Supporting Information Appendix

Title: Induction of defense in cereals by 4-fluorophenoxyacetic acid suppresses insect pest populations and increases crop yields in the field

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SI Materials and Methods

Quantification of 4-FPA and 4-FP in plants. Plant tissue (about 100 mg) was ground in liquid nitrogen and then 1 mL of 100% methanol was added to each sample. Samples were vortexed for 5 min and centrifuged at 18,000 g for 20 min at 4℃. The supernatants were collected and 4-FPA and 4-FP were analyzed by high performance liquid chromatography (HPLC)-mass spectrometry (MS)-MS as follows: The HPLC separation was performed on an Agilent ZORBAX C_{18} column (150 × 2.1 mm, 3.5 μm) at 35ºC. The injected volume of sample was 10 μl. The gradient mobile phase consisted of 0.1% acetic acid in water (solvent A) and acetonitrile (solvent B) at a constant flow rate of 0.3 ml min^{-1}. A linear gradient profile with the following proportions (v/v) of solvent B was applied: 0 to 5 min, 5% of B; 5 to 10 min, 5% to 55% of B; 10-12 min, 55% to 95% of B. The mass spectrometric analysis was performed using an ESI source in positive ion mode, and the quantification was obtained using multiple reaction monitoring (MRM) mode. The conditions for MS analysis were listed below: capillary voltage of 3500 V, gas temperature of 325ºC, gas flow of 5 L min^{-1}, nebulizing pressure of 45 psi, sheath gas temperature of 350ºC, sheath gas flow of 11 L min^{-1} and nozzle voltage of 500 V. The m/z (parent and product) of 4-FPA and 4-FP were 169/111 and 111.1/91, and the CE (V) of 4-FP and 4-FPA were 12 and 25. Standard 4-FPA and 4-FP was purchased from J&K Scientific (Germany) and Shanghai Aladdin biochemical Polytron Technologies Inc. (Shanghai, China), respectively. Each treatment at each time interval was replicated five times.

Contact and stomach poisoning toxicity of 4-FPA and 4-FP measurement. For contact toxicity measurements, 40 neonates were placed into a Petri dish (diameter 12 cm, height 2.5 cm) lined with filter paper wetted with 1 ml of 4-FPA (final concentrations ranging from 5 to 50 mg L^{-1}); controls were lined with filter paper wetted with 1 ml of distilled water containing the same volume of acetone as in treatments. After 2 h, the nymphs were transferred to rice plants (15 nymphs/plant) contained within a glass cylinder. For stomach poisoning toxicity measurements, 15 x 2^{nd} instar nymphs were fed on artificial diet containing 4-FPA at concentrations

ranging from 5 to 50 mg L^{-1} or containing 4-FP at a single concentration of 5 mg L^{-1} in a 30 ml double-ended open glass cylinder (diameter 2 cm, length 9 cm) as described in Fu et al. (2001); controls were fed on artificial diet without 4-FPA or 4-FP. Ten replicates were carried out per treatment. The number of nymphs surviving on each plant or in each cylinder was recorded daily.

Preparation of methanol extracts of plants. The methanol extract of 4-FPA-treated or control plants was prepared as follows: 0.1 g of leaf sheaths of 4-FPA-R plants (5 mg l^{-1} 4-FPA, for 4.5 d) or control plants were ground in liquid nitrogen to which was added 1 mL of 80% aqueous ethanol. Samples were vortexed for 5 min, extracted by ultrasound for 20 min and centrifuged at 18,000 g for 20 min at 4℃. Supernatants were collected and concentrated to 50 μL, and then was added into artificial diets at a final concentration of 50 μL mL^{-1}.

Phenolic acid, flavonoid and lignin analysis. For phenolic acid and flavonoid analysis, samples (100 mg each) were ground in liquid nitrogen and extracted in 1 mL of 80% aqueous ethanol by vortexing for 5 min, followed by ultrasonic treatment for 20 min and finally centrifuged at 18,000 g for 20 min at 4℃. Phenolic acids and flavonoids present in the supernatants were quantified by HPLC-MS-MS as described in (Caristi et al., 2003). Each treatment was replicated five times. Phenolic acid and flavonoid standards were purchased from BioBioPha Biotech Company (Kunming, China). Lignin was extracted and quantified as described by (Xu et al., 2014). Each treatment was replicated five times.

Polymerization reaction of 4-FP and flavonoids *in vitro*. To elucidate the potential involvement of 4-FP, flavonoids, H_2O_2 and PODs in the formation of phenolic polymers, *in vitro* studies were carried out. Two flavonoids, naringenin and quercitrin, which are regulated by 4-FPA in rice, were selected as representative flavonoids for these experiments; both were individually dissolved in 100% methanol to a final concentration of 0.05 mg mL^{-1}. 30% H_2O_2 was diluted to 0.3% in 0.05 mM phosphate buffer solution (PBS) at PH 7.0. 4-FP and POD (Sigma, Aldrich) were dissolved in PBS to final concentrations of 10 mg mL^{-1} and 0.34 mg mL^{-1}, respectively. The

typical biological reaction system was prepared in a 1.5 mL centrifuge tube as follows: 200 μL of 0.3% H_2O_2+ 100 μL of 10 mg mL^{-1} 4-FP + 100 μL of 0.05 mg mL^{-1} naringenin (or quercitrin), and finally 10 μL of 0.34 mg mL^{-1} POD was added. To confirm which components in the reaction system are essential for the polymerization reaction, a series of reaction systems were set up (*SI Appendix*, Table S8). After incubation for 12 h at room temperature, samples were centrifuged at 18,000 g for 10 min and the levels of flavonoids and 4-FP in the supernatants quantified using HPLC-MS-MS following the methods for flavonoid or 4-FP analysis as described above. Each reaction was carried out in triplicate.

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Caristi C*, et al.* (2003) Flavonoids Detection by HPLC-DAD-MS-MS in Lemon Juices from Sicilian Cultivars. *J. Agric. Food Chem* 51:3528-3534.

Xu Q*, et al.* (2014) Activator- and repressor-type MYB transcription factors are involved in chilling injury induced flesh lignification in loquat via their interactions with the phenylpropanoid pathway. *Journal of Experimental Botany* 65(15):4349-4359.

SI Figures and Tables

Fig. S1. 4-FPA has no direct toxic effect on WBPH nymphs.

Fig. S2. Mean root length and plant height (+SE, n=10) of rice plants 10 d after they were grown in nutrient solution containing 0-5 mg L^{-1} 4-FPA.

Fig. S3. Chromatograms of 4-FPA and 4-FP.

Fig. S4. 4-FPA treatment does not affect levels of JA, JA-Ile, SA, or ethylene in rice plants.

Fig. S5. Mean levels (+ SE, n = 6) of H2O2 in rice plants at 0.5 and 1 post exposure to NP, 4-FPA, 4-FPA+NP or control (Con).

Fig. S6. 4-FPA treatment does not affect levels of phenolic acid and lignin in rice plants.

Fig. S7. 4-FP and flavonoids participate in the formation of polymers *in vitro*.

Fig. S8. Spraying with 4-FPA sodium salt (SA) causes the deposition of phenolic polymers in rice plants and decreases the survival rate of WBPH nymphs.

Fig. S9. Spraying with 4-FPA sodium salt (SA) does not decrease spider numbers.

Fig. S10. Mean number of panicles per hill, number of grains per panicle and 1,000 seed weight (+SE, n=3) of plants that were sprayed with different concentrations of 4-FPA in 2015 (upper) and 2016 (below).

Fig. S11. Mean number of panicles per hill, number of grains per panicle, seed setting rate, 1,000 seed weight and yield per plant (+SE, n=4) of plants that were sprayed with pymetrozine plus 4-FPA or pymetrozine alone.

