Plant Archives Vol. 20, Supplement 2, 2020 pp. 3480-3486 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

ARBUSCULAR MYCORRHIZA FUNGI AND POLYAMINES IN MITIGATION OF RHIZOSPHERE SALTS: WITH SPECIAL REFERENCE TO LEAF PIGMENTATION

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Abstract

Plant growth is suppressed by salt-stressed soils. Crops grown in salt soil suffer from high osmotic stress and toxicity, soil malignancies and reduced crop productivity. In reaction to the production of water tension, Sorghum builds up solutes and osmotically changes, evidently more than maize. This would allow sorghum to stay open and photosynthesize longer than soil water depletes and could also help delay the sulfur induced by water stress. The best mitigation effect in T8 treatments, increased chlorophyll by 61.84% at 60DAS, increased by 65.25% in T9 at 60DAS. Compared with T1, the indices of chlorophyll were significantly improved by 58.55 percent when treated with a higher dose of mycorrhiza T5 in 90DAS.

Keywords: Agriculture, Biotic, Crop, Dose, Economy, Forage, Sorghum.

Introduction

Sorghum is judiciously accepting the salinity stress. As the EC amplified from 11 to 18 dS m^{-1}, the output of grain decreased from 50 to 100 percent (Kumar and Dwivedi, 2018a; Kumar *et al.*, 2018b; Kumar *et al.*, 2018c; Kumar 2018d; Kumar *et al.*, 2018e). Higher temperate effects sorghum growth and development. The length of the leaf roughly correlates to ambient temperature at about 34 °C (Kumar and Pathak, 2019f; Kumar *et al.*, 2019g; Siddique and Kumar, 2018h; Siddique *et al.*, 2018i). In case of a decline at night temperatures below 12-15 ° C and pollen under 10 ° C and over 40 ° C, pollination and fruit settings are more likely to fail. Approximately 1.5% nitrogen and 0,25% phosphorus are present in kernels of sorghum. Alone the plant derives 120 kg N and 20 kg P, with a high yield of 8 tons. Of this production, N and P will also take account of fertilization of furnace residues and the quality of the nutrients used and of the native soil source. In water-limited conditions, the fertilization rate will be changed downward. At the beginning of the season, too much N in places vulnerable to terminal drought must be pre-empted as the effects will suck water out of the soil and contribute to the final drought risk (Pathak *et al.*, 2017j; Prakash and Kumar, 2017k; Kumar and Mandal, 2014L; Kumar *et al.*, 2014m; Kumar *et al.*, 2014n; Kumar, 2013o; Kumar and Dwivedi, 2015p; Gogia *et al.*, 2014q).

