ab	57.202 h-k
V28	1.750 h-j	31.203 n-p	0.537 r-t	0.179 p-s	63.845 v-y	51.330 m-p
V29	4.500 ab	59.872 a-f	0.553 p-s	0.199 n-r	58.557 z	42.345 s-u
V30	3.750 b-d	50.041 d-i	0.499 tu	0.229 k-n	60.322 yz	46.125 q-s
V32	3.500 c-e	48.287 f-i	0.643 i-m	0.224 l-n	84.180 a-d	68.226 b-d
V33	1.250 j	23.542 p	0.590 n-p	0.404 e	78.881 e-l	72.186 ab
V36	3.250 d-f	43.197 i-l	0.612 m-o	0.207 n-p	82.343 b-f	65.272 d-f
V40	2.500 f-h	33.044 m-p	0.519 s-u	0.211 n-p	60.962 x-z	51.582 m-p
V41	4.500 ab	57.201 a-g	0.538 r-t	0.125 v-x	69.978 s-u	48.037 q-r
V43	1.750 h-j	27 .455 n-p	0.584 o-q	0.308 hi	68.047 t-v	59.098 g-i
V47	2.750 e-g	35.743 k-o	0.638 j-m	0.326 h	58.996 z	48.469 p-r
V49	2.250 g-i	33.640 l	0.717 b-d	0.364 fg	65.424 v-x	55.362 i-m
V57	4.250 a-c	52.197 c-i	0.672 d-k	0.234 k-n	76.799 g-n	53.366 k-o
V62	4.750 a	64.776 ab	0.695 b-g	0.141 t-w	75.749 i-q	49.671 o-q
V63	4.500 ab	58.051 a-f	0.617 l-o	0.217 m-o	79.792 d-j	53.789 j-o
V64	3.250 d-f	44.445 h-l	0.663 f-k	0.253 j-l	83.227 a-e	62.941 fg
V66	4.500 ab	54.397 a-i	0.658 g-k	0.169 q-t	66.521 u-w	45.296 r-t
V69	4.750 a	64.085 a-c	0.791 a	0.201 n-q	85.224 a-c	54.269 j-m
V71	4.750 a	63.198 a-c	0.575 o-r	0.137 t-x	61.040 x-z	39.918 u
V73	2.250 g-i	31.114 n-p	0.801 a	0.339 f-h	80.196 d-i	64.164 ef
V77	4.250 a-c	53.763 a-i	0.657 g-l	0.165 r-t	79.037 e-k	52.750 l-o
V79	4.250 a-c	53.157 b-i	0.706 b-f	0.207 n-p	81.109 c-g	56.049 i-l
V80	2.250 g-i	33.567 l-p	0.712 b-d	0.224 l-n	66.385 u-w	56.419 i-l
V82	1.250 j	23.775 p	0.598 m-o	0.425 de	75.209 jr	68.239 b-d
V86	4.750 a	63.246 a-c	0.554 p-s	0.096 y	74.112 l-s	47.599 q-r
V88	1.750 h-j	30.857 n-p	0.632 k-n	0.275 ij	75.096 jr	63.204 f
V89	1.250 j	23.698 p	0.544 q-s	0.371 f	61.724 x-z	56.787 i-l
V90	1.750 h-j	32.195 m -p	0.599 m-o	0.249 j-m	72.926 n-s	59.165 g-i
V95	4.750 a	63.707 a-c	0.669 e-k	0.126 u-x	76.203 h-p	49.918 n-q
V99	1.750 h-j	24.032 p	0.719 bc	0.467 bc	83.268 a-e	73.213 a
T7	4.750 a	65.438 a	0.608 m-o	0.103xy	71.829 o-t	46.628 qr
T32	3.250 d-f	46.086 h-k	0.717b-d	0.261 jk	77.785 g-m	59.006 g-i
T37	3.500 c-e	48.630 e-i	0.593 o-p	0.203 n-q	76.599 g-n	54.601 jm
T65	4.500 ab	60.416 a-e	0.639 i-m	0.162 st	87.330 a	56.158 i-l
T72	4.750 a	64.630 ab	0.691 b-g	0.160 s-u	62.667 w-z	41.779 tu
T121	3.500 c-e	50.346 e-i	0.705 b-f	0.183 o-s	71.397 q-t	54.982 i-m
V-e1	4.250 a-c	53.988 a-i	0.669 e-k	0.156 s-v	74.755 k-r	54.979 i-m
V-a1	1.250 j	23.038 p	0.681 c-j	0.481 a-c	76.399 g-o	69.935 a-c
V-g1	2.250 g-i	37.574 k-o	0.680 c-j	0.308 hi	70.779 r-u	61.264 f-h
Zulbiye	4.750 a	65.701 a	0.633 k-n	0.120 w-x	71.544 p-t	46.385 qr
Yakutiye	1.250 j	22.236 p	0.705 b-f	0.509 a	77.816 f-m	71.511 a-c
Mean ± SD	3.188 ± 0.518	44.706 ± 6.603	0.631 ± 0.025	0.247 ± 0.019	72.99 ± 2.639	56.02 ± 2.407

SD: Standard Deviation

Table 2. The fresh and dry shoot and root weights (g) of the bean genotypes in drought stress study.