Fig. S12. 4-FP does not induce rice defences and has no direct harmful effects on WBPH nymphs.

Fig. S13. Methanol extracts of 4-FPA-treated rice plants did not influence WBPH nymph performance.

Fig. S14. Rice variety does not influence the 4-FPA-induced defenses in rice plants against WBPH nymphs.

Table S1. Verification of differently-expressed genes by qRT-PCR

Table S2. Differentially-expressed genes related to the auxin-mediated signaling pathway

Table S3. Differentially-expressed genes related to hydrogen peroxide generating and scavenging system.

Table S4. Differentially-expressed genes related to the phenylpropanoid pathway.

Table S5. 4-FPA treatment increases the level of free amino acids in plants

Table S6. Management measurements for field experiments in 2015, 2016 and 2019

Table S7. Selected genes and their primers used for qRT-PCR

Table S8. The composition of reagents or chemicals in different reaction systems

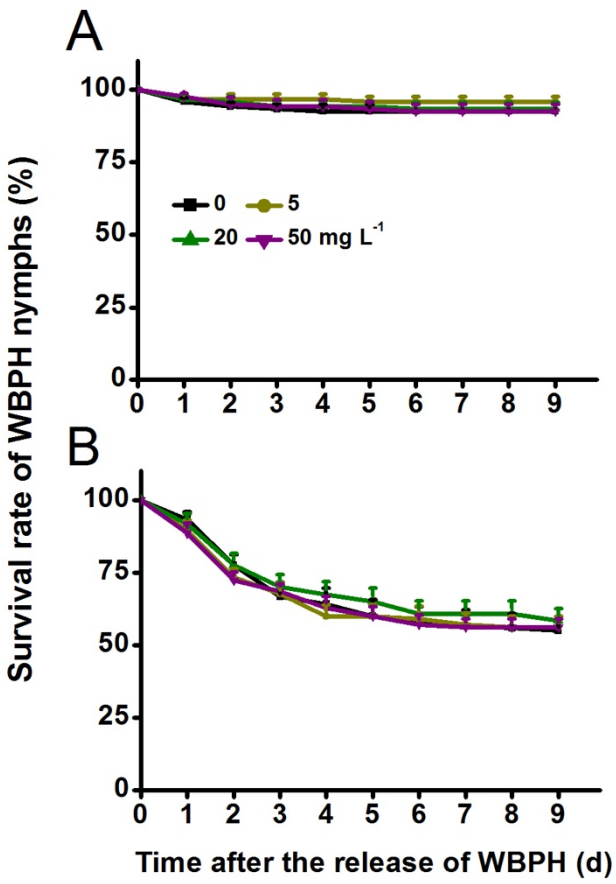

Fig. S1. 4-FPA has no direct toxic effect on WBPH nymphs.

(A) Mean survival rate (+SE, n=6) of 2nd instar WBPH nymphs following exposure to 5 mg L^{-1} 4-FPA for 2 h, 1-9 d after placing on rice plants in contact toxicity studies. (B) Mean survival rate (+SE, n=6) of 2nd instar WBPH nymphs fed artificial diet containing 5 mg L^{-1} 4-FPA, 1-9 d after exposure. Differences between treatments are not significant.

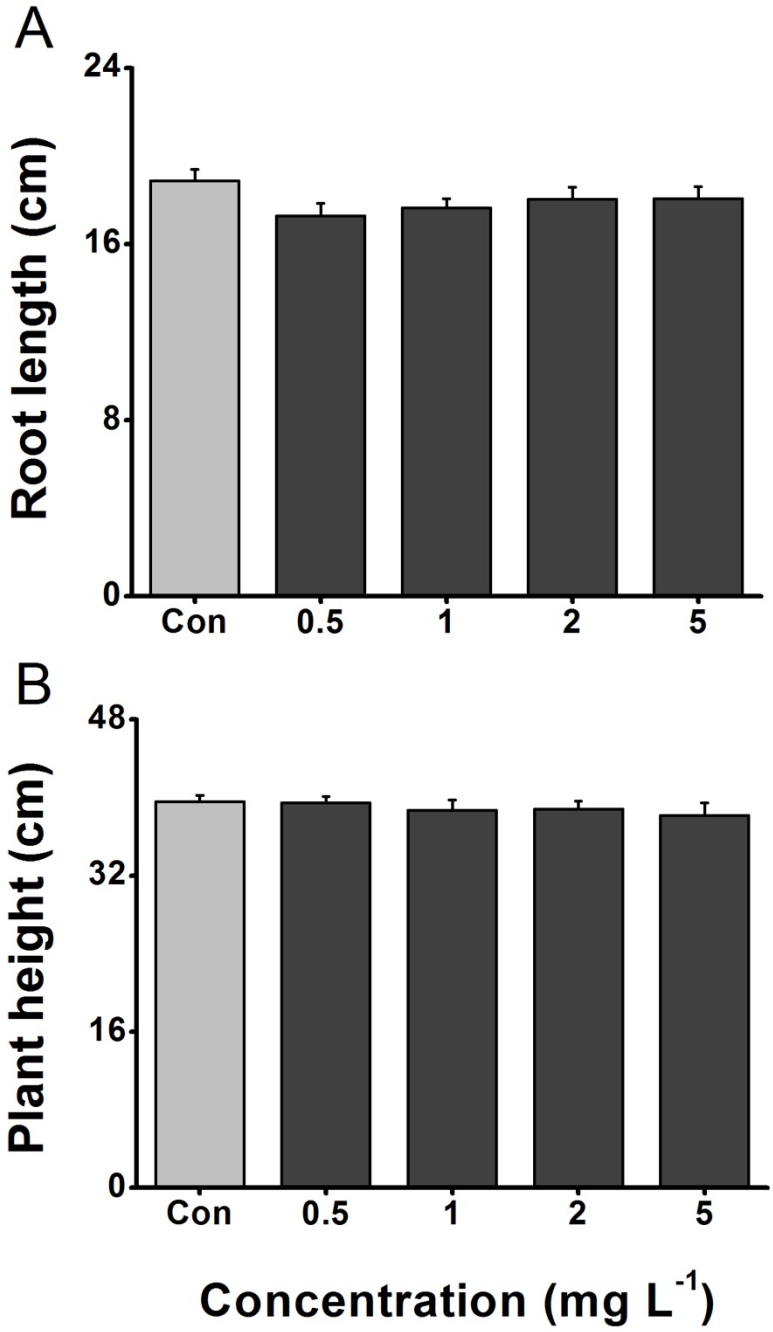

Fig. S2. Mean root length and plant height (+SE, n=10) of rice plants 10 d after they were grown in nutrient solution containing 0-5 mg L^{-1} 4-FPA. Differences between treatments are not significant.

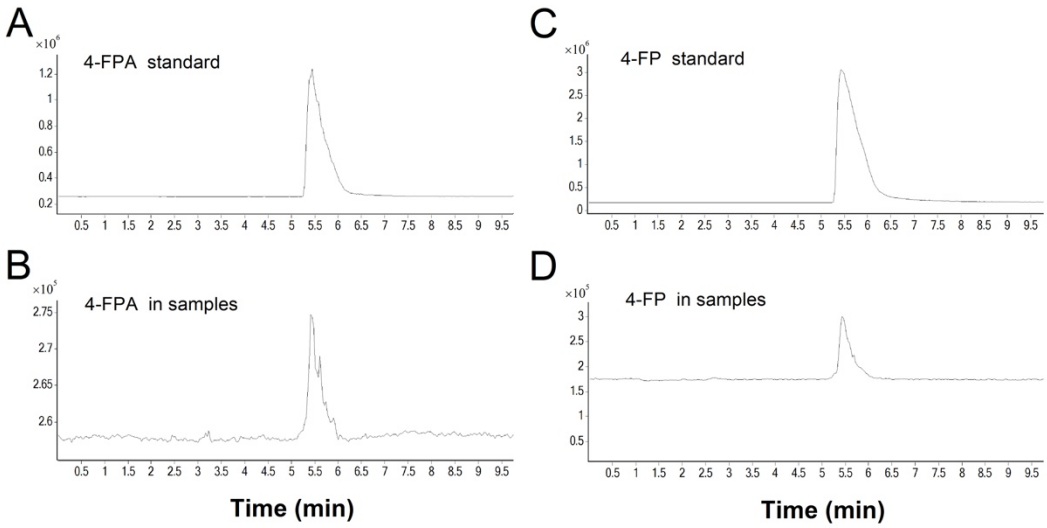

Fig. S3. Chromatograms of 4-FPA and 4-FP.

