Table S1 Maize grain P concentrations as affected by intercropping with legumes or oilseed rape and P application rates in each year at each experimental location.

Location	Harvest year	P application rate (kg ha^{-1})	Maize monoculture (mg kg^{-1})	Maize intercropped with (mg kg^{-1})							Mean (mg kg^{-1})	*ANOVA* (*P* × *C*)	*ANOVA* (*Y* × *P* × *C*)
				Oilseed rape (*Brassica napus* L.)	Oilseed rape (*Brassica campestris* L.)	Chickpea	Faba bean	Soybean	Peanut				
									Conventional treatment	Chemical regulation			
Jingyuan	2009	0	1.91a	1.91a	-	1.93a	2.07a	2.09a	-	-	1.98A	*P* = 0.7630	
		40	1.95a	2.15a	-	1.92a	1.88a	1.90a	-	-	1.96A	*C* = 0.0631	
		80	1.72c	2.30a	-	2.10ab	2.03b	1.89bc	-	-	2.01A	*P* × *C* = 0.0839	
		Mean	1.86B	2.12A	-	1.98AB	1.99AB	1.96AB	-	-	1.98		
Wuwei	2009	0	1.96ab	2.44a	-	2.37ab	2.22ab	1.92b	-	-	2.18A	*P* = 0.3438	*Y* < 0.0001
		40	1.92b	2.63a	-	2.37ab	2.25ab	2.28ab	-	-	2.29A	*C* < 0.0001	*P* = 0.0005
		80	2.01c	2.65a	-	2.27bc	2.34ab	2.02bc	-	-	2.26A	*P* × *C* = 0.6315	*C* < 0.0001
		Mean	1.97C	2.57A	-	2.33B	2.27B	2.07C	-	-	2.24		*Y* × *P* = 0.1896
	2010	0	1.67a	-	1.87a	2.05a	1.79a	2.14a	-	-	1.90B	*P* = 0.0116	*Y* × *C* = 0.0123
		40	1.91a	-	2.07a	2.50a	2.10a	2.53a	-	-	2.22A	*C* = 0.0726	*P* × *C* = 0.3403
		80	2.03b	-	2.62a	2.22ab	2.30ab	2.33ab	-	-	2.30A	*P* × *C* = 0.6649	*Y* × *P* × *C* = 0.9125
		Mean	1.87B	-	2.19AB	2.26A	2.06AB	2.33A	-	-	2.14		
	2011	0	1.82a	-	2.02a	2.09a	2.10a	1.90a	-	-	1.98B	*P* = 0.0121	
		40	1.91b	-	2.27a	2.14ab	2.18a	2.14ab	-	-	2.13A	*C* = 0.0387	
		80	2.07a	-	2.16a	2.21a	2.24a	2.21a	-	-	2.18A	*P* × *C* = 0.8646	
		Mean	1.93B	-	2.15A	2.15A	2.17A	2.08AB	-	-	2.10		
	2012	0	1.96ab	-	1.85ab	2.34a	1.77ab	1.54b	-	-	1.89A	*P* = 0.7076	
		40	1.83a	-	1.91a	1.98a	1.94a	1.90a	-	-	1.91A	*C* = 0.0254	
		80	1.80a	-	2.01a	2.11a	1.92a	1.95a	-	-	1.96A	*P* × *C* = 0.1847	

		Mean	1.87B	-	1.92B	2.15A	1.87B	1.80B	-	-	1.92		
Wuzhong	2008	0	2.13a	-	-	-	2.34a	-	-	-	2.23A	*P* = 0.6919	
		52.4	2.12a	-	-	-	2.41a	-	-	-	2.27A	*C* = 0.0371	
		Mean	2.12B	-	-	-	2.38A	-	-	-	2.25	*P* × *C* = 0.6509	
	2009	0	2.08a	-	-	-	2.46a	-	-	-	2.27A	*P* = 0.1464	
		26.2	2.23a	-	-	-	1.93a	-	-	-	2.08AB	*C* = 0.5782	
		52.4	1.90a	-	-	-	2.02a	-	-	-	1.96B	*P* × *C* = 0.1116	
		Mean	2.07A	-	-	-	2.14A	-	-	-	2.10		
Quzhou	2009	0	-	-	-	-	-	-	-	-	-		
		40	-	-	-	-	-	-	-	-	-		
		80	-	-	-	-	-	-	-	-	-		
		Mean	-	-	-	-	-	-	-	-	-		
	2010	0	2.96	3.04	-	3.56	3.45	3.28	-	-	3.26		
		40	3.48	3.40	-	3.65	3.51	3.70	-	-	3.55		
		80	2.94	3.21	-	3.67	3.64	3.56	-	-	3.40		
		Mean	3.13	3.22	-	3.63	3.53	3.51	-	-	3.40		
Luoyang	2012	0	2.21b	-	-	-	-	-	3.13a	3.25a	2.87B	*P* < 0.0001	*Y* < 0.0001
		80	2.52b	-	-	-	-	-	3.77a	4.10a	3.46A	*C* < 0.0001	*P* < 0.0001
		Mean	2.37B	-	-	-	-	-	3.45A	3.67A	3.16	*P* × *C* = 0.0670	*C* < 0.0001
	2013	0	3.18b	-	-	-	-	-	3.77a	3.81a	3.59B	*P* = 0.0175	*Y* × *P* = 0.4680
		80	3.64a	-	-	-	-	-	4.11a	4.37a	4.04A	*C* = 0.0137	*Y* × *C* = 0.0288
		Mean	3.41B	-	-	-	-	-	3.94A	4.09A	3.81	*P* × *C* = 0.8763	*P* × *C* = 0.4095 *Y* × *P* × *C* = 0.5586
Jinan	2017	0	2.92a	-	-	-	-	-	3.10a	-	3.01B	*P* = 0.0077	
		40	2.61b	-	-	-	-	-	3.30a	-	2.96B	*C* = 0.0054	