Genotype	Shoot fresh weights in control	Shoot fresh weights in drought stress	Shoot dry weights in control	Shoot dry weights in drought stress	Root fresh weights in control	Root fresh weights in drought stress	Root dry weights in control	Root dry weights in drought stress
V5	26.838 a-g	10.328 g-l	3.859 p-s	2.131 k	6.665 gh	2.661 np	0.901 ab	0.538cd
V6	24.394 c-i	7.365 l-n	3.523 s-u	1.242 o-r	5.005 n	3.581ij	0.909 ab	0.521 c-e
V7	25.076 c-i	14.972 b-f	5.305 e-g	4.238 d	6.040 i-k	3.585 ij	0.840 cd	0.550 bc
V10	23.808 c-i	13.027 d-h	3.636 r-t	3.162 gh	4.649 n-p	4.129 gh	0.549 i-m	0.498 ef
V12	33.560 a	17.215 a-c	4.911 hi	3.823 e	3.767 q-s	3.430 j-l	0.479 n-p	0.395 h-j
V14	25.532 b-i	8.293 i-n	3.194 uv	1.288 o-r	4.702 no	1.957 rs	0.523 k-n	0.241 qr
V15	20.443 hi	14.802 b-f	2.844 x-z	2.389 I-k	3.381 st	3.145 lm	0.417 q-s	0.390 I-k
V21	25.071 c-i	9.086 h-n	4.618 j-l	1.304 o-r	8.228 c	2.335 pq	0.903 ab	0.249 p-r
V28	27.298 a-h	12.578 d-i	3.996 o-q	2.201 jk	5.180 ln	4.460 fg	0.599 g-i	0.261 pq
V29	26.394 b-i	12.087 d-j	6.736 bc	3.452 fg	9.331 b	2.664 n-p	0.871 bc	0.336 mn
V30	19.491 i	8.641 h-n	2.603 z	1.288 o-r	4.076 p-r	1.906 rs	0.496 m-p	0.201 s-v
V32	32.569 ab	9.568 j-n	4.371 l-o	2.967 h	10.236 a	5.830 cd	0.940 a	0.422 h
V33	24.384 c-i	16.234 a-e	6.100 d	5.201 b	6.829 f-h	6.327 b	0.766 e	0.689 a
V36	27.016 a-h	11.287 f-l	4.051 n-q	2.332 I-k	5.724 j-l	2.964 mn	0.664 f	0.369 j-l
V40	25.051 c-i	12.469 d-i	5.045 g-i	3.133 h	5.020 n	3.801 hi	0.508 l-o	0.338 mn
V41	24.579 c-i	7.667 k-n	3.243 u-w	1.395 n-q	4.542 n-p	1.727 st	0.403 rs	0.176 v-x
V43	22.583 f-i	16.337 a-d	3.276 t-v	2.136 k	7.221 e-g	5.568 de	0.821 d	0.487 fg
V47	24.173c-i	11.900 e-k	2.806 y-z	1.519 n-p	4.252 o-q	2.334 pq	0.302 tu	0.126 z
V49	27.466 a-h	14.942 b-f	4.219 m-p	2.187 jk	5.689 k-m	3.527 i-k	0.617 g	0.361 l-m
V57	28.332 a-g	10.106 g-l	3.573 s-u	1.668 l-n	3.733 q-s	1.208 vw	0.289 t-v	0.131 z
V62	25.970 b-i	8.712 h-n	4.104 n-p	1.080 r	6.304 h-j	1.663 st	0.734 e	0.274 op
V63	25.808 b-i	9.495 h-n	2.892 w-z	1.402 m-q	5.015 n	1.821 st	0.516 l-n	0.218 r-t
V64	25.321 c-i	12.681 d-i	4.667 i-l	2.241 i-k	6.547 hi	4.285 fg	0.596 g-i	0.229 rs
V66	28.573 a-f	8.859 h-n	4.247 m-o	1.381 m-q	4.799 no	1.583 s-u	0.571 g-k	0.179 u-x
V69	30.306 a-d	7.996 j-n	5.451 ef	1.325 o-r	8.921 b	2.674 n-p	0.884 bc	0.322 n
V71	26.045 b-i	6.012 mn	2.989 v-y	1.221 p-r	7.808 cd	2.197 qr	0.681 f	0.153 x-z
V73	28.620 a-g	15.362 b-f	4.797 i-j	2.497 ij	4.653 n-p	2.330 pq	0.535 j-m	0.209 s-u
V77	27.936 a-g	9.499 h-n	6.805 bc	2.545 I	6.476 hi	2.422 o-q	0.582 g-j	0.167 w-y
V79	25.572 c-i	9.859 g-l	3.283 v-u	1.494 n-p	4.959 n	1.508 t-v	0.255 uv	0.128 z
V80	27.045 a-h	16.264 a-d	4.223 m-p	2.251 i-k	4.871 no	2.379 o-q	0.262 uv	0.180 u-x
V82	22.238 g-i	15.154 b-f	6.927 b	5.803 a	6.463 hi	6.005 bc	0.742 e	0.684 a
V86	23.826 c-i	7.508 k-n	4.793 i-k	1.367 n-r	3.524 r-t	1.163 vw	0.316 t	0.109 z
V88	26.975 a-h	15.842 a-e	5.203 f-h	3.661 ef	4.783 no	1.832 r-t	0.509 l-o	0.282 o
V89	25.761 e-i	15.826 a-e	5.601 e	4.578 c	4.740 no	4.513 f	0.556 h-l	0.518 de
V90	25.164 c-i	15.496 b-f	4.912 i-j	2.542 I	3.736 q-s	3.207 k-m	0.237 v	0.192 t-w

