Supplemental Table S1: Plant growth promoting bacteria studied in hydroponic systems

Crop	PGPB	Increase in yield obtained (%)	Number of plants tested	Day harvested	Hydroponic system used	Mechanism of action and main conclusion	Reference
Banana Barangan dessert	• *Azospirillum* • *Bacillus sphaericus*	137-141% (nitrogen free system)	Randomized design 6 replicates 3 treatments	45 days post transplant 10-11cm height	Nitrogen free system 4L pot	• Nitrogen fixation from bacteria in a nitrogen free system • Increased nitrogen uptake led to increased photosynthesis	Mia, 2010 [102]
Banana BRS Princesa Prata Anã	• *Bacillus cereus* • *Bacillus thuringiensis* • *Buttiauxella agrestis*	10.8 (BRS) - 31.7% (PA)	Randomized design 5 replicates, 3 plants 4 inoculants + control	90 days post transplant	5 floating systems 500 L reservoir Daily nutrient replenishing	• Seedling acclimatization period was reduced from 90 to either 25 (PA) or 15 (BRS) days • Auxin production • Increased photosynthetic rate	Araújo, 2022 [124]
Canola Sarigol	• *Pseudomonas fluorescens*	~10%	Split plots design 3 replicates	"Latest stage of morphological growth"	Unspecified system with 10-20L tanks	• Inoculated plants performed better under both regular and osmotically stressed (PEG 6000 - 50-70% FC) conditions • Higher metabolic/energy related protein expression in inoculated plants	Gharelo, 2016 [145]

Canola Xikouhuazi	• *Arthrobacter* sp. • *Bacillus altitudinis* • *Bacillus megaterium* • *Sphingomonas*	10-20%	4 inoculants + control 6 replicates	3 months	Unknown	• ACC deaminase, IAA, phosphorus solubilization, siderophores	Pan, 2017 [115]
Choy sum	• *Azotobacter*	Percent yield increase not stated	Randomized factorial design 5 levels of PBPR concentration, 6 levels of IAA solution 5 pots per treatment	45 days	Sterilized pots containing vermiculite	• 5 g of immobilized *Azotobacter* sp. bead per plant and 1 ml/plant/week of 40-60 µM IAA solution was optimal for growth increases	Ma-on, 2009 [103]
Chrysanthemum Fina	• *Pseudomonas chlororaphis* • *Pseudomonas corrugata* • *Pseudomonas fluorescens* • *Bacillus cereus* • *Comamonas acidovorans* • *Burkholderia gladioli*	*Pythium* root colonization reduced 72-91%	Randomized complete block Untreated+ pathogen controls 13 inoculants 4 plants/ exp Repeated twice	18 days	500mL or 1.9L individual units Aerated via continuous bubbling	• *Pseudomonas chlororaphis* and *Bacillus cereus* were the best at *Pythium* biocontrol	Liu, 2007 [130]

Cucumber	• *Pseudomonas putida* • *Serratia marcescens* • *Bacillus spp.* • *Pseudomonas fluorescens* Commercial product: • *Bacillus amyloliquefaciens*	78.5-121.1% Commercial product was 66.1% increase	Randomized block 5 PGPR +control 9 plants/pot 4 replicates	14 weeks	Drip irrigation 2L/h flow rate 8L Perlite/plant 3.48 plants/m^2	• Highest yields were obtained from *Pseudomonas putida* and *Serratia marcescens* • IAA production • *Fusarium* antagonism • Native PGPR strains resulted in higher yield increases than the *Bacillus* inoculant	Gül, 2013 [122]
Cucumber	• *Pseudomonas chlororaphis* • *Trichoderma harzianum* (RootShield Drench) • *Streptomyces griseoviridis* (Mycostop) • *Gliocladium catenulatum (Prestop WP, Prestop Mix)* • *Trichoderma (Gliocladium) virens* (SoilGard)	Decreased mortality > 50%	5 inoculants, 3 media types, 2 fungicides	Up to 40 days	10 × 10 × 7 cm high rock wool blocks in individual plastic bag	• *G. catenulatum* and *Pseudomonas chlororaphis* reduced seedling mortality from *Fusarium* under varying experimental conditions • *G. catenulatum* and *Streptomyces* were more effective than *Trichoderma* at preventing *Pythium* root rot and damping off	Rose, 2003 [137] Punja, 2003 [136]
Cucumber	• *Trichoderma harzianum*	~42% increase in dry shoot weight No data on fruit	20 plants x 5 containers per treatment PGPR+ control Repeated twice	28 days	Autoclavable transparent polycarbonate boxes 500mL, adjusted daily	• Increased P, Fe, Cu, Mn, Zn after inoculation	Yedidia, 2001 [116]