(A, B) Chromatograms of 4-FPA standard (a) and 4-FPA in samples, showing the same retention time. (C, D) Chromatograms of 4-FP standard (c) and 4-FP in samples, showing the same retention time.

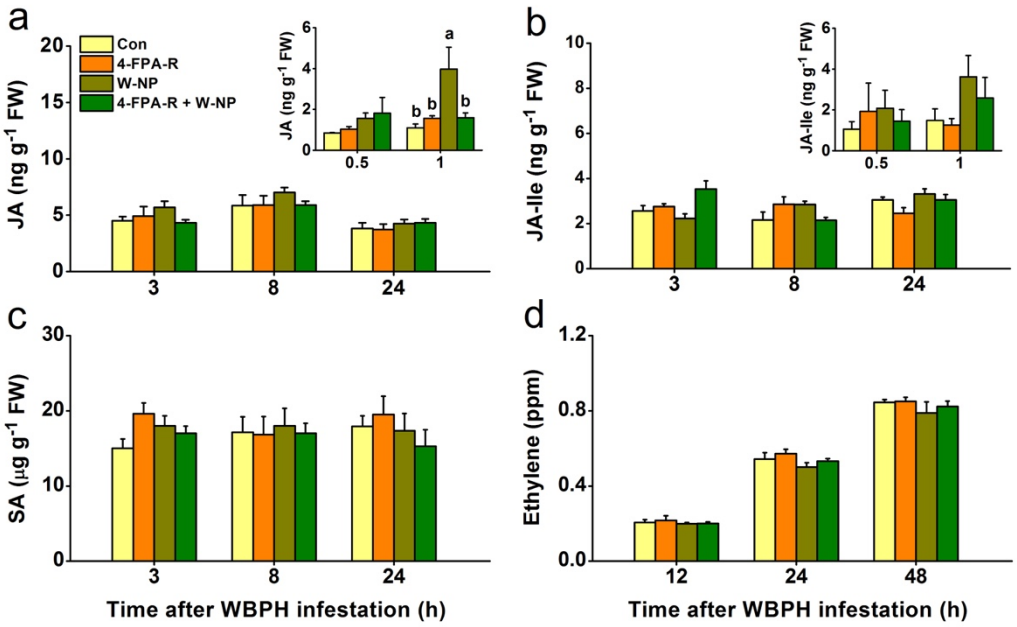

Fig. S4. 4-FPA treatment does not affect levels of JA, JA-Ile, SA, or ethylene in rice plants.

(A-C) Mean levels (+ SE, n = 6) of JA (A) and JA-Ile (B) in rice plants at 0.5, 1, 3, 8 and 24 h as well as of SA (C) in rice plants at 3, 8 and 24 h post exposure to NP, 4-FPA, 4-FPA+NP or control (Con). (D) Mean levels (+ SE, n = 6) of ethylene at 12, 24 and 48 h post exposure to W-NP, 4-FPA, 4-FPA+W-NP or control (Con). Treatment details are described in Materials and Methods. FW, Fresh weight. Letters indicate significant differences among treatments ($P < 0.05$; Duncan's multiple-range test).

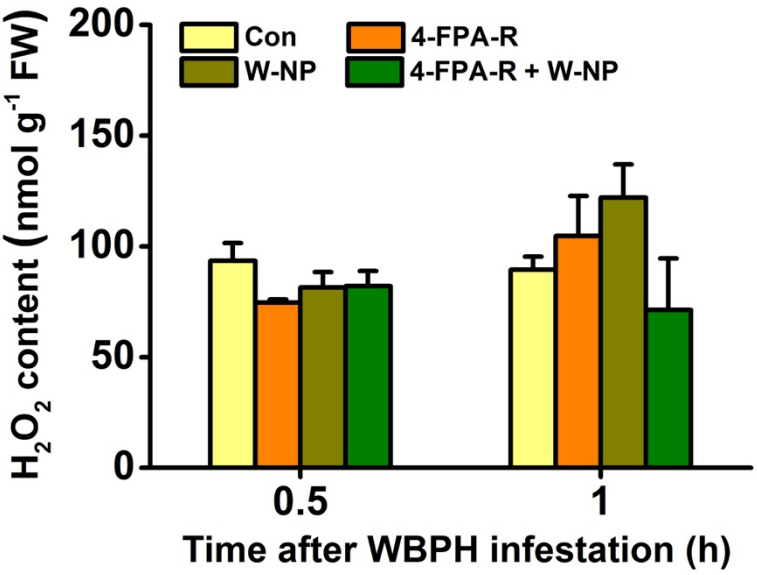

Fig. S5. Mean levels (+ SE, n = 6) of H2O2 in rice plants at 0.5 and 1 post exposure to NP, 4-FPA, 4-FPA+NP or control (Con).

Treatment details are described in Materials and Methods. FW, Fresh weight. Differences between treatments are not significant.

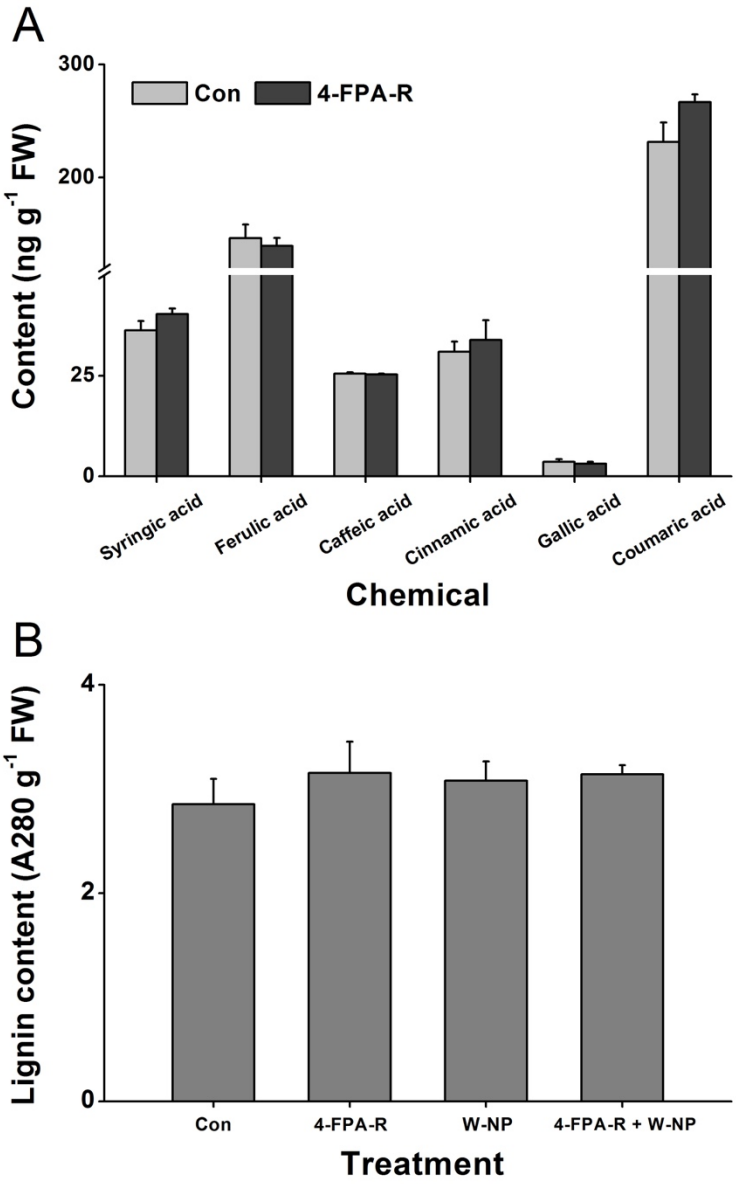

Fig. S6. 4-FPA treatment does not affect levels of phenolic acid and lignin in rice plants.