Saline soil is usually well-defined to exceed 4 dS m^{-1} (approximately 40 mM NaCl) at 25°C and to have exchangeable sodium of 15 percent in the area of the root (EC) in electrically-driven conductivity (EC). In this ECe, the output of most crop plants is reduced but many crops have lower ECes. The global figure is estimated to be high in salinity, at 20% of total crops and 33% in irrigated farmlands (Kumar, 2014r; Kumar, P., Dwivedi, P., Singh, P., 2012s, Mishra, P.K., Maurya, B.R., Kumar, Pp. 2012t, Kumar, P., Mandal, B., Dwivedi, P. 2011u. Kumar, P., Mandal, B., Dwivedi, P. 2011v, Kumar, P., Pathak, S. 2016w, Pathak, S., Kumar, P., Mishra, P.K., Kumar, M. 2016x, Kumar, P., Harsavardhn, M. *et al.*, 2018y. Kumar, P., Yumnam, J. *et al.*, 2018z.). Besides, salinized areas rise by 10% a year of different geographical areas, counting squat precipitation, high surface development, indigenous rock weathering, saltwater irrigation, and poor culture. More than 50% of the arable land is estimated to be salinized by 2050 (Kumar, P., Pandey, A.K., *et al.*, 2018aa, Kumar, P., Kumar, S. *et al.*, 2018bb, Kumar, P., Krishna, V., *et al.*, 2018cc, Kumar, P. and Dwivedi, P. 2018gg. Kumar P., Siddique A., *et al.*, 2018ff, Kumar, P, Pathak, S, Kumar, M and Dwivedi, P. 2018cd, Kumar P. and Pathak S. 2018kk, Kumar P and Pathak S. 2018pq. Singh *et al* 2020a., Singh *et al.*, 2020b., Sood, *et al.*, 2020., Bhadrecha *et al* 2020, Singh *et al.*, 2020c, Sharma *et al.*, 2020, Singh *et al.*, 2020d, Bhati *et al.*, 2020, Singh *et al.*, 2019, Sharma *et al.*, 2019). It has been estimated. Soil salinity is an enormous problem for irrigated agriculture. In the warm and dry parts of the world, soils are often saline with low agricultural potential. In these areas, most plants are irrigated, which leads to secondary salinization of 20 percent of irrigated soil worldwide to exacerbate the problem (Kumar P. 2018i., Kumar P. 2018ii., Kumar P. 2018iii, Kumar P.2018iv, Kumar P. 2018v. , Kumar P. 2018vi, Kumar P. 2018vii, Kumar P. 2018viii, Kumar P., Pathak S. 2018ix, Kumar P., Pathak S. 2018x, Kumar P., Pathak S. 2018xi, Kumar P., Pathak S, Kumar P., Pathak S. 2018xiii, Kumar P., Pathak S. 2018xiv, Kumar P., Pathak S. 2018xv, Kumar P., Pathak S. 2018xvi, Kumar P., Pathak S. 2018xvii, Kumar P., Pathak S. 2018xviii). In many countries, the salinization of nearly 1 billion ha worldwide, which represent approximately 7 percent of the continental extent of the world, is recognized as the main threats to the environment or health of humans, approximately ten times the size of a nation like Venezuela or 20 times the size of France. Approximately 7 million hectares of soil in India has been estimated to cover saline soil. Most of them occur in the soil of Punjab, Haryana, U.P. Bihar and certain parts of Rajasthan. Also, salt-land areas are largely affected by the arid tracts of Gujarat, Rajasthan and semi-Arid tracts of Gujarat, Madhya Pradesh, Maharashtra, Karnataka, and Andhra Pradesh. Salinity affects nearly every aspect of plant development including germination, vegetative growth, and breeding. Soil salinity places ion toxicities and osmotic stress on plants, and thus restricts water intake from the soil. Nutrient deficiency (N, Ca, K, P, Fe, Zn) and oxidative stress on plants. Soil salinity reduces phosphorus plant uptake (P) significantly because Ca ions precipitate phosphate ions. All of these factors harm physiological and biochemical plant growth and development. The world's major cereal after rice, wheat, maize, and barley is sorghum [*Sorghum bicolor* (L.) Moench]. It is India's third-largest basic food grain after rice and wheat in the semiarid Tropics (SAT) for millions of poor and most food-insecure individuals. Where in India it is commonly called *jwaarie, jowar, jola*, or *jondhalaa*, sorghum is one of the staple sources of nutrition. An Indian bread called *bhakri, jowar roti*, or *jolada rotti*, is prepared from this grain. Whereas sorghum is primarily used for livestock feed during the rainy season, products after the rainy season are used for human consumption. Sorghum is indeed a dual crop in the SAT India, both grain and stove are highly valued. The sorghum stoves account for up to 50% of the total value of the crop in large areas of SAT India, particularly during drought (Kumar P. 2018i., Kumar P. 2018ii., Kumar P. 2018iii, Kumar P.2018iv, Kumar P. 2018v. , Kumar P. 2018vi, Kumar P. 2018vii, Kumar P. 2018viii, Kumar P., Pathak S. 2018ix, Kumar P., Pathak S. 2018x, Kumar P., Pathak S. 2018xi, Kumar P., Pathak S, Kumar P., Pathak S. 2018xiii, Kumar P., Pathak S. 2018xiv, Kumar P., Pathak S. 2018xv, Kumar P., Pathak S. 2018xvi, Kumar P., Pathak S. 2018xvii, Kumar P., Pathak S. 2018xviii). Because of its extensive adaptation, rapid growth and high green fodder yields as well as good quality, sorghum has also great potential to add to the forage demand of the growing dairy industry in India. Nigeria (12.6%), India (11.2%), Mexico (11.2%), and the United States were the leading producers of sorghum bicolor in 2011. Sorghum is grown in a wide variety of temperatures, elevations, and poisonous soil. It has four characteristics, making it a very wide surface ratio root to leaf, rolling out its leaves during a drought to reduce transpiration-lost water and going to sleep in a drought rather than death condition, and the leaf is protected with a waxy cuticle. It is one of the seed plants that have the highest resistance. Sorghum is generally seeded from the last week of September to the second week in October after the rainy season and is usually exposed to low winter temperatures at seeds, resulting in low sprouting and poor standing. The late seated Rabi season plants, which are cultivated with stored soil moisture on black soils (vertisols), are subject to terminal drought and are susceptible to diseases like rot. Sweet sorghum is sugar-rich sorghum, almost like sugarcane, for a special purpose. Sweet sorghum has greater adaptability, besides fast growth, high sugar accumulation and the potential for production of bio-mass.

