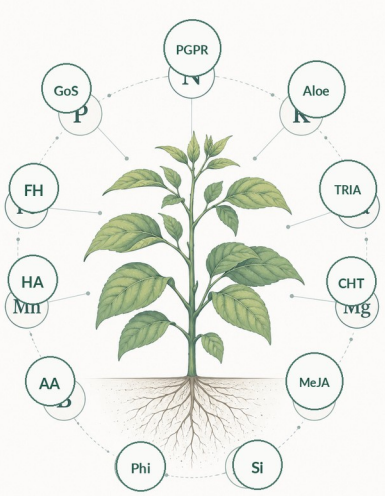
CANNABIS BIOSTIMULANTS & PLANT GROWTH REGULATORS

An evidence-led handbook for yield, phytochemical and sensory-quality trials



MICROBES • EXTRACTS • ELICITORS • PHYTOACTIVES

A larger response is not stronger evidence.
Formulation identity and controls determine what the result means.

by Seymore Budz

Version 1.0

Literature reviewed through 16 August 2026

INDEPENDENT TECHNICAL REFERENCE

COMPANION HANDBOOK

Purpose and scope

This handbook converts the biostimulant evidence matrix into a reader-first technical reference. It profiles only treatments with direct cannabis or hemp evidence in the reviewed dataset. Each profile separates the studied formulation, proposed mode of action, measured outcome, limitations and practical trial status.

> **Quality is not the same as medical efficacy**
>
> Cannabinoids, terpenes, volatile profiles, phenolics and antioxidant assays are cultivation and product-quality endpoints. They do not establish greater clinical efficacy, safety or therapeutic benefit.

What is included

- Fourteen formulation-specific profiles covering microbes, carbohydrate complexes, botanical extracts, amino acids, chitosan, jasmonate signalling, silicon/phosphite, triacontanol and humic acid.
- A directional score for growth, rooting, flower yield, cannabinoids, terpenes/aroma and phenolics/defence.
- Evidence grades that remain separate from response magnitude: a large response in a small trial does not outrank a smaller, better-controlled and more reproducible result.
- A distinct back section for trade-offs, confounded treatments and direct negative evidence.
- A controlled-trial framework that keeps the base A/B/C nutrition unchanged unless an additive contributes measurable N, P, K, S, silicon, phosphite, organic carbon or live microbes.

Contents

- Evidence grading and directional scoring
- Summary scorecard
- Section I - Trial candidates and formulation-specific opportunities
- Section II - Research-only and conflicting treatments
- Section III - Trade-offs and negative evidence
- Trial design, compatibility and references

HOW TO READ THE HANDBOOK

Evidence method and scoring

The evidence grade answers “how confident are we that this specific formulation caused the reported outcome?” The directional score answers “what direction and approximate magnitude did the endpoint move in the cited study?” They are deliberately not combined into one number.

Grade	Meaning	Operational interpretation
A	Direct controlled cannabis evidence with a defined formulation and meaningful production or chemical endpoint.	Suitable for a controlled trial candidate, while still requiring replication and product traceability.
B	Direct cannabis/hemp evidence, but preliminary, small-n, single-cultivar, field-limited or strongly product-specific.	Useful for a defined research arm; do not generalise beyond the tested material and dose.
C	Direct evidence with major nutrient, carrier, product, timing or design confounding.	Conditional or research-only. Build matched controls and account for all added nutrients.
D	Mechanistic or broader-crop context without a direct cannabis operating result.	Not converted into a schedule. Use only to explain a plausible pathway.

Directional score

Scores range from -5 to +5. A positive score means the endpoint improved in the cited study; a negative score means it declined. Zero means no reliable positive effect or the endpoint was not measured. “SHIFT” means the chemical profile changed in a direction that may be useful or undesirable depending on the target chemotype.

Core interpretation rule

Compare concentration and whole-plant output. A treatment may increase terpene percentage while reducing flower mass, or increase yield while lowering cannabinoid concentration. Report dry flower yield, concentration and compound yield per plant together.

