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Research Article

Ameliorative Effect of Sodium Nitroprusside and Trichoderma on Morpho-Physiological Character of Chickpea (*Cicer arietinum* L.) Genotypes under Drought Stress

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ABSTRACT

Chickpea is very important food legume also it is the good source of carbohydrate (48.2-67.6%), starch (41-50%), protein (12.4-31.5%), fat (6%) as well as nutritionally important minerals. It is also used as a rotation crop as of its nitrogen fixing property. Drought stress is one of the most important abiotic stress disturbing plant growth and productivity worldwide. Grain legumes, in general, and chickpea, in particular, as compared to cereals seem to have more sensitivity towards drought stress. The present study was carried out during 2015-2016, in order to estimate drought tolerance in two chickpea genotypes (susceptible and tolerant), under both control and drought conditions and various parameters were recorded. The experiment was laid out in randomized block design with three replications. Drought stress is created by applying PEG 10%. PEG 10% reduced most of the morpho-physiological attributes, but plants could sustain up drought stress when SNP and Trichoderma alone or in combination given.

Keywords: *Drought stress, Chickpea, SNP, Trichoderma.*

INTRODUCTION

Chickpea is a crucial food legume which will be grown under a varied range of environments. It is well identified as a drought tolerant crop that performs well in low input agriculture and is taken into account as the second important leguminous crop in the world. The agri-food importance of chickpeas is associated to its great richness in proteins: 25.3 to 28.9% (Hulse, 1991). This leguminous crop is taken into account as substitute source of proteins for human nutrition (Tejera et al., 2006). Smita and Nayyar (2005) witnessed reduction in root length of *Cicer arietinum* under water stress and detrimental effects may be because of reduction in root-hair diameter as well as distortion and plasmolysis, therefore rendering the uptake of accessible water by roots.

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MATERIALS AND METHODS

1. Morphological and Growth Parameters

Root length (cm)

Root length is measured at 35 and 70 DAS in the net house in controlled and treated plants from the root-stem transition to the base of the root apex.

Shoot length (cm)

Shoot height or length of one plant, from each treatment and under each replication was measured in centimetre from the base of the plant to the growing tip of the main shoot with the help of a meter scale and expressed in cm. The shoot height of three plants (one from each replication) was averaged to obtain the height of per plant for each treatment.

Number of leaves plant^{-1}

The number of leaves plant^{-1} was counted separately at 35 and 70 DAS in net house in controlled and treated plants of chick pea genotypes.

Root shoot length ratio

The ratio root of root and shoot length is measured at 35 and 70 DAS.

RESULTS

MORPHO-PHYSIOLOGICAL CHARACTERS

1. Length of root (cm)

The data on root length at different treatments under two growth periods (35 and 70 DAS) are presented in Fig. 1. There was a significant decrease in root length with 10% PEG treatment. Among treatments, the maximum reduction of 44.06% and 43.36% in root length (9.89 and 9.88 cm) was recorded at 35 DAS under drought stress in Pusa 262 and Pant G-114, respectively as compared to SNP and *Trichoderma* treatment. Our results are in accordance with the findings of several workers who reported decreased root length in various crops under heavy metal stress (Esmaeilian et al., 2011; Asgharipour et al., 2011; Shekar et al., 2011). Both treatments namely, SNP and *Trichoderma* alone or in combination of SNP and *Trichoderma* showed increasing root length as compared to both control and PEG 10%. Smita and Nayyar (2005) also observed reduction in root length of *Cicer arietinum* under water stress and detrimental effects could be due to reduction in root-hair diameter as well as distortion and plasmolysis.

Among treatments, maximum root length (20.23 and 19.57 cm) was observed with SNP and *Trichoderma* at 70 DAS, in both the varieties, Pusa 262 and Pant G-114 respectively. Effect of NO on growth parameters of plants under drought, heavy metal and salinity stress has been reported (Nasibi & Kalantari, 2009; Zhao et al., 2001; Singh et al., 2008). Reduction of root length under stress conditions may due to an impediment of cell division and elongation leading kinds of tuberization.

Table- 4.1.1. Effect of Drought stress, Sodium nitroprusside and *Trichoderma* on root length at two growth periods in Chickpea (*Cicer arietinum* L.)