V95	28.852 a-g	6.627 mn	7.412 a	1.755 l	5.110 mn	1.261 u-w	0.471 n-p	0.136 z
V99	29.847 a-e	17.907 ab	4.407 l-n	3.590 ef	3.119 t	2.729 no	0.451 p-r	0.412 hi
T7	22.844 e-i	5.411 n	4.522 k-m	1.113 q-r	4.925 n	1.241 u-w	0.382 s	0.140 z
T32	27.580 a-g	12.163 d-j	3.682 r-s	1.579 l-o	5.020 n	2.383 o-q	0.459 o-q	0.249 p-r
T37	27.112 a-h	14.204 d-g	2.990 v-y	1.703 lm	3.815 q-s	1.863 r-t	0.372 s	0.173 v-x
T65	23.404 d-i	10.087 g-m	3.531 s-u	1.112 q-r	3.849 q-s	1.045 w	0.297 tu	0.120 z
T72	25.076 c-i	6.509 mn	4.923 i-j	2.277 o-r	3.708 q-s	1.025 w	0.279 t-v	0.104 z
T121	26.857 a-h	9.852 g-m	5.187 f-g	2.369 o-p	6.623 hi	2.700 n-p	0.590 g-i	0.232 q-s
V-e1	30.771 a-c	9.918 g-m	6.481 c	2.303 i-k	5.796 jk	2.414 o-q	0.457 o-q	0.226 rs
V-a1	29.642 a-f	19.770 a	3.729 r-s	3.216 g-h	5.634 k-m	5.314 e	0.502 l-p	0.469 g
V-g1	26.636 a-h	12.715 e-i	4.689 i-k	2.235 i-k	7.303 d-f	3.730 ij	0.745 e	0.344 l-n
Zulbiye	26.081 b-i	6.656 mn	6.055 d	1.453 l-q	5.175 l-n	1.490 t-v	0.516 l-n	0.109 z
Yakutiye	28.565 a-g	19.730 a	4.136 n-p	3.597 ef	7.631 de	7.164 a	0.606 gh	0.572 b
Mean ± SD	26.31 ± 3.466	11.97 ± 2.294	4.47 ± 0.201	2.35 ± 0.167	5.39 ± 0.304	2.95 ± 0.188	0.557 ± 0.030	0.301 ± 0.017

SD: Standard Deviation

Table 3. The fresh and dry shoot/root ratios, stem diameter (mm), and number of leaves of the bean genotypes in drought stress study.

Genotype	Fresh shoot/root ratio in control	Fresh shoot/root ratio in drought stress	Dry shoot/root ratio in control	Dry shoot/root ratio in drought stress	Stem diameter in control	Stem diameter in drought stress	Leaf number in control	Leaf number in drought stress
V5	0.250 e-l	0.627 a	0.236 bc	0.252 b	5.738 a-d	3.765 k-p	14.500 a	8.500 c-f
V6	0.207 i-m	0.634 a	0.259 a	0.419 a	5.508 a-g	3.958 e-n	12.500 ag	6.500 g-l
V7	0.247 e-j	0.245 g-n	0.159 ef	0.130 I-k	5.793 a-c	4.800 b	11.750 bg	9.500 b-d
V10	0.196 k-q	0.329 c-j	0.151 fg	0.158 g	4.995 e-l	4.370 b-f	12.250 ag	9.750 bc
V12	0.121 st	0.201 j-n	0.098 n-p	0.104 l-p	5.350 b-i	4.798 b	14.250 ab	9.250 b-e
V14	0.186 l-q	0.267 e-l	0.164 ef	0.188 e	5.238 b-k	3.435 o-t	12.250 ag	6.000 i-n
V15	0.165 n-s	0.217 j-n	0.147 f-i	0.163 g	4.540 l	3.965 e-n	12.250 ag	8.000 d-f
V21	0.332 ab	0.267 e-l	0.196 d	0.192 d	5.143 c-l	3.308 q-t	12.500 ag	5.000 l-o
V28	0.191 l-q	0.410 bc	0.149 f-h	0.119 k-m	4.600 kl	3.978 e-m	14.250 ab	9.750 bc
V29	0.363 a	0.228 i-n	0.129 i-l	0.098 m-q	5.335 b-i	3.503 n-t	12.000 ag	6.000 i-n
V30	0.210 i-n	0.221 i-n	0.191 d	0.156 gh	4.648 j-l	3.650 k-r	10.750 ag	5.500 k-o
V32	0.330 a-c	0.621 a	0.221 c	0.147 g-j	5.598 a-e	4.063 d-k	13.000 af	6.250 i-m
V33	0.283 c-f	0.390 b-e	0.126 j-m	0.132 h-k	5.003 e-l	4.308 d-g	11.750 bg	10.500 b
V36	0.216 h-m	0.300 c-k	0.165 ef	0.159 g	5.590 a-e	4.005 e-l	13.250 ae	8.500 c-f
V40	0.202 i-o	0.315 c-k	0.101no	0.108 k-o	4.738 h-l	3.938 f-n	10.500 fg	6.500 g-l
V41	0.186 l-q	0.234 g-n	0.124 k-m	0.127 j-l	5.218 b-k	3.513 m-t	11.250 cg	5.000 l-o
V43	0.325 a-c	0.362 b-h	0.251 ab	0.228 c	4.708 i-l	3.948 f-n	11.500 cg	9.500 b-d
V47	0.178 m-r	0.202 j-n	0.107 mn	0.083 o-r	5.298 b-j	4.258 d-h	11.750 bg	7.250 f-j
V49	0.208 i-n	0.241 g-n	0.146 f-j	0.166 f-	5.083 d-l	4.020 d-l	12.500 ag	8.500 c-f

