



Figure S1. Mass fragments of monoterpene peaks detected in volatile organic compounds from *Pinus densiflora*, *P. koraiensis* and those of authentic standards: (a)  $\alpha$ -pinene; (b) camphene; (c)  $\beta$ -pinene; (d)  $\beta$ -myrcene; (e) 3-carene; (f)  $\beta$ -phellandrene; (g) D-limonene.

Sequence 1: P.densiflora 3-carene 626 aa  
Sequence 2: P.banksiana 3-carene1 626 aa  
Sequence 3: P.banksiana 3-carene2 626 aa  
Sequence 4: P.contorta 3-carene1 626 aa  
Sequence 5: Picea abies 3-carene 627 aa  
Sequence 6: Picea sitchensis 3-carene 627 aa

Pinus banksiana 3-carene2 MSLISAVPLASS-CYSKSLISSVREHTALPRAIATLQMSRPGKSVAAASIRMSSATAGSD  
Pinus contorta 3-carene1 MSLISAVPLASS-CYSKSLISSVREHTALPRAIATLQMSRPGKSVAAASIRMSSATAGSD  
Pinus densiflora 3-carene MSLISAVPLASS-CYSKSLISSVREHTALPRAIATLQMSRPGKSVAAASIRMSSATAGSD  
Pinus banksiana 3-carene1 MSLISAVPLASS-CYSKSLISSVREHTALPRAIATLQMSRPGKSVAAASIRMSSATAGSD  
Picea abies 3-carene MSVLSILPLASKSCLYKSLMSSSTHELKALCRPIATLGMCRPGKSVMAKSTSLTAVSD  
Picea sitchensis 3-carene MSVLSIYPLASKPCLYKSFISFTHPKALCRPISTVGLCRRAKSVTASMSSTALSD  
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Pinus banksiana 3-carene2 GVKRRI GDVHNSLWDDNF IQSLSSPVGASSVGEHADRLI GEVKEIFNFSFIADGELI SPV  
Pinus contorta 3-carene1 GVKRRI GDVHNSLWDDNF IQSLSSPVGASSVGEHADRLI GEVKEIFNFSFIADGELI SPV  
Pinus densiflora 3-carene GVKRRI GDVHNSLWDDNF IQSLSSPVGASSVGEHADRLI GEVKEIFNFSFIADGELI SPV  
Pinus banksiana 3-carene1 GVKRRI GDVHNSLWDDNF IQSLSSPVGASSVGEHADRLI GEVKEIFNFSFIADGELI SPV  
Picea abies 3-carene GVQPRI GDHNSLWDDNF IQSLSSPVGASSVGERAERLI GEVKEIFNLSRITDGLVSHV  
Picea sitchensis 3-carene GVQPRI GNHNSLWDDNF IQSLSSPVGASSVGERAERLI GEVKEIFNRI SMANGELYSHV  
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Pinus banksiana 3-carene2 NDLLDQLWMYDNERLGI DRHFQTEIKYALDYYVRYWSEEGI GCGRDSAFDTLNTTALAF  
Pinus contorta 3-carene1 NDLLDQLWMYDNERLGI DRHFQTEIKYALDYYVRYWSEEGI GCGRDSAFDTLNTTALAF  
Pinus densiflora 3-carene NDLLDQLWMYDNERLGI DRHFQTEIKYALDYYVRYWSEEGI GCGRDSAFDTLNTTALAF  
Pinus banksiana 3-carene1 NDLLDQLWMYDNERLGI DRHFQTEIKYALDYYVRYWSEEGI GCGRDSAFDTLNTTALAF  
Picea abies 3-carene DDLLDQLSMYDNERLGI DRHFQTEIKYSLDYYVRYWSEEGI GSGRDI VCTDLNTTALGF  
Picea sitchensis 3-carene DDLLDQLSMYDNERLGI DRHFQTEIKYSLDYYVRYWSEEGI GSGRDI VCDLNTTALGF  
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Pinus banksiana 3-carene2 RIFRLHGYTVSSDVFEHFKDQKGFQFAASANDTELQTRSVFNLFRASLI AFPEEKVLEEAE  
Pinus contorta 3-carene1 RIFRLHGYTVSSDVFEHFKDQKGFQFAASANDTELQTRSVFNLFRASLI AFPEEKVLEEAE  
Pinus densiflora 3-carene RIFRLHGYTVSSDVFEHFKDQKGFQFAASANDTELQTRSVFNLFRASLI AFPEEKVLEEAE  
Pinus banksiana 3-carene1 RIFRLHGYTVSSDVFEHFKDQKGFQFAASANDTELQTRSVFNLFRASLI AFPEEKVLEEAE  