TREATMENT (T)	GENOTYPE(G)			
	35DAS		70DAS	
	PUSA 262	PANT G-114	PUSA 262	PANT G-114
$P_0S_0T_0$	16.65	16.61	18.51	18.39
$P_1S_0T_0$	9.89	9.88	10.81	10.73
$P_0S_1T_0$	17.10	16.88	19.44	19.58
$P_0S_0T_1$	17.63	17.21	19.98	19.28
$P_1S_1T_0$	12.88	12.25	14.98	14.41
$P_1S_0T_1$	13.53	13.03	15.65	14.95
$P_0S_1T_1$	18.11	17.38	20.23	19.47
$P_1S_1T_1$	16.94	16.43	18.77	18.26
	SEM±	**CD 5%**	**SEM±**	**CD 5%**
G	0.043	0.125	0.062	0.181
T	0.086	0.25	0.125	0.362
G×T	0.122	0.354	0.176	N/A

P_0 = No PEG treatment; P_1= PEG treatment

S_0= No SNP; S_1 =SNP treatment

T_0=No *Trichoderma;* T_1= *Trichoderma* treatment

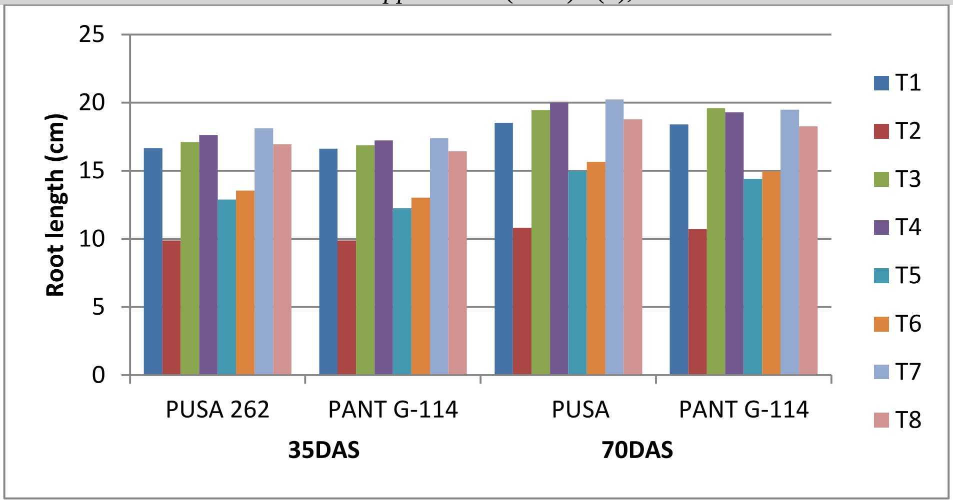

Fig. 1: Effect of Drought stress, Sodium nitroprusside and *Trichoderma* on root length at two growth periods in Chickpea (*Cicer arietinum* L.)

$P_0S_0T_0$	=	T1
$P_1S_0T_0$	=	T2
$P_0S_1T_0$	=	T3
$P_0S_0T_1$	=	T4
$P_1S_1T_0$	=	T5
$P_1S_0T_1$	=	T6
$P_0S_1T_1$	=	T7
$P_1S_1T_1$	=	T8

2. Length of shoot (cm)

The data on shoot length at different treatments under two growth periods (35 and 70 DAS) are presented in Fig. 2. There was a significant decrease in shoot length under drought stress. Among the treatments, the maximum 73.96% and 71.09% reduction (14.28 and 13.70 cm) in root length was observed at 35 DAS under drought stress in Pusa 262 and Pant G-114, respectively. Many studies have shown that there is significant decrease in shoot length under drought stress (Turkan et al., 2004; Tuna et al., 2010), Kavar et al. (2007).

According to Mohammadkhani and Heidari, (2008), all the upland rice varieties displayed significant reduction in shoot length at the most drought levels as compared with control. This reduction in growth might be due to low osmotic potential as well as a decrease in wall extensibility and cellular expansion.

Table-4.1.2. Effect of Drought stress, Sodium nitroprusside and *Trichoderma* on shoot length at two growth periods in Chickpea (*Cicer arietinum* L.)

