Supplementary Materials

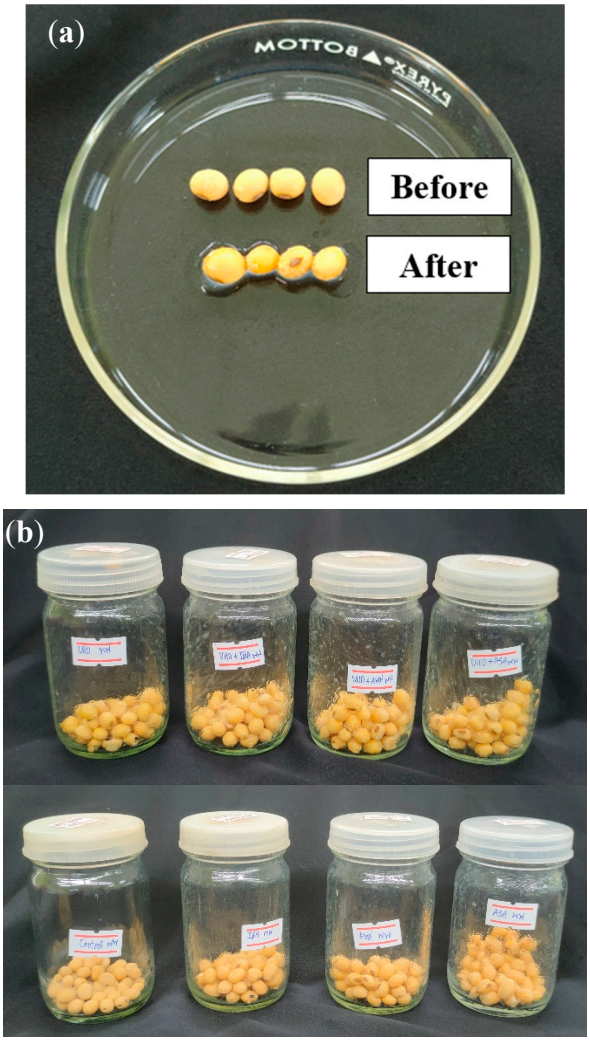


Figure S1: Soybean seed coating with 0.6% xanthan gum. Comparing soybean seeds before and after mixed with 0.6% xanthan gum (a). The mixture of 0.6% xanthan gum along with *Bradyrhizobium diazoefficiens* strain USDA110 and PGRs (b).



Figure S2: Experimental setup in laboratory and greenhouse. Soybean growth trials in Laboratory-based trials using modified Leonard's jars (a), and in pot under greenhouse condition (b).

