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重茬土壤、枯叶腐解液对广藿香扦插苗生理生化指标的影响

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摘　要:为了研究和探讨广藿香连作障碍成因及其作用机制,以广藿香扦插苗(2、8周龄苗)为试材,采用盆栽试验法,研究了广藿香重茬土壤、枯叶腐解液对其扦插苗叶片生理生化指标的影响。结果表明:2、8周苗龄广藿香扦插苗培育在广藿香重茬土壤和含不同浓度的枯叶腐解液的培养基质中60 d,叶片过氧化氢酶(CAT)、过氧化物酶(POD)、超氧化物歧化酶(SOD)活性均较对照土呈升高的变化趋势,且随枯叶腐解液浓度的增加而升高,2、8周幼苗叶片CAT、POD、SOD活性均呈含高浓度枯叶腐解液的土壤>重茬土>含低浓度枯叶腐解液的土壤>对照土的变化规律;丙二醛(MDA)含量也较对照土显著升高,呈含高浓度枯叶腐解液的土壤>含低浓度枯叶腐解液的土壤>重茬土>对照土的变化规律。广藿香植株枯叶腐解物导致的化感自毒作用可能是其连作障碍的主要因素之一。

关键词:广藿香;重茬土;枯叶腐解液;扦插;生理生化指标

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广藿香(*Pogostemon cablin*(blanco)Benth.)属唇形科刺蕊草属植物,以干燥地上部分入药,性辛、微温,具有芳香化湿、开胃止呕、发表解暑功效,是岭南的常用中药[1]。近年来在医药和精油市场对广藿香的需求有逐年增加的趋势,但在其栽培生产中出现严重的连作障碍问题[2]。连作障碍指在正常的管理措施下,在同一块地连续多年种植相同作物造成作物产量降低、品质变劣、生长状况变差、病虫害加剧的现象。研究表明,化感自毒作用是导致植物连作障碍的重要因素之一[3-5]。

植物通过淋溶、植株残体腐解、根系分泌化感物质等方式使其临近植物或其自身产生化感自毒作

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Effect of Arbuscular Mycorrhizal on Growth and Resistance of *Glycyrrhiza uralensis* Seedling

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Abstract:Taking 1-year-old seedlings of *G. uralensis* as experiment material,the effect of arbuscular mycorrhizal on the growth and resistance of *Glycyrrhiza uralensis* seedling were studied. The results indicated that the four kinds of inoculated arbuscular mycorrhizal fungi could form mycorrhizal fungi with *G. uralensis* seedlings,and promote the growth of these seedlings significantly. Moreover,arbuscular mycorrhizal fungi improved remarkably the resistance index of the seedlings,including the content of soluble sugar and protein increased,as well as,the contents of proline and MDA decreased.

Keywords:arbuscular mycorrhizal(AM);*Glycyrrhiza uralensis*;growth;resistance

用,并在连作中对后茬植物生长产生不利影响[6-7],课题组前期研究了广藿香根系分泌物、器官水浸液的化感自毒作用及连作土壤水浸液对扦插苗生根影响等研究[8-10],为了进一步揭示广藿香连作障碍成因及其作用机制,研究了广藿香重茬土壤及枯叶腐解液对其幼苗叶片抗氧化酶活性的影响,为揭示其连作障碍成因和作用机制提供参考依据。

1　材料与方法

1.1　试验材料

供试广藿香扦插苗参考唐堃等[8]方法,在广东药科大学城校区药圃培育。

1.2　试验方法

1.2.1　广藿香枯叶腐解液的制备　取干燥好的广藿香枯叶,粉碎后过100目筛。称取适量,按1∶1∶10(枯叶∶土壤∶水)加入无菌水搅拌均匀,置于35 ℃恒温恒湿箱中腐解30 d,过滤,除残渣,再抽滤2次,滤液为供试母液,浓度记为0.1 g·mL^{-1},4 ℃下保存。取适量供试母液,经稀释得到浓度为0.01、0.03、0.05、0.07 g·mL^{-1}腐解液。