TREATMENT (T)	GENOTYPE(G)			
	35DAS		70DAS	
	PUSA 262	PANT G-114	PUSA 262	PANT G-114
$P_0S_0T_0$	19.79	19.18	22.56	21.53
$P_1S_0T_0$	14.29	13.70	16.78	16.81
$P_0S_1T_0$	24.86	23.44	29.63	28.61
$P_0S_0T_1$	23.13	22.91	26.81	25.71
$P_1S_1T_0$	16.31	15.30	19.53	18.58
$P_1S_0T_1$	17.23	16.40	20.30	19.63
$P_0S_1T_1$	22.29	21.58	24.25	23.55
$P_1S_1T_1$	20.85	19.72	23.37	22.17
	SEM±	CD 5%	SEM±	CD 5%
G	0.072	0.2088	0.081	0.234
T	0.144	0.417	0.161	0.467
G×T	0.203	N/A	0.228	N/A

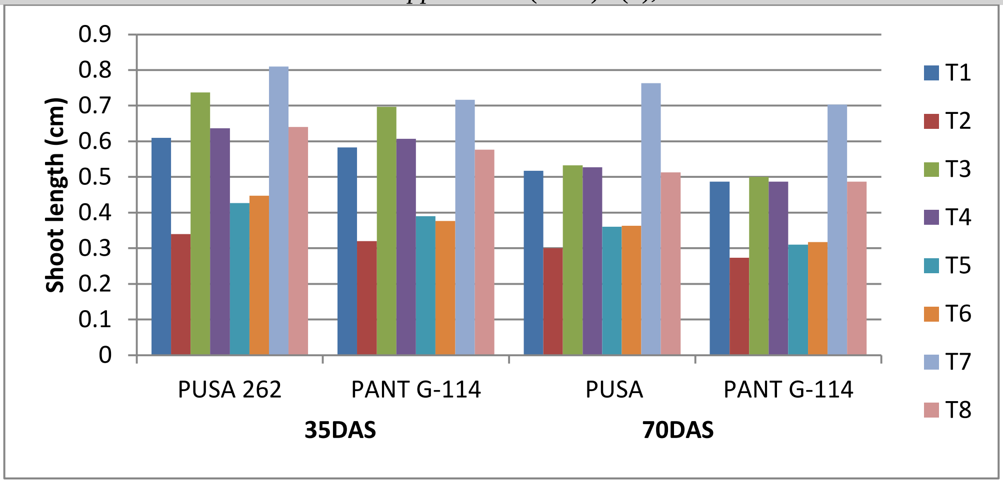

Fig. 2: Effect of Drought stress, Sodium nitroprusside and *Trichoderma* on shoot length at two growth periods in Chickpea (*Cicer arietinum* L.)

3. Number of Leaves per plant

Data pertaining to number of leaves per plant at two growth periods (35 and 70 DAS) are presented in Fig.3. which elucidated that the treatments had significantly decreased number of leaves per plant in drought condition. Among the treatments, the maximum 57.45 and 58.81% decrease in number of leaves (40.14 and 38.37) per plant was observed at 35 DAS in Pusa 262 and Pant G-114, respectively in drought stress as compared to SNP and *Trichoderma* in combination. Similar result was observed by Ali et al. (2007) who indicated that the reduction in growth characters during stress may be due to water potential hampering nutrient uptake, reduction in meristem cells and oxidative stress.

Among treatments, SNP alone or in combination of *Trichoderma*, showed ameliorative effects at both the growth periods. Among treatments, maximum number of leaves per plant (140.49 and 139.47) was observed with SNP and *Trichoderma* at 70 DAS. The results of reduced leaf number in water deficit condition is similar to the findings of Khalil et al. (2010) in *Ocimum basilicum*. Similar result was observed by Shao et al. (2008) where reduction in leaf area index and number of leaves under water stress were perhaps due to decline in cell enlargement and more leaf senescence resulting from reduced turgor pressure.

Table- 4.1.3. Effect of Drought stress, Sodium nitroprusside and *Trichoderma* on number of leaf at two growth periods in Chickpea (*Cicer arietinum* L.)