V57	0.133 r-t	0.128 mn	0.081 o-r	0.079 p-r	5.020 e-l	3.578 l-s	13.000 af	7.500 f-i
V62	0.245 f-k	0.197 j-n	0.179 de	0.253 b	5.390 b-h	3.628 k-r	12.000 ag	5.500 k-o
V63	0.195 l-q	0.196 j-n	0.178 de	0.156 gh	5.320 b-i	3.818 g-o	12.250 ag	5.750 j-n
V64	0.259 d-h	0.354 c-i	0.128 i-m	0.103 l-q	4.805 h-l	3.900 f-n	11.500 cg	7.500 f-i
V66	0.170 m-r	0.191 k-n	0.135 f-j	0.131 i-k	5.480 a-g	3.760 k-q	11.500 cg	4.750 mo
V69	0.298 b-d	0.483 b	0.162 ef	0.244 cd	5.763 a-c	3.505 n-t	12.250 ag	5.500 k-o
V71	0.300 b-d	0.387 b-f	0.229 c	0.126 j-l	5.578 a-f	3.353 q-t	11.500 cg	5.500 k-o
V73	0.163 n-s	0.158 l-n	0.112 l-n	0.085 o-r	5.038 e-l	4.170 d-j	12.750 ag	7.250 f-j
V77	0.233 g-l	0.269 e-l	0.085 o-q	0.067 r	5.323 b-i	3.853 g-o	12.000 ag	5.750 j-n
V79	0.198 k-p	0.155 l-n	0.077 p-r	0.089 n-r	4.790 h-l	3.290 r-t	11.250 cg	6.000 i-n
V80	0.185 l-q	0.156 l-n	0.063 t-r	0.081 p-r	5.088 d-l	4.258 d-h	13.000 af	7.000 f-k
V82	0.295 b-e	0.407 b-d	0.107 mn	0.117 k-m	5.020 e-l	4.470 b-d	11.250 cg	10.000 bc
V86	0.151 o-t	0.158 l-n	0.066 r-t	0.082 o-r	4.968 e-l	3.318 q-t	10.250 g	5.250 l-o
V88	0.181 m-r	0.116 n	0.097 n-p	0.077 p-r	5.345 b-i	4.358 c-f	11.750 bg	7.750 e-h
V89	0.190 l-q	0.302 c-k	0.099 no	0.114 k-n	4.908 g-l	4.418 b-e	11.000 dg	7.750 e-h
V90	0.149 p-t	0.208 j-n	0.048 t	0.076 qr	5.268 b-k	4.185 d-j	10.250 g	6.000 i-n
V95	0.177 m-r	0.199 j-n	0.057 st	0.078 p-r	5.385 b-h	3.223 r-t	13.500 ad	5.500 k-o
V99	0.104 t	0.153 l-n	0.102 no	0.116 k-m	5.410 b-h	4.765 bc	11.250 cg	6.500 g-l
T7	0.217 h-m	0.230 h-n	0.085 o-q	0.126 j-l	5.180 c-l	3.098 t	10.250 g	4.500 no
T32	0.183 l-q	0.201 j-n	0.125 l-m	0.158 g	4.910 g-l	4.235 d-i	11.500 cg	6.500 g-l
T37	0.146 r-t	0.147 l-n	0.125 l-m	0.102 l-q	5.193 b-l	3.935 f-n	11.000 dg	5.750 j-n
T65	0.168 m-s	0.117 n	0.084 o-q	0.108 k-o	4.843 g-l	3.295 r-t	11.250 cg	5.000 l-o
T72	0.149 p-t	0.160 l-n	0.057 st	0.083 o-r	5.225 b-k	3.193 r-t	12.500 ag	5.250 l-o
T121	0.249 e-i	0.279 d-l	0.114 k-n	0.098 m-q	5.025 e-l	3.933 f-n	11.500 cg	6.500 g-l
V-e1	0.191 l-q	0.262 e-m	0.071 q-s	0.098 m-q	5.250 b-k	4.033 d-l	12.250 ag	6.500 g-l
V-a1	0.190 l-q	0.269 e-l	0.135 g-k	0.146 g-j	5.853 ab	5.295 a	14.250 ab	13.000 a
V-g1	0.288 b-f	0.297 c-k	0.159 ef	0.154 g-i	5.140 c-l	3.910 f-n	12.000 ag	7.000 f-k
Zulbiye	0.200 l-p	0.255 f-m	0.085 o-q	0.077 qr	5.283 b-j	3.163 st	11.500cg	4.000 o
Yakutiye	0.267 d-g	0.364 b-g	0.147 g-i	0.161 g	6.078 a	5.585 a	13.750 ac	12.500 a
Mean ± SD	0.214 ± 0.025	0.273 ± 0.062	0.131 ± 0.010	0.144 ± 0.013	5.21 ± 0.341	3.94 ± 0.246	12.06 ± 1,353	7.06 ± 0.878

SD: Standard Deviation

Table 4. Plant heigh (cm), leaf area (cm^2), and shoot and root Ca contents (%) of the bean genotypes in drought stress study.