Duckweed	• *Acinetobacter calcoaceticus*	1.9-2.3x more	20-30 fronds/ 100mL	7 days	1L and 100mL containers Repeated batch experiments with re-colonization	• PGPB was involved with phosphorus and nitrogen cycling	Ishizawa, 2020 [100]
Duckweed	• *Aquitalea magnusonii*	11.7-32.1% 5/9 experiments	10 fronds/60mL 10^4 and 10^6 inoculation doses 9 replicates for 12 different groups	7 days	60mL Erlenmeyer flasks	• *Aquitalea magnusonii* significantly increased duckweed growth • PGPB quantities decreased after 7 days	Ishizawa et al., 2020 [104]
Lettuce Black Seeded Simpson Bibb	• *Gluconacetobacter diazotrophicus*	8.2-16.2%	Two factor fixed effect randomized 1 PGPB +control 6 levels fertilizer 3-4 replicates repeated twice	30-31 days	Kratky hydroponic jars 44 jars/chamber Foil wrapped, 800mL	• *Gluconacetobacter diazotrophicus* increased lettuce yields • IAA, gibberellins	Sebring, 2022 [125]

Lettuce Cortina	• Boost (*Bacillus subtilis*) • *Enterobacter aerogenes* • Rootshield (*Trichoderma harzianum*) • Soilguard (*Gliocladium virens*)	Boost increased fresh lettuce weight by 30% in presence of *Pythium*	Random design 11 treatments 3 replicates 3 troughs per treatment	28 days	Recirculating troughs	• *Bacillus subtilis* increased fresh lettuce weight • Mechanism against *Pythium* was unknown, suspected induction of plant resistance genes, general plant growth promotion, or preventing *Pythium* colonization	Utkhede, 2000 [132]
Lettuce Crispa	• 1.5 g/L of TNC Bactorr containing 12 *Bacillus* spp. and *Paenibacillus polymyxa*	Prevented ~15% decrease in yields from salt stress	4 treatments or controls 4 replicate tanks/group 150 plants/tank	20-22 days	Floating system Drilled polystyrene panels 300 plants/m^2	• Alleviate salt stress (20mM NaCl) • Plants tolerated salinity better in autumn trial compared to spring • Inoculant increased yields	Moncada, 2020 [146]

Lettuce Grand Rapids	• Tested shifts in native rhizosphere community over time. Main organisms include: • *Pseudomonas* • *Burkholderia* • *Sphingomonas*	K-struvite had similar yields to traditional NPK fertilizer	Randomized complete block design 6 plants, 3 replicates 3 urine-derived fertilizers	29 days	2L pots with rockwool 12.5 plants/m^2 Manual irrigation	• K-struvite supported rhizosphere communities and had highest nitrogen levels • ED concentrate and hydrolyzed urine treatments both had distinct microbial communities and were worse treatments for the crop • The most complex microbial community was not always the best one for plant growth	Van Gerrewey, 2021 [97]
Lettuce Linda	• *Trichoderma viride* • *Bacillus thuringiensis* • *Pseudomonas fluorescens*	70.3% inhibition of bacterial wilt	7 treatments + control	Unknown	Deepwater culture 30"x18" Continuous aeration	• Combining the three PGPB was the most effective combination to reduce bacterial wilt disease caused by *Ralstonia solanacearum*	Khan, 2018 [138]
Lettuce Red Cherokee	2.41g commercial Sanolife mix • *Bacillus* spp.	314% increase in growth, however low light and chlorosis were reported in all groups	6 replicate units *Bacillus* + control 3 replicates per treatment	6 weeks	NFT system: 10L 100L aquaponics tank with tilapia	• Phosphorus solubilization • *Bacillus* influenced nitrogen cycle including ammonia, nitrite, and nitrate levels	Da Silva Cerozi, 2016 [105]

