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Research on Saline Land Improvement and Cultivation

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Abstract: Soil salinisation can lead to soil compaction and fertility decline, which is unfavourable to crop nutrient absorption and hinders crop growth. In order to reduce its adverse effects on plant growth, tomato No.4 and 202 were used as experimental materials, AM fungi and Bacillus subtilis were used as inoculants, and three treatments of Gm, B, Gm + B and CK were established by soil inoculation and rooting method. Each group corresponded to three concentrations of salt solution (15, 75 and 150 mmol / L) for rooting, a total of 12 groups. The physiological changes of tomato and the differences of soil physical and chemical properties after 7d, 14d and 21d were studied. The results showed that the addition of AM fungi and Bacillus subtilis could promote plant height and root length development, and increase the activities of antioxidant enzymes, of which the maximum growth rates of SOD, POD, and CAT were 12.8%, 112.1%, and 30.6%, respectively, and the maximum reductions of MDA and Pro contents were 44.38% and 42.39%. In addition, the synergistic interactions between the two biocontrol bacteria inoculated made the saline soil pH decrease, the water content increase significantly, the N, P, and K contents increase in general, and the soil enzyme activities increased, which alleviated the problems of soil compaction and low fertility.

1. Introduction

Soil salinity is a major problem affecting global agroforestry production, development and ecological environment, which mainly harms plants and hinders crop growth through osmotic stress, ionic toxicity and oxidative stress. Domestic and foreign related reports show that the increase of Salt stress time will cause a significant decrease in the relative height, ground growth and biomass of tassel seedlings, dysregulation of ionic balance in barley[1] , and induce the production of reactive oxygen species (ROS)[2] . At the same time, the high percentage of saline and alkaline components in the soil will lead to a decrease in the content of organic phosphorus (P) and exchangeable calcium (Ca) in it, and the pH and hydrolysed nitrogen (N) will show a tendency of decreasing, then increasing and then decreasing [3]. Based on this, it is of great significance to find an effective way to alleviate salinity stress to expand the scale of crop cultivation and improve economic benefits.

Tomato is an herbaceous plant of the Solanaceae family, with high food and medicinal value and outstanding market potential. However, in recent years, secondary salinisation of soil caused by irrational fertilization and irrigation has become increasingly severe, and has become an important problem restricting the sustainable and efficient development of tomato industry in China[4] . Studies have shown that arbuscularmycorrhizal (AM) has a positive role in improving plant salinity tolerance, and can resist salinity-induced diseases by increasing the activity of plant resistance-related enzymes, promoting the uptake of mineral nutrients, and inhibiting heavy metal ions and Salt ions in the inter-root environment [5]; Bacillussubtilis Cohn, as an ideal biocontrol bacterium for plant Salt stress, can be used as an ideal biocontrol bacterium for plant Salt stress. BacillussubtilisCohn, as an ideal biocontrol fungus for plant Salt stress, can colonise the root surface and body of host plants, secrete certain antimicrobial substances to inhibit the diffusion of Salt ions, and at the same time induce physiological Salt tolerance in plants to prevent Salt ion infestation. At present, there is no report on the research of two kinds of bacterial agents on saline and alkaline land management and crop cultivation, thus, this paper explores the synergistic effect of two kinds of biocontrol fungi through the stress of Salt ions at different concentrations and the single inoculation and double inoculation of AM fungi and Bacillus subtilis and discusses the effectiveness of the joint prevention and control, which will provide theoretical basis and technical support for the exploration of the relevant cultivated crops grown in saline and alkaline soils.

2. Materials and Methods

2.1. Experimental materials

Tomato No. 4 and 202 were used as test plants, sown in seedling trays containing culture substrate (gravel) after germination in sterile water, and when the seedlings emerged, good and similar seedlings were selected and transferred to plastic pots containing sandy soil for cultivation, with four plants per pot.