Picea abies 3-carene RILRLHGYTVFPDVFEHFKDQMGRI ACSDNHTERQISSILNLFRASLI AFPEEKVLEEAE  
Picea sitchensis 3-carene RLLRLHGYTVFPDVFEHFKDQMGRI ACSTNQTERQISSILNLFRASLI AFPEEKVLEEAE  
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Pinus banksiana 3-carene2 KFAAAVLKAAALQTLPVSGLSREIQVYFDVYRWHSNLPLEARSYIDILADNTISGTPDANT  
Pinus contorta 3-carene1 KFAAAVLKAAALQTLPVSGLSREIQVYFDVYRWHSNLPLEARSYIDILADNTISGTPDANT  
Pinus densiflora 3-carene EFAAAVLKAAALQTLPVSGLSREIQVYFDVYRWHSNLPLEARSYIDILADNTISGTPDANT  
Pinus banksiana 3-carene1 KFAAAVLKAAALQTLPVSGLSREIQVYFDVYRWHSNLPLEARSYIDILADNTISGTPDANT  
Picea abies 3-carene IFSAITVLKEALQTI PVSSLSQEI QVYFDVYRWHSNLPLEARSYIDILQENTKNQMLDVNT  
Picea sitchensis 3-carene IFSTAVLKEALQTI PVSSLSREIQVYFDVYRWHSNLPLEARTYIDILRENATNETLDMKT  
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Pinus banksiana 3-carene2 KKLLELAKLEFNIFHSVQKELQCLWRWWWKEWGCELTFI RHRVVEFYTLVSGIDMVPEH  
Pinus contorta 3-carene1 KKLLELAKLEFNIFHSVQKELQCLWRWWWKEWGCELTFI RHRVVEFYTLVSGIDMVPEH  
Pinus densiflora 3-carene KKLLELAKLEFNIFHSLQKELQCLWRWWWKEWGCELTFI RHRVVEFYTLVSGIDMVPEH  
Pinus banksiana 3-carene1 KKLLELAKLEFNIFHSLQKELQCLWRWWWKEWGCELTFI RHRVVEFYTLVSGIDMVPEH  
Picea abies 3-carene KKVLELAKLEFNIFHSLQKELQCLWRWWWKEWGCELTFI RHRVVEFYTLVSGIDMEPKH  
Picea sitchensis 3-carene EKLLELAKLEFNIFHSLQKELQCLWRWWWKEWGCELTFI RHRVVEFYTLVSGIDMEPKR  
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Pinus banksiana 3-carene2 ATRFLSCVKTCHLITILDDMYDTFGTIDELRLFTAAYKRWDPSSATECLPEYMKGVVMVLY  
Pinus contorta 3-carene1 ATRFLSCVKTCHLITILDDMYDTFGTIDELRLFTAAYKRWDPSSATECLPEYMKGVVMVLY  
Pinus densiflora 3-carene ATRFLSCVKTCHLITILDDMYDTFGTIDELRLFTAAYKRWDPSSATECLPEYMKGVVMVLY  
Pinus banksiana 3-carene1 ATRFLSFVKMCHLITILDDMYDTFGTIDELRLFTAAYKRWDPSSATECLPEYMKGVVMVLY  
Picea abies 3-carene CTRFLSFVKMCHLITIVLDDMYDTFGTIDELRLFTAAYKRWDPSTTECLPEYMKGVVTVLY  
Picea sitchensis 3-carene STFRINFKVICHFTVILDDMYDTFGTIDELRLFTAAYKRWDPSSATECLPEYMKGVVTVLY  
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Pinus banksiana 3-carene2 ETYNEMAKEAQKSGRRDTLGYYRQALEDYIGSYLKEAEWATGVVPTFQEVFENGKLSG  
Pinus contorta 3-carene1 ETYNEMAKEAQKSGRRDTLGYYRQALEDYIGSYLKEAEWATGVVPTFQEVFENGKLSG  
Pinus densiflora 3-carene ETYNEMAKEAQKSGRRDTLGYYRQALEDYIGSYLKEAEWATGVVPTFQEVFENGKLSG  
Pinus banksiana 3-carene1 ETYNEMAKEAQKSGRRDTLGYYRQALEDYIGSYLKEAEWATGVVPTFQEVFENGKLSG  
Picea abies 3-carene ETYNEMAKEAQKSGRRDTLGYYRQALEDYIGSYLKEAEWATGVVPTFQEVFENGKLSG  
Picea sitchensis 3-carene ETYNELAREAVKSGRRDTLNYRQALEDYIGSYLKEAEWATGVVPTFQEVFENGKLSG  
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Figure S2. Amino acid sequences of 3-carene synthase in *Pinus* and *Picea* species.

