

Electronic Supplementary Material

Multiple detection of 15 triazine herbicides by gold nanoparticle based-paper sensor

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Figure S1. UV-vis spectra of 15 nm-GNP solution.

Figure S2. Optimization of K₂CO₃ usage using sodium chloride.

Figure S3. The cross reactivity of ICA with cyanazine, dipropetryn, and metributon. The standard concentrations are 0, 40, 200, 1000 and 5000 ng/mL from left to right.

Figure S4. Strip images of 15 triazines in spiked brown rice samples. The 15 triazines are in order (1~15) as follows: ametryn, cyprazine, atraton, prometon, prometryn, atrazine, propazine, terbuthylazine, simetryn, trietazine, secbumeton, simazine, desmetryn, terbumeton and simetone. The spiked concentrations of each triazine are 0, 0.02, 0.1, 0.5 and 2.5 mg/kg from left to right.

Figure S5. Strip images of 15 triazines in spiked wheat samples. The 15 triazines are in order (1~15) as follows: ametryn, cyprazine, atraton, prometon, prometryn, atrazine, propazine, terbuthylazine, simetryn, trietazine, secbumeton, simazine, desmetryn, terbumeton and simetone. The spiked concentrations of each triazine are 0, 0.02, 0.1, 0.5 and 2.5 mg/kg from left to right.

Figure S6. Strip images of 15 triazines in spiked sorghum samples. The 15 triazines are in order (1~15) as follows: ametryn, cyprazine, atraton, prometon, prometryn, atrazine, propazine, terbuthylazine, simetryn, trietazine, secbumeton, simazine, desmetryn, terbumeton and simetone. The spiked concentrations of each triazine are 0, 0.02, 0.1, 0.5 and 2.5 mg/kg from left to right.

Table S1. Instrument parameters for UPLC-MS/MS analyses.

Table S2. MS/MS parameters for 15 triazines.

Table S3. The optimization results expressed as gray values.

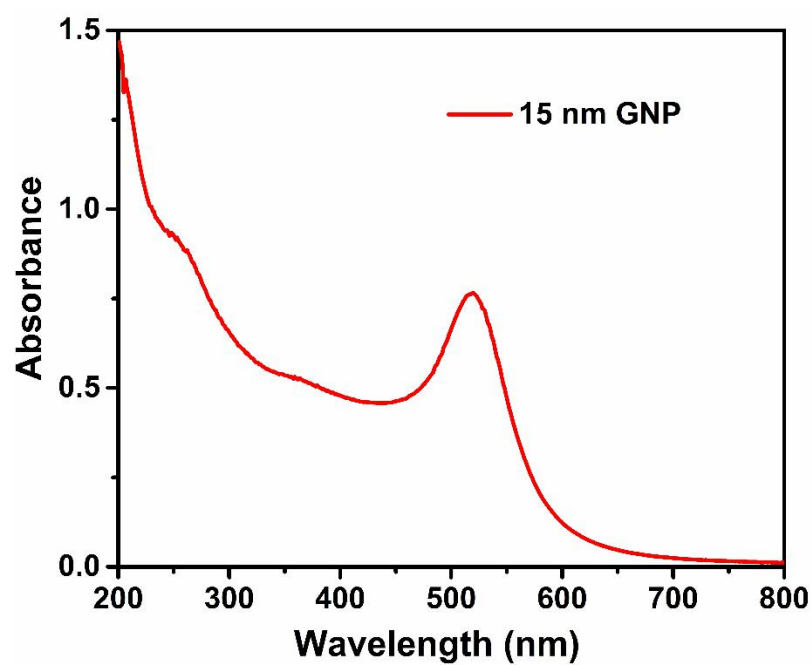


Figure S1 UV-vis spectra of 15 nm-GNP solution.



Figure S2. Optimization of K_2CO_3 usage using sodium chloride.