(A, B) Mean levels (+ SE, n = 6) of phenolic acids (A) and lignin (B) in rice plants at 4 d after exposure to W-NP, 4-FPA, 4-FPA+W-NP or control (Con). Treatment details are described in Materials and Methods. FW, Fresh weight. Difference between treatments are not significant.

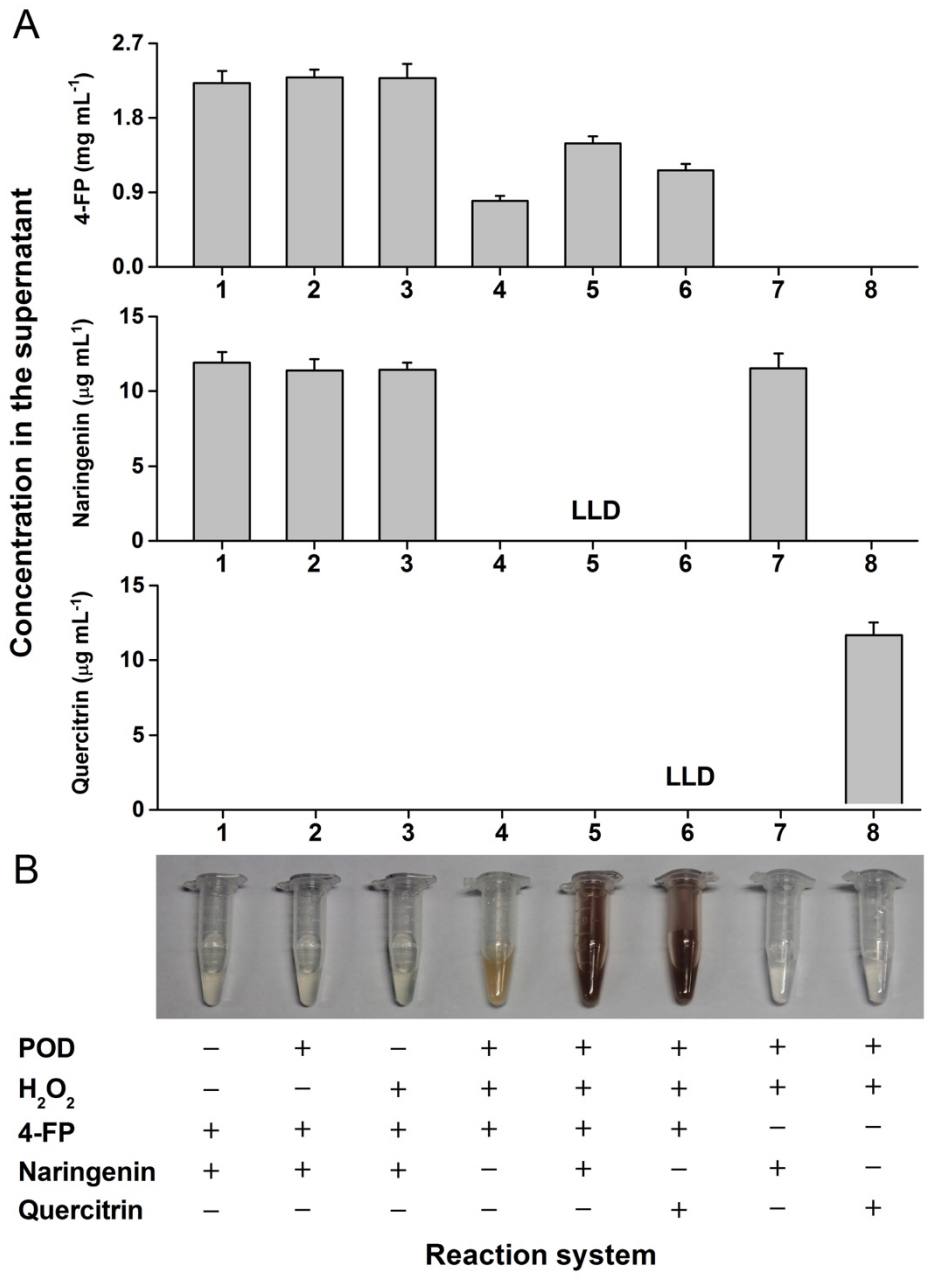

Fig. S7. 4-FP and flavonoids participate in the formation of polymers *in vitro*.

(A) Mean levels (+SE, n = 3) of 4-FP, naringenin and quercitrin in the supernatants of different reaction systems (No. 1-8) 24 h post reaction. LLD, lower limit of detection. (B) Photographs showing the colours of the different reaction systems (No. 1-8) 24 h post reaction. "＋" and "—" indicates the presence or absence of the reagent or chemical in the system. No.1-8 indicate different reaction systems.

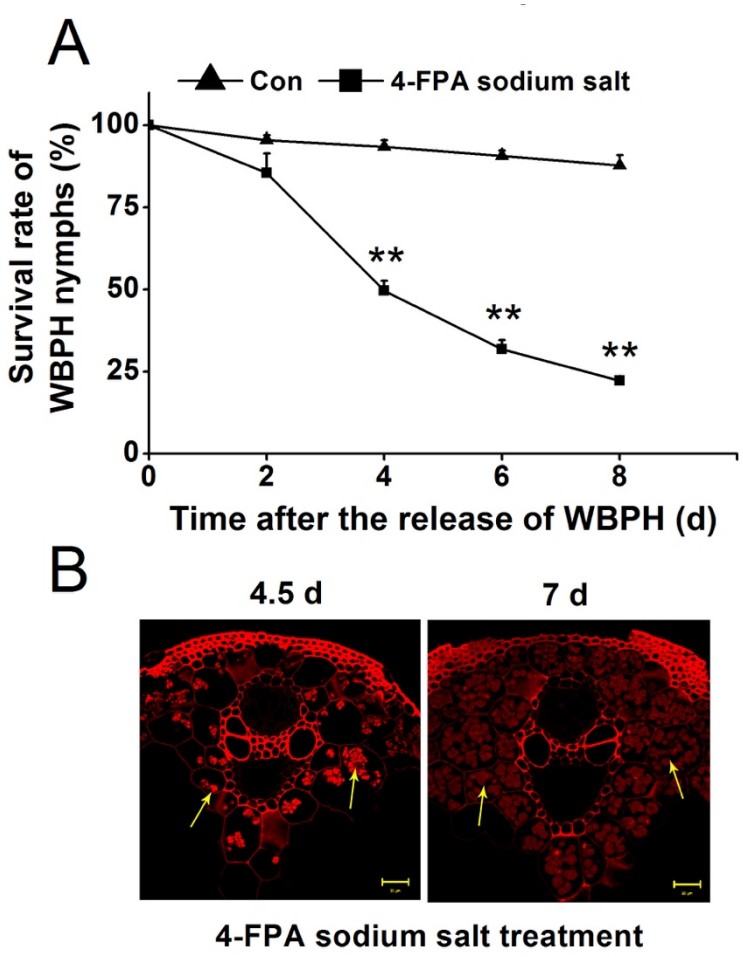

Fig. S8. Spraying with 4-FPA sodium salt (SA) causes the deposition of phenolic polymers in rice plants and decreases the survival rate of WBPH nymphs.