As a C4 crop, cool temperature regimes are not tolerated by sorghum. The minimum temperature for germinating seeds is approximately 8oC and the optimum temperature is 21–35°C. For 80 percent emergencies in 10 to 12 days under field conditions, a minimum soil temperature of 15-is required. It usually takes 5–10 days to emerge in the field. After the last leaf has been initiated and about one-third of the entire leaf area developed, panicle initiation occurs after about one-of the growth cycle. Rapid growth and elongation of the leaves follow the initiation of the panicle.

Sorghum absorbs solutes and osmotically transitions to fix water tension more naturally than maize. This makes stomata opening and photosynthesizing longer as soil water flows and may lead to delay canopy senescence triggered by stress in water. The locking of the stomata, sorghum rolls under water stress and is therefore called transpiration. Rolling is triggered by shifts in the rows and veins of the motor cells in the main fugal lines called the middle stripes on the top surface of the blade. The engine cells are usable even in the maize leaves, but only underwater tension rolls. Maize leaves. The expansion of the leaf is highly susceptible to sorghum water tension.

Materials and Methods

This was the pot for the experiment with a 30 cm diameter and a 25 cm height and ten kg of soil each along with a small hole underneath it. Under the work plan, targeted pots with Endomycorrhiza have been inoculated. Salinity stresses created by the exogenous application of NaCl at the concentration of 8dsm^{-1} per 10kg of soil. Putrescine was applied at the rate of 1.5 and 3.0 mM through the foliar spray at the fifteen days of interval. The various measurements were taken at three stages such as 30, 60, and 90DAS (Table 1 and 2).

Table 1 : Name of the Treatments and symbol used respectively

Treatments	Symbol Used For Respective Treatments
T0	Control
T1	NaCl (8 dsm^{-1})
T2	Endomycorrhizal fungi
T3	Putrescine (1.50 mM)
T4	Putrescine (3.0 mM)
T5	NaCl (8 dsm^{-1}) + Endomycorrhizal fungi(150 spores per pot)
T6	NaCl (8 dsm^{-1}) + Putrescine (1.5 mM)
T7	NaCl (8 dsm^{-1}) + Putrescine (3.0 mM)
T8	NaCl (8 dsm^{-1})+Putrescine (1.50 mM) + Endomycorrhizal fungi (AMF)(150 spores per pot);
T9	NaCl(8dsm^{-1}) + Putrescine(3.00mM) + Endomycorrhizal fungi (AMF)(150 spores per pot)