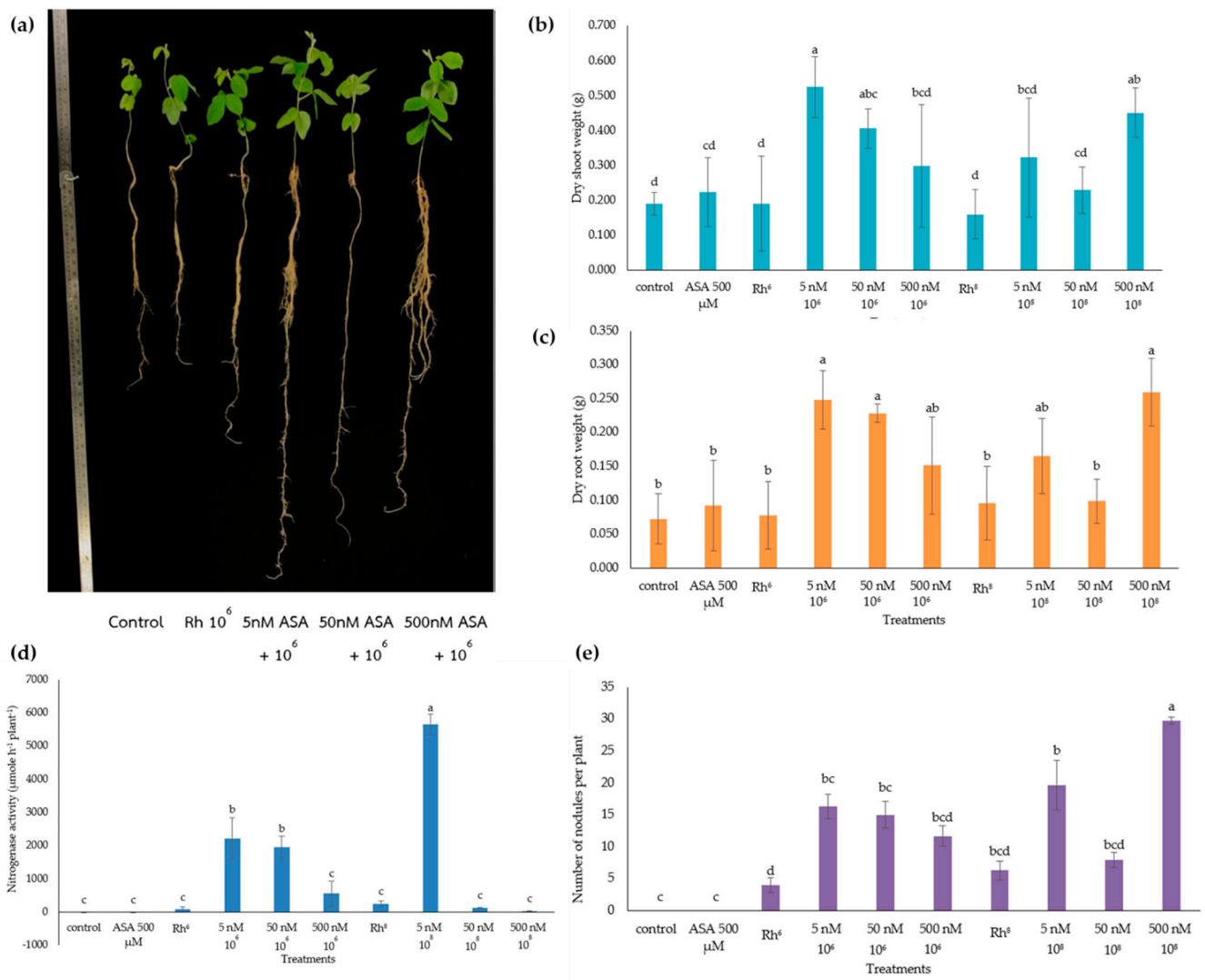


Figure S3: Effect of ASA and *B. diazoefficiens* USDA110 on soybean plants under laboratory condition. (a) Growth of soybean subjected to each treatment. Response of (b) shoot dry weight, (c) root dry weight, (d) nitrogenase activity, and (e) number of nodules from 30-day-old soybean plants following treatment with various ASA concentrations combined with USDA110 (Rh) at a 10^6 concentration. Different lowercase letters in the columns indicate significant differences ($p < 0.05$). Data are presented as mean ± standard deviation (SD) ($n = 6$ replications).