The test fungi, Mossy Balloon Mycorrhizal fungi, were purchased from the Institute of Root Biology, College of Horticulture and Landscape Architecture, Cheung Kong University, and ACCC60429 Bacillus subtilis was purchased from the China Agricultural Microorganisms Deposit and Management Centre.

2.2. Experimental design

The two varieties of tomato seeds were sterilised and soaked in water for 8 h. After germination, the seeds were sown in seedling trays containing culture substrate (gravel), and then, after the seedlings emerged, the well-grown and similar seedlings were selected and transferred to the soil added with different strains of fungi and a control group was set up, with four plants in each pot, which were acclimatised to saline and alkaline stress treatments for 5 d. The control group was set up with four plants in each pot, which were acclimatised to saline and alkaline stress treatments. By designing the pre-test of 0~250mmol/L Salt solution stress, the maximum concentration of 150mmol/L that can inhibit the growth of tomato but not lethal was mapped out to start the subsequent experiments. In this experiment, three Salt solutions (composed of Na2CO3 and NaHCO3 in a 1:1 ratio) were selected at concentrations of 15 (Salt15), 75 (Salt75), and 150 (Salt150) mmol/L, corresponding to the setting of the control (CK) and three treatment groups: AM fungi (Gm), Bacillus subtilis (B), and AM fungi + Bacillus subtilis (Gm + B), totalling 12 groups, each with three replicates, and tomato-related physiological indexes were measured at the 7th, 14th and 21st d of treatment, and soil-related parameters were measured after the 21st d. The soil-related parameters were measured at the 7th, 14th and 21st d of treatment.

2.3. Experimental methods

The height and root length of tomato plants were determined by tape measure; superoxide dismutase (SOD) activity of tomato leaves was measured by the nitrogen blue tetrazolium (NBT) photochemical reduction method at[6] ; peroxidase (POD) activity was determined by the guaiacol method at[7] ; catalase (CAT) activity was determined by the NBT photochemical reduction method at ; malondialdehyde (MDA) was measured by the thiobarbituric acid method at[8] ; free proline was determined by the ninhydrin chromatography method at[9] ; water content of soil was measured by the balance; pH value of soil suspension was measured by the pH meter; Kjeldahl nitrogen determination, sodium bicarbonate extraction-molybdenum antimony spectrophotometry and sodium tetraphenylboron weight method were used for measuring soil water content; pH meter to measure the pH of soil suspension; Kjeldahl nitrogen determination, sodium bicarbonate leaching - molybdenum antimony spectrophotometry, sodium tetraphenylborate gravimetric method to measure elemental N, P, and K in soil; phenol-hypochlorite colourimetric method to determine the activity of urease (URE); 3,5-dinitrosalicylic acid colourimetric method to determine sucrase (SUC); and UV spectrophotometric method to determine the enzyme catalase (CAT) in soil.

2.4. Data processing

The experimental data were analysed for significant differences (α=0.05 and α=0.01) by calculating the mean and standard error by one-way ANOVA (one-way ANOVA) and Duncan method using SPSS26.0 statistical software and plotted using Origin2022 software.

3. Results and Discussion

3.1. Effect of AM fungi and Bacillus subtilis on plant height and root length of tomato under salinity stress

Plant height can directly reflect the growth and resistance of plants, the root system is both the object of direct stress of Salt solution and the main receptor of the action of the fungus, its development can reflect the mitigation effect of biocontrol fungi on Salt stress.The combination of AM fungi with Bacillus subtilis and the two fungi had a significant effect on the growth and development of tomato. 15 mmol/L, 75 mmol/L and 150 mmol/L Salt solution treatment, the maximum increment in plant height of the Gm, B and Gm+B treatment groups of No. 4 was 13.64%, 36.03% and 47.20%, respectively; and the maximum increment of corresponding to No. 202 was 39.05%, respectively. Increments were 39.05, 24.00 and 87.77%, respectively. The root length of both varieties became shorter under single Salt stress and increased after inoculation with the fungus, in which the increase of Gm+B was much higher than that of the single biocontrol fungus treatment group, with the maximum increases of 41.83% and 59.13% for No. 4 and No. 202. Thus, the AM fungus-Bacillus subtilis combination had a significant growth-promoting effect on Salt-stressed tomato plants, and the increase in plant height was more pronounced with this double inoculation combination.