Table 2 : Layout Details

Sl. No	Particulars	Action
1.	Layout	CRD
2.	Treatments	10
3.	Replications	3
4.	Total number of pots	30
5.	Soil per pot	15kg
6.	Genotype	SSV74

Observation Recorded

The observations were recorded three stages such as 30, 60, and 90 DAS. The recorded observations of biochemical parameters and the standard procedure adopted during the study are given below:

Chlorophyll content (mg g^{-1} fresh weight)

The protocol of Arnon DI (1949) was followed to estimate the chlorophyll content in leaves of the sorghum.

Results and Discussion

Chlorophyll a

In a sorghum variant SSV74 under the stress of salinity, the effect of putrescine and mycorrhiza and the combination of these on chlorophyll was studied. The data was registered at the time of sowing (DAS) 30, 60 and 90 days (Table 3 & Fig. a). It is obvious that the mean salinity stress (T1) compared to control (T0), was reduced significantly by 32.0% by 26.83 percent and 27.69% at intervals 30, 60 and 90 DAS. The mitigation effect was demonstrated by exogenous application of endomycorrhiza in the earth (T2) by increasing the amount of chlorophyll by 42.94 percent, 4.14 and 4.14 percent compared with T1 by 30, 60 and 90 DAS. T3 compared to T1 was significantly higher in chlorophyll by 20.01%, 16.90%, and 15.53% in proposed DAS, when compared. In comparison to T1 exogenous use of putrescine (T4), chlorophyll has increased by 24.94%, 13.23%, 13.98%, and the proposed DAS, which has an attenuating effect. The average chlorophyll-a in the treatment of a higher dose of mycorrhiza has been significantly improved compared to T1, by 44.66 percent, 59.39%, and 41.75%. Similarly, chlorophyll increased substantially by 16.07%, 15.99% and 21.97% at proposed DAS, when comparing T6 with T1. Compared to T1, average chlorophyll a was increased by 33.14%, 19.08%, and 20.19% when treated with a high dosage of putrescine (T7). The combination of putrescine and mycorrhiza has shown the best mitigation effect in T8, with chlorophyll increasing by 52.15%, 61.84%, and 44.51% for T1 in the proposed DAS. When treatment T9 was compared with treatment T1 then significant chlorophyll a was increased by 54.47%, 54.60%, and 50.20%, respectively. Based on the above results obtained, it was found that the combined application of mycorrhiza and putrescine showed the best mitigation effect in crops concerning salinity stress.

Table 3 : Chlorophyll a of Sorghum during *Rabi*

Treatments	Chlorophyll a (30 DAS)	Chlorophyll a (60 DAS)	Chlorophyll a (90 DAS)
T0	$4.008^{c}\pm0.292$	$5.022^{c}\pm0.037$	$4.866^{c}\pm0.037$
T1	$2.722^{f}\pm0.011$	$3.675^{e}\pm0.019$	$3.519^{e}\pm0.019$
T2	$4.771^{b}\pm0.019$	$3.827^{e}\pm0.118$	$3.671^{e}\pm0.118$
T3	$3.403^{de}\pm0.152$	$4.322^{d}\pm0.128$	$4.166^{d}\pm0.128$
T4	$3.627^{d}\pm0.013$	$4.247^{d}\pm0.256$	$4.091^{d}\pm0.256$
T5	$4.919^{b}\pm0.013$	$6.197^{b}\pm0.084$	$6.041^{b}\pm0.084$
T6	$3.243^{e}\pm0.057$	$4.666^{cd}\pm0.031$	$4.510^{cd}\pm0.031$
T7	$4.072^{c}\pm0.047$	$4.565^{d}\pm0.144$	$4.409^{d}\pm0.144$
T8	$5.689^{a}\pm0.015$	$6.498^{b}\pm0.155$	$6.342^{b}\pm0.155$
T9	$5.979^{a}\pm0.016$	$7.224^{a}\pm0.205$	$7.068^{a}\pm0.205$