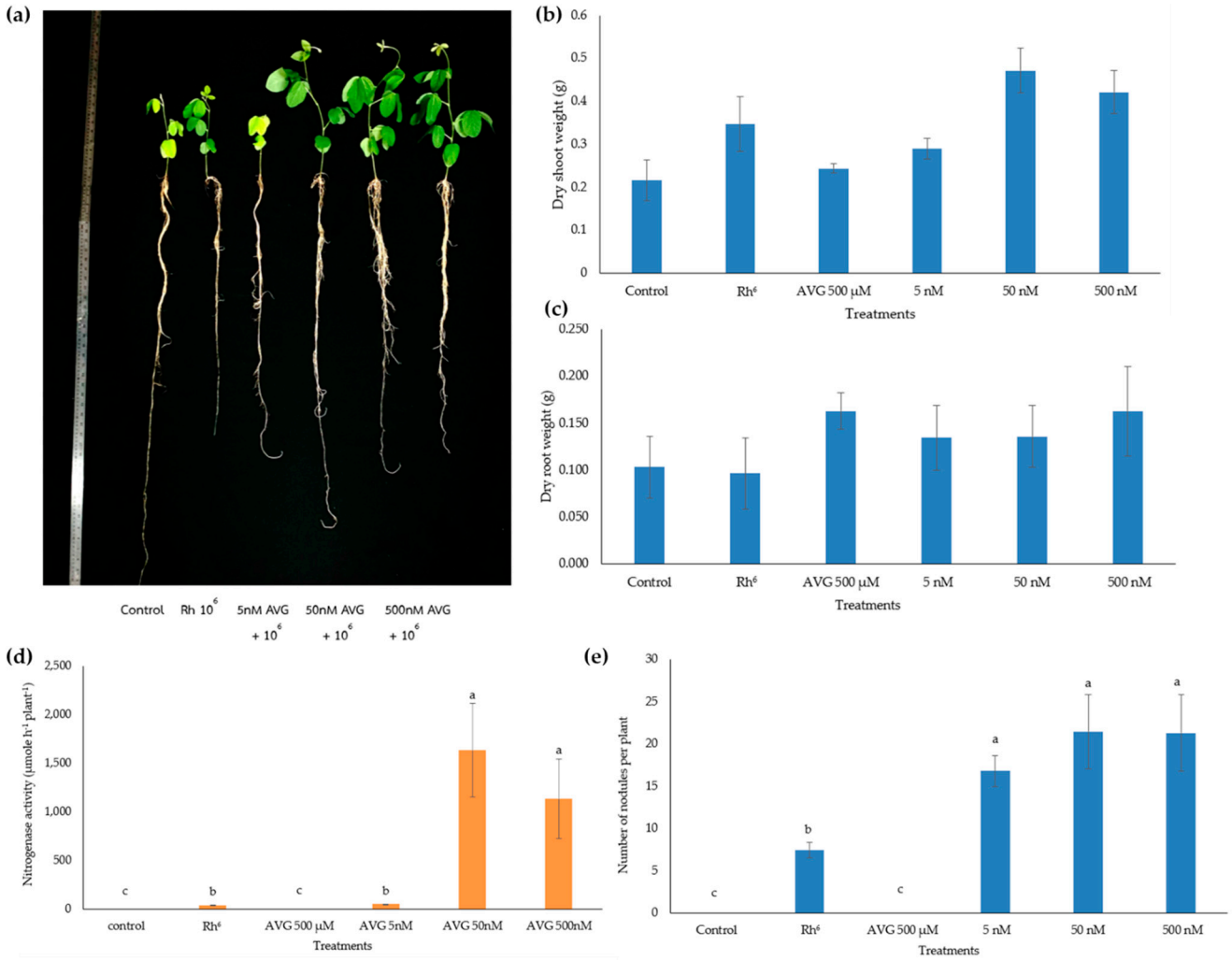


Figure S4: Effect of AVG and *B. diazoefficiens* USDA110 on soybean plants under laboratory condition. (a) Growth of soybean subjected to each treatment. Response of (b) shoot dry weight, (c) root dry weight, (d) nitrogenase activity, and (e) number of nodules from 30-day-old soybean plants following treatment with various AVG concentrations combined with USDA110 (Rh) at a 10^6 concentration. Different lowercase letters in the columns indicate significant differences ($p < 0.05$). Data are presented as mean ± standard deviation (SD) ($n = 6$ replications).