3.2. Effect of AM fungi and Bacillus subtilis on soil physico-chemical properties under saline stress

3.2.1. Effect of AM fungi, Bacillus subtilis on soil pH and water content under saline stress

Soil pH and water content affect the changes in soil fertility, and the decrease in its moisture content causes the precipitation of Salt ions dissolved in water, and the increase in pH, which causes the soil to slough off and produces problems such as lack of oxygen in the root system, which results in the death of plants[10] . As can be seen from Table 1, soil pH was higher at all concentrations without microbial agents. After the addition of two bacteria, the soil pH showed different degrees of reduction. Under the same concentration of Salt solution treatment, the Gm+B treatment group had the best effect on ameliorating soil salinity, with the maximum reduction of 3.99%, which was 2.50% higher than that of the single bacterial species treatment. In addition, compared with the low-Salt environment, the soil water content in the high-Salt environment showed a significant decreasing trend, with the decreasing rates of 37.66% and 47.98% for No. 4 and No. 202, respectively, but after the treatment of microbial fungi, the improvement effect was considerable, in which the Gm+B treatment group had the greatest increase, with the rates of 91.60% and 82.46%, respectively. It can be concluded that the application of AM fungi and Bacillus subtilis is beneficial to reduce the pH value of saline soil, effectively increase the soil water content, and then reduce the inhibitory effect of saline stress on tomato seedlings, and the AM fungi-Bacillus subtilis symbiosis system has a better effect on the improvement of saline soil than the single inoculation of bacterial groups.

Table 1: Effect of AM fungi, Bacillus subtilis on soil pH and water content under salinity stress (mean ± standard error)

process group	No. 4		No. 202	
	pH	Water content (%)	pH	Water content (%)
$Salt_{15}$ CK	8.49 ±0.02d	3.93 ±0.13g	8.49 ±0.01d	4.96 ±0.07g
$Salt_{15}$ Gm	8.52 ±0.03cd	5.67 ±0.11d	8.39 ±0.02fg	5.67 ±0.09
$Salt_{15}$ B	8.46+0.02e	4.82 ±0.16e	8.38 ±0.01gh	6.09 ±0.14d
$Salt_{15}$ Gm+B	8.43 ±0.03ef	7.53 ±0.24a	8.34 ±0.03h	9.05+0.12a
$Salt_{75}$ CK	8.56 ±0.01b	2.53 ±0.14j	8.61 ±0.04b	3.38 ±0.16j
$Salt_{75}$ Gm	8.42 ±0.03ef	3.64 ±0.15i	8.53 ±0.02c	4.49 ±0.17h
$Salt_{75}$ B	8.43 ±0.03ef	4.46 ±0.16f	8.42 ±0.03ef	5.16 ±0.10f
$Salt_{75}$ Gm+B	8.28 ±0.02g	6.47 ±0.10b	8.42 ±0.03efg	7.91 ±021b
$Salt_{150}$CK	8.67 ±0.01a	2.45+0.23k	8.78 ±0.05a	2.58 ±0.23k
$Salt_{150}$Gm	8.54 ±0.03be	2.55 ±0.18j	8.64 ±0.03b	3.78 ±0.06i
$Salt_{150}$B	8.43 ±0.01ef	3.76 ±0.17h	8.46 ±0.04de	3.83 ±0.15i
$Salt_{150}$Gm+B	8.41 ±0.02f	6.12 ±0.17c	8.43 ±0.02ef	6.19 ±0.20c

*Data in the table are mean ± standard error, the same letter after the data of the same peer group indicates no significant difference at the P-0.05 level, below.