where T0-Control; T1- NaCl (8 dsm^{-1}); T2-Endomycorrhizal fungi (AMF); T3-Putrescine (1.50 mM); T4-Putrescine (3.0 mM); T5- NaCl (8 dsm^{-1}) + Putrescine 1.5 mM; T6- NaCl (8 dsm^{-1}) + Putrescine (3.00mM); T7- NaCl (8 dsm^{-1}) + Endomycorrhizal fungi (AMF); T8- NaCl (8 dsm^{-1}) + Putrescine (1.50 mM) + Endomycorrhizal fungi (AMF); T9- NaCl (8 dsm^{-1}) + Putrescine (3.00 mM) + Endomycorrhizal fungi (AMF)

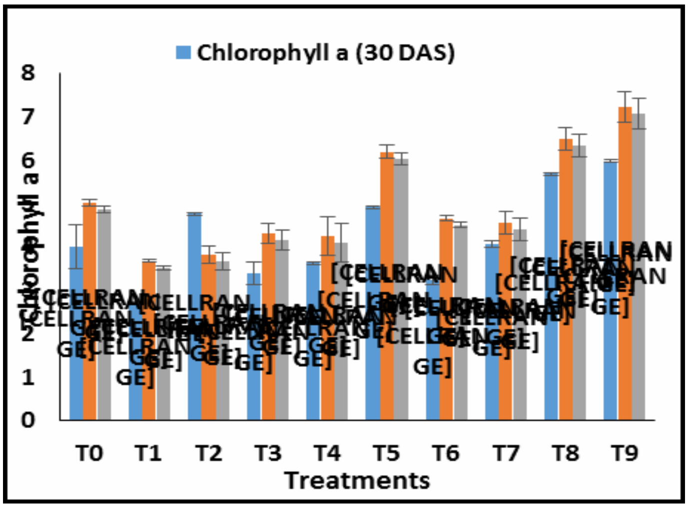

Fig. a : Chlorophyll a of Sorghum during *Rabi*

where T0-Control; T1- NaCl (8 dsm^{-1}); T2-Endomycorrhizal fungi (AMF); T3-Putrescine (1.50 mM); T4-Putrescine (3.0 mM); T5- NaCl (8 dsm^{-1}) + Putrescine 1.5 mM; T6- NaCl (8 dsm^{-1}) + Putrescine (3.00mM); T7- NaCl (8 dsm^{-1}) + Endomycorrhizal fungi (AMF); T8- NaCl (8 dsm^{-1}) + Putrescine (1.50 mM) + Endomycorrhizal fungi (AMF); T9- NaCl (8 dsm^{-1}) + Putrescine (3.00 mM) + Endomycorrhizal fungi (AMF)

Chlorophyll b

The impact and combinations of putrescine and mycorrhizae on chlorophyll b have been studied in the salinity stress of sorghum SSV74. Thirty, 60 and 90 days of sowing (DAS) data was collected (Table 4 & Fig. b). The average chlorophyll b was significantly decreased at intervals 30 60 and 90 DAS by 61.23%, 38.0% and 41.08% when exposed to the stress of salinity (T1) when compared with control (T0). The mitigation effect has been shown by exogenous application to soil of endomycorrhiza (T2), which increased chlorophyll b by 45.35%, 39.88% and 44.41% in comparative terms to T1 in 30, 60- and 90 DAS. When compared with T1, T3 increased substantially by 43.63%, 36.24%, and 40.36% at proposed DAS when compared with T1. Compared with T1, the exogenous use of putrescine (T4) demonstrated a decreasing effect by 40.28%, 16.39% and 18.25% on the proposed DAS by increasing chlorophyll-b. The average of chlorophyll b in treatments with higher doses of mycorrhiza (T5) has been significantly increased compared with T1 by 17.58%, 14.38%, and 16.01%. In comparison with T1, T6 also significantly increased chlorophyll b with 10.89%, 18.29%, and 19.97% with the proposed DAS when compared with T1. The average chlorophyll b has been significantly increased with the higher dose of putrescine (T7) compared with T1 by 15.66%, 15.58%, and 17.02%. The combination of putrescine with mycorrhiza showed the best effect of mitigation in T8 by an increase of 44.68%, 31.87% and 35.49% in T1 in proposed DAS treatment. In comparison with T1, T9 was then significantly increased in chlorophyll b by 44.98%, by 65.25% and by 72.66%, respectively. Based on the above results obtained, it was found that the combined application of mycorrhiza and putrescine showed the best mitigation effect in crops concerning salinity stress.