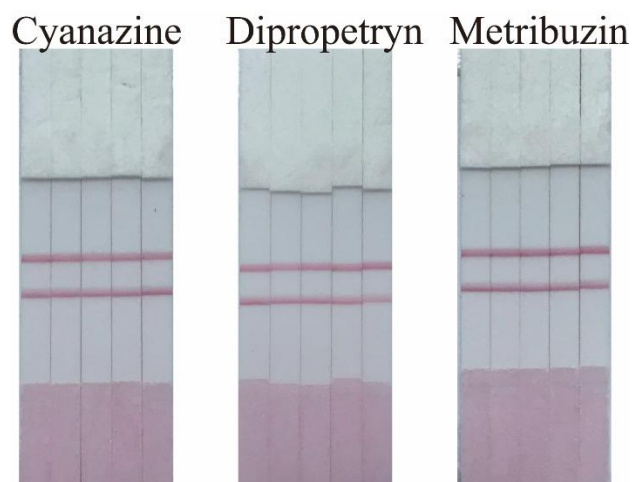


Figure S3 The cross reactivity of ICA with cyanazine, dipropetryn, and metributon. The standard concentrations are 0, 40, 200, 1000 and 5000 ng/mL from left to right.

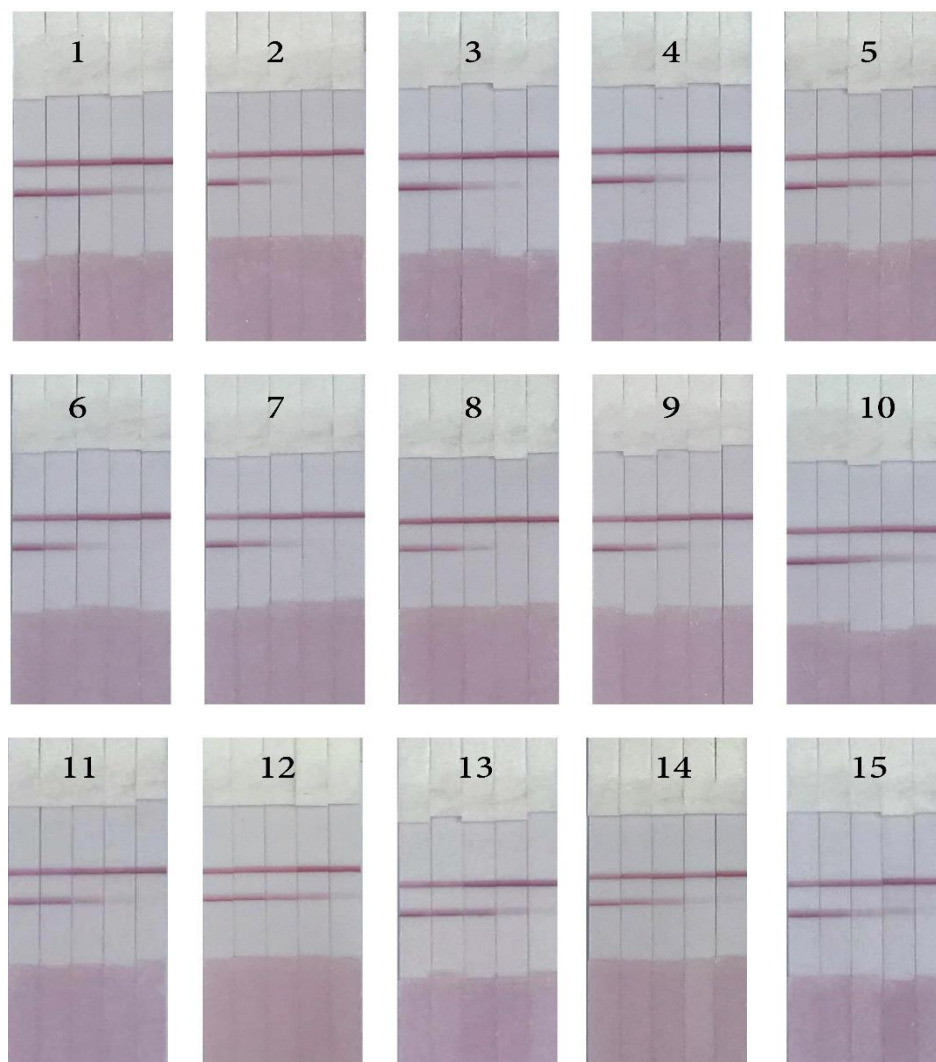


Figure S4 Strip images of 15 triazines in spiked brown rice samples. The 15 triazines are in order (1~15) as follows: ametryn, cyprazine, atraton, prometon, prometryn, atrazine, propazine, terbuthylazine, simetryn, trietazine, secbumeton, simazine, desmetryn, terbumeton and