TREATMENT (T)	GENOTYPE(G)			
	35DAS		70DAS	
	PUSA 262	PANT G-114	PUSA 262	PANT G-114
$P_0S_0T_0$	67.70	66.64	99.70	98.50
$P_1S_0T_0$	40.14	38.37	67.11	66.18
$P_0S_1T_0$	91.22	89.96	135.45	133.92
$P_0S_0T_1$	87.65	86.54	120.11	119.11
$P_1S_1T_0$	54.23	53.21	89.56	88.59
$P_1S_0T_1$	57.42	56.26	92.33	91.31
$P_0S_1T_1$	94.34	93.17	140.49	139.47
$P_1S_1T_1$	71.53	70.47	110.47	109.12
	SEM±	**CD 5%**	**SEM±**	**CD 5%**
G	0.053	0.154	0.087	0.252
T	0.106	0.309	0.174	0.504
G×T	0.151	N/A	0.245	N/A

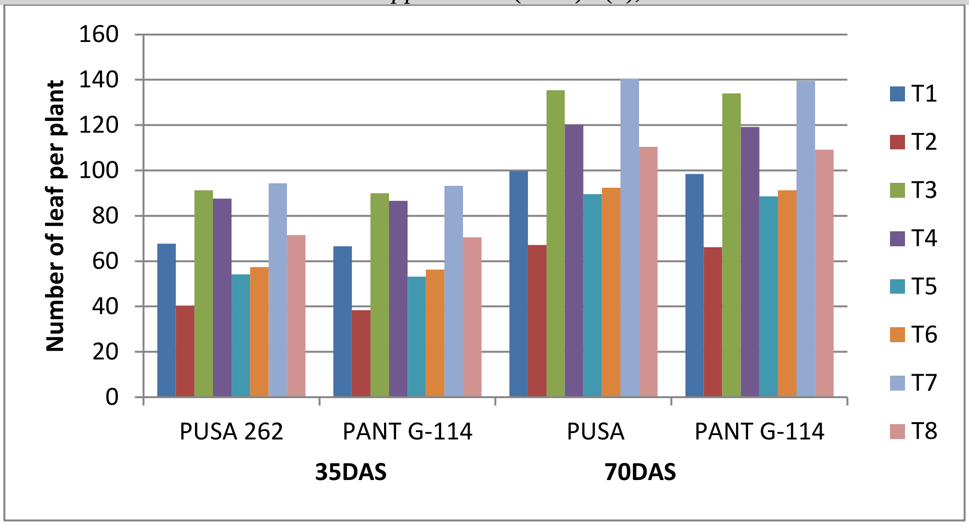

Fig. 3: Effect of Drought stress, Sodium nitroprusside and *Trichoderma* on number of leaf at two growth periods in Chickpea *(Cicer arietinum* L.)

4. Root and Shoot Length ratio

Data pertaining to root shoot ratio at two growth periods (35 and 70 DAS) are presented in Fig. 4. which elucidated that the treatments had significantly decreased root shoot ratio under drought stress in both the varieties. Among the treatments, the maximum increase in root shoot length ratio was observed in control treatment at 35 DAS in both the varieties, which is followed by SNP and *Trichoderma* treatment in combination at 70 DAS.

Table- 4.1.4. Effect of Drought stress, Sodium nitroprusside and *Trichoderma* on root shoot length ratio at two growth periods in Chickpea *(Cicer arietinum* L.)

TREATMENT (T)	GENOTYPE(G)			
	35DAS		70DAS	
	PUSA 262	PANT G-114	PUSA 262	PANT G-114
$P_0S_0T_0$	0.840	0.867	0.820	0.854
$P_1S_0T_0$	0.689	0.721	0.643	0.639
$P_0S_1T_0$	0.688	0.720	0.656	0.683
$P_0S_0T_1$	0.762	0.751	0.745	0.750
$P_1S_1T_0$	0.789	0.801	0.767	0.775
$P_1S_0T_1$	0.785	0.794	0.771	0.761
$P_0S_1T_1$	0.812	0.805	0.833	0.827
$P_1S_1T_1$	0.812	0.832	0.803	0.824
	SEM±	CD 5%	SEM±	CD 5%
G	0.004	0.011	0.003	N/A
T	0.008	0.023	0.007	0.019
G×T	0.011	N/A	0.009	N/A