3.2.2. Effects of AM fungi and Bacillus subtilis on soil N, P and K elements under salinity stress

N、P and K are large amounts of elements required for plant growth, while Salt can reduce the absorption of nutrients in plants, when the presence of AM fungi in the inter-root of plants, it can improve the plant's resilience to Salt stress, by enhancing the absorption of nutrients N, P and K and thus enhancing its ability to grow in adversity. Under high concentration Salt stress treatment, the N, P, and K contents in soil decreased to different degrees relative to low concentration Salt treatment, with maximum decreases of 33.28%, 52.53%, and 59.75%, respectively. The maximum increase in N, P, and K with the addition of the two fungicides was 92.71% at 15 Gm+B Salt, 513.3% at 150 Gm+B Salt, and 157.8% at 150 Gm+B Salt, respectively. It can be seen that the incorporation of AM fungi and Bacillus subtilis can enhance the content of N, P and K elements in the soil, and the best effect of the two co-application can improve the soil fertility and the potential oxygen supply level, and promote the good growth of tomato in saline areas.

3.3. Effect of AM fungiand Bacillus subtilis on soil enzyme activities under saline stress

AM fungi can improve biological characteristics such as soil enzyme activity while enhancing host plant access to nutrient resources[11] , while Bacillus subtilis has a significant growth promoting effect on tomato seedlings in continuous cropping soil and can increase soil enzyme activities such as sucrase and urease.Soil catalase, urease and sucrase activities were significantly increased after the application of AM fungi, Bacillus subtilis and mixed fungal agents, but the sensitivity of soil catalase to the strains was slightly lower than that of sucrase and urease. The catalase activities of No. 4 and No. 202 were only 19.29% and 7.69% higher than that of CK at $Salt_{150}$ Gm+B, while the increase of urease activity was as high as 139.5% and 114.5%, sucrase plus mixed bacterial agent was also more effective, 36.99% higher compared to single B group and 45.49% higher compared to single Gm group. From the changes in the activity of the three enzymes, it can be seen that the utility of AM fungi, Bacillus subtilis and mixed fungal agents on different soil enzyme activity has a large difference, and the two together with the formation of a good synergistic effect, which can significantly enhance the index of soil enzyme activity and increase soil fertility.

3.4. Effect of AM fungi and Bacillus subtilis on proline and MDA content of tomato under saline stress

Under adversity stress, plants accumulate proline to maintain their osmotic balance and membrane structural integrity[12]. When the rate of stress-generated reactive oxygen radicals exceeds the scavenging capacity of the cellular antioxidant defence system, membrane lipid peroxidation leads to a rapid increase in MDA content[13]. MDA and Pro contents increased dramatically in tomato when subjected to Salt stress, and both showed a decreasing trend with the addition of AM fungi and Bacillus subtilis and their mixture, and maximum Salt resistance was obtained under the mixed fungal conditions. The MDA and Pro contents of both No. 4 and No. 202 fell to a low level under 15 mmol/L Salt solution condition with the synergistic treatment of AM fungi and Bacillus subtilis, and their maximum decreases were 44.38%, 33.90% and 42.39%, 39.89%, respectively. It is assumed that the synergistic treatment with biocontrol fungi can activate a series of physiological responses in tomato, form an endogenous protection system, reduce intracellular oxidative stress under Salt treatment, enhance the ability of plants to remove excess reactive oxygen species, so that they can better adapt to the Salt-stressed environment, and No. 4 has a better salinity tolerance compared to No. 4.