										$P \times C =$
80	3.33a	-	-	-	-	-	3.41a	-	3.37A	0.0316
Mean	2.95B	-	-	-	-	-	3.27A	-	3.11	

Values are means of 3 replicates. In Quzhou, only mean results of 3 replicates in 2010 were collected without each repeated values. Values followed by the same lowercase letters are not significantly different among different cropping systems within the same P application rate in one year in each experimental location at the 5% level by Fisher's protected LSD (horizontal comparison); values followed by the same capital letters are not significantly different among different P application rates (vertical comparison) or among different cropping systems (horizontal comparison) in one year in each experimental location at the 5% level by Fisher's protected

LSD. Values under *ANOVA* are the probabilities (*P* values) of the source of variation. *Y*: year. *P*. P application rate. *C*: cropping system.

Table S2 Maize straw P concentrations as affected by intercropping with legumes or oilseed rape and P application rates in each year at each experimental location.

Location	Harvest year	P application rate (kg ha^{-1})	Maize monoculture (mg kg^{-1})	Maize intercropped with (mg kg^{-1})							Mean (mg kg^{-1})	*ANOVA* ($P \times C$)	*ANOVA* ($Y \times P \times C$)
				Oilseed rape (*Brassica napus* L.)	Oilseed rape (*Brassica campestris* L.)	Chickpea	Faba bean	Soybean	Peanut				
									Conventional treatment	Chemical regulation			
Jingyuan	2009	0	0.36a	0.42a	-	0.45a	0.36a	0.40a	-	-	0.40A	P = 0.7919	
		40	0.39b	0.37b	-	0.40ab	0.54a	0.35b	-	-	0.41A	C = 0.2137	
		80	0.34a	0.40a	-	0.49a	0.45a	0.42a	-	-	0.42A	$P \times C$ = 0.4001	
		Mean	0.36B	0.40AB	-	0.44AB	0.45A	0.39AB	-	-	0.41		
Wuwei	2009	0	0.40a	0.28a	-	0.41a	0.31a	0.28a	-	-	0.34A	P = 0.5012	Y < 0.0001
		40	0.32a	0.44a	-	0.33a	0.40a	0.42a	-	-	0.38A	C = 0.8916	P = 0.1205
		80	0.45a	0.31b	-	0.30b	0.34b	0.30b	-	-	0.34A	$P \times C$ = 0.4940	C = 0.6989
		Mean	0.39A	0.34A	-	0.35A	0.35A	0.33A	-	-	0.35		$Y \times P$ = 0.4377
	2010	0	0.31ab	-	0.28b	0.40a	0.30ab	0.36ab	-	-	0.33A	P = 0.2137	$Y \times C$ = 0.6084
		40	0.28a	-	0.35a	0.42a	0.40a	0.38a	-	-	0.37A	C = 0.0613	$P \times C$ = 0.9484
		80	0.33b	-	0.44a	0.41ab	0.38ab	0.31b	-	-	0.37A	$P \times C$ = 0.2757	$Y \times P \times C$ = 0.7791
		Mean	0.30B	-	0.36AB	0.41A	0.36AB	0.35AB	-	-	0.36		
	2011	0	0.70a	-	0.78a	0.87a	0.81a	0.70a	-	-	0.77B	P = 0.2520	
		40	0.97a	-	0.81a	0.82a	0.99a	0.87a	-	-	0.89A	C = 0.8979	
		80	0.80a	-	0.80a	0.79a	0.84a	0.84a	-	-	0.81B	$P \times C$ = 0.9309	
		Mean	0.83A	-	0.80A	0.83A	0.88A	0.80A	-	-	0.83		
	2012	0	0.80ab	-	0.91a	0.70b	0.76ab	0.82ab	-	-	0.80A	P = 0.3944	
		40	0.85a	-	0.81a	0.83a	0.80a	0.65a	-	-	0.79A	C = 0.1774	
		80	0.85a	-	0.95a	0.80a	0.85a	0.79a	-	-	0.85A	$P \times C$ = 0.6542	