Lettuce Red coral Green oak	• *Bacillus velezensis*	~46-244% increase in growth in *Pythium* contaminated lettuce	8x25 plants per treatment 3 treatments plus non-treated controls	40 days	Dynamic root floating technique 1000L 60 × 94 cm 24 platforms/unit	• *Bacillus* reduced *Pythium* root colonization	Kanjanamaneesathian, 2014 [133]
Lettuce Romaine	• *Pseudomonas chlororaphis*	17% in weight	8 treatments 24 replicates per treatment	10 weeks	Window farm/ drip system	• Changed levels of cellular and metabolic gene expression in lettuce • Involved in stress reduction and *Pythium* prevention	Lee, 2015 [16]
Lettuce Tiberius romaine	• *Azotobacter chroococcum* • *Azospirillum brasilense* • *Pseudomonas fluorescens* • *Bacillus subtilis* • *Aspergillus niger*	~7-21% increases in total fresh weight	Nested design 50%, 75%, 100% nutrient solution Second factor:4 experimental groups per nutrient level	28/42 days after planting Transplanted at on day 21	Drip irrigation system Average discharge of 3.6 L/h	• Inoculation reduced the density of indigenous rhizopheric bacteria • Inoculant increased leaf thickness, area, and macronutrient uptake • Bacteria+fungus results in larger yield increases than with group alone	Aini, 2019 [106,112]

Maize	• *Trichoderma virens*	Reduced disease severity	2 inoculant strains	14 days	300mL Polycarbonate culture boxes (10.9 by 10.9 by 15.7 cm) 16 seedlings/unit	• T. virens provided protection against the pathogen *Colletotrichum graminicola* • The PGPR produces Sm1, which induces plant defense mechanisms • Jasmonic acid genes were induced	Djonović, 2007 [140]
Pepper Cubico (sweet)	• *Pseudomonas chlororaphis*	12-20% increase in fresh shoot mass No data on fruit	Predisposed vs non plants ± *Pseudomonas* ± *Pythium* 3-4 replicates	Up to 19 days	Single plant units 475mL Aerated via bubbler	• *Pseudomonas* significantly increased growth of peppers with and without *Pythium* • *P. chlororaphis* delayed root browning	Sopher, 2011 [131]
Potato	• *Rhodococcus*	Reduced maceration to 20% of control plants	2 systems, 300 plants	14 weeks	Two systems One 13L batch system holding 100 plants Larger system with long gutters held 200 plants (PHS)	• Quorum sensing degradation of *Pectobacterium* resulted in biocontrol • Gamma-caprolactone treatment was used to initiate the biocontrol	Cirou, 2011 [139]

Potato (P) Soybean (S) Durum (D) & bread (B) wheat	Myco Madness: 0.38 g/L ● 48 taxa isolated ● 7 fungi ● 41 bacteria ● 85% was the fungi *Mucor*	Measured but not reported; focus was on community structure	Sampled systems every 2 weeks to determine microbial community shifts	103 days (DW) 120 days (BW) 114 days (P) 98 days (S)	NFT systems	● Microbial communities of inoculated plants were more stable over time ● The Myco Madness product had unexpected composition compared to label ● *Pseudoalteromonas* sp. were the most effective colonizers from the commercial mix ● Crop specific trends after receiving the same microbial inoculant	Sheridan, 2017 [99]
Rice	From 305 total strains, 30 were tested further. TY0307 (genus and species not provided) was the best growth promoter	~30%	30 strains screened 10 plants/flask 3 replicates	10 days	Flasks containing 150mL	● ACC deaminase ● Salt tolerance ● TY0307 was the most effective isolate ● Increase proline and reduced ROS stress	Zhang, 2018 [120]
Rice	● *Bacillus amyloliquefaciens*	15.4%	1 inoculant + control Regular and 200mM salt [] 6-12 replicates	10-30 days	15mL conical tube floating	● PGPB upregulated 14 genes, induced salt tolerance ● During salt stress, the microbial community shifted to organisms that use osmoprotectants such as trehalose	Nautiyal, 2013 [147]