Table S1. HS-SPME/GC-MS analysis of comparative peak area of volatile organic compounds in control and pine wood nematode infected *Pinus densiflora* and *P. koraiensis*.

Peak	Compound	Retention time (min)	Peak area $\times 10^{-6}$			
			<i>P. densiflora</i>		<i>P. koraiensis</i>	
			Control (%)	Infected tree (%)	Control (%)	Infected tree (%)
1	oxime-methoxy-phenyl	3.75	1.29 $\pm$ 0.04 (100)	0.29 $\pm$ 0.09 (22.48)	1.22 $\pm$ 0.05 (100)	0.97 $\pm$ 0.15 (79.51)
2	tricyclene	4.46	0.46 $\pm$ 0.11 (100)	0.19 $\pm$ 0.02 (41.30)	0.04 $\pm$ 0.01 (100)	0.18 $\pm$ 0.04 (450.00)
3	$\alpha$ -pinene	4.72	13.32 $\pm$ 1.66 (100)	26.68 $\pm$ 2.39 (200.30)	1.00 $\pm$ 0.13 (100)	17.02 $\pm$ 5.45 (1702.00)
4	camphene	5.09	1.68 $\pm$ 0.77 (100)	1.33 $\pm$ 0.04 (79.17)	0.28 $\pm$ 0.11 (100)	2.35 $\pm$ 0.30 (839.29)
5	$\beta$ -pinene	5.80	4.08 $\pm$ 0.69 (100)	11.95 $\pm$ 2.59 (292.89)	0.21 $\pm$ 0.00 (100)	4.33 $\pm$ 1.73 (2061.90)
6	$\beta$ -myrcene	6.12	0.25 $\pm$ 0.12 (100)	0.64 $\pm$ 0.13 (256.00)	0.10 $\pm$ 0.04 (100)	0.78 $\pm$ 0.09 (780.00)
7	3-carene	6.70	0.09 $\pm$ 0.01 (100)	0.87 $\pm$ 0.30 (966.67)	0.38 $\pm$ 0.01 (100)	20.77 $\pm$ 5.55 (5465.79)
8	<i>p</i> -cymol	7.10	0.44 $\pm$ 0.00 (100)	0.70 $\pm$ 0.02 (159.26)	0.03 $\pm$ 0.01 (100)	0.24 $\pm$ 0.05 (800.00)
9	$\beta$ -phellandrene	7.23	2.18 $\pm$ 1.06 (100)	8.37 $\pm$ 2.34 (383.94)	—	—
10	D-limonene	7.24	—	—	0.11 $\pm$ 0.00 (100)	3.80 $\pm$ 1.34 (3454.54)

— indicates not detected.