(A) Mean survival rate (+SE, n=8) of 15 newly hatched WBPH nymphs on plants that were individually sprayed with 4 ml of 100 mg L^{-1} 4-FPA SA, 1-8 d post exposure. (B) Fluorescence image of cross-sections from the leaf sheath of rice plants that were individually sprayed with 4ml of 100 mg L^{-1} 4-FPA SA for 4.5 d or 7 d. Scale bars = 20 μm. Asterisks indicate significant differences between treatments and controls (**, $P < 0.01$; Student's t-tests). Yellow arrows indicate polymer particles.

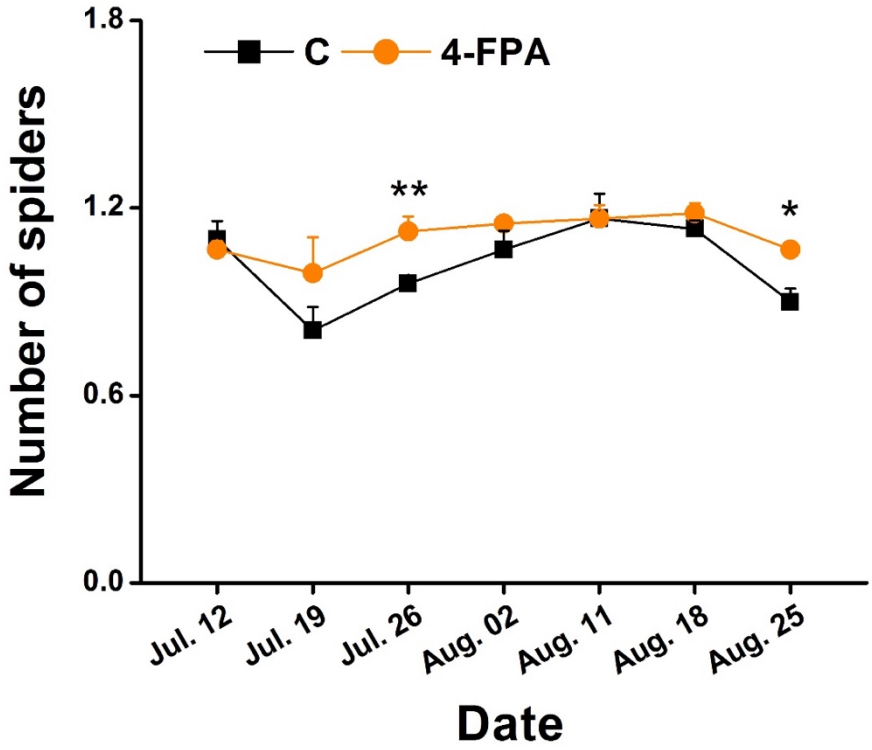

Fig. S9. Spraying with 4-FPA sodium salt (SA) does not decrease spider numbers. Mean number (+SE, n=3) of spiders per hill on plants that were sprayed with 200 mg L^{-1} 4-FPA SA and control plants in the field. 4-FPA sodium salt was sprayed on July 12th 2016. Asterisks indicate significant differences between treatments and controls (*P < 0.05, **P < 0.01; Student's t-tests).

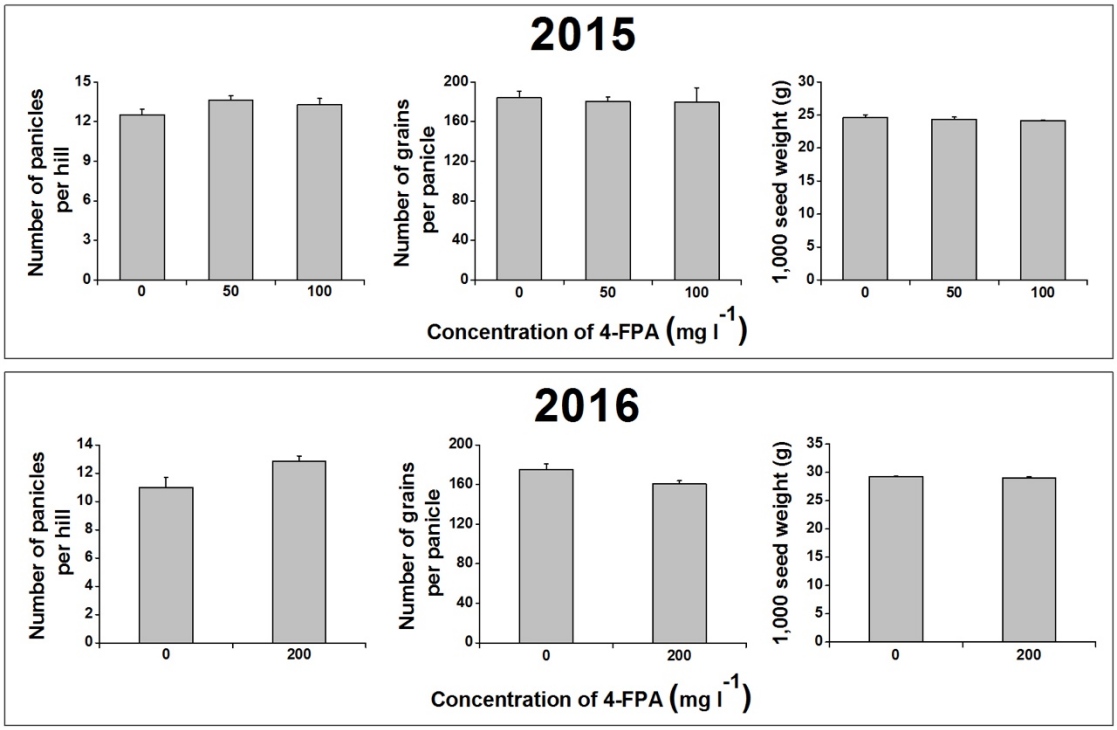

Fig. S10. Mean number of panicles per hill, number of grains per panicle and 1,000 seed weight (+SE, n=3) of plants that were sprayed with different concentrations of 4-FPA in 2015 (upper) and 2016 (below). Differences between treatments are not significant.