		Mean	0.83AB	-	0.89A	0.78AB	0.80AB	0.75B	-	-	0.81		
Wuzhong	2008	0	0.21a	-	-	-	0.49a	-	-	-	0.35B	*P* = 0.1126	
		52.4	0.50a	-	-	-	0.65a	-	-	-	0.57A	*C* = 0.1246	
		Mean	0.35A	-	-	-	0.57A	-	-	-	0.46	*P* × *C* = 0.6234	
	2009	0	0.36a	-	-	-	0.33a	-	-	-	0.35B	*P* = 0.5226	
		26.2	0.45a	-	-	-	0.45a	-	-	-	0.45A	*C* = 0.8290	
		52.4	0.37a	-	-	-	0.44a	-	-	-	0.41AB	*P* × *C* = 0.8196	
		Mean	0.39A	-	-	-	0.41A	-	-	-	0.40		
Quzhou	2009	0	-	-	-	-	-	-	-	-	-		
		40	-	-	-	-	-	-	-	-	-		
		80	-	-	-	-	-	-	-	-	-		
		Mean	-	-	-	-	-	-	-	-	-		
	2010	0	1.17	1.06	-	1.34	1.12	1.19	-	-	1.17		
		40	1.51	1.04	-	1.65	1.20	1.48	-	-	1.38		
		80	1.35	1.05	-	1.32	1.32	1.81	-	-	1.37		
		Mean	1.34	1.05	-	1.44	1.21	1.49	-	-	1.31		
Luoyang	2012	0	1.70a	-	-	-	-	-	1.70a	1.74a	1.71B	*P* < 0.0001	*Y* < 0.0001
		80	1.99a	-	-	-	-	-	2.04a	2.04a	2.03A	*C* = 0.7415	*P* < 0.0001
		Mean	1.85A	-	-	-	-	-	1.87A	1.89A	1.87	*P* × *C* = 0.8983	*C* < 0.0001
	2013	0	2.68b	-	-	-	-	-	2.68b	3.05a	2.80B	*P* < 0.0001	*Y* × *P* = 0.0075
		80	3.01c	-	-	-	-	-	3.33b	3.57a	3.30A	*C* < 0.0001	*Y* × *C* < 0.0001
		Mean	2.84C	-	-	-	-	-	3.00B	3.31A	3.05	*P* × *C* = 0.0267	*P* × *C* = 0.0764 *Y* × *P* × *C* = 0.2329
Jinan	2017	0	1.09a	-	-	-	-	-	1.19a	-	1.14A	*P* = 0.5220	
		40	0.73a	-	-	-	-	-	1.14a	-	0.93A	*C* = 0.2244	

											P × *C* =
80	1.06a	-	-	-	-	-	1.17a	-	1.12A	0.6749	
Mean	0.96A	-	-	-	-	-	1.17A	-	1.06		

Values are means of 3 replicates. In Quzhou, only mean results of 3 replicates in 2010 were collected without each repeated values. Values followed by the same lowercase letters are not significantly different among different cropping systems within the same P application rate in one year in each experimental location at the 5% level by Fisher's protected LSD (horizontal comparison); values followed by the same capital letters are not significantly different among different P application rates (vertical comparison) or among different cropping systems (horizontal comparison) in one year in each experimental location at the 5% level by Fisher's protected LSD. Values under *ANOVA* are the probabilities (*P* values) of the source of variation. *Y*: year. *P*: P application rate. *C*: cropping system.

Table S3 Maize harvest indexes and P harvest indexes as affected by intercropping with legumes or oilseed rape across all experimental sites, study years and P application rates.

Maize monoculture	Maize intercropped with						The P value of paired t test	Increase (%) in harvest index over maize monoculture	Standard deviation (%) for different trials
	Oilseed rape (*Brassica napus* L.)	Oilseed rape (*Brassica campestris* L.)	Chickpea	Faba bean	Soybean	Peanut			
					Harvest indexes				
0.56	0.56	-	-	-	-	-	NS (n = 24)	0.1	4.4
0.52	-	0.53	-	-	-	-	NS (n = 27)	2.1	5.0
0.54	-	-	0.54	-	-	-	NS (n = 51)	1.1	3.7
0.53	-	-	-	0.54	-	-	NS (n = 66)	1.3	3.6
0.54	-	-	-	-	0.53	-	NS (n = 51)	-1.1	2.5
0.56	-	-	-	-	-	0.56	NS (n = 33)	-0.3	8.7
					P harvest indexes				
0.85	0.87	-	-	-	-	-	NS (n = 21)	2.6	3.6
0.76	-	0.77	-	-	-	-	NS (n = 27)	1.5	5.2
0.80	-	-	0.81	-	-	-	NS (n = 48)	1.7	3.2
0.81	-	-	-	0.81	-	-	NS (n = 63)	0.1	4.0
0.80	-	-	-	-	0.80	-	NS (n = 48)	0.4	3.2
0.66	-	-	-	-	-	0.69	0.0069 (n = 33)	5.4	12.1

Table S4 Maize harvest indexes and P harvest indexes as affected by P application rates across all experimental sites, study years and cropping systems.

Cropping system		P application rate			The *P* value of paired *t* test		
		Low (L)	Medium (M)	High (H)	L and M	L and H	M and H
Harvest indexes							
Maize monoculture (n = 23)		0.55	0.56	0.55	NS	NS	NS
Maize monoculture (n = 32)		0.53	-	0.53	-	NS	-
Maize intercropped with	Oilseed rape (*Brassica napus* L.) (n = 8)	0.54	0.56	0.57	NS	NS	NS
	Oilseed rape (*Brassica campestris* L.) (n = 9)	0.52	0.52	0.56	NS	NS	NS
	Chickpea (n = 17)	0.55	0.55	0.53	NS	NS	NS
	Faba bean (n = 20)	0.54	0.55	0.54	NS	NS	NS
	Faba bean (n = 23)	0.54	-	0.52	-	NS	-
	Soybean (n = 17)	0.53	0.53	0.54	NS	NS	NS
	Peanut (n = 15)	0.56	-	0.56	-	NS	-
Grand mean (n = 97)		0.54	0.55	0.55	NS	NS	NS
Grand mean (n = 121)		0.54	-	0.54	-	NS	-
P harvest indexes							
Maize monoculture (n = 22)		0.81	0.81	0.81	NS	NS	NS
Maize monoculture (n = 31)		0.78	-	0.77	-	NS	-
Maize intercropped with	Oilseed rape (*Brassica napus* L.) (n = 7)	0.86	0.86	0.88	NS	NS	NS
	Oilseed rape (*Brassica campestris* L.) (n = 9)	0.75	0.77	0.79	NS	NS	NS
	Chickpea (n = 16)	0.82	0.81	0.81	NS	NS	NS
	Faba bean (n = 19)	0.83	0.81	0.81	NS	NS	NS
	Faba bean (n = 22)	0.82	-	0.8	-	NS	-
	Soybean (n = 16)	0.79	0.81	0.8	NS	NS	NS
	Peanut (n = 15)	0.68	-	0.69	-	NS	-
Grand mean (n = 92)		0.81	0.81	0.81	NS	NS	NS
Grand mean (n = 116)		0.78	-	0.78	-	NS	-