simetone. The spiked concentrations of each triazine are 0, 0.02, 0.1, 0.5 and 2.5 mg/kg from left to right.

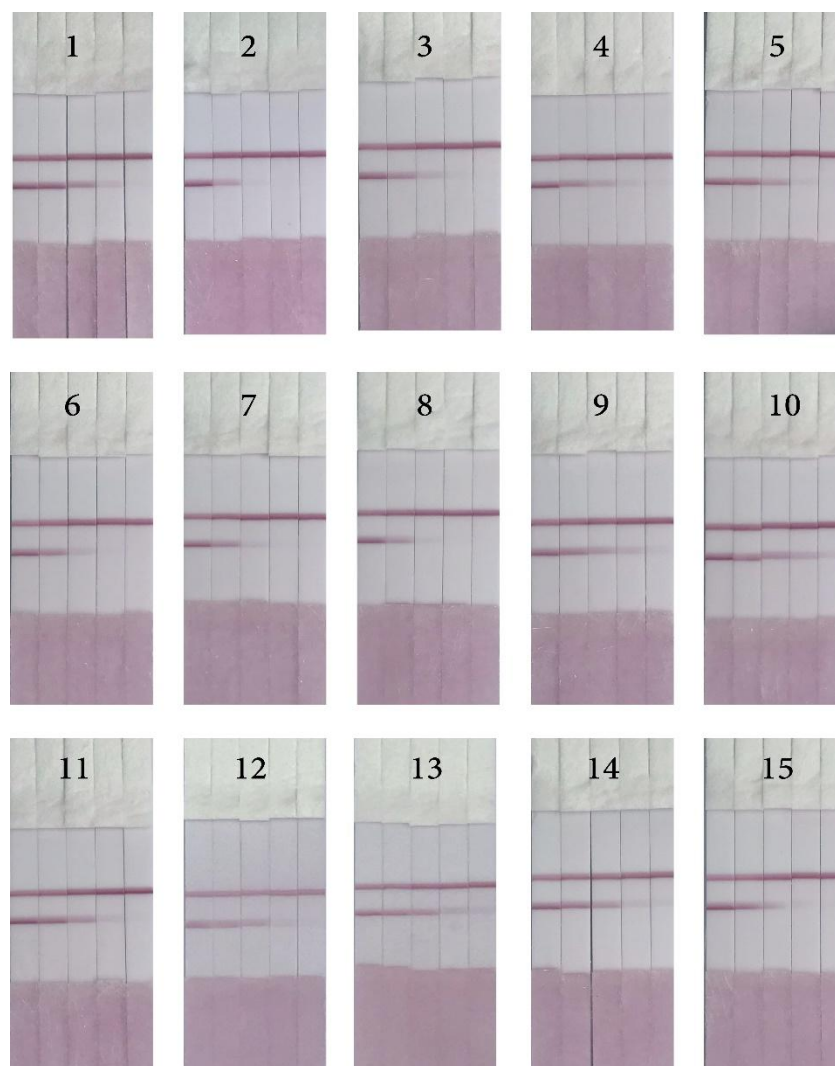


Figure S5 Strip images of 15 triazines in spiked wheat samples. The 15 triazines are in order (1~15) as follows: ametryn, cyprazine, atraton, prometon, prometryn, atrazine, propazine, terbuthylazine, simetryn, trietazine, secbumeton, simazine, desmetryn, terbumeton and simetone. The spiked concentrations of each triazine are 0, 0.02, 0.1, 0.5 and 2.5 mg/kg from left to right.