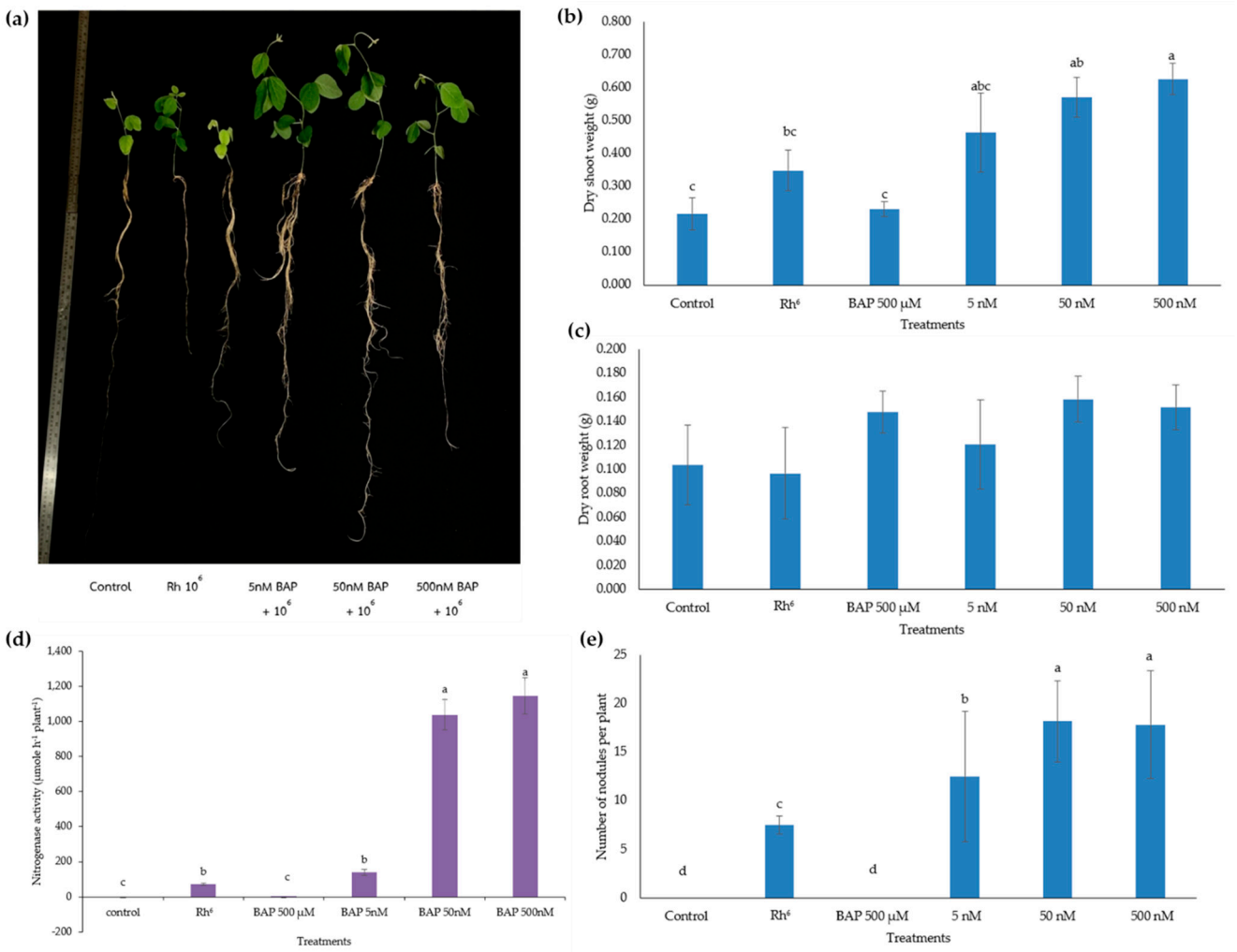


Figure S5: Effect of BAP and *B. diazoefficiens* USDA110 on soybean plants under laboratory condition. (a) Growth of soybean subjected to each treatment. Response of (b) shoot dry weight, (c) root dry weight, (d) nitrogenase activity, and (e) number of nodules from 30-day-old soybean plants following treatment with various BAP concentrations combined with USDA110 (Rh) at a 10^6 concentration. Different lowercase letters in the columns indicate significant differences ($p < 0.05$). Data are presented as mean ± standard deviation (SD) (n=6 replications).