Table 4 : Chlorophyll b of Sorghum during *Rabi*

Treatments	Chlorophyll b (30 DAS)	Chlorophyll b (60 DAS)	Chlorophyll b (90 DAS)
T0	0.342^{bcd}±0.150	3.350^{a}±0.105	3.140^{a}±0.105
T1	0.881^{abcd}±0.118	2.060^{c}±0.123	1.850^{c}±0.123
T2	0.129^{e}±0.063	1.238^{e}±0.067	1.028^{e}±0.067
T3	0.497^{abcd}±0.031	1.313^{e}±0.047	1.103^{e}±0.047
T4	0.174^{cd}±0.165	1.722^{d}±0.074	1.512^{d}±0.074
T5	1.069^{ab}±0.101	1.764^{d}±0.105	1.554^{d}±0.105
T6	0.989^{abc}±0.692	0.303^{g}±0.027	0.093^{g}±0.027
T7	0.743^{abcd}±0.246	0.709^{f}±0.056	0.499^{f}±0.056
T8	0.487^{abcd}±0.038	2.717^{b}±0.025	2.507^{b}±0.025
T9	0.342^{bcd}±0.150	3.404^{a}±0.052	3.194^{a}±0.052

where T0-Control; T1- NaCl (8 dsm^{-1}); T2-Endomycorrhizal fungi (AMF); T3-Putrescine (1.50 mM); T4-Putrescine (3.0 mM); T5- NaCl (8 dsm^{-1}) + Putrescine 1.5 mM; T6- NaCl (8 dsm^{-1}) + Putrescine (3.00mM); T7- NaCl (8 dsm^{-1}) + Endomycorrhizal fungi (AMF); T8- NaCl (8 dsm^{-1}) + Putrescine (1.50 mM) + Endomycorrhizal fungi (AMF); T9- NaCl (8 dsm^{-1}) + Putrescine (3.00 mM) + Endomycorrhizal fungi (AMF)