Table S5 Maize harvest indexes as affected by intercropping with legumes or oilseed rape and P application rates in each year at each experimental location.

Location	Harvest year	P application rate (kg ha^{-1})	Maize monoculture	Maize intercropped with							Mean	*ANOVA* ($P \times C$)	*ANOVA* ($Y \times P \times C$)
				Oilseed rape (*Brassica napus* L.)	Oilseed rape (*Brassica campestris* L.)	Chickpea	Faba bean	Soybean	Peanut				
									Conventional treatment	Chemical regulation			
Jingyuan	2009	0	0.58a	0.59a	-	0.62a	0.60a	0.59a	-	-	0.60A	$P = 0.0847$	
		40	0.59a	0.60a	-	0.64a	0.64a	0.63a	-	-	0.62A	$C = 0.0578$	
		80	0.60a	0.58a	-	0.62a	0.61a	0.60a	-	-	0.60A	$P \times C = 0.9262$	
		Mean	0.59C	0.59BC	-	0.62A	0.62AB	0.61ABC	-	-	0.61		
Wuwei	2009	0	0.53a	0.51a	-	0.54a	0.55a	0.54a	-	-	0.53A	$P = 0.7235$	$Y < 0.0001$
		40	0.58a	0.51a	-	0.54a	0.51a	0.52a	-	-	0.53A	$C = 0.7492$	$P = 0.8606$
		80	0.51b	0.54ab	-	0.55ab	0.54ab	0.58a	-	-	0.54A	$P \times C = 0.4053$	$C = 0.4993$
		Mean	0.54A	0.52A	-	0.54A	0.53A	0.55A	-	-	0.54		$Y \times P = 0.5240$
	2010	0	0.57ab	-	0.62a	0.58ab	0.56b	0.58ab	-	-	0.58A	$P = 0.2361$	$Y \times C = 0.0832$
		40	0.57a	-	0.58a	0.57a	0.58a	0.56a	-	-	0.57A	$C = 0.4444$	$P \times C = 0.3744$
		80	0.56a	-	0.56a	0.58a	0.53a	0.57a	-	-	0.56A	$P \times C = 0.5891$	$Y \times P \times C = 0.1895$
		Mean	0.57A	-	0.59A	0.58A	0.56A	0.57A	-	-	0.57		
	2011	0	0.52a	-	0.50a	0.53a	0.51a	0.46a	-	-	0.50A	$P = 0.5378$	
		40	0.50a	-	0.51a	0.54a	0.52a	0.49a	-	-	0.51A	$C = 0.0422$	
		80	0.52ab	-	0.61a	0.52ab	0.50ab	0.46b	-	-	0.52A	$P \times C = 0.3061$	
		Mean	0.51AB	-	0.54A	0.53A	0.51AB	0.47B	-	-	0.51		
	2012	0	0.47ab	-	0.43b	0.50a	0.46ab	0.47ab	-	-	0.47A	$P = 0.5663$	
		40	0.48a	-	0.47a	0.46a	0.49a	0.47a	-	-	0.48A	$C = 0.5737$	
		80	0.50a	-	0.50a	0.43b	0.48ab	0.47ab	-	-	0.48A	$P \times C = 0.0270$	
		Mean	0.48A	-	0.47A	0.46A	0.48A	0.47A	-	-	0.47		
Wuzhong	2008	0	0.38b	-	-	-	0.48a	-	-	-	0.43A	$P = 0.8982$	

		52.4	0.41a	-	-	-	0.45a	-	-	-	0.43A	$C = 0.0014$	
		Mean	0.39B	-	-	-	0.46A	-	-	-	0.43	$P \times C = 0.0185$	
	2009	0	0.56a	-	-	-	0.57a	-	-	-	0.56A	$P = 0.0337$	
		26.2	0.55a	-	-	-	0.56a	-	-	-	0.56A	$C = 0.0295$	
		52.4	0.56a	-	-	-	0.57a	-	-	-	0.56A	$P \times C = 0.1357$	
		Mean	0.558B	-	-	-	0.564A	-	-	-	0.56		
Quzhou	2009	0	0.59	0.60	-	0.58	0.60	0.54	-	-	0.58		
		40	0.55	0.62	-	0.58	0.62	0.60	-	-	0.59		
		80	0.58	0.68	-	0.56	0.60	0.60	-	-	0.60		
		Mean	0.57	0.63	-	0.57	0.61	0.58	-	-	0.59		
	2010	0	0.51	0.45	-	0.49	0.50	0.48	-	-	0.48		
		40	0.51	0.51	-	0.50	0.43	0.46	-	-	0.48		
		80	0.47	0.53	-	0.44	0.45	0.48	-	-	0.48		
		Mean	0.50	0.50	-	0.48	0.46	0.47	-	-	0.48		
Luoyang	2012	0	0.58a	-	-	-	-	-	0.59a	0.60a	0.591A	$P = 0.2248$	$Y < 0.0001$
		80	0.59a	-	-	-	-	-	0.59a	0.61a	0.598A	$C = 0.0634$	$P = 0.2735$
		Mean	0.586B	-	-	-	-	-	0.594AB	0.60A	0.59	$P \times C = 0.7502$	$C = 0.0319$
	2013	0	0.49a	-	-	-	-	-	0.48a	0.52a	0.50A	$P = 0.5391$	$Y \times P = 0.8512$
		80	0.49a	-	-	-	-	-	0.51a	0.52a	0.51A	$C = 0.2332$	$Y \times C = 0.6498$
		Mean	0.49A	-	-	-	-	-	0.50A	0.52A	0.50	$P \times C = 0.5989$	$P \times C = 0.7084$
													$Y \times P \times C = 0.4282$
Jinan	2017	0	0.63a	-	-	-	-	-	0.58a	-	0.61A	$P = 0.0630$	
		40	0.66a	-	-	-	-	-	0.57b	-	0.62A	$C = 0.0004$	
		80	0.60a	-	-	-	-	-	0.58a	-	0.59A	$P \times C = 0.0296$	
		Mean	0.63A	-	-	-	-	-	0.58B	-	0.60		