1.2.2　培养基质的配制　对照土:取自广东省广州市广东药科大学大学城校区药圃,与广藿香种植地相邻未种植过广藿香的土壤。枯叶腐解液+对照土:在广藿香移栽前分别用0.01、0.03、0.05、0.07 g·mL^{-1}枯叶腐解液浇透对照土。重茬土:取自广东省广州市广东药科大学大学城校区药圃,连续种植2年广藿香后的土壤。

1.2.3　盆栽方法　采用16 cm×16 cm规格的育苗袋,每袋装培养基质约1.5 kg,将已经扦插生根的2、8周龄广藿香扦插苗移栽到培养袋中,每袋种植扦插苗2株,枯叶腐解液+对照土处理组每天分别浇灌10 mL不同浓度的腐解液,对照土和重茬土处理每天浇灌10 mL蒸馏水。每处理6袋,随机排列,试验重复3次。

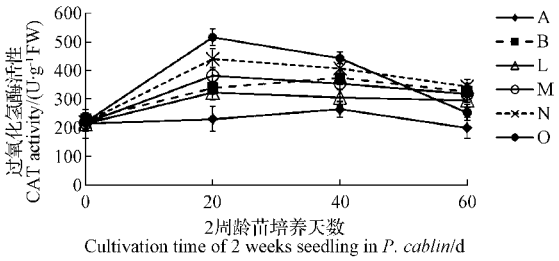
1.3　项目测定

随机剪取扦插苗上的叶片,用去离子水清洗干净,称取0.25 g,加5 mL磷酸盐缓冲液(0.1 mol·L^{-1},pH 7.0),冰浴研磨成匀浆,4 ℃、12 000 r·min^{-1}离心15 min后冷藏保存,上清液为酶提取液。过氧化氢酶(CAT)活性和丙二醛(MDA)含量均采用紫外分光光度法测定[11-12];过氧化物酶(POD)活性采用愈创木酚法测定[11,13];超氧化物歧化酶(SOD)活性采用NBT还原法测定[11,13]。

2　结果与分析

2.1　重茬土及枯叶腐解液对广藿香扦插苗叶片CAT活性的影响

由图1、2可知,2、8周龄苗广藿香扦插苗培育在不同处理基质中,在培养期间,其叶片CAT活性均呈升高变化,与对照土差异显著($P<0.05$)。2种幼苗叶片CAT活性在培养20 d均达到高峰。其中,在含有高浓度枯叶腐解液的土壤基质中2、8周龄苗叶片CAT活性分别较对照增加123.66%和104.24%,随即呈降低的变化。在培养期间,2种幼苗叶片CAT活性均呈含高浓度枯叶腐解液的土壤>重茬土>含低浓度枯叶腐解液的土壤>对照土的变化。在各培养时期,不同基质培养的2周龄苗的CAT活性均高于8周龄苗。



注:A.对照土+蒸馏水;B.重茬土+蒸馏水;L.0.01 g·mL^{-1}土壤枯叶腐解液+对照土;M.0.03 g·mL^{-1}土壤枯叶腐解液+对照土;N.0.05 g·mL^{-1}土壤枯叶腐解液+对照土;O.0.07 g·mL^{-1}土壤枯叶腐解液+对照土。下同。

Note:A. control soil and distilled water;B. continuous cropping soil and distilled water;L. 0.01 g·mL^{-1} decomposed liquid of dead leaves and control soil;M. 0.03 g·mL^{-1} decomposed liquid of dead leaves and control soil;N. 0.05 g·mL^{-1} decomposed liquid of dead leaves and control soil;O. 0.07 g·mL^{-1} decomposed liquid of dead leaves and control soil. The same as follow.

