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Research Article

INFLUENCE OF WATER DEFICIT ON MORPHOLOGICAL CHARACTERISTICS OF GREEN MANURE CROP (DHAINCHA) *SESBANIA CANNABINA* POIR

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ABSTRACT

Developing countries are lagging behind in the crop production in comparison to the developed countries. The developed countries have gained the high crop production by adoption of various developed varieties, varieties resistant to environmental hazards, and by the adoption of modern agricultural practices. The charm of use of chemical fertilizers for increasing the production of crop plants are continuously fading down due to its various harmful effects on crop and environment, and now-a-days farmers are more interested in the benefits of green manuring. But the farmers in the developing countries still hesitate in adoption of green manuring and one of the major reasons behind this is lack of irrigation facilities for green manure crops. Therefore the green manure crop which requires less irrigation attracts more. *Sesbania cannabina* is a multipurpose green manure crop and is widely adaptable to different adverse climatic conditions.In view of above mentioned facts present study was undertaken to study drought tolerance in green manure crop *Sesbania cannabina*. The drought tolerance experiment for *Sesbania cannabina* lasted for one growing season and involved four treatments: a control group of plants was well-watered; a second group was subjected to drought after 15 days of sowing for 10 days, a third group was subjected to drought for 15 days and the fourth group was subjected to drought for 20 days. All morphological parameters were taken after 45 days of sowing.

Keywords: Drought Tolerance; Green Manuring; Morphological Parameters; *Sesbania Cannabina;* Soil.

INTRODUCTION

Due to their sedentary mode of life, plants resort to many adaptive strategies in response to different environmental hazards, such as drought, cold, heat and flooding. Crop plant breeding for drought resistance has long been part of the breeding process in most crops that have been or are being grown under dryland conditions. During the period of the pre-scientific agriculture, the genetic improvement of plant adaptation to dry conditions was simply attained by repeatedly selecting plants that appeared to do well when drought stress occurred. These factors tend to alter plant-environmental equilibrium and represent a driving force away from cellular homeostasis[1]. Among all the osmotic stresses to which plants may be exposed, drought-stress is probably the most limiting on plant distribution and productivity, both in natural and agricultural systems[2]. Drought-stress leads to disruption of water potential gradients, loss of turgor, disruption of membrane integrity, and denaturation of proteins[3]. Responses to water deficit depend on the species and genotype, length and severity of water loss, age and stage of development, organ and cell type, and subcelullar compartment[4]. The responses to water loss may occur within a few seconds (such as changes in the phosphorylation status of a protein), or within minutes, hours or days (such as changes in gene expression and plant morphology)[5].

Drought stress is especially important in countries where crop agriculture is essentially rain-fed[6].These drought-stressed plants consequently exhibit poor growth and yield. Certain plants have devised mechanisms to survive under low water conditions. These mechanisms have been classified as tolerance, avoidance or escape[7]. Drought stress reduced dry matters of chicory by reduction in the area of the leaf and height of plant[8].

Drought and salinity affect more than 10 percent of crop areas, and land desertification and salinization are rapidly increasing on a global scale decreasing the potential yields for most major crops by more than 50%[9]. Droughts affect more people than any other natural hazard[10] and economical losses because of this factor are enormous. Considering that up to 70-80% of the fresh water is utilized for irrigation of field crops (CEAG 2001), development of plants with less water requirements can contribute much to alleviate the problem of excessive water consumption in agriculture. Present study was undertaken to study drought stress tolerance in green manure crop *Sesbania cannabina*.

MATERIALS AND METHODS

Dry and healthy seeds of *Sesbania cannabina* variety ND-1 were soaked in double distilled water and sown in pots at Department of Botany, University of Allahabad, Allahabad, Uttar Pradesh, India to raise the population. The drought stress experiment lasted for one growing season and involved four treatments: a control group of plants was well-watered; a second group was subjected to drought after 15 days of sowing for 10 days, a third group was subjected to drought for 15 days and the fourth group was subjected to drought for 20 days. Data for all morphological parameters were taken after 45 days of sowing. Statistical analysis was done using Statistica 8 software.

RESULTS

During the study, germination percentage was not evaluated because initially the seeds were sown as control.Drought condition was imposed after the germination of the seeds. Morphological traits such as plant height, stem girth, number of leaves and pod length were taken into consideration (Table 1).

Plant height (cm): The mean height of the control plants has been recorded as 101.0cm. The maximum mean plant height in drought stress treated plants was observed after 10 days duration and it was measured as 84.50cm which was very much less than that of the control plants. The maximum reduction in plant height was observed in case of 20 days set where it was recorded to be 57.50 cm.

Stem Girth (cm): The mean stem girth of the control plants has been recorded as 2.07cm. The drought stress treated plants exhibited much lower values than the control and showed a decreasing trend with increasing duration of drought stress treatment. The maximum mean stem girth in drought stress treated plants was observed in case of 10 days duration and it was measured as 1.92cm. The maximum reduction in stem girth was observed in case of 20 days set where it was recorded to be 1.60 cm.