Values are means of 3 replicates. In Quzhou, only mean results of 3 replicates were collected without each repeated values. Values followed by the same lowercase letters are not significantly different among different cropping systems within the same P application rate in one year in each experimental

location at the 5% level by Fisher's protected LSD (horizontal comparison); values followed by the same capital letters are not significantly different among different P application rates (vertical comparison) or among different cropping systems (horizontal comparison) in one year in each experimental location at the 5% level by Fisher's protected LSD. Values under *ANOVA* are the probabilities (*P* values) of the source of variation. *Y*: year. *P*: P application rate. *C*: cropping system.

Table S6 Maize P harvest indexes as affected by intercropping with legumes or oilseed rape and P application rates in each year at each experimental location.

Location	Harvest year	P application rate (kg ha^{-1})	Maize monoculture	Maize intercropped with							Mean	*ANOVA* ($P \times C$)	*ANOVA* ($Y \times P \times C$)
				Oilseed rape (*Brassica napus* L.)	Oilseed rape (*Brassica campestris* L.)	Chickpea	Faba bean	Soybean	Peanut				
									Conventional treatment	Chemical regulation			
Jingyuan	2009	0	0.88a	0.87a	-	0.87a	0.90a	0.88a	-	-	0.88A	$P = 0.8481$	
		40	0.88a	0.89a	-	0.90a	0.86a	0.90a	-	-	0.88A	$C = 0.9909$	
		80	0.88a	0.89a	-	0.87a	0.88a	0.87a	-	-	0.88A	$P \times C = 0.6743$	
		Mean	0.88A	0.88A	-	0.88A	0.88A	0.88A	-	-	0.88		
Wuwei	2009	0	0.85a	0.90a	-	0.87a	0.90a	0.89a	-	-	0.88A	$P = 0.5978$	$Y < 0.0001$
		40	0.89a	0.85a	-	0.89a	0.85a	0.86a	-	-	0.87A	$C = 0.5015$	$P = 0.5376$
		80	0.82b	0.91a	-	0.90a	0.89a	0.90a	-	-	0.88A	$P \times C = 0.3830$	$C = 0.3031$
		Mean	0.85A	0.89A	-	0.89A	0.88A	0.88A	-	-	0.88		$Y \times P = 0.5294$
	2010	0	0.88ab	-	0.92a	0.88b	0.88ab	0.89ab	-	-	0.89A	$P = 0.8942$	$Y \times C = 0.1705$
		40	0.90a	-	0.90a	0.89a	0.88a	0.89a	-	-	0.89A	$C = 0.3482$	$P \times C = 0.7076$
		80	0.89a	-	0.88a	0.88a	0.87a	0.91a	-	-	0.89A	$P \times C = 0.7388$	$Y \times P \times C = 0.0999$
		Mean	0.89A	-	0.90A	0.88A	0.88A	0.90A	-	-	0.89		
	2011	0	0.74a	-	0.72a	0.73a	0.73a	0.69a	-	-	0.72AB	$P = 0.2995$	
		40	0.66b	-	0.75a	0.75a	0.71ab	0.71ab	-	-	0.71B	$C = 0.1463$	
		80	0.74a	-	0.81a	0.75a	0.74a	0.69a	-	-	0.75A	$P \times C = 0.6238$	
		Mean	0.71AB	-	0.76A	0.74AB	0.73AB	0.70B	-	-	0.73		
	2012	0	0.68ab	-	0.60b	0.76a	0.67ab	0.63b	-	-	0.67A	$P = 0.5470$	
		40	0.67a	-	0.67a	0.68a	0.70a	0.72a	-	-	0.69A	$C = 0.3427$	
		80	0.68a	-	0.68a	0.67a	0.68a	0.69a	-	-	0.68A	$P \times C = 0.0642$	
		Mean	0.68AB	-	0.65B	0.70A	0.68AB	0.68AB	-	-	0.68		
Wuzhong	2008	0	0.89a	-	-	-	0.80a	-	-	-	0.85A	$P = 0.0730$	