Genotype	Shoot heigh in control	Shoot heigh in drought stress	Leaf area in control	Leaf area in drought stress	Shoot Ca content in control	Shoot Ca content in drought stress	Root Ca content in control	Root Ca content in drought stress
V5	53.225 j-n	38.550 h-i	30.346 a-h	14.240 f-o	3.299 c	1.832 p	2.163 g	1.348 l
V6	66,025 e-g	32.325 j-l	29.522 a-h	11.527 j-p	3.042 j-k	1.586 q	1.467 u	0.798 z
V7	46.875 n-s	36.825 h-j	29.761 a-h	17.976 d-g	2.682 r	2.285 gh	1.819 n	1.583 fg

V10	36.475 uv	30.850 k-l	26.523 c-h	17.568 d-g	2.714 qr	2.358 ef	2.031 i	1.718 e
V12	39.050 s-v	33.300 i-l	36.445 a-d	14.977 f-n	3.229 de	2.599 a	1.218 w	0.961 u-w
V14	46.750 n-s	22.675 o-r	25.900 e-h	9.213 n-p	3.384 ab	1.569 qr	1.693 r	0.973 tu
V15	91.925 a	82.500 a	36.253 a-e	18.587 b-f	2.683 r	2.259 h	2.388 c	2.043 c
V21	63.375 g-i	22.075 p-s	24.822 f-h	8.809 op	2.727 p-r	1.303 uv	1.913 l	1.108 r
V28	60.425 g-j	44.525 de	31.159 a-h	18.765 b-f	3.157 f-g	2.341 fg	1.343 v	0.969 u
V29	78.775 cd	38.625 h-i	26.922 c-h	10.570 k-p	3.148 g-i	1.587 q	1.688 r	0.855 z
V30	64.375 f-i	36.025 h-k	24.772 f-h	10.023 l-p	3.190 e-g	1.871 p	1.474 u	0.838 z
V32	59.700 g-k	44.000 d-f	30.771 a-h	12.602 g-p	3.217 ef	1.992 l-m	2.164 g	1.589 f
V33	50.750 l-q	43.075 e-g	37.594 ab	25.714 a	2.785 p	2.315 fg	2.389 c	2.171 a
V36	44.125 o-t	31.800 j-l	36.835 a-c	14.299 f-o	3.332 bc	2.406 de	2.557 b	1.565 gh
V40	51.650 k-p	34.425 h-k	29.030 a-h	15.151 e-m	3.083 i-k	2.319 fg	2.339 e	1.598 f
V41	56.200 i-m	28.475 l-n	29.521 a-h	13.355 f-o	3.172 e-g	1.337 u	1.489 u	0907 xy
V43	51.500 k-p	34.500 h-k	32.396 a-h	18.164 c-f	2.718 qr	1.946 no	1.601 s	1.454 k
V47	67.500 e-g	51.050 bc	26.319 d-h	16.903 c-j	2.697 qr	1.981 m-o	1.995 j	1.507 j
V49	87.250 ab	53.350 b	28.226 a-h	15.761 d-l	2.763 pq	2.075 j	1.999 j	1.532 I
V57	53.775 j-n	27.800 m-o	27.456 b-h	12.995 f-p	2.724 p-r	1.817 p	2.007 j	1.496 j
V62	33.125 v	12.725 t-u	25.107 f-h	9.973 l-p	3.136 g-i	2.092 j	2.093 h	0.937 w
V63	63.850 f-i	33.000 j-l	29.700 a-h	12.083 h-p	2.713 qr	2.014 k-m	1.595 s	1.138 q
V64	78.975 cd	48.225 cd	30.122 a-h	11.618 i-p	2.747 p-r	1.959 m-o	1.718 q	0.891 xy
V66	72.875 de	32.450 j-l	37.917 a	12.939 f-p	3.285 cd	1.602 q	1.699 qr	0.963 uv
V69	62.958 g-i	31.050 k-l	26.349 d-h	8.652 op	3.227 de	1.509 s	1.467 u	0.995 t
V71	42.700 q-t	17.000 s-t	22.827 h	7.323 p	2.686 r	1.607 q	1.334 v	0.857 z
V73	84.325 cb	54.525 b	31.318 a-h	15.629 d-l	2..849 o	2.152 i	1.474 u	1.253 n
V77	60.500 g-j	25.650 n-p	22.747 h	10.933 k-p	2.978 l-n	1.933 o	2.260 f	1.307 m
V79	53.325 j-n	27.825 m-o	27.568 a-h	9.414 m-p	2.858 o	1.527 rs	1.521 t	0.972 tu
V80	47.625 n-r	32.000 j-l	32.782 a-h	20.373 b-e	2.861 o	2.039 j-l	1.759 p	1.507 j
V82	45.400 n-t	39.175 g-h	29.665 a-h	21.762 a-c	2.531 s	2.164 i	1.696 qr	1.603 f
V86	50.350 l-q	24.050 n-r	22.547 h	9.632 m-p	3.038 j-l	1.839 p	1.969 k	1.195 o
V88	49.525 l-q	22.700 o-r	30.946 a-h	15.180 e-m	3.144 g-i	2.348 f	1.686 r	1.064 s
V89	43.700 p-t	23.550 n-r	28.998 a-h	18.462 b-f	3.028 kl	2.582 ab	1.139 y	0.695 c
V90	71.900 d-f	45.500 de	31.089 a-h	17.427 c-i	2.942 n	2.064 jk	1.171 x	0.887 y
V95	65.775 e-h	25.050 n-q	28.817 a-h	8.967 op	3.008 lm	1.836 p	1.595 s	1.163 p
V99	65.400 e-h	54.950 b	33.735 a-g	23.832 ab	2.983 l-n	2.413 d	2.262 f	2.087 b
T7	63.575 g-i	21.850 p-s	34.681 a-f	9.552 m-p	2.959 mn	1.273 v	1.529 t	0.763 b
T32	40.900 r-v	25.025 n-q	24.411 f-h	12.036 i-p	3.395 a	2.426 cd	1.469 u	1.163 p
T37	53.075 j-n	33.925 h-l	23.667 gh	11.405 j-p	3.334 bc	2.571 ab	2.718 a	1.908 d
T65	47.975 m-r	19.575 q-s	29.787 a-h	11.593 i-p	3.318 c	2.067 jk	2.362 d	1.089 r
T72	57.458 h-l	19.225 r-s	22.651 h	8.602 op	3.126 g-i	1.349 u	2.282 f	1.195 o
T121	36.925 u-v	19.275 r-s	26.275 d-h	12.081 i-p	3.008 lm	1.499 s	1.864 m	1.333 l
V-e1	52.375 j-o	21.675 p-s	25.162 f-h	11.805 i-p	3.144 g-i	2.345 f	1.923 l	1.548 hi