3.5. Effect of AM fungi and Bacillus subtilis on antioxidant enzyme system of tomato under salinity stress

Plant tissues produce reactive oxygen species when subjected to disease, and the accumulation of this substance can lead to cellular damage. Antioxidant enzymes can hydrolyse the hydrogen peroxide produced in the plant, thus effectively reducing the damage caused by reactive oxygen radicals and creating a protective barrier for the cells. After treating tomato with different measures, the antioxidant enzyme content was analysed by enzyme marker measurement and the results are shown in Table 2. From the overall point of view, the three antioxidant enzyme activities fluctuated and the change trend was basically the same. Taking the third cycle (21d) as an example, during the single Salt stress, the higher the Salt treatment concentration, the lower the antioxidant enzyme activity, the degree of influence of POD>SOD>CAT, while in the cultivation of the soil after the application of different fungicides, the antioxidant enzyme activity of the tomato body increased significantly, the three kinds of antioxidant enzyme activity of the No. 4 increased the maximum of 12.8%, 112.1%, 30.6%, respectively, and No. 202 increased 11.9%, respectively, and No. 202

increased 11.9%, respectively, and No. 202 increased 11.9%. No. 4 increased by 11.9%, 58.3% and 27.1%, respectively, indicating that the simultaneous presence of AM fungi and Bacillus subtilis could moderate the physiological damage of Salt stress on tomato. In addition, the degree of adaptation of the two varieties to the treatment of biotrophic fungi at different Salt concentrations varied, with the antioxidant enzyme activities of No. 4 and No. 202 peaking at 112.09% and 58.28%, respectively, for the most pronounced growth of POD under the $Salt_{75}$ Gm+B condition. In conclusion, it can be concluded that for different tomato varieties, both biocontrol bacteria can help to enhance the free radical scavenging ability of tomato plants, i.e., under saline and alkaline stress by increasing the antioxidant enzyme activity of the plant and its osmoregulatory substance content to improve the plant's resistance to stress, and the simultaneous inoculation of two biocontrol bacteria has a more excellent effect than a single strain.

Table 2: Effect of AM fungi, Bacillus subtilis on antioxidant enzyme system of tomato under salinity stress (mean ± standard error)