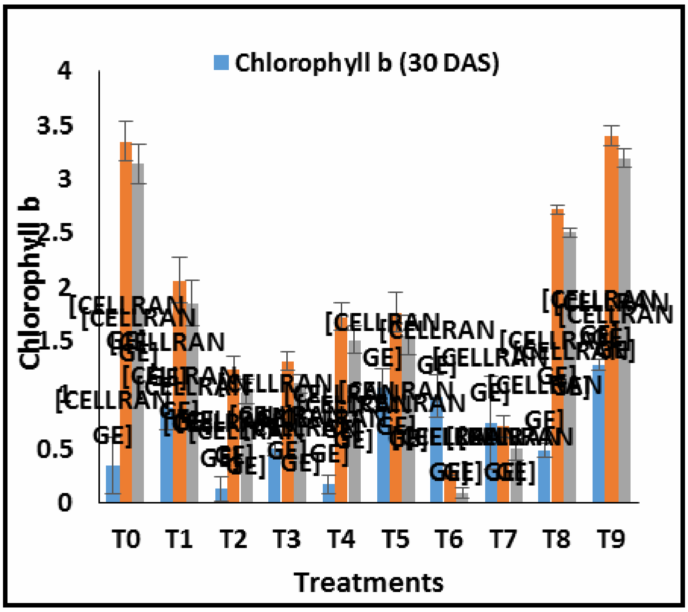

Fig. b. Chlorophyll b of Sorghum during *Rabi*

where T0-Control; T1- NaCl (8 dsm^{-1}); T2-Endomycorrhizal fungi (AMF); T3-Putrescine (1.50 mM); T4-Putrescine (3.0 mM); T5-NaCl (8 dsm^{-1}) + Putrescine 1.5 mM; T6- NaCl (8 dsm^{-1}) + Putrescine (3.00mM); T7- NaCl (8 dsm^{-1}) + Endomycorrhizal fungi (AMF); T8- NaCl (8 dsm^{-1}) + Putrescine (1.50 mM) + Endomycorrhizal fungi (AMF); T9- NaCl (8 dsm^{-1}) + Putrescine (3.00 mM) + Endomycorrhizal fungi (AMF)

Chlorophyll Index

The effect and combination of putrescine and mycorrhiza on the chlorophyll index were investigated in the salinity stress of the SSV74 sorghum species. Thirty, 60, and 90 days after the sowing (DAS) data were collected (Table 5 and Fig. c). It can be seen that when exposed to salinity stress (T1) about control (T0) in intervals 30, 60 and 90 DAS, the average chlorophyll index was significantly lowered by 2.49%, 48.30%, and 51.60%. Exogenous application of endomycorrhiza in soil (T2) showed a mitigation effect by increasing 10.62%, 21.80%, and 44.28% compared to 30.60 and 90 DAS for the chlorophyll index. Compared to T1, T3 was significantly increased with the chlorophyll index by 18.48%, 15.51% and 45.74% with the proposed DAS when compared to T1. In contrast to T1, an increase of the chlorophyll index by 2.84 percent, 32.46 percent and 53.82 percent on the proposed DAS was the effect of an exogenous application of putrescine (T4). When treated with a higher dose of mycorrhiza (T5), the mean index of chlorophyll was significantly increased compared to T1 by 4.38%, 37.88%, and 58.55%. Likewise, when T6 was compared to T1, a significant increase in the chlorophyll index at the proposed DAS increased with 7.28%, 0.4%, and 51.77%. When treated with a high dose of putrescine (T7), the average chlorophyll index was improved significantly compared to T1 by 9.13 percent by 24.4 and 37.0 percent. In T8 treatment, the combination of putrescin and mycorrhiza showed the best mitigation effect with an increase in chlorophyll index of 12.34%, 34.27% and 38.19% concerning T1 at the proposed DAS. When treatment T9 was compared with treatment T1 then a significant chlorophyll index was increased by 32.13%, 40.64%, and 56.31%, respectively. Based on the above results obtained, it was found that the combined application of mycorrhiza and putrescine showed the best mitigation effect in crops concerning salinity stress.

Table 5 : Chlorophyll Index of Sorghum during *Rabi*

Treatments	Chlorophyll Index (30 DAS)	Chlorophyll Index (60 DAS)	Chlorophyll Index (90 DAS)
T0	18.700^{b}±0.493	28.433^{a}±0.521	31.200^{ab}±1.484
T1	18.233^{b}±0.555	14.700^{g}±0.361	15.100^{c}±0.436
T2	20.400^{b}±1.617	18.800^{ef}±1.442	27.100^{ab}±0.862
T3	22.367^{ab}±1.424	17.400^{f}±0.252	27.833^{ab}±3.105
T4	18.767^{b}±2.571	21.767^{d}±0.376	32.700^{ab}±3.884
T5	17.467^{b}±3.005	23.667^{bc}±0.088	36.433^{a}±6.267
T6	19.667^{b}±0.940	14.633^{g}±0.240	31.267^{ab}±3.113
T7	20.067^{b}±0.953	19.467^{e}±0.338	24.200^{bc}±2.248
T8	20.800^{b}±1.914	22.367^{cd}±0.437	24.433^{bc}±4.236
T9	26.867^{a}±0.921	24.767^{b}±0.578	34.567^{ab}±1.068