V-a1	36.350 uv	32.500 j-l	32.972 a-g	21.102 a-d	2.993 l-n	2.532 b	2. 044 i	1.915 d
V-g1	38.175 uv	23.125 n-r	29.169 a-h	16.150 c-k	3.098 h-j	2.189 i	1.341 v	0.944 vw
Zulbiye	33.950 v	10.125 u	23.899 gh	9.874 l-p	3.139 g-i	1.418 t	1.783 o	0.913 x
Yakutiye	38.650 s-v	34.725 h-k	32.006 a-h	20.157 b-e	2.938 n	2.469 c	2.043 i	1.915 d
Mean ± SD	55.45 ± 4.475	32.86 ± 2.892	29.11 ± 5.126	14.08 ± 2.976	3.01 ± 0.016	1.99 ± 0.017	1.819 ± 0.005	1.275 ± 0.005

SD: Standard Deviation

Table 5. The shoot and root K and Na contents (%) of the bean genotypes in drought stress study.

Genotype	Shoot K content in control	Shoot K content in drought stress	Root K content in control	Root K content in drought stress	Shoot Na content in control	Shoot Na content in drought stress	Root Na content in control	Root Na content in drought stress
V5	2.399 de	1.567 ij	1.805 e	1.353 g	0.2504 e	0.3148 g	0.2759 hi	0.3409 k
V6	1.787 z	1.036 t	1.233 v	0.774 w	0.2369 fg	0.3819 b	0.2788 h	0.3951 e
V7	2.018 wx	1.860 c	1.657 kl	0.720 x	0.1824 z	0.2373 t	0.2455 mn	0.3538 ij
V10	2.375 ef	1.843 c	1.755 f-h	1.182 m	0.2079 o	0.2384 t	0.2512 ml	0.3086m-o
V12	2.386 e	2.072 a	1.591 n	1.292 ij	0.2410 f	0.2767 no	0.2262 rs	0.2596 q
V14	2.208 o-t	1.421 l-n	1.656 kl	1.352 g	0.1620 c	0.2708 p	0.2183 uv	0.3872 ef
V15	1.758 z	1.565 ij	1.382 r	1.039 q	0.1961 p-r	0.2224 w	0.2572 k	0.4083 d
V21	2.447 bc	1.379 n-p	1.758 fg	0.796 v	0.2394 f	0.3994 a	0.2781 h	0.4398 b
V28	2.264 j-l	1.477 k	1.848 d	1.153 n	0.1586 cd	0.2153 x	0.2149 v	0.2403 rs
V29	2.196 q-t	1.709 e	1.733 ij	0.833 u	0.1914 r-v	0.3091 h-i	0.2550 kl	0.4409 b
V30	1.798 z	1.172 s	1.659 k	0.837 u	0.1925 q-u	0.2384 t	0.2193 t-v	0.2384 st
V32	2.392 de	1.998 b	1.840 d	1.399 ef	0.1944 q-s	0.2812 n	0.2142 v	0.2918 p
V33	2.203 p-t	1.537 j	1.543 o	1.238 l	0.2107 no	0.2406 st	0.1968 x	0.2264 u
V36	2.111 v	1.479 k	1.735 h-j	1.042 q	0.1723 b	0.2369 tu	0.2039 w	0.3168 m
V40	2.478 ab	1.976 b	1.641 kl	1.152 n	0.1940 q-s	0.2481 r	0.2327 pq	0.2892 p
V41	2.489 a	1.788 d	1.798 e	1.043 q	0.1856 x-z	0.2799 n	0.2468 mn	0.4103 cd
V43	2.283 ij	1.946 b	1.205 w	0.650 y	0.2000 p	0.2708 p	0.2548 kl	0.3038 o
V47	2.244 k-o	1.479 k	1.408 q	1.163 n	0.1884 u-y	0.2319 uv	0.3082 c	0.3447 k
V49	2.185 r-u	1.643 g	1.739 g-i	1.230 l	0.1863 x-z	0.2593 q	0.2913 fg	0.4042 d
V57	2.222 n-r	1.657 fg	1.358 s	1.030 qr	0.1836 z	0.2790 n	0.2882 g	0.3672 h
V62	2.289 ij	1.367 op	1.842 d	1.148 n	0.1859 z	0.3039 j	0.2043 w	0.3536 ij
V63	1.807 z	1.399 m-p	1.324 t	1.018 r	0.1814 z	0.2864 lm	0.2481 mn	0.3103m-o
V64	2.035 w	1.354 pq	1.235 v	0.775 w	0.1890 t-x	0.2447 rs	0.3297 a	0.4171 c
V66	2.259 j-m	1.463 kl	1.801 e	1.089 p	0.1875 v-y	0.2908 kl	0.2984 de	0.4603 a
V69	2.443 bc	1.298 r	1.601 mn	0.829 u	0.2001 p	0.2933 k	0.2628 j	0.3752 gh
V71	2.346 fg	1.652 fg	1.859 d	0.985 s	0.2069 o	0.3038 j	0.2486 mn	0.3274 l
V73	2.093 v	1.644 g	1.859 d	1.401 e	0.2287 hi	0.3200 f	0.2149 v	0.3062 no
V77	2.234 l-p	1.672 e-g	1.741 g-i	0.781 vw	0.2270 ij	0.3349 e	0.2999de	0.4659 a
V79	2.171 tu	1.698 ef	1.473 p	0.713 x	0.2228 jk	0.3119 gh	0.2460 mn	0.4367 c