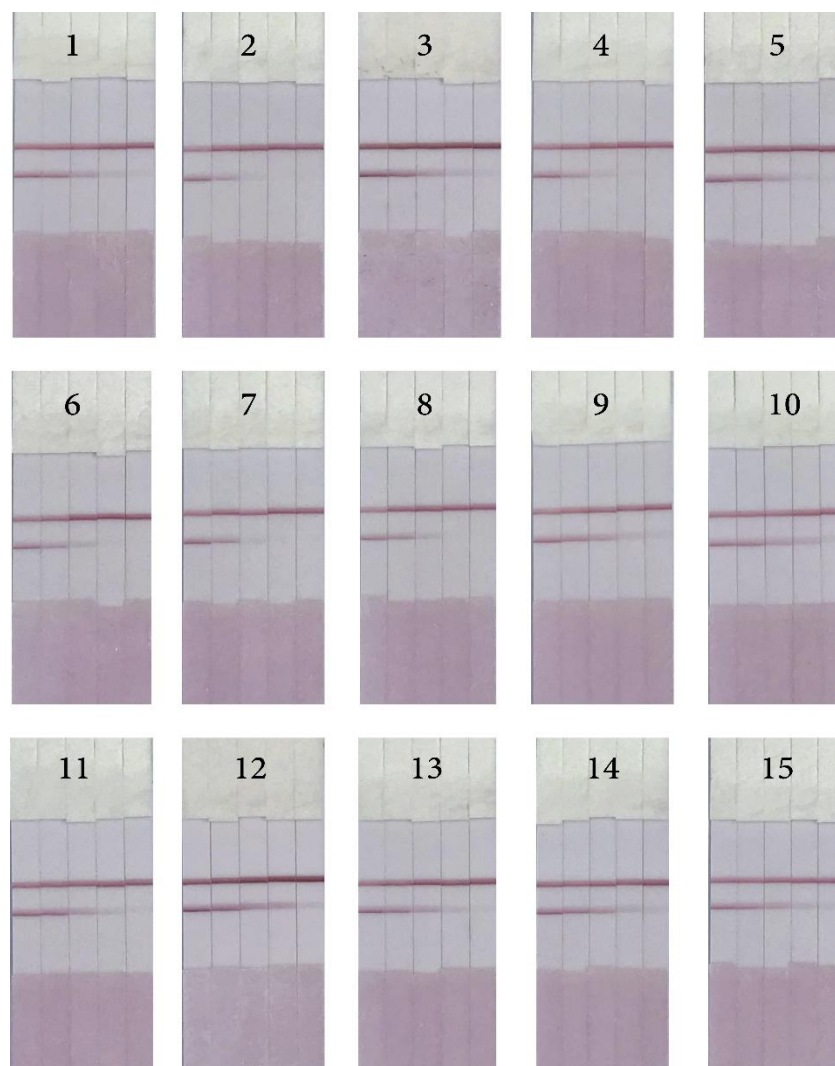


Figure S6 Strip images of 15 triazines in spiked sorghum samples. The 15 triazines are in order (1~15) as follows: ametryn, cyprazine, atraton, prometon, prometryn, atrazine, propazine, terbuthylazine, simetryn, trietazine, secbumeton, simazine, desmetryn, terbumeton and simetone. The spiked concentrations of each triazine are 0, 0.02, 0.1, 0.5 and 2.5 mg/kg from left to right.

Table S1 Instrument parameters for UPLC-MS/MS analyses.

UPLC parameters		
Column	Waters BEH C18 (2.1×100 mm, 1.8 μm)	
Flow rate	0.30 ml/min	
Column temperature	40°C	
Injection volume	2μl	
Gradient timetable		
Time (min)	Acetonitrile (%)	0.1% Formic acid in water (%)
0	3	97
1	3	97
1.5	15	85
2.5	50	50
14	70	30
16	98	2
20	98	2
20.1	3	97
23	3	97
Electrospray MS parameters		
Desolvation gas flow	650 L/h	
Cone gas flow	50 L/h	
Desolvation gas temperature	350°C	
Source temperature	120°C	

Table S2 MS/MS parameters for 15 triazines.