Measurement indicators	process group	No.4			No.202		
		7d	14d	21d	7d	14d	21d
SOD U/g-min	$Salt_{15}$ CK	248.5843 ±6.1292f	270.8337 ±7.7572f	245.6420 ±4.2436f	251.6017 ±11.5467g	268.6943 ±5.3298g	251.8760 ±3.2708g
	$Salt_{15}$ Gm	246.9670 ±13.7519f	268.0593 ±3.9546f	255.2193 ±7.5797f	259.8580 ±8.0786de	274.5030 ±2.9388de	263.9850 ±2.4005de
	$Salt_{15}$ B	255.5880 ±2.8778e	265.0170 ±3.5303e	253.7640 ±3.5866e	247.4170 ±10.8084c	273.3210 ±5.1896c	244.8110 ±4.9137c
	$Salt_{15}$ Gm + B	253.4877 ±10.2566b	284.9893 ±4.8055b	261.1610 ±5.1529b	260.0067 ±7.0928bc	285.0913 ±5.5479bc	264.2120 ±4.9778bs
	$Salt_{75}$ CK	241.5963 ±8.2782f	265.4000 ±5.0617f	236.0210 ±12.3769f	245.8900 ±12.4654f	265.6343 ±6.8444f	243.5757 ±2.3304f
	$Salt_{75}$ Gm	260.1763 ±7.0456f	271.8507 ±6.1353f	250.7883 ±8.0882f	251.1677 ±10.0474d	271.6153 ±2.6218d	259.6563 ±4.0761d
	$Salt_{75}$ B	239.2497 ±8.4389d	263.9817 ±6.4168d	244.4597 ±2.3886d	251.5410 ±4.0265d	268.5650 ±3.1751d	245.4757 ±2.6674d
	$Salt_{75}$ Gm + B	254.2430 ±11.0332a	282.8977 ±3.3159a	266.3057 ±3.4304a	259.1657 ±9.2987a	279.6513 ±3.5551a	258.8723 ±2.4069a
	$Salt_{150}$CK	242.2427 ±10.2326d	256.8810 ±6.6443d	225.5937 ±9.3330d	244.9057 ±6.7837ef	262.6693 ±2.9695ef	225.4367 ±6.8924f
	$Salt_{150}$Gm	255.6367 ±8.1445c	264.8987 ±5.4909c	253.7200 ±2.4793c	250.8570 ±9.6405b	272.3847 ±1.7962b	250.6840 ±5.0358b
	$Salt_{150}$B	247.7220 ±14.4396ab	259.8257 ±6.4932ab	244.4923 ±8.8955ab	248.5403 ±4.9698b	262.3330 ±2.6976b	239.4370 ±6.3865b
	$Salt_{150}$Gm + B	256.6213 ±12.0758a	262.7373 ±3.2208a	242.4033 ±2.6489a	254.1927 ±7.2037a	280.2783 ±4.6082a	252.2630 ±1.6063a
POD U/g-min	$Salt_{15}$ CK	552.0000 ±15.6205f	510.6667 ±9.9555f	377.3333 ±9.9387f	646.6667 ±8.7433g	605.3333 ±7.4237g	440.3333 ±7.5351g
	$Salt_{15}$ Gm	740.6667 ±7.8811f	447.0000 ±4.5826f	430.0000 ±10.5831e	669.3333 ±2.9060de	555.3333 ±9.3867de	425.6667 ±7.7960de
	$Salt_{15}$ B	819.3333 ±9.2796e	571.0000 ±14.1067e	610.0000 ±12.4231b	705.3333 ±9.0615c	621.3333 ±9.7354c	527.0000 ±3.0000c
	$Salt_{15}$ Gm + B	950.6667 ±13.5442b	830.0000 ±7.3711b	358.3333 ±13.5442f	950.3333 ±8.0898bc	857.6667 ±11.5662bc	547.6667 ±7.3106bc
	$Salt_{75}$ CK	514.0000 ±9.2916f	486.0000 ±10.1160f	340.3333 ±13.0937f	575.6667 ±11.0202f	516.6667 ±9.9051f	445.0000 ±6.0828f
	$Salt_{75}$ Gm	714.0000 ±10.2144f	428.3333 ±11.0955f	421.6667 ±12.5477d	601.0000 ±13.6504d	562.6667 ±8.0898d	375.6667 ±6.1192d
	$Salt_{75}$ B	825.0000 ±7.2111d	589.0000 ±8.3865d	760.0000 ±1.1547a	674.0000 ±12.8970d	577.6667 ±11.6952d	531.6667 ±6.3333d
	$Salt_{75}$ Gm + B	921.3333 ±26.9588a	801.3333 ±12.4410a	317.3333 ±9.2616d	830.3333 ±10.9138a	740.3333 ±12.4677a	704.3333 ±5.7831a
	$Salt_{150}$CK	495.3333 ±11.2596d	478.6667 ±7.6884d	438.0000 ±9.5394c	505.6667 ±8.6859ef	442.0000 ±4.7258ef	334.0000 ±11.1355ef
	$Salt_{150}$Gm	596.6667 ±10.1708c	550.6667 ±7.0553c	504.0000 ±7.0000ab	540.6667 ±5.4569b	481.6667 ±6.8880b	363.3333 ±6.1734b
	$Salt_{150}$B	737.0000 ±6.0277ab	671.0000 ±10.0167ab	605.6667 ±5.2387a	567.0000 ±3.2146b	574.3333 ±5.3645b	542.3333 ±6.1734b
	$Salt_{150}$Gm + B	818.6667 ±9.2075a	722.6667 ±8.5114a	472.0000 ±6.4291f	694.6667 ±4.6308a	656.0000 ±7.3711a	603.0000 ±8.0829a
CAT U/g-min	$Salt_{15}$ CK	97.1445 ±3.9896f	106.5993 ±2.4612f	103.0700 ±3.1401f	97.0750 ±4.7090g	103.0830 ±2.7385g	99.2797 ±2.6003g
	$Salt_{15}$ Gm	110.3410 ±3.4626f	131.7817 ±3.7970f	110.7753 ±3.7321f	106.7407 ±4.7906de	116.2103 ±2.1912de	109.3747 ±0.5457de
	$Salt_{15}$ B	111.9960 ±1.0781e	130.9417 ±2.3509e	119.2530 ±6.0326e	109.0683 ±4.1424c	116.9657 ±2.1469c	115.1287 ±.6230c
	$Salt_{15}$ Gm + B	118.5437 ±7.9642b	141.1157 ±2.8601b	134.6137 ±1.4908b	121.2827 ±2.5889bc	124.0197 ±3.1581bc	124.4423 ±2.3444bc
	$Salt_{75}$ CK	95.0163 ±2.0098f	100.6907 ±2.6190f	95.4303 ±2.8483f	96.5107 ±2.0355f	99.8753 ±2.0870f	95.8577 ±0.8553f
	$Salt_{75}$ Gm	119.2993 ±5.0568f	109.0567 ±2.5583f	111.3963 ±4.6504f	107.2747 ±3.5171d	109.7943 ±2.0572d	105.1797 ±0.9579d
	$Salt_{75}$ B	118.2503 ±1.5467d	120.2123 ±3.7130d	114.4793 ±1.9911d	109.2257 ±3.5101d	117.7383 ±0.9436d	114.0320 ±1.9931d
	$Salt_{75}$ Gm + B	116.9170 ±3.6557a	117.4250 ±4.3915a	119.7943 ±1.2968a	111.2300 ±3.1329a	119.8307 ±3.0971a	121.8627 ±0.7852a
	$Salt_{150}$CK	81.8010 ±2.8563d	96.5460 ±2.6592d	97.8743 ±2.9310d	95.1557 ±3.1827ef	97.6917 ±0.8303ef	93.7663 ±0.9664ef
	$Salt_{150}$Gm	99.0840 ±4.5633c	104.2390 ±2.3340c	100.7857 ±2.7380c	97.5817 ±3.4869b	99.0787 ±0.8784b	99.7183 ±2.7642b
	$Salt_{150}$B	106.2943 ±1.1385ab	116.2187 ±2.3953ab	111.9413 ±2.2262ab	105.3373 ±2.3774b	110.2443 ±0.6813b	109.5213 ±3.0102b
	$Salt_{150}$ Gm + B	119.0200 ±3.0486a	118.4993 ±2.0653a	112.8867 ±2.6689a	110.4903 ±2.7652a	117.2760 ±1.6832a	113.2863 ±1.3701a