		52.4	0.78a	-	-	-	0.76a	-	-	-	0.77A	$C = 0.1888$	
		Mean	0.83A	-	-	-	0.78A	-	-	-	0.81	$P \times C = 0.3959$	
	2009	0	0.88b	-	-	-	0.91a	-	-	-	0.89A	$P = 0.2649$	
		26.2	0.87a	-	-	-	0.85a	-	-	-	0.86B	$C = 0.9070$	
		52.4	0.87a	-	-	-	0.86a	-	-	-	0.86AB	$P \times C = 0.5214$	
		Mean	0.87A	-	-	-	0.87A	-	-	-	0.87		
Quzhou	2009	0	-	-	-	-	-	-	-	-	-		
		40	-	-	-	-	-	-	-	-	-		
		80	-	-	-	-	-	-	-	-	-		
		Mean	-	-	-	-	-	-	-	-	-		
	2010	0	0.73	0.75	-	0.71	0.79	0.73	-	-	0.74		
		40	0.71	0.76	-	0.67	0.76	0.68	-	-	0.72		
		80	0.71	0.80	-	0.68	0.74	0.63	-	-	0.71		
		Mean	0.72	0.77	-	0.69	0.76	0.68	-	-	0.72		
Luoyang	2012	0	0.64b	-	-	-	-	-	0.73a	0.74a	0.70A	$P = 0.3089$	$Y < 0.0001$
		80	0.65b	-	-	-	-	-	0.73a	0.76a	0.71A	$C < 0.0001$	$P = 0.6689$
		Mean	0.64B	-	-	-	-	-	0.73A	0.75A	0.71	$P \times C = 0.6484$	$C < 0.0001$
	2013	0	0.53a	-	-	-	-	-	0.57a	0.58a	0.56A	$P = 0.9649$	$Y \times P = 0.6065$
		80	0.53a	-	-	-	-	-	0.57a	0.57a	0.56A	$C = 0.1944$	$Y \times C = 0.0453$
		Mean	0.53A	-	-	-	-	-	0.57A	0.57A	0.56	$P \times C = 0.9278$	$P \times C = 0.9712$
													$Y \times P \times C = 0.7431$
Jinan	2017	0	0.83a	-	-	-	-	-	0.79a	-	0.81A	$P = 0.4133$	
		40	0.88a	-	-	-	-	-	0.79b	-	0.84A	$C = 0.0234$	
		80	0.83a	-	-	-	-	-	0.80a	-	0.82A	$P \times C = 0.3785$	
		Mean	0.84A	-	-	-	-	-	0.80B	-	0.82		

Values are means of 3 replicates. In Quzhou, only mean results of 3 replicates were collected without each repeated values. Values followed by the same lowercase letters are not significantly different among different cropping systems within the same P application rate in one year in each experimental

location at the 5% level by Fisher's protected LSD (horizontal comparison); values followed by the same capital letters are not significantly different among different P application rates (vertical comparison) or among different cropping systems (horizontal comparison) in one year in each experimental location at the 5% level by Fisher's protected LSD. Values under *ANOVA* are the probabilities (*P* values) of the source of variation. *Y*: year. *P*: P application rate. *C*: cropping system.

Table S7 Maize plant-internal P use efficiency as affected by intercropping with legumes or oilseed rape and P application rates in each year at each experimental location.

Location	Harvest year	P application rate (kg ha^{-1})	Maize monoculture (kg kg^{-1})	Maize intercropped with (kg kg^{-1})							Mean (kg kg^{-1})	*ANOVA* ($P \times C$)	*ANOVA* ($Y \times P \times C$)
				Oilseed rape (*Brassica napus* L.)	Oilseed rape (*Brassica campestris* L.)	Chickpea	Faba bean	Soybean	Peanut				
									Conventional treatment	Chemical regulation			
Jingyuan	2009	0	795.1a	774.6a	-	734.5a	727.8a	720.5a	-	-	750.5A	$P = 0.6319$	
		40	768.3a	690.8a	-	729.4a	719.8a	761.9a	-	-	734.0A	$C = 0.0042$	
		80	852.4a	669.4c	-	673.6c	707.3bc	769.1b	-	-	734.4A	$P \times C = 0.1512$	
		Mean	805.3A	711.6B	-	712.5B	718.3B	750.5B	-	-	739.6		
Wuwei	2009	0	833.2a	721.2a	-	682.2a	752.6a	866.6a	-	-	771.1A	$P = 0.2995$	$Y = 0.0002$
		40	814.8a	645.7b	-	709.0ab	748.5ab	736.2ab	-	-	730.8A	$C = 0.0026$	$P < 0.0001$
		80	810.5a	633.1b	-	730.8ab	715.8ab	771.5a	-	-	732.3A	$P \times C = 0.7294$	$C < 0.0001$
		Mean	819.5A	666.6C	-	707.3C	738.9BC	791.4AB	-	-	744.8		$Y \times P = 0.3742$
	2010	0	920.8a	-	792.5a	753.4a	883.0a	744.6a	-	-	818.8A	$P = 0.0113$	$Y \times C = 0.0298$
		40	840.4a	-	741.5a	646.3a	718.5a	652.6a	-	-	719.9B	$C = 0.0174$	$P \times C = 0.3238$
		80	791.1a	-	620.2a	685.2a	729.3a	682.7a	-	-	701.7B	$P \times C = 0.9101$	$Y \times P \times C = 0.9977$
		Mean	850.7A	-	718.1B	694.9B	776.9AB	693.3B	-	-	746.8		
	2011	0	778.5ab	-	721.0ab	669.0b	683.5b	801.5a	-	-	730.7A	$P = 0.0131$	
		40	697.7a	-	639.5a	660.5a	630.3a	673.4a	-	-	660.3B	$C = 0.1226$	
		80	681.5a	-	631.6a	654.7a	655.4a	684.9a	-	-	661.6B	$P \times C = 0.8756$	
		Mean	719.2A	-	664.0A	661.4A	656.4A	719.9A	-	-	684.2		
	2012	0	748.3ab	-	763.3ab	677.4b	819.7ab	861.4a	-	-	774.0A	$P = 0.1052$	
		40	756.9a	-	761.4a	745.1a	742.9a	805.3a	-	-	762.3A	$C = 0.0285$	
		80	754.9a	-	679.9a	732.5a	736.0a	749.8a	-	-	730.6A	$P \times C = 0.1911$	
		Mean	753.4AB	-	734.9B	718.3B	766.2AB	805.5A	-	-	755.6		
Wuzhong	2008	0	1158.7a	-	-	-	723.0a	-	-	-	940.8A	$P = 0.1470$	
		52.4	908.6a	-	-	-	719.8a	-	-	-	814.2A	$C = 0.0114$	