where T0-Control; T1- NaCl (8 dsm^{-1}); T2-Endomycorrhizal fungi (AMF); T3-Putrescine (1.50 mM); T4-Putrescine (3.0 mM); T5- NaCl (8 dsm^{-1}) + Putrescine 1.5 mM; T6- NaCl (8 dsm^{-1}) + Putrescine (3.00mM); T7- NaCl (8 dsm^{-1}) + Endomycorrhizal fungi (AMF); T8- NaCl (8 dsm^{-1}) + Putrescine (1.50 mM) + Endomycorrhizal fungi (AMF); T9- NaCl (8 dsm^{-1}) + Putrescine (3.00 mM) + Endomycorrhizal fungi (AMF)

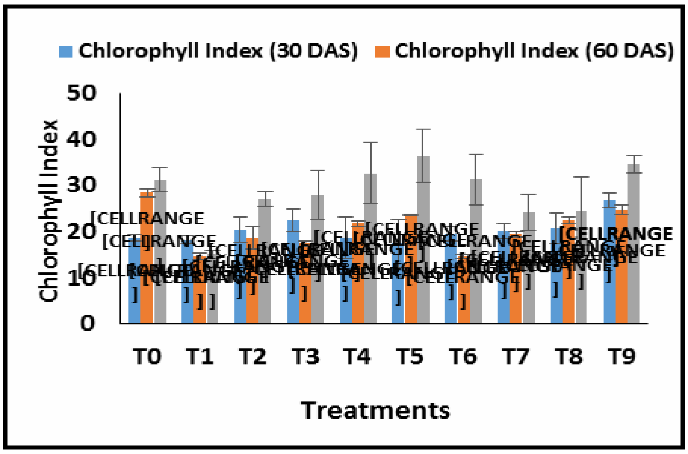

Fig. c : Chlorophyll Index of Sorghum during *Rabi*

where T0-Control; T1- NaCl (8 dsm^{-1}); T2-Endomycorrhizal fungi (AMF); T3-Putrescine (1.50 mM); T4-Putrescine (3.0 mM); T5-NaCl (8 dsm^{-1}) + Putrescine 1.5 mM; T6- NaCl (8 dsm^{-1}) + Putrescine (3.00mM); T7- NaCl (8 dsm^{-1}) + Endomycorrhizal fungi (AMF); T8- NaCl (8 dsm^{-1}) + Putrescine (1.50 mM) + Endomycorrhizal fungi (AMF); T9- NaCl (8 dsm^{-1}) + Putrescine (3.00 mM) + Endomycorrhizal fungi (AMF)

Conclusion

Ion toxicity and osmotic imbalances were observed to cause salinity stress and cause plant oxidative stress. *Arbuscular mycorrhizae* (AM) is considered as bio-enhancers of saline soil capable of developing salinity tolerances on cultivated plants. Sorghum compatibility with polyamines and mycorrhizas to reduce stress on salinity. The best mitigation effect in T8 treatments, increased chlorophyll by 61.84% at 60DAS, increased by 65.25% in T9 at 60DAS. Compared with T1, the indices of chlorophyll were significantly improved by 58.55 percent when treated with a higher dose of mycorrhiza T5 in 90DAS.

Acknowledgments

P.K. and M.H gratefully acknowledge the support provided by Lovely Professional University.

Author Contributions

The study was designed by P.K. and M.H, the morphological protocolizations were established, experiments were carried out and the data analyzed and interpreted were collected. The paper has been written by P.K. and M.H.

Conflict of Interest Statement

The authors declare that they have no conflict of interest.

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