图1　重茬土和枯叶腐解液对2周龄苗广藿香叶片CAT活性的影响

Fig. 1　Effects of continuous cropping soil and decomposed liquid of dead leaves on the CAT activity of 2 weeks cutting seedlings in *P. cablin*

2.2　重茬土及枯叶腐解液对广藿香扦插苗叶片POD活性的影响

由图3、4可知,2周龄苗广藿香扦插苗培育在不同处理基质中,在培养期间,其叶片POD活性均呈升高的变化,与对照土差异显著($P<0.05$),8周龄苗广藿香扦插苗在含低浓度枯叶腐解液的基质中培育40、60 d时,叶片POD活性与对照土差异不显著($P>0.05$),其它处理组的叶片POD活性均呈升高

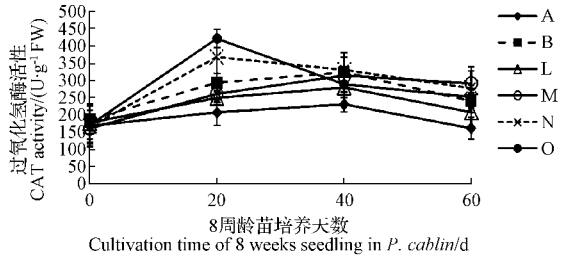


图 2 重茬土和枯叶腐解液对 8 周龄苗广藿香叶片 CAT 活性的影响

Fig. 2 Effects of continuous cropping soil and decomposed liquid of dead leaves on the CAT activity of 8 weeks cutting seedlings in *P. cablin*

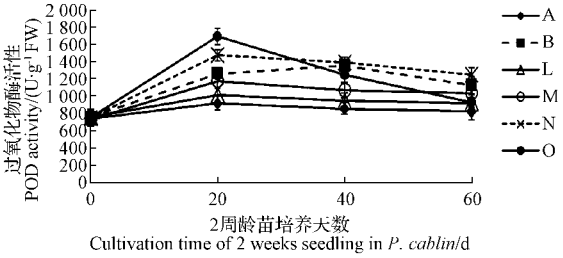


图 3 重茬土和枯叶腐解液对 2 周龄苗广藿香叶片 POD 活性的影响

Fig. 3 Effects of continuous cropping soil and decomposed liquid of dead leaves on the POD activity of 2 weeks cutting seedlings in *P. cablin*

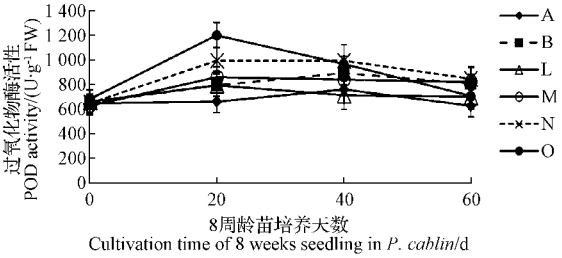


图 4 重茬土和枯叶腐解液对 8 周龄苗广藿香叶片 POD 活性的影响

Fig. 4 Effects of continuous cropping soil and decomposed liquid of dead leaves on the POD activity of 8 weeks cutting seedlings in *P. cablin*

的变化,与对照土相比差异显著($P<0.05$)。2 种幼苗叶片 POD 活性在培养 20 d 时均达到高峰,2、8 周龄苗叶片 POD 活性分别较对照增加 84.15%和 81.47%,随即呈降低的变化。在培养期间,2 种幼苗叶片 POD 活性均呈含高浓度枯叶腐解液的土壤>重茬土>含低浓度枯叶腐解液的土壤>对照土的变化。在各培养时期,不同基质培养的 2 周龄苗的叶片 POD 活性均高于 8 周龄苗。

