Supplementary Material

Table S1. Effect of cold plasma on symbiotic nitrogen fixation and plant growth related traits in different legume crops.

Crop Type	Gas/Air Type	CP Treatment Time	CP Responses on the Shoot, Root, and Nodule Parameters and SNF	References
Indeterminate nodule-forming legumes				

Red clover	Air (200 Pa)	5 or 7 mins	- The plants from CP-treated seeds showed the early formation of secondary roots and nodules
			- In 5-weeks-old seedlings from CP-treated seeds (5 and 7 mins), increased:
			  - root length
			  - number of secondary roots
			  - nine specific root exudates flavonoids
			- In 5-weeks-old seedlings, CP treatment with 7 min increased:
			  - shoot weight
			  - number of leaves
			  - nodule number
			  - total root exudates flavonoids
				[22]

Red clover	Air (200 Pa)	5 or 7 mins	- CP treatment effects depended on the seed color (yellow, purple, and brown)
			- In 7-day-old seedlings from CP-treated seeds (5 and 7 mins) increased:
			  - seedling height of yellow and brown seeds
			  - seedling weight of brown seeds
				[24]

			- In 5-weeks-old yellow seed seedlings from CP treated seeds (5 and 7 mins): - increased the root length. - did not increase the nodule number. - In 5-weeks-old dark purple seed seedlings from CP treated seeds: - 5 min CP treatment increased the root length. - both 5- and 7-min CP treatments strongly increased the nodule number	
Red clover	Air (200 Pa)	5 mins	- In 1-2 tri-foliate leaf stage, plants from cold plasma treated seeds increased: - Total root and shoot length by 25% and 57%, respectively. - Fresh root and shoot weight by 2.5 folds compared to the control - 2nd year of vegetation, plants from cold plasma-treated seeds increased: - Root length by 13% - Fresh shoot weight by 25 folds - Nodules per plant by 38% - Root isoflavonoids; Daidzein and Formononetin content by 2 and 1.4-fold, respectively - Enhanced root size was positively correlated with the nodule number per plant compared to the control	[65]

Pea	Air (atmospheric pressure)	Experiment 1: 3 min for different power values (9-35 W) Experiment 2: different timings (1-10 min) for 15 W power	Experiment 1: - In 15-day-old plants, 15 W, 21W, and 28 W CP treatments increased: - Seedling height - Seedling dry weight - Chlorophyll content Experiment 2: - In 15-day-old plants, 15 W for 3 min CP treatment increased: - Seedling height - Seedling dry weight - Chlorophyll content	[46]
Determinate nodule-forming legumes				
Soybean	Air (atmospheric pressure) with alternate supply of O_2 or N_2 (gas-flow rate of 6 NL min^{-1})	2-3 mins	- In 5-day-old plants, CP treatments increased: - Root growth - *GmEXP1* gene expression in (1.7-fold higher than the control) roots in both N_2 and O_2 plasma treatments - In 15-day old plants, CP treatments increased: - Seedling fresh weight - Seedling length decreased: - daidzein, genistein, and daidzin isoflavonoid contents in roots - Total glutathione content in roots - *GmEXP1* gene expression in roots	[23]

- Lower root IAA (auxin) content compared to the control
- tZR content was negatively correlated with auxin

- In 40-day-old plants, CP treatments increased:

  - Aerial length (by 12%)
  - Root length (by 1.2-fold)
  - Total foliar area (by 25-30%)
  - Total leaf chlorophyll content (by 5-10%)
  - Average nodule number in primary roots (by 17 to 21-22%)
  - Total nodule fresh weight (by 73%)
  - Individual nodule fresh and dry weights (by 48% and 72% respectively)
  - Nitrogenase activity in nodules (by 1.4-1.6-fold)
  - Leghaemoglobin content (by 2 folds)
  - Total nitrogen content per plant (by 25%)
  - Nitrogen content in nodular tissues (by 2.1-3-fold)

decreased:

			- Nitrogen content in roots (by 28%)	
Soybean	Air (atmospheric pressure) with alternate supply of O_2 or N_2 (gas-flow rate of 6 NL min^{-1})	2-3 mins	- At the total maturity stage CP (N_2) treatment increased the: - Plant height, stem diameter and root dry weight by 3%, 8% and 12%, respectively - Number of pods, seeds per plant, the total seed dry weight, and the 1000 seeds weight were improved by 8%, 4%, 11% and 2%, respectively	[66]
Soybean	Helium (150 Pa)	15 sec for different power values (0, 60, 80, 100, and 120 W)	- In 7-day-old seedlings, 80 W CP treatment increased: - Shoot length and dry weight - Root length and dry weight	[68]
Peanut	Helium (150 Pa)	15 sec for different power values (0, 60, 80, 100, and 120 W)	- In 7-day-old seedlings: - 120 W CP treatment increased the shoot and root dry weight - 60 W and 80 W CP treatments increased the root dry weight - In the field (120 W CP treatment): - Fruiting stage plants increased: - The leaf area - Leaf thickness - Leaf N concentration - Leaf chlorophyll content (SPAD) - Leaf dry weight - Maturity stage plants increased:	[67]

	- Plant height - Stem diameter - Root dry weight - Branch number - Pod number - 100 pod weight - Final yield