4. Conclusion

In this article, two varieties of tomato, No. 4 and No. 202, were selected for cultivation experiments with the application of AM fungi and Bacillus subtilis and their mixed mycorrhizal agents in saline-alkaline soils with different concentrations. The results showed that the two fungicides had a certain effect on the physiological and biochemical functions of tomato under saline stress. Different concentrations of Salt solution inhibited the growth of tomato plant height and root length. Compared with the low concentration treatment, the activity of antioxidant enzymes was weakened in the plant cells of the high and medium Salt concentration treatment group, and the contents of CAT and SOD showed a trend of increasing and then decreasing, while the contents of POD were gradually reduced, and the contents of MDA and Pro were obviously reduced in the three measurement cycles. After the application of appropriate amounts of AM fungi and Bacillus subtilis and their hybrids, all the indexes recovered, and the combined effect was the best, and the trend of changes in the two varieties of tomato was more or less the same. In terms of changes in soil physicochemical properties, the addition of suitable AM fungi and Bacillus subtilis can increase the content of N, P, K and other elements in the soil, increase the soil water content, and reduce the pH value. In conclusion, the co-inoculation of AM fungi and Bacillus subtilis is feasible to alleviate Salt stress in tomato, and the experimental results can provide a technical basis for screening the optimal AM fungi-Bacillus subtilis combination system, which can help to optimise the distribution of water and Salt and the soil structure of saline and alkaline soils, and thus improve the growth of cultivated crops.

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