2.3 重茬土及枯叶腐解液对广藿香扦插苗叶片 SOD 活性的影响

由图 5、6 可知,2、8 周龄苗广藿香扦插苗培育在不同处理基质中,在培养期间,其叶片 SOD 活性整体变化趋势与 CAT 相似,呈先升高后下降的变化,与对照土差异显著($P<0.05$),而 2、8 周龄苗扦插苗在含低浓度枯叶腐解液的基质中培育 40、60 d 时,叶片 SOD 活性与对照土差异不显著($P>0.05$)。在重茬土培养基质培育的 2、8 周龄苗叶片 SOD 活性在培育 40 d 时达到高峰,在含枯叶腐解液的培养基质培育的 2 种幼苗叶片 SOD 活性在培养 20 d 时均达到高峰,其中,在含高浓度枯叶腐解液的培养基质中的 2、8 周龄苗叶片 SOD 活性分别较对照增加 77.14%和 71.49%,随即呈降低的变化。在培养期间,2 种幼苗叶片 SOD 活性均呈含高浓度枯叶腐解液的土壤>重茬土>含低浓度枯叶腐解液的土壤>对照土的变化。在各培养时期,不同基质培养的 2 周龄苗的叶片 SOD 活性均高于 8 周龄苗。

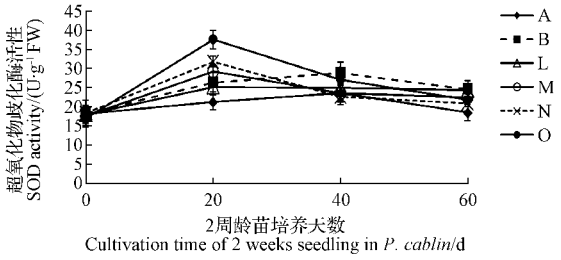


图 5 重茬土和枯叶腐解液对 2 周龄苗广藿香叶片 SOD 活性的影响

Fig. 5 Effects of continuous cropping soil and decomposed liquid of dead leaves on the SOD activity of 2 weeks cutting seedlings in *P. cablin*

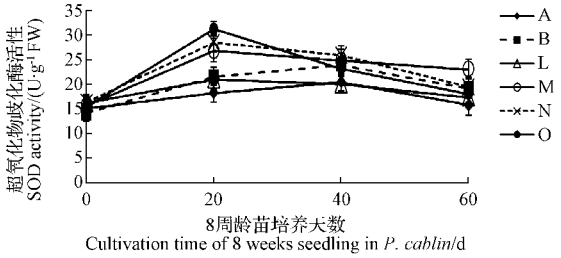


图 6 重茬土和枯叶腐解液对 8 周龄苗广藿香叶片 SOD 活性的影响

Fig. 6 Effects of continuous cropping soil and decomposed liquid of dead leaves on the SOD activity of 8 weeks cutting seedlings in *P. cablin*

2.4　重茬土及枯叶腐解液对广藿香扦插苗叶片MDA活性的影响

由图7、8可知,2、8周龄苗广藿香扦插苗培育在不同处理基质中,在培养期间,其叶片MDA含量均呈升高的变化,与对照土差异显著($P<0.05$)。2种幼苗叶片MDA含量在培养60 d时均达到高峰,其中,在含高浓度枯叶腐解液的培养基质中的2、8周龄苗叶片MDA含量分别较对照增加了135.61%和92.24%。在培养期间,2周龄苗叶片MDA含量均呈含高浓度枯叶腐解液的土壤>重茬土>含低浓度枯叶腐解液的土壤>对照土的变化;8周龄苗叶片MDA含量呈含高浓度枯叶腐解液的土壤>含低浓度枯叶腐解液的土壤>重茬土>对照土的变化。在各培养时期,不同基质培养的8周龄苗叶片MDA含量均高于2周龄苗。

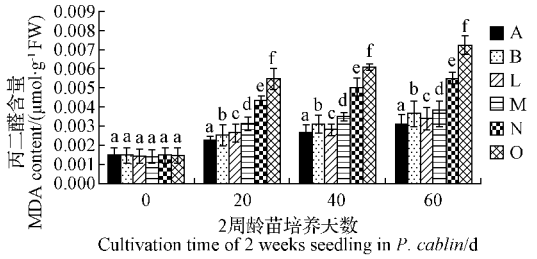


图7　重茬土和枯叶腐解液对2周龄苗广藿香叶片MDA含量的影响

Fig. 7　Effects of continuous cropping soil and decomposed liquid of dead leaves on the MDA content of 2 weeks cutting seedlings in *P. cablin*