		Mean	1033.6A	-	-	-	721.4B	-	-	-	877.5	$P \times C = 0.1551$	
	2009	0	768.9a	-	-	-	652.8a	-	-	-	710.9B	$P = 0.3168$	
		26.2	705.6a	-	-	-	792.8a	-	-	-	749.2AB	$C = 0.4093$	
		52.4	827.6a	-	-	-	753.3a	-	-	-	790.4A	$P \times C = 0.1580$	
		Mean	767.4A	-	-	-	732.9A	-	-	-	750.2		
Quzhou	2009	0	422.1	409.6	-	377.4	433.0	424.3	-	-	413.3		
		40	427.3	418.2	-	384.9	395.0	357.6	-	-	396.6		
		80	436.9	383.0	-	372.9	448.9	382.3	-	-	404.8		
		Mean	428.8	403.6	-	378.4	425.6	388.0	-	-	404.9		
	2010	0	476.8	427.9	-	411.7	377.1	429.9	-	-	424.7		
		40	386.2	467.2	-	399.3	357.0	404.7	-	-	402.9		
		80	405.5	420.7	-	432.5	352.9	386.7	-	-	399.7		
		Mean	422.8	438.6	-	414.5	362.4	407.1	-	-	409.1		
Luoyang	2012	0	500.7a	-	-	-	-	-	393.5b	378.4b	424.2A	$P < 0.0001$	$Y < 0.0001$
		80	434.4a	-	-	-	-	-	326.2b	304.0b	354.8B	$C < 0.0001$	$P < 0.0001$
		Mean	467.6A	-	-	-	-	-	359.9B	341.2B	389.5	$P \times C = 0.9152$	$C < 0.0001$
	2013	0	341.0a	-	-	-	-	-	312.4b	289.7c	314.4A	$P < 0.0001$	$Y \times P = 0.0135$
		80	302.0a	-	-	-	-	-	269.7ab	252.4b	274.7B	$C = 0.0002$	$Y \times C < 0.0001$
		Mean	321.5A	-	-	-	-	-	291.0B	271.0C	294.5	$P \times C = 0.9474$	$P \times C = 0.9695$
													$Y \times P \times C = 0.8898$
Jinan	2017	0	445.4a	-	-	-	-	-	440.2a	-	442.8A	$P = 0.1627$	
		40	508.3a	-	-	-	-	-	425.2a	-	466.7A	$C = 0.1380$	
		80	419.4a	-	-	-	-	-	410.9a	-	415.2A	$P \times C = 0.2417$	
		Mean	457.7A	-	-	-	-	-	425.4A	-	441.6		

Values are means of 3 replicates. In Quzhou, only mean results of 3 replicates were collected without each repeated values. Values followed by the same lowercase letters are not significantly different among different cropping systems within the same P application rate in one year in each experimental location at the 5% level by Fisher's protected LSD (horizontal comparison); values followed by the same capital letters are not significantly different

among different P application rates (vertical comparison) or among different cropping systems (horizontal comparison) in one year in each experimental location at the 5% level by Fisher's protected LSD. Values under *ANOVA* are the probabilities (*P* values) of the source of variation. *Y*: year. *P*: P application rate. *C*: cropping system.

Table S8 Maize P amounts needed to produce 100 kg grains as affected by intercropping with legumes or oilseed rape and P application rates in each year at each experimental location.