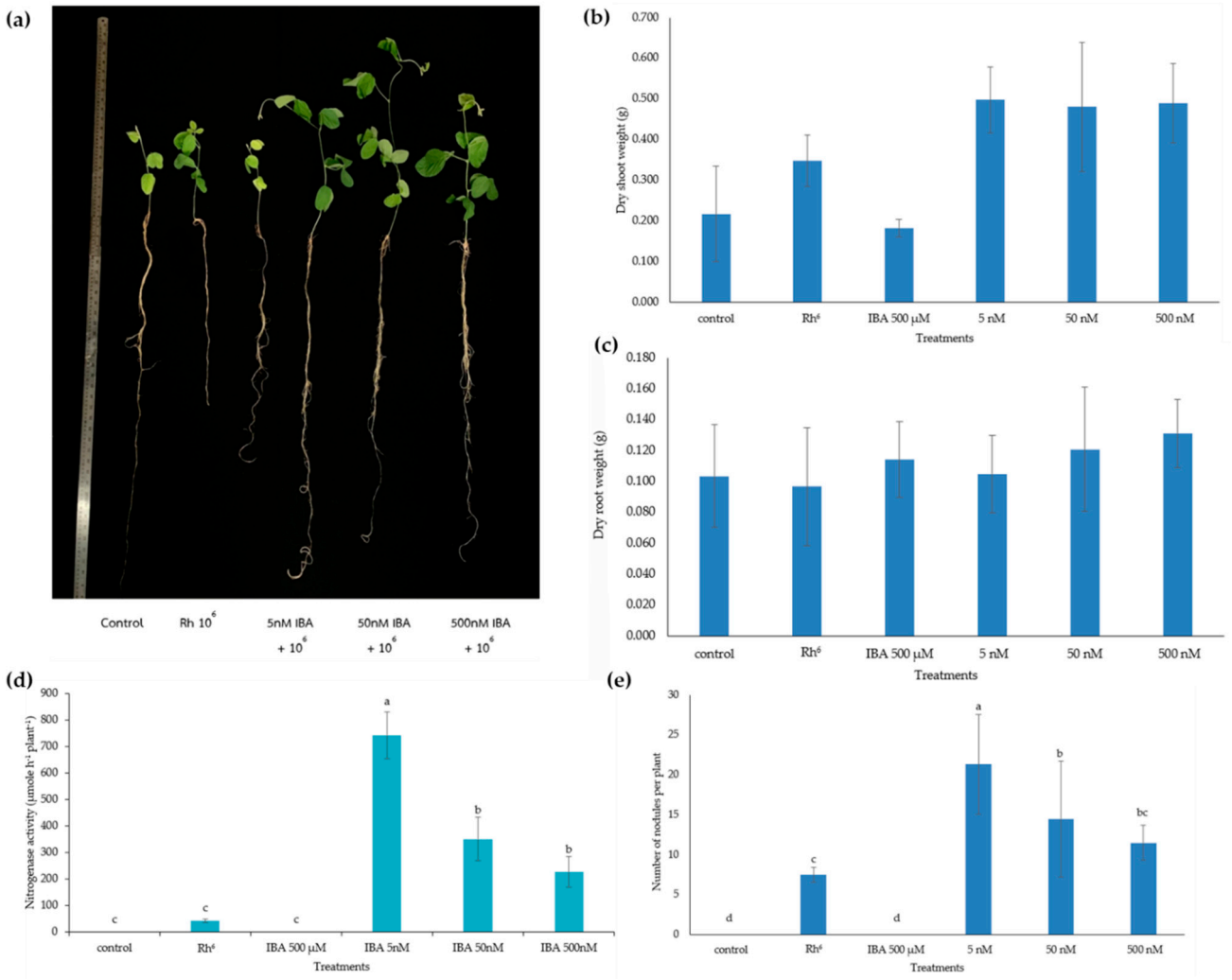


Figure S6: Effect of IBA and *B. diazoefficiens* USDA110 on soybean plants under laboratory condition. (a) Growth of soybean subjected to each treatment. Response of (b) shoot dry weight, (c) root dry weight, (d) nitrogenase activity, and (e) number of nodules from 30-day-old soybean plants following treatment with various IBA concentrations combined with USDA110 (Rh) at a 10^6 concentration. Different lowercase letters in the columns indicate significant differences ($p < 0.05$). Data are presented as mean ± standard deviation (SD) ($n = 6$ replications).