Number of leaves/plant: The mean value of number of leaves/plant in case of control plant was observed to be 19.20 and it showed a decreasing trend with increasing duration of drought stress. The maximum number of leaves/plant in drought stressed treated plants was observed in case of 10 days duration and was measured as 18.25. The maximum reduction in number of leaves/plant was observed in case of 20 days set where it was recorded to be 13.0.

Pod length (cm): The mean value of pod length in case of control plants has been recorded as 19cm. The maximum value for pod length in drought stressed plants was observed in case of 10 days duration and it was measured as 17.50cm which was very much less than that of the control plants. The maximum reduction in pod length was observed in case of 20 days set where it was recorded to be 14.0cm.

DISCUSSION

Drought is the most significant environmental stress in agriculture worldwide and improving yield under drought is a major goal of plant breeding.More than 80 years of breeding activities have led to some yield increase in drought environments for many crop plants. Meanwhile, fundamental research has provided significant gains in the understanding of the physiological and molecular responses of plants to water deficits, but there is still a large gap between yields in optimal and stress conditions[11]. Minimizing the ‘yield gap’ and increasing yield stability under different stress conditions are of strategic importance in guaranteeing food for the future. Breeders and crop physiologists need to work closely in testing the viability/validity of the trait-based approaches for drought tolerance. This has not happened to any great extent previously, but a few success stories have been recently reviewed[12]. An appropriate screening trait for drought stress tolerance should fill the following criteria: (i) a strong link with higher or more stable grain yield in the target stress environment, (ii) a high level of heritability, and (iii) the expression of tolerance must be easily measurable, with adequate replication.Soil water content either directly or indirectly influences plant growth as well as transpiration rate, since they are mainly turgor-dependent processes. At the onset of stress extension, growth and leaf expansion are first affected, followed by a decrease in rate of transpiration due to partial stomatal closure potentially. During present study, a significant reduction has been observed in different morphological traits viz. plant height, stem girth, number of leaves/plant and pod length due to drought stress treatment for different time durations. The height of plants was significantly affected by changes in soil moisture. These results are in agreement with the findings of Bradford and Hsiao[13] and Chartzoulakis *et al.*[14]. It is well known that as soil water availability is limited, plant growth is usually decreased. This was previously considered to be due to turgor loss in expanded cells. More recent studies, however, have shown that stem and leaf growth may be inhibited at the low water potential despite complete maintenance of turgor in the growing regions as a result of osmotic adjustment. This suggests that the growth inhibition may be metabolically regulated possibly serving an adaptive role by restricting the development of transpiring leaf area in the water-stressed plants[15].There were significant reductions in fruit yield in the drought-stressed plants compared to unstressed control plants. A number of other workers have reported similar effects of water stress on fruit yield and/or biomass reduction for a range of other agricultural and horticultural crops including *Sorghum*[16], tomato[17,18], peach[19] and strawberry[20].Cell division and “house-keeping” functions may be slowed or shut down depending on the severity and type of stress[21]. Drought, salt and cold stresses are associated with changes in the genome, proteome and metabolome[22]. Drought stress causes stomata closure and reduced CO_2 diffusion into leaves, limiting photosynthesis and it reduces cell division, enlargement and differentiation[23], resulting in a reduction of the leaf area and biomass of the plant[24].

CONCLUSION

On the basis of present undertaken study it can be clearly concluded that *Sesbania cannabina* is a successful survivor in harsh condition of drought stress for such a longtime duration and can tolerate water stress upto 15-20 days with production of low biomass.

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Table 1: Effect of drought stress on morphological traits of *Sesbania cannabina*

Drought stress		Mean	Min	Max	S.E.	C.V.
Plant height (cm)	Control	101.00	95.00	110.00	2.52	5.60
	10 days	84.50	68.00	100.00	7.70	18.24
	15 days	60.50	45.00	72.00	6.40	21.18
	20 days	57.50	55.00	60.00	2.50	6.14
Stem girth (cm)	Control	2.07	1.75	2.50	0.15	17.04
	10 days	1.92	1.70	2.30	0.13	13.66
	15 days	1.70	1.50	2.00	0.10	12.70
	20 days	1.60	1.50	1.70	0.10	8.83
Number of leaves/plant	Control	19.20	15.00	22.00	1.24	14.45
	10 days	18.25	16.00	22.00	1.31	14.41
	15 days	13.50	12.00	15.00	0.64	9.56
	20 days	13.00	11.00	15.00	2.00	21.75
Pod length (cm)	Control	19.00	18.00	20.00	0.31	3.72
	10 days	17.50	17.00	18.00	0.28	3.29
	15 days	14.50	12.00	16.00	0.86	11.94
	20 days	14.00	13.00	15.00	1.00	10.10

Figure 1: Effect of drought stress on morphology of *Sesbania cannabina*

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