Rice	• *Pantoea agglomerans* • *Lelliottia amnigena* • *Enterobacter* sp.	~20%	8 plants 6 replicates	9 days	1.2L container Solution renewed every 3 days	• IAA, nitrogen fixation, phosphorus solubilization • *Pantoea agglomerans* reduced cadmium concentrations and increased yield	Tian, 2022 [113]
Rice KDML105	• *Pseudomonas stutzeri* • *Cupriavidus taiwanensis* • *Delftia acid ovorans*	50% arsenic reduction	3 replicates 5 inoculants	90-135 days	10 × 10 ×15 cm containers containing 300mL	• *Cupriavidus taiwanensis* and *Pseudomonas stutzeri* was the optimal combination to reduce arsenic toxicity in rice • Root sulfide accumulation increased to transition arsenic into a harmless arsenic sulfide form • IAA, phosphorus solubilization, nitrogen fixation, ACC deaminase	Thongnok, 2021 [126]

Sedum alfredii	• *Pseudomonas fluorescens*	Increased lateral root formation	1 inoculant + control 4 replicates	4 weeks	1L container	• *Pseudomonas fluorescens* promoted cadmium uptake • 146 plant hormone genes were upregulated • IAA, ACC deaminase • Decreased multiple compounds including jasmonic and abscisic acid	Wu, 2020 [128]
Sorghum	12 species total tested: • *Pseudomonas* spp. • *Bacillus* spp. • *Burkholderia* spp. • *Phyllobacterium* • *Chitinophaga japonensis*	7-140%	12 inoculants + control 6 replicates	4 weeks	Tyndallized vermiculite Watered every other day	• IAA, siderophores, phosphorus solubilization • IAA producing *Pseudomonas* strains resulted in the greatest increase in plant yields	Amora-Lazcano, 2022 [108]
Soybean	Myco Madness mix • 14 bacteria • Yeasts • 12 fungi	29.9% increase in plant growth 36.9% increase in seed yield	48 per group 16/double gully x 3 rep	98 days	NFT system Double gully Polyprop. 21L reservoir	• Higher density stomata • Thicker palisade parenchyma • Better maximal PSII photochemical efficiency	Paradiso, 2017 [114]

Strawberry Pájaro	• *Gluconacetobacter diazotrophicus* • *Azospirillum brasilense*	Reduced iron + inoculant was best for plant nutrition and phenolic compounds	3x3 factorial randomized design 2 inoculants + control 3 iron levels 10 replicates	60 days	100mL glass container covered with aluminum foil	• Siderophore production • Hydroxamate siderophores were more beneficial than catechol siderophores	Delaporte‑Quintana, 2020 [118]
Switchgrass	• *Pseudomonas grimontii* • *Pantoea vagans* • *Pseudomonas veronii* • *Pseudomonas fluorescens*	22-112% fresh shoot increase	6 replicate pots 7 plants per pot 4 PBPR plus a consortium	Up to 45 days	1.5 L polypropylene pots	• PBPB inoculated plants had elevated HSP70 and HMA3 genes under cadmium stress (20 µmol/L) • IAA production, ACC deaminase, phosphorus solubilization • *Pseudomonas fluorescens* and *Pseudomonas veronii* resulted in the largest increase in fresh shoot weight	Begum, 2018 [109] Begum, 2019 [110]
Tomato Bandita Kardelen	• *Pseudomonas fluorescens* • *Pseudomonas putida*	~10-26% fruit mass increase	Randomized complete block design 2 cultivars, 4 PGPR+1 control 12 plants/group	6 weeks	Drip irrigation system 2L/h flow rate	• IAA, phosphorus solubilization, siderophores, HCN • *Pseudomonas* strains significantly increased tomato plant and fruit yields	Gül, 2012 [111]