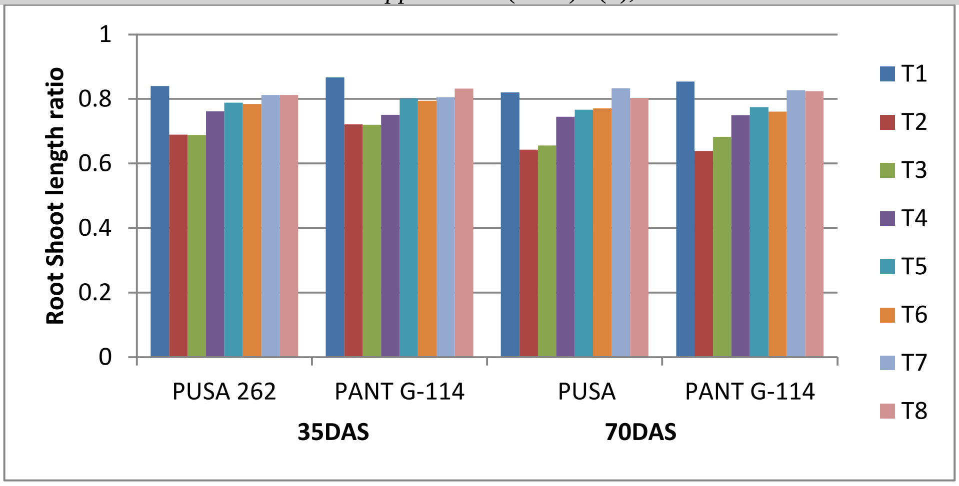

Fig.- 4. Effect of Drought stress, Sodium nitroprusside and *Trichoderma* on root shoot length ratio at two growth periods in Chickpea (*Cicer arietinum* L.)

RESULT AND DISCUSSION

Drought stress is one of the major abiotic stresses affecting plant growth and productivity globally. Keeping this in mind, the present investigation was undertaken in net house of Institute of Agricultural Sciences, Banaras Hindu University, Varanasi during winter session 2015-2016 to study the influence of PEG 6000 (10%) either alone or in combination with SNP and *Trichoderma* in chickpea (*Cicer arietinum* L.). The experiment was laid out in Factorial Randomized Block Design (FRBD), which consisted of 8 treatments, 3 replication for each treatment, 2 varieties, and plants were subjected to these chemicals in the pots at two different growth periods- 35 and 70 DAS. The summary and conclusion obtained from the investigation are presented in this chapter. The salient finding of the investigation are summarized as under:

1. Drought stress is considered a major abiotic stress affecting plant growth and productivity. PEG 10% reduced most of the morpho-physiological attributes *viz.* Shoot length, root length, number of leaf per plant, root shoot length ratio, but plants could sustain up drought stress when SNP and *Trichoderma* alone or in combination given.
2. Length of root (cm) increased significantly with SNP (100μM), and *Trichoderma* (10^6cfu), alone or in combination, showing ameliorative effect against drought stress. Among various treatments, the maximum root length was recorded in combination of both SNP (100μM) and *Trichoderma* (10^6cfu) at 70 DAS.
3. Length of shoot (cm) increased significantly with SNP (100μM) and *Trichoderma* (10^6cfu) alone or in combination. These showed ameliorative effect against drought stress, however, SNP alone led to increase shoot length by 31.33% and 32.88% at 70 DAS in both the varieties *viz.* Pusa 262 and Pant G-114, respectively as compared to control.
4. Number of leaves per plant increased significantly in combined treatment of SNP (100μM) and *Trichoderma* (10^6cfu) which showed ameliorative effect against drought stress. Among treatments, the maximum number of leaves was recorded in combination of both SNP and *Trichoderma* at 70 DAS.
5. Root shoot length ratio decreased significantly with PEG 10%. And it increased significantly with SNP (100μM) and *Trichoderma* (10^6cfu), alone or in combination. These showed ameliorative effect against drought stress.

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