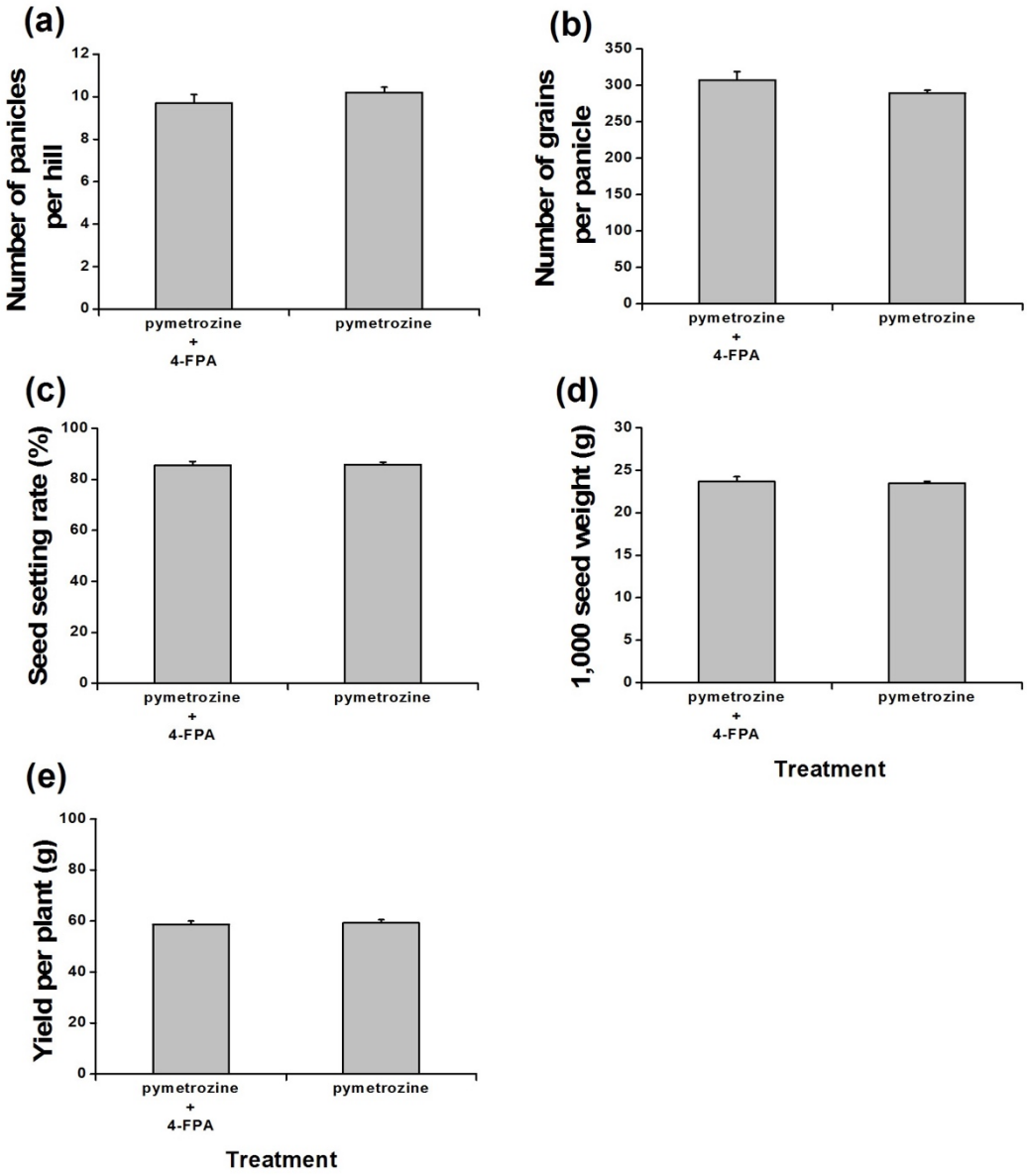

Fig. S11. Mean number of panicles per hill, number of grains per panicle, seed setting rate, 1,000 seed weight and yield per plant (+SE, n=4) of plants that were sprayed with pymetrozine plus 4-FPA or pymetrozine alone. Differences between treatments are not significant.

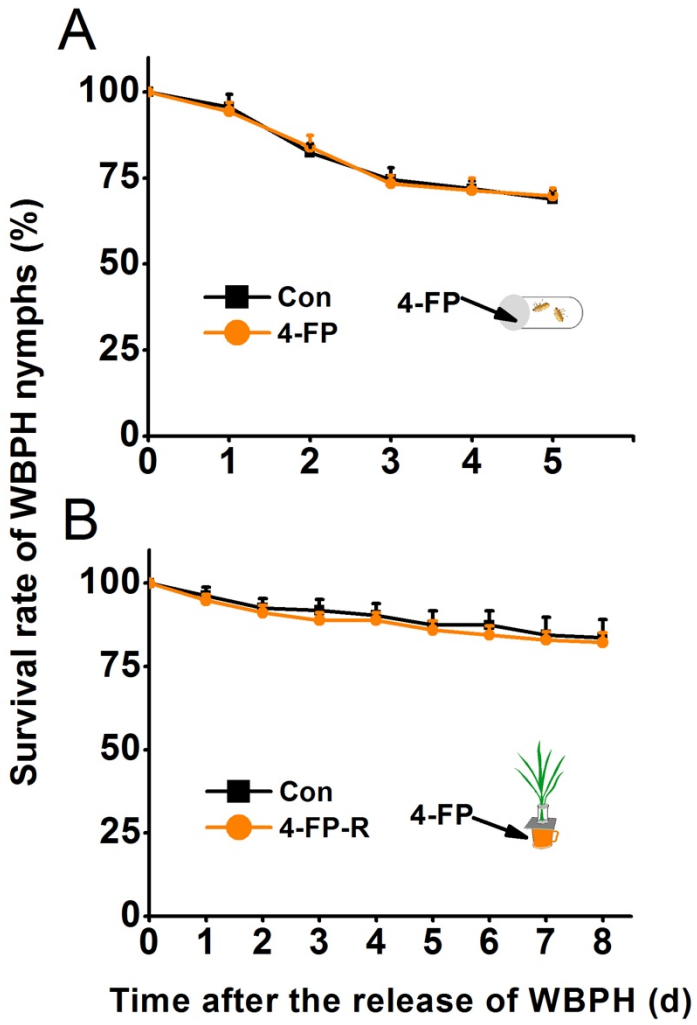

Fig. S12. 4-FP does not induce rice defences and has no direct harmful effects on WBPH nymphs.

(A) Mean survival rate (+SE, n=8) of 15 newly hatched WBPH nymphs fed artificial diet containing 50 mg l^{-1} 4-FP or not (Con). (B) Mean survival rate (+SE, n=8) of 15 newly hatched WBPH nymphs on plants that had been grown in nutrient solution containing 5 mg l^{-1} 4-FP or not (Con) for 12 h, 1-8 d post exposure. Differences between treatments are not significant.

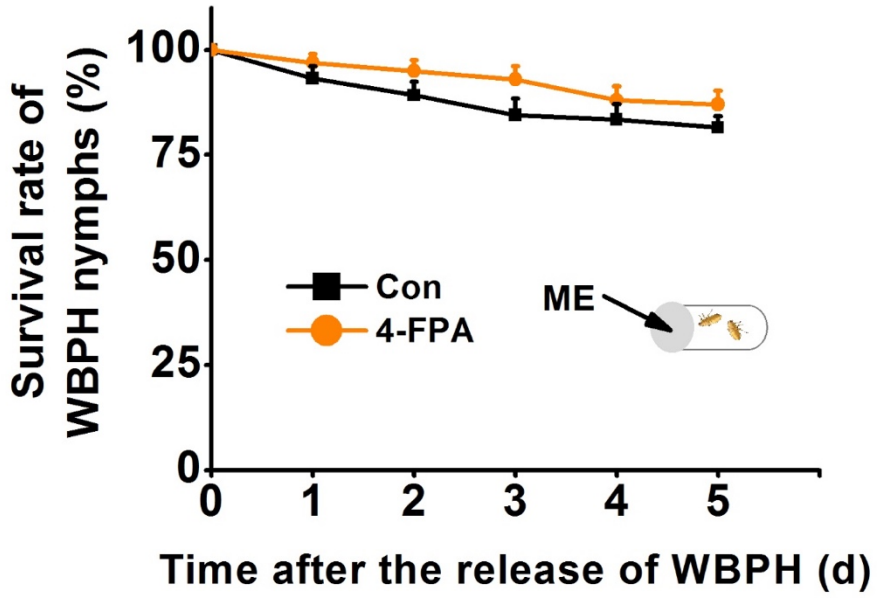

Fig. S13. Methanol extracts of 4-FPA-treated rice plants did not influence WBPH nymph performance.

Mean survival rate (+SE, n=8) of 15 newly hatched WBPH nymphs fed artificial diet containing the methanol extract (ME) of plants that had been grown in nutrient solution containing 5 mg L^{-1} for 4.5 d or control plants. One ml of artificial diet was added 50 µl of 500 µl g^{-1} fresh weight ME. Differences between treatments are not significant.