Tomato Belladonna F1 grated onto self and M82	• *Paenibacillus* • *Enterobacter mori* • *Lelliottia sp.*	No impact on fruit biomass	Randomized block design with three factors 4 PGPB 3 replicates	55 days post transplant	Open hydroponic system in pots Perlite growing medium	• *Enterobacter mori* had the highest plant vegetative biomass under stressed and control conditions • Trehalose biosynthesis was increased by PGPB application	Kalozoumis, 2021 [148]
Tomato Cherry Golden Gem	PGPR: • *Azotobacter chroococcum* • *Azospirillum brasilense* • *Pseudomonas fluorescens* • *Bacillus subtilis* • *Aspergillus niger* AMF • *Glomus*	PGPR=29% AMF=64% Both=48%	Completely randomized nested design 3 nutrient []s 3 inoculants and control	Unknown	Drip irrigation 3.6L/h Transplanted to polybags containing sand, rice straw charcoal, and compost on day 28	• Fungal applications resulted in the highest fruit weight and diameter compared to bacteria or fungi + bacteria • Higher fertilizer increased sugar content and reduced total titrated acid: phosphate availability is involved in this process. Inoculants increased sugar content and titrated acid.	Aini, 2019 [106,112]

Tomato Ingvar	• *Pseudomonas fluorescens* Three commercial mixes: • Binab T (*Trichoderma polysporum* and *T. harzianum*) • Gliomix (*Gliocladium cantenulatum*) • Mycostop (*Streptomyces griseoviridis*)	>50% decrease in disease incidence ~30-50% increase in dry shoot weight	6 treatments: 4 inoculants, pathogen exposure only, no pathogen 4 replicates	4 weeks	Static aerated culture system 1L containers	• All tested products were effective against *Pythium* • Binab T and Mycostop were effective against *Fusarium*	Khalil, 2010 [134]
Tomato Saturn Ponderosa Lettuce Saradana	• Unspecified soil-derived ammonifers and nitrifiers	No significant difference	3 replicates per treatment 4 plants per pot Inorganic vs organic vs fish based fertilizers	Various measurements recorded up to 70 days	1L hydroponic pots Aerated with pumps	• Soil based microorganisms that were able to convert organic nitrogen to nitrate were cultured • Outlined a method to use organic fertilizer in hydroponic instead of inorganic	Shinohara, 2011 [107]
Tomato Vision	• *Pseudomonas fluorescens* strains	5.6-9.6% in spring 13.3-18.2% in fall	Randomized complete block 3 plants per grow bag 5 replicates	Fruit collected 1-2x per week	24L peat mix growbags	• Fall crop has significantly larger crop yield increases than the spring • *P. fluorescens* strain 63-28 was the most beneficial • Unknown mechanism: no effect on shoots at transplant stage	Gagné, 1993 [127]

Wheat	Cyanobacteria: • *Calothrix* sp. • *Anabaena cylindrica* PGPB: • *Chryseobacterium balustinum* • *Pseudomonas simiae* • *Pseudomonas fluorescens*	36-80%	13 treatments 3 controls 5 replicates per group	17 days	Truncated plastic Eppendorf microtube (seedings) Day 2: 50mL test tubes	• IAA production • The consortium of five organisms produced the greatest increase in growth	Kholssi, 2021 [123]
Wheat	18 tested in total including: • *Bacillus* sp. • *Halobacillus* sp. • *Staphylococcus succinus* • *Zhihengliuella halotolerans* • *Oceanobacillus oncorhynchi* • *Exiguobacterium aurantiacum* • *Halomonas* sp. • *Virgibacillus picturae* • *Thalassobacillus* sp	Reduced growth reduction from salt stress from 58.4% to 15.6%.	Control + 18 strains 4 salt []s Replicated 3 times	Day 10 after germination	Unspecified Aerated with pumps	• Alleviate salt stress (200mM NaCl) • IAA, ammonia production, nitrogen fixation, phosphorus solubilization, ACC deaminase • The most effective organisms were *Thalassobacillus* sp. *Bacillus* sp., *Halomonas* sp., *Oceanobacillus* sp., *Zhihengliuella* sp.and *S. succinus*	Orhan, 2016 [121]

Note: Although the review predominantly focuses on plant growth promoting bacteria, key studies that tested both fungi and bacteria were included to provide a thorough update on the current state of hydroponic research.