Number	Chemicals	CAS	Formula	Mw	Retention time (min)	Parent ion (m/z)	Daughter ion (m/z)	Cone voltage(V)	Collision energy(V)
1	Ametryn	834-12-8	$C_9H_{17}N_5S$	227.33	4.31	228	186	45	25
							96*		36
							91		35
2	Cyprazine	22936-86-3	$C_9H_{14}ClN_5$	227.69	4.56	228	186	120	25
							108*		34
							68		50
3	Atraton	1610-17-9	$C_9H_{17}N_5O$	211.264	3.75	212	170*	110	26
							100		35
							184*		26
4	Prometon	1610-18-0	$C_{10}H_{19}N_5O$	225.29	3.93	226	142	100	29
							86		41
							200		25
5	Prometryn	7287-19-6	$C_{10}H_{19}N_5S$	241.36	4.79	242	158*	100	30
							174		24
							104*		34
6	Atrazine	1912-24-9	$C_8H_{14}ClN_5$	215.68	4.56	216	96	85	32
							188		25
							146*		30
7	Propazine	139-40-2	$C_9H_{16}ClN_5$	229.71	5.15	230	104	100	44
							188		26
							146*		31
8	Terbuthylazine	5915-41-3	$C_9H_{16}ClN_5$	229.71	5.15	230	104	120	41
							124*		27
							96		31
9	Simetryne	1014-70-6	$C_8H_{15}N_5S$	213.3	3.99	214	68	85	47
							202		26
							132*		29
10	Trietazine	1912-26-1	$C_9H_{16}ClN_5$	229.71	6.12	230	99	120	32
							104		40
							170*		34
11	Secbumeton	26259-45-0	$C_{10}H_{19}N_5O$	225.29	3.92	226	170*	100	34

							100		40
							69		51
							132*		27
12	Simazine	122-34-9	C ₇ H ₁₂ ClN ₅	201.66	4.16	202	104	120	37
							96		41
13	Desmetryn	1014-69-3	C ₈ H ₁₅ N ₅ S	213.3	3.98	214	172*	108	26
							82		38
							170*		35
14	Terbumeton	33693-04-8	C ₁₀ H ₁₉ N ₅ O	225.29	3.93	226	100	80	42
							114		32
							100*		34
15	Simetone	673-04-1	C ₈ H ₁₅ N ₅ O	197.24	3.59	198	96	100	33
							68		46
							128		25

* Ion for quantification.

Table S3 The optimization results expressed as gray values

Optimization type	Optimization condition	Spiked level, ng/mL	C value	T value	T/C value	Inhibition ratio
GNP labelled mAb	(5 μ L, 8 μ g)	0	56.36	63.36	1.12	15.0%
		20	57.04	54.50	0.96	
	(5 μ L, 10 μ g)	0	66.79	63.85	0.96	22.9%
		20	74.75	55.07	0.74	
	(8 μ L, 8 μ g)	0	63.10	58.61	0.93	15.7%
		20	68.00	53.26	0.78	
	(8 μ L, 10 μ g)	0	68.39	59.31	0.87	17.7%
		20	73.44	52.42	0.71	
	TW-20	0	65.54	83.73	1.28	23.8%
		20	70.16	68.29	0.97	
Suspension buffer	Triton X-100	0	42.00	73.09	1.74	30.1%
		20	49.87	60.69	1.22	
	ON-870	0	69.90	81.64	1.17	24.7%
		20	80.82	71.10	0.88	
	Brij-35	0	73.61	72.97	0.99	31.1%
		20	77.77	53.11	0.68	
Assay buffer	Tris-HCl	0	74.42	65.70	0.88	13.9%
		20	69.63	52.94	0.76	
	PBS	0	66.80	67.36	1.01	28.1%
		20	72.67	52.66	0.72	
	BBS	0	67.39	67.06	1.00	14.1%
		20	69.21	59.13	0.85	
	CBS	0	71.71	65.39	0.91	6.8%
		20	73.79	62.71	0.85	