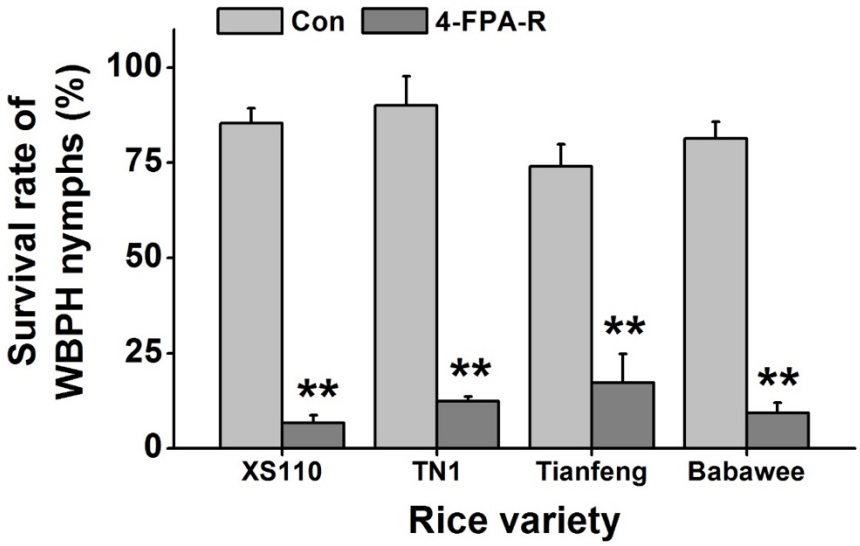

Fig. S14. Rice variety does not influence the 4-FPA-induced defenses in rice plants against WBPH nymphs.

Mean survival rate (+SE, n=8) of 15 newly hatched WBPH nymphs on plants of different rice varieties grown in nutrient solution containing 5 mg l^{-1} 4-FPA, or control plants for 12 h, 1-8 d post exposure. Asterisks indicate significant differences between treatments and controls (**P < 0.01; Student's t-tests).

Table S1. Verification of differently-expressed genes by qRT-PCR

Gene ID	Fold change (Transcriptome)	Fold change (qRT-PCR)
LOC_Os02g56120	25.23	24.69
LOC_Os01g09700	60.04	31.22
LOC_Os07g44440	50.35	66.38
LOC_Os01g27210	11.23	11.04
LOC_Os09g20260	30.18	27.31
LOC_Os11g06770	10.52	4.19
LOC_Os05g35290	2.78	2.34
LOC_Os08g34790	4.08	2.76
LOC_Os09g34250	109.32	178.41
LOC_Os01g55940	72.23	61.49
LOC_Os01g45110	117.28	137.98
LOC_Os12g02400	0.07	0.12
LOC_Os01g58100	0.18	0.22
LOC_Os04g49210	0.16	0.15
LOC_Os11g02530	0.12	0.23
LOC_Os05g34030	0.07	0.64

Table S2. Differentially-expressed genes related to the auxin-mediated signaling pathway

Category	Upregulated	Downregulated	Total
Auxin transporter-like protein	4	0	4
Auxin-responsive protein IAA	17	1	18
Auxin response factor	1	1	2
Jasmonic acid-amido synthetase	6	0	6
Auxin-responsive SAUR family	10	0	10
Total	38	2	40

Table S3. Differentially-expressed genes related to hydrogen peroxide generating and scavenging system.

Category	Upregulated	Downregulated	Total
Hydrogen peroxide generating			
Polyamine oxidase	2	1	3
Amine oxidase	1	1	2
Xanthine oxidase	1	0	1
Superoxidase dismutase	1	3	4
Glycolate oxidase	1	2	3
Glucose oxidase	1	0	1
Glyoxal oxidase	1	0	1
NADH dehydrogenase	9	0	9
Pyranose oxidase	2	0	2
Cytochrome C oxidase subunit	2	0	2
Respiratory burst oxidase	1	0	1
Protoporphyrinogen oxidase	0	1	1
Coproporphyrinogen Ⅲ oxidase	0	1	1
Acyl-CoA oxidase	4	1	5
Sarcosine oxidase	1	0	1
Sulfite oxidase	1	0	1
Total	28	10	38
Hydrogen peroxide scavenging			
Peroxidase	25	2	27
L-ascorbate peroxidase	2	3	5
Glutathione peroxidase	2	0	2
Glutathione S-transferase	13	3	16
Glutathione reductase	2	1	3
Monodehydroascorbate reductase	1	1	2
Catalase	1	2	3
Total	46	12	58

Table S4. Differentially-expressed genes related to the phenylpropanoid pathway.

Category	Upregulated	Downregulated	Total
Phenylalanine ammonia-lyase	3	1	4
Trans-cinnamate 4-monooxygenase	2	0	2
4-coumarate--CoA ligase	4	1	5
Cinnamoyl-CoA reductase	3	0	3
Phenylalanine/tyrosine ammonia-lyase	1	0	1
Cinnamyl-alcohol dehydrogenase	3	1	4
Peroxidase	25	2	27
Shikimate O-hydroxycinnamoyltransferase	2	0	2
Coumaroylquinate 3'-monooxygenase	1	0	1
Caffeoyl-CoA O-methyltransferase	1	0	1
Coniferyl-aldehyde dehydrogenase	2	0	2
Chalcone synthase	1	0	1
Chalcone isomerase	1	0	1
Flavonoid 3'-monooxygenase	1	1	2
Flavonol synthase	1	0	1
Leucoanthocyanidin reductase	1	0	1
Anthocyanidin reductase	0	1	1
Total	52	7	59

Table S5. 4-FPA treatment increases the level of free amino acids in plants

Amino acid	Con	4-FPA-R	W-NP	4-FPA-R + W-NP
P-Ser	37.90±1.8b	107.27±8.7a	46.34±1.6b	117.36±5.9a
PEA	68.38±10.0b	86.23±5.5ab	91.91±5.0a	88.70±3.9ab
Urea	157.29±23.4a	205.65±43.2a	176.22±28.8a	205.93±25.1a
Asp	178.27±10.9b	215.65±6.6a	208.60±8.5a	217.50±8.3a
Thr	50.89±6.2b	157.50±16.5a	72.50±5.3b	169.97±8.8a
Ser	184.88±23.9b	870.94±73.6a	238.44±14.1b	919.28±45.7a
Glu	421.58±23.2b	601.66±35.2a	479.78±18.8b	610.01±18.5a
Gly	8.50±2.3b	38.26±3.2a	13.73±1.8b	43.39±3.9a
Ala	104.09±21.7b	482.05±80.5a	112.37±8.1b	498.87±107.8a
Cit	7.26±1.6b	17.17±2.6a	9.31±0.4b	20.11±1.7a
a-ABA	LLD	2.89±1.0a	LLD	3.80±0.3a
Val	23.92±2.6c	53.92±4.5b	28.41±2.5c	63.89±3.4a
Cys	LLD	LLD	LLD	10.32±3.3
Met	LLD	LLD	LLD	5.17±2.3
Ile	5.16±0.9b	14.43±1.6a	6.52±0.8b	17.57±1.1a
Leu	7.70±0.9b	21.46±2.3a	9.78±1.1b	24.57±1.5a
Tyr	10.04±1.0b	28.61±2.6a	10.93±0.8b	29.56±1.0a
Phe	1.61±1.0c	16.58±2.3b	3.33±1.4c	22.74±2.1a
g-ABA	8.23±1.8b	20.86±2.3a	7.42±1.0b	20.39±3.3a
NH3	5.35±0.3d	18.47±1.0b	8.26±0.3c	24.48±0.4a
Lys	2.76±0.5c	6.38±0.6ab	5.77±0.8b	7.98±0.7a
His	LLD	9.49±0.7a	6.20±0.5b	10.59±1.5a
Arg	9.69±3.2b	34.24±6.3a	33.82±5.7a	53.27±9.3a
Pro	LLD	34.83±4.9a	8.88±2.3b	41.57±3.4a
Total	**1293.50±101.7b**	**3044.53±210.6a**	**1578.53±89.5b**	**3233.13±176.9a**

Data are mean ± SE; Letters indicate significant differences among treatments ($P < 0.05$; Duncan's multiple-range test). Plants received one of four treatments, 4-FPA, 4-FPA+W-NP, W-NP and control. Treatment details are described Materials and Methods.