V80	2.422 cd	1.412 l-o	1.949 a	1.307 hi	0.2562 d	0.3110 gi	0.2887 g	0.3823 fg
V82	2.279 i-k	1.853 c	1.812 e	1.669 b	0.2765 a	0.3064 ij	0.2927 fg	0.3081m-o
V86	2.366 ef	1.563 ij	1.773 f	0.995 s	0.2486 e	0.3409 d	0.2726 i	0.3832 fg
V88	2.211 n-s	1.462 kl	1.912 b	1.652 c	0.2686 b	0.3322 e	0.3036 cd	0.3585 i
V89	1.985 y	1.708 e	1.638 l	1.383 f	0.2631 c	0.2813 n	0.2964 ef	0.3304 l
V90	1.985 xy	1.532 j	1.360 s	1.031qr	0.2330 gh	0.2727 op	0.2914 fg	0.3484 jk
V95	2.449 bc	1.959 b	1.949 a	1.280 j	0.2261 ij	0.2698 p	0.2442 n	0.3137 mn
V99	2.308 hi	1.975 b	1.891 c	1.782 a	0.2150 mn	0.2322 uv	0.2276 qr	0.2482 r
T7	2.177 s-u	1.318 qr	1.856 d	0.786 vw	0.2010 p	0.3446 d	0.2211s-u	0.3796 fg
T32	2.246 k-n	1.794 d	1.792 e	1.258 k	0.1556 d	0.2167 x	0.1921 x	0.2311 tu
T37	2.282 ij	1.766 d	1.224 v	0.839 u	0.1924 q-v	0.2412st	0.2294 qr	0.3091m-o
T65	2.223 m-q	1.635 gh	1.255 u	0.708 x	0.1901 s-x	0.3053 j	0.2595 kj	0.3676 h
T72	2.156 u	1.592 hi	1.455 p	0.643 y	0.1874w-y	0.3309 e	0.2373 op	0.3799 fg
T121	2.005 x-y	1.549 ij	1.546 o	1.117 o	0.2007 p	0.2791 n	0.2388 o	0.3041 o
V-e1	2.195 q-t	1.480 k	1.618 m	1.323 h	0.2213 kl	0.2819 mn	0.25.81 jk	0.3329 l
V-a1	2.311 hi	1.974 b	1.744 g-i	1.563 d	0.1869w-z	0.2073 y	0.2168 uv	0.2349 st
V-g1	2.328 gh	1.790 d	1.891 c	1.652 c	0.1935 q-t	0.2292 v	0.3152 b	0.4407 b
Zulbiye	2.290 ij	1.441 k-m	1.719 j	0.861 t	0.2179 lm	0.3573 c	0.2242 r-t	0.3798 fg
Yakutiye	2.173 s-u	1.869 c	1.849 d	1.646 c	0.1970 pq	0.2158 x	0.2361 op	0.2563 q
Mean ± SD	2.21 ± 0.010	1.62 ± 0.011	1.65 ± 0.007	1.11 ± 0.006	0.21 ± 0.001	0.28 ± 0.002	0.25 ± 0.002	0.34 ± 0.003

SD: Standard Deviation

Table 6. The shoot and root Ca/Na and K/Na ratios of the bean genotypes in drought stress study.

Genotype	Shoot Ca/Na ratio in control	Shoot Ca/Na ratio in drought stress	Root Ca/Na ratio in control	Root Ca/Na ratio in drought stress	Shoot K/Na ratio in control	Shoot K/Na ratio in drought stress	Root K/Na ratio in control	Root K/Na ratio in drought stress
V5	13.18 r-t	5.82 t	7.84 kl	3.95 no	9.581 t-v	4.978 q-s	6.541 m	3.969 l
V6	12.84 t-v	4.15 x	5.26 b1	2.02 z	7.545 z	2.712 x	4.422 y	1.960 z
V7	14.72 k-m	9.63 g	7.41 op	4.48 l	11.077 lm	7.839 d	6.749 l	2.036 yz
V10	13.06 s-u	9.63g	8.08 j	5.57 f	11.427 jk	7.527 e	6.989 k	3.83 l
V12	13.39 q-s	9.39 gh	5.39 a1b1	3.70 pq	9.899 s	7.491 ef	7.036 k	4.979 f
V14	20.89 b	5.79 t	7.75 k-m	2.51 w	13.629 b	5.249 op	7.584 hi	3.491n
V15	13.68 pq	10.16 f	9.29 gh	5.00 i	8.962 x	7.037 i	5.373 u	2.546 t
V21	11.39 xy	3.26 z	6.88 qr	2.52 w	10.223 qr	3.453 w	6.323 n	1.809 z
V28	19.89 c	10.87 d	6.25 v-x	4.03 mn	14.274 a	6.862 j	8.601 c	4.796 h
V29	16.45 g-i	5.13 v	6.62 st	1.94 z	11.473 jk	5.531 mn	6.797 l	1.890 z
V30	16.57 gh	7.85 k	6.72 rs	3.52 r	9.338 vw	4.914 rs	7.567 hi	3.509 n
V32	16.55 gh	7.08 mn	10.09 de	5.45 g	12.303 de	7.104 hi	8.583 c	4.795 g
V33	13.21 q-t	9.62 g	12.14 b	9.58 a	10.454 pq	6.388 k	7.842 g	5.47 d
V36	19.34 d	10.16 f	12.54 a	4.94 i	12.251 de	6.244 k	8.511 cd	3.289 pq