Location	Harvest year	P application rate (kg ha^{-1})	Maize monoculture (kg)	Maize intercropped with (kg)							Mean (kg)	*ANOVA* ($P \times C$)	*ANOVA* ($Y \times P \times C$)
				Oilseed rape (*Brassica napus* L.)	Oilseed rape (*Brassica campestris* L.)	Chickpea	Faba bean	Soybean	Peanut				
									Conventional treatment	Chemical regulation			
Jingyuan	2009	0	0.22a	0.22a	-	0.22a	0.23a	0.24a	-	-	0.23A	$P = 0.5889$	
		40	0.22a	0.24a	-	0.21a	0.22a	0.21a	-	-	0.22A	$C = 0.0336$	
		80	0.19d	0.26a	-	0.24ab	0.23bc	0.22c	-	-	0.23A	$P \times C = 0.0701$	
		Mean	0.21B	0.24A	-	0.23AB	0.23AB	0.22B	-	-	0.23		
Wuwei	2009	0	0.23a	0.27a	-	0.27a	0.25a	0.22a	-	-	0.25A	$P = 0.2931$	$Y < 0.0001$
		40	0.22a	0.32a	-	0.27a	0.27a	0.27a	-	-	0.27A	$C = 0.0031$	$P = 0.0031$
		80	0.24bc	0.29a	-	0.25bc	0.26ab	0.22c	-	-	0.26A	$P \times C = 0.5452$	$C = 0.0010$
		Mean	0.23C	0.29A	-	0.26AB	0.26BC	0.24BC	-	-	0.26		$Y \times P = 0.1900$
	2010	0	0.19a	-	0.20a	0.23a	0.20a	0.24a	-	-	0.21B	$P = 0.0081$	$Y \times C = 0.0268$
		40	0.21a	-	0.23a	0.28a	0.24a	0.28a	-	-	0.25A	$C = 0.0685$	$P \times C = 0.9022$
		80	0.23b	-	0.30a	0.25ab	0.26ab	0.26ab	-	-	2.26A	$P \times C = 0.5077$	$Y \times P \times C = 0.7064$
		Mean	0.21B	-	0.24AB	0.26A	0.24AB	0.26A	-	-	0.24		
	2011	0	0.25a	-	0.28a	0.29a	0.29a	0.27a	-	-	0.28A	$P = 0.1167$	
		40	0.29a	-	0.30a	0.28a	0.31a	0.30a	-	-	0.30A	$C = 0.2795$	
		80	0.28ab	-	0.27b	0.29ab	0.31ab	0.32a	-	-	0.29A	$P \times C = 0.6460$	
		Mean	0.27A	-	0.28A	0.29A	0.30A	0.30A	-	-	0.29		
	2012	0	0.29a	-	0.31a	0.30a	0.27a	0.25a	-	-	0.28A	$P = 0.4071$	
		40	0.27a	-	0.28a	0.29a	0.28a	0.26a	-	-	0.28A	$C = 0.0075$	
		80	0.27b	-	0.30ab	0.32a	0.28ab	0.28ab	-	-	0.29A	$P \times C = 0.5829$	
		Mean	0.28BC	-	0.30AB	0.31A	0.28BC	0.26C	-	-	0.28		
Wuzhong	2008	0	0.24a	-	-	-	0.29a	-	-	-	0.26A	$P = 0.1421$	
		52.4	0.27a	-	-	-	0.32a	-	-	-	0.30A	$C = 0.0408$	

		Mean	0.26B	-	-	-	0.31A	-	-	-	0.28	$P \times C = 0.8918$	
	2009	0	0.24a	-	-	-	0.27a	-	-	-	0.25A	$P = 0.2939$	
		26.2	0.26a	-	-	-	0.23a	-	-	-	0.24A	$C = 0.5994$	
		52.4	0.22a	-	-	-	0.24a	-	-	-	0.23B	$P \times C = 0.1723$	
		Mean	0.24A	-	-	-	0.25A	-	-	-	0.24		
Quzhou	2009	0	0.40	0.40	-	0.46	0.39	0.43	-	-	0.42		
		40	0.42	0.39	-	0.45	0.41	0.47	-	-	0.43		
		80	0.40	0.39	-	0.48	0.37	0.43	-	-	0.41		
		Mean	0.41	0.39	-	0.46	0.39	0.45	-	-	0.42		
	2010	0	0.41	0.52	-	0.50	0.53	0.49	-	-	0.49		
		40	0.51	0.42	-	0.50	0.65	0.53	-	-	0.52		
		80	0.52	0.45	-	0.52	0.63	0.54	-	-	0.53		
		Mean	0.48	0.46	-	0.51	0.60	0.52	-	-	0.51		
Luoyang	2012	0	0.35b	-	-	-	-	-	0.43a	0.44a	0.41B	$P < 0.0001$	$Y < 0.0001$
		80	0.39b	-	-	-	-	-	0.52a	0.54a	0.48A	$C < 0.0001$	$P < 0.0001$
		Mean	0.37B	-	-	-	-	-	0.47A	0.49A	0.44	$P \times C = 0.1089$	$C = 0.0002$
	2013	0	0.61a	-	-	-	-	-	0.67a	0.66a	0.64B	$P = 0.0240$	$Y \times P = 0.8966$
		80	0.68a	-	-	-	-	-	0.73a	0.77a	0.73A	$C = 0.2101$	$Y \times C = 0.3266$
		Mean	0.64A	-	-	-	-	-	0.70A	0.71A	0.69	$P \times C = 0.8296$	$P \times C = 0.5212$
													$Y \times P \times C = 0.8079$
Jinan	2017	0	0.35a	-	-	-	-	-	0.39a	-	0.37A	$P = 0.0494$	
		40	0.30b	-	-	-	-	-	0.42a	-	0.36A	$C = 0.0064$	
		80	0.40b	-	-	-	-	-	0.43a	-	0.41A	$P \times C = 0.0795$	
		Mean	0.35B	-	-	-	-	-	0.41A	-	0.38		

Values are means of 3 replicates. In Quzhou, only mean results of 3 replicates were collected without each repeated values. Values followed by the same lowercase letters are not significantly different among different cropping systems within the same P application rate in one year in each experimental location at the 5% level by Fisher's protected LSD (horizontal comparison); values followed by the same capital letters are not significantly different among different P application rates (vertical

comparison) or among different cropping systems (horizontal comparison) in one year in each experimental location at the 5% level by Fisher's protected LSD. Values under *ANOVA* are the probabilities (*P* values) of the source of variation. *Y*: year. *P*: P application rate. *C*: cropping system.