Table S6. Management measurements for field experiments in 2015, 2016 and 2019

Item	Year		
	2015	**2016**	**2019**
Date of soaking seeds	16 May	20 May	11 May
Date of sowing	20 May	23 May	14 May
Seedling bed period			
Fertilizers (kg per hectare/applied date)			
45%Compound fertilizer	225/20 May	225/23 May	225/14 May
45%Compound fertilizer	150/29 May	150/1 June	150/28 May
45%Compound fertilizer+46%urea	150+150/10 June	150+150/12 June	150+150/2 June
Pesticides (amount/applied date)			
Rancona D 45g/l ME (ml/kg seeds)(soaking seeds)	3/16 May	3/20 May	3/11 May
4%Benzylsulfuron+36% Prochlorine WP (g/ha.)	900/24 May	900/27 May	900/17 May
Transplanting date	16 June	20 June	9 June
Field growth period			
Fertilizers (kg per ha./applied date)			
46%Urea + 60%KCl	300+112.5/22 June	300+112.5/25 June	300+112.5/13 June
45%Compound fertilizer	262.5/9 June	262.5/10 July	262.5/27 June
45%Compound fertilizer+46%urea	150+112.5/23 July	150+112.5/24 July	150+112.5/24 July
Pesticides (amount/applied date)			
3.2% Benzylsulfuron+10.8% Acetochlor WP (g/ha.)	450/22 June	450/25 June	450/13 June
1.8%Abamectin EC (ml/ha.)+ 50% Pymetrozine WG (g/ha.) + 32.5%AzTop 325SC (ml/ha.)	450+450+450/24 Aug.	450+450+450/25 Aug.	450+450+450/23 Aug.
20%Tricyclazole WP (g/ha.)	1500/12 Sep.	1500/13 Sep.	1500/10 Sep.
Applied date of 4-FPA sodium salt AS	8 July	12 July	27 June
Date of yield measurement	8 Oct.	11 Oct.	29 Sep.

Note: the fertilizers and pesticides used in the field are produced by the following companies. 45%Compound fertilizer, containing 15% urea, 15% P_2O_5 and 15% K_2O, Liuguo Chemical Industry, Tongling, Anhui, China; 46% urea, Anhui Sierte Fertilizer Industry Co., Ltd., Xuancheng, Anhui, China; 60% KCl, Sinofert Holding Limited, Beijing, China; Rancona D 45g/l ME, Arysta Lifescience (Shanghai) Co., Ltd., Shanghai, China; 4%Benzylsulfuron+36% Prochlorine WP, Zhejiang Tianyi Agrochemical Co., Ltd., Shaoxing, Zhejiang, China; 3.2% Benzylsulfuron+10.8% Acetochlor WP, Jiangsu kuaida Agrochemical Co., Ltd., Rudong, Jiangsu, China; 1.8%Abamectin EC, Hebei Weiyuan Biochemical Co., Ltd., Shijiazhuang, Hebei, China; 50% Pymetrozine WG, Syngenta, Basel, Switzerland; 32.5%AzTop 325SC, containing 20% Azoxystrobin and 15% Defenoconazole, Syngenta, Basel, Switzerland; 20%Tricyclazole WP, Wenzhou Pesticide Factory, Wenzhou, Zhejiang, China.

Table S7. Selected genes and their primers used for qRT-PCR

Gene ID	Definition		
LOC_Os02g56120	Auxin-responsive protein IAA	**F**	GGCGCCAACTACGTGAAGGT
		R	GCAGCGAGCTCGTCGTAGG
LOC_Os01g09700	1-aminocyclopropane-1-carboxylate synthase	**F**	CTCGAGGCCTACCTCCGTGA
		R	AACAGCGCGTTGTCCCTGAA
LOC_Os07g44440	Peroxidase	**F**	ACGTCGAGTCGCACAAGGAC
		R	CTCGTCGGCGTCGATCATGT
LOC_Os01g27210	Glutathione S-transferase	**F**	GCGGACCTCAGCCACTTCTC
		R	GCCATCACCTTCTGCACCGT
LOC_Os09g20260	Polyamine oxidase	**F**	AGCCTGCAGAACACCGTTCC
		R	GGACTTGTCGGCGTTGAGGT
LOC_Os11g06770	Ethylene-responsive transcription factor ERF110	**F**	GCGGCGAGGAAGAAGAGGAG
		R	CGCGGACACCATCACAGACA
LOC_Os05g35290	Phenylalanine ammonia-lyase	**F**	CCTCGTCCCGCTCTCCTACA
		R	TGGGCTGCAGCTCGAAGAAG
LOC_Os08g34790	4-coumarate--CoA ligase	**F**	GCAGGGCCGGTGCTATCAAT
		R	ATCTTCAGCTCGGCGTTCCG
LOC_Os09g34250	UDP-glucosyl transferase	**F**	CGAGCTCCAGCCACAGGAAG
		R	GTCGTCGGCGAGAAGAGGTG
LOC_Os01g55940	Jasmonic acid-amido synthetase	**F**	CCGAGTGCGGGAAGGACAAG
		R	GGAGCCCACCGCTGTAGAAC
LOC_Os01g45110	Anthocyanin 3'-O-beta-glucosyltransferase	**F**	GGTCGCTCTTGCGAACAAGG
		R	GCCGAAGGAGACGTACACCA
LOC_Os12g02400	WRKY114	**F**	GCCCTCTCCGTCATGAACCA
		R	TTCCAGCGACGTGGTTGTCT
LOC_Os01g58100	Polyphenol oxidase	**F**	AACGAGCGATGTCGTGTTGC
		R	GTCAGAGTTTGGGCGCATGG
LOC_Os04g49210	Naringenin,2-oxoglutarate 3-dioxygenase	**F**	CGACTTCCTGCGCTTGCATT
		R	CGAGTAGGTGCCGACCACTT
LOC_Os11g02530	WRKY40	**F**	AGGCAACAAAGACGGTGCAG
		R	AGCAGGTATGCTGGCCGTAG
LOC_Os05g34030	Peptide transporter PTR2	**F**	CGACGATCGGGTTCAATGCC
		R	CCGACGATCGGTGTGAGGTT
LOC_Os03g50885	Actin	**F**	TGGACAGGTTATCACCATTGGT
		R	CCGCAGCTTCCATTCCTATG

Table S8. The composition of reagents or chemicals in different reaction systems

No.	POD (μL) (0.34mg/mL)	H_2O_2 (μL) (0.3%)	4-FP (μL) (10mg/mL)	Naringenin (μL) (50 mg/L)	Quercitrin (μL) (50 mg/L)	PBS (μL) (0.05 mM)	Total volume
1	—	—	100	100	—	210	410
2	10	—	100	100	—	200	410
3	—	200	100	100	—	10	410
4	10	200	100	—	—	100	410
5	10	200	100	100	—	—	410
6	10	200	100	—	100	—	410
7	10	200	—	100	—	100	410
8	10	200	—	—	100	100	410