V40	15.89 j	9.35 h	10.06 de	5.52g	12.771 c	7.967 d	7.053 k	3.983 l
V41	17.09 e	4.78 w	6.04 x	2.21 y	13.410 b	6.387 k	7.285 j	2.541 t
V43	13.59 p-r	7.18 m	6.28 u-w	4.79 j	11.417 jk	7.185 g-i	4.731 vw	2.141 wx
V47	14.32 m-o	8.84 i	6.47 tu	4.37 l	11.910 f-i	6.382 k	4.571 x	3.373 op
V49	14.83 kl	8.00 k	6.86 qr	3.79 p	11.728 h-j	6.339 k	5.972 r	3.044 r
V57	14.83 kl	6.51 s	6.97 q	4.07 m	12.099 d-g	5.940 l	4.711 v-x	2.806 s
V62	16.87 g	6.88 n-p	10.24 d	2.65 v	12.316 de	4.499 t	9.016 b	3.248 q
V63	14.96 k	7.03 m-o	6.44 t-v	3.67 q	9.964 sr	4.884 rs	5.342 u	3.281 pq
V64	14.53 k-n	8.01 k	5.21 b1	2.14 yz	10.766 m-o	5.531 mn	3.745 z	1.858 bc
V66	17.51 e	5.51 u	5.69 yz	2.09 z	12.043 d-h	5.031qr	6.037qr	2.366 u
V69	16.13 h-j	5.15 v	5.58 za1	2.65 v	12.209 d-f	4.425 t	6.093 p-r	2.211 vw
V71	12.98 s-u	5.29 uv	5.37 a1	2.62 vw	11.341 lk	5.437 mn	7.479 i	3.009 r
V73	12.45 v-w	6.72 p-r	6.86 qr	4.09 m	9.150 wx	5.138 pq	8.649 c	4.578 i
V77	13.12 r-t	5.77 t	7.54 m-o	2.80 u	9.841 st	4.993 q-s	5.807 s	1.677 z
V79	12.83 t-v	4.89 w	6.18 wx	2.22 y	14.433 a	5.443 mn	5.989 qr	1.633 z
V80	11.16 y	6.56 q-s	6.09 wx	3.94 no	9.452 u-v	4.541 t	6.752 l	3.419 no
V82	9.15 z	7.06 mn	5.79 y	5.20 h	8.244 y	6.048 l	6.192 n-p	5.419 e
V86	12.22 w	5.39 u	9.10 gh	3.12 s	9.517 u-v	4.584 t	6.505 m	2.596 t
V88	11.70 x	7.07 mn	5.56 za1	2.97 t	8.230 y	4.402 t	6.297 n	4.609 h
V89	11.5 xy	9.18 gh	3.84 d1	2.10 z	7.508 z	6.072 l	5.525 t	4.187 j
V90	12.62 u-w	7.57 l	4.02 d1	2.55 vw	8.519 y	5.617 m	4.667 wx	2.959 r
V95	13.29 q-t	6.81 op	6.53 st	3.71 pq	10.828 mn	7.262 gh	7.982 f	4.086 k
V99	13.87 op	10.39 e	9.94 e	8.41 b	10.734 n-p	8.508 b	8.309 e	7.181 a
T7	14.72 k-m	3.69 y	6.92 qr	2.01 z	10.834 mn	3.826 v	8.393 de	2.071 xy
T32	21.82 a	11.19 c	7.65 l-n	5.04 i	14.433 a	8.281 c	9.331 a	5.443 d
T37	17.33 e	10.39 e	11.85 c	6.17 e	11.862 g-i	7.322 fg	5.336 u	2.716 s
T65	17.46 e	6.77 pq	9.10 h	2.96 t	11.699 ij	5.355 no	4.837 v	1.928 z
T72	16.68 fg	4.08 x	9.62 f	3.15 s	11.503 jk	4.811 s	6.133 o-q	1.694 z
T121	14.99 k	5.37 uv	7.81 kl	4.38 l	9.990 sr	5.554 m	6.476 m	3.672 m
V-e1	14.21 no	8.32 j	7.45 no	4.65 k	9.920 sr	5.250 op	6.272 no	3.974 l
V-a1	16.01 ij	12.21 a	9.43 fg	8.17 c	12.364 d	9.521 a	8.043 f	6.652 b
V-g1	16.01 ij	9.55 gh	4.25 c1	2.14 yz	12.026 e-	7.813 d	5.999 qr	6.816 b
Zulbiye	14.41 l-m	3.97 x	7.95 jk	2.40 x	10.511 o-q	4.034 u	7.670 h	2.267 v
Yakutiye	14.91 k	11.44 b	8.65 i	7.47 d	11.031 mn	8.666 b	7.834 g	6.422 c
Mean ± SD	14.82 ± 0.148	7.41 ± 0.079	7.41 ± 0.067	3.95 ± 0.035	11.01 ± 0.099	5.97 ± 0.056	6.66 ± 0.050	3.44 ± 0.033

SD: Standard Deviation

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