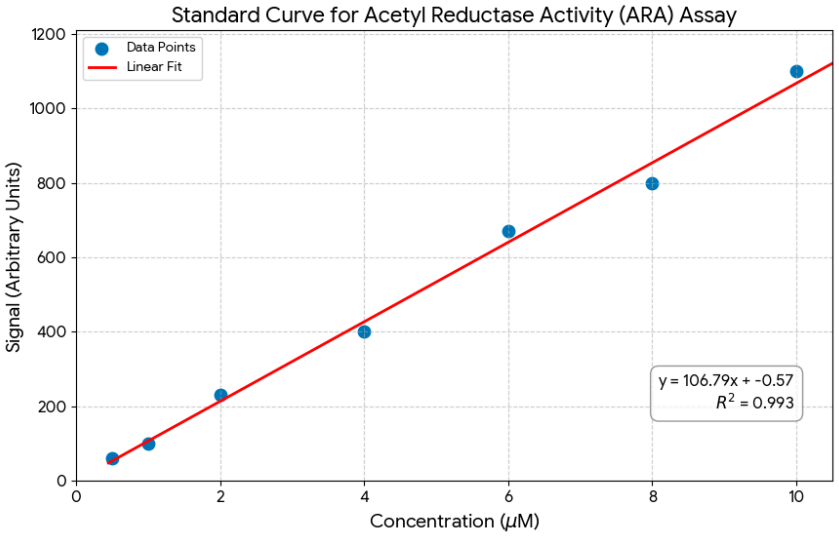


Figure S7: The standard curve for acetyl reductase activity assay (ARA)

Table S1. Chemical composition and physical properties of the soil used for the greenhouse experiments.

Practical size distribution, %			Soil texture	Field capacity (%Vol)	Permanent wilting point (%Vol)	Available water holding capacity (%Vol)	pH	OM (%)	Avail.P (ppm.)	Exch.K (mg/L)	Exch. Ca (mg/L)	Exch. Mg (mg/L)
Sand	Slit	Clay										
62.40	13.42	24.18	Sandy clay loam	18.04	9.75	8.29	7.1	1.2	32.31	127.4	2,027.0	196.2

Vol, volume; pH, Potential of Hydrogen (Measure of acidity/alkalinity); OM, Organic Matter; Avail. P, Available Phosphorus; Exch.K, Exchangeable Potassium; Exch. Ca, Exchangeable Calcium Exch. Mg, Exchangeable Calcium

Table S2 The impact of AVG and USDA110 on ethylene emission levels in soybean roots (cv. CM60) after inoculation for 7 days under environmentally controlled laboratory conditions.

Treatments	**Ethylene emission (nmole h^{-1} $plant^{-1}$)**				
	0 DAI	1 DAI	3 DAI	5 DAI	7 DAI
Control	225.69±9.14ab	350.28±12.49a	309.33±38.14a	148.46±2.26a	113.92±8.99a
AVG	174.62±17.44b	125.47±13.57b	107.13±18.77bc	122.35±4.88a	45.23±5.59c
USDA110	238.49±10.91a	151.15±5.25b	149.49±18.17b	135.22±19.11a	88.48±2.85b
USDA110+AVG	223.14±19.58ab	137.06±13.42b	52.46±16.26c	53.62±9.55b	94.35±3.59ab
Sig	0.039	0.000	0.000	0.000	0.000
%CV	15.48	15.01	14.54	23.47	16.52

Different lowercase letters in the columns indicate significant differences ($p < 0.05$). Data are presented as mean ± standard error (SE) (n = 6 replications); DAI, day after inoculation; CV, coefficient of variation; ** significant differences at $p < 0.01$.