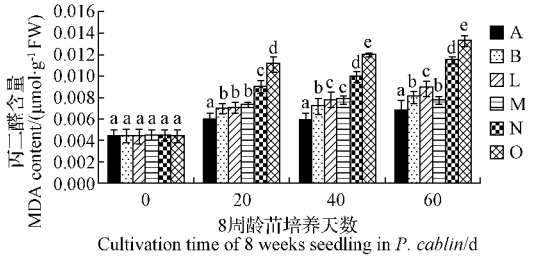


图8　重茬土和枯叶腐解液对8周龄苗广藿香叶片MDA含量的影响

Fig. 8　Effects of continuous cropping soil and decomposed liquid of dead leaves on the MDA content of 8 weeks cutting seedlings in *P. cablin*

3　讨论

植株枯叶腐解是导致连作障碍的重要因素[14],植株腐解液中的酯类、烃类、醛酮类等化感物质会影响植株生长发育[15-16]。张学鹏等[17]研究表明,西兰花茎叶腐解液对其生长有抑制作用,且浓度越大抑制作用越强。该研究发现广藿香重茬土和枯叶腐解液导致其幼苗叶片CAT、POD、SOD活性升高,MDA含量增加。MDA是反映植物膜质过氧化的重要指标,CAT、POD、SOD是抗氧化酶系统中重要的细胞保护酶,其变化反映了植物对外界胁迫的响应。CAT是植物组织中普遍存在的一种抗氧化酶,能够有效清除植物体内多余的H_2O_2[18];POD是活性较高的适应性酶,能够反映植物生长发育的特性、体内代谢状况以及对外界环境的适应性[19];SOD在植物逆境胁迫中,能够高效清除胁迫过程产生的大量活性氧[20]。有研究表明,连作导致植物生长、品质、根系活力、抗氧化酶活性下降[16,21]。以往研究表明,重茬土抑制广藿香扦插苗不定根的生长,对其鲜质量、叶片面积、根长、根系活力等有不同程度的抑制作用,且其根、茎、叶中的MDA含量也有不同程度的增加[10,22]。

该研究表明,2、8周龄的广藿香扦插苗培育在广藿香重茬土、含枯叶腐解液的土壤中产生了氧化胁迫,推测广藿香枯叶腐解物中的化感物质发挥了重要的作用,广藿香植株腐解物导致的化感自毒作用可能是其连作障碍的重要因素之一。有关枯叶腐解物在广藿香连做障碍中的作用、作用机制及主要成分将做进一步深入研究。

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Effect of Continuous Cropping Soil and Decomposed Liquid of Dead Leaves on Physiological and Biochemical Indexes of *Pogostemon cablin* Cutting Seedlings

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Abstract:In order to study the causes and mechanism of continuous cropping obstacle in *Pogostemon cablin*, the pot experiment method was used to study the effect of physiological and biochemical indexes in its 2 and 8 weeks cutting seedlings cultured in cultivation substrate containing continuous cropping soil and decomposed liquid of dead leaves. The results showed that 2 and 8 weeks cutting seedlings cultured in cultivation substrate containing continuous cropping soil and decomposed liquid of dead leaves for 60 days,the activities of CAT,POD and SOD showed risen change in the leaves of the two cutting seedlings compared with that of the control,and raised with the concentration of decomposed liquid of dead leaves. The activities of CAT,POD and SOD in the leaves of two cutting seedlings showed the change in which the soil containing high concentration decomposed liquid of dead leaves>continuous cropping soil>soil containing low concentration decomposed liquid of dead leaves>control soil. The content of MDA significantly increased compared with that of the control,and showed the change in which the soil containing high concentration decomposed liquid of dead leaves>soil containing low concentration decomposed liquid of dead leaves>continuous cropping soil>control soil. Allelopathic autotoxicity caused by decomsosition of dead leaves in *Pogostemon cablin* might be the one of the main factors causing contiuous cropping obstacle.

Keywords:*Pogostemon cablin*;continuous cropping soil;decomposed liquid of dead leaves;cutting propagation;physiological and biochemical indexes