PGR scope

This booklet includes plant-derived or endogenous-like signalling treatments represented in the evidence matrix, such as triacontanol and methyl jasmonate. It does not review unlabelled synthetic PGR mixtures or imply that a “natural” product is automatically residue-safe for harvested inflorescences.

AT-A-GLANCE

Evidence-weighted scorecard

The scorecard is a triage tool. Use the profile page before selecting a treatment: formulation identity, timing, substrate, cultivar and carrier often determine whether the score is transferable.

Treatment	Growth	Root	Yield	Cann.	Terp.	Phen./def.	Grade
Five-strain Bacillus consortium	+2	+2	+4	+2	+1	+2	A
GoS + Aloe vera + triacontanol (BC2)	+1	+1	+5	0	+4	+1	B
Molasses + Aloe vera + fish hydrolysate (BC1)	0	0	+1	+1	+1	+2	C
Defined Pseudomonas + Bacillus consortia	+5	+4	+2	0	0	+3	B
Fish hydrolysate + Aloe vera + kelp root complex	+3	+5	+1	0	0	+3	C
Tricostimulant botanical extract	+3	0	+2	+3	0	+1	C
Potassium silicate + phosphite complex	-1	0	+1	0	0	+3	C

Treatment	Growth	Root	Yield	Cann.	Terp.	Phen./def.	Grade
PGPR delivered in King's B growth broth	+2	+1	+3	+2	+3	+1	C
PGPR as a cannabinoid-profile modulator	0	+1	0	SHIFT	0	+2	B
Low-molecular-weight chitosan	0	0	0	0	0	+5	B
Methyl jasmonate (MeJA)	+1	0	+2	+3	-3	+4	B
Amino-acid biostimulant supplement	0	0	-1	-4	+5	0	C
Triacontanol with altered NPK (PKT regimen)	0	0	+4	-3	+1	0	C
Humic acid supplementation	0	0	0	-5	0	0	A

Best first-pass pair

Use a shared untreated control plus separate five-strain Bacillus and exact-BC2 arms. Do not combine them in the first trial. BC2 has the largest reported response; Bacillus has the more operationally reproducible formulation and stronger overall evidence.

SECTION 1

Trial candidates and formulation-specific opportunities

Direct signals worth testing - without stacking

How to use this section

These profiles contain the most actionable direct evidence, but several still require nutrient rebalancing or exact formulation matching. “Candidate” means suitable for a controlled comparison, not validated for universal routine use.

Profiles in this section

- Five-strain Bacillus consortium
- BC2: GoS + Aloe + triacontanol
- BC1: molasses + Aloe + fish hydrolysate
- Defined Pseudomonas + Bacillus consortia
- Fish hydrolysate + Aloe + kelp root complex
- Tricostimulant botanical extract
- Potassium silicate + phosphite complex

SECTION I • TRIAL CANDIDATES

BIO-MIC-01 Five-strain Bacillus consortium

Class	Route	Best-supported endpoint	Evidence grade
Microbial PGPR	Root-zone	Flower yield	A

What it is

A defined commercial consortium containing two Bacillus velezensis strains, two B. megaterium strains and one B. licheniformis strain. Unlike a generic “beneficial bacteria” product, the evidence applies to this five-strain composition and its application pattern, not to Bacillus as a whole.

Mode of action

Bacillus PGPR can alter the rhizosphere, improve nutrient access, release signalling compounds and prime induced systemic resistance. The cannabis trial demonstrated the outcome but did not isolate which pathway caused it; substrate-dependent responses indicate that root environment and microbial establishment are part of the mechanism.

Evidence in cannabis / hemp

Across pure coco fibre and a peat/perlite potting mix, inoculation increased flower yield by 16% and 12%, respectively. Acidic cannabinoid concentration increased by about 5% in coco and 10% in potting mix. Total terpenes rose by 5% in coco, with no clear increase in the potting mix. The study therefore supports a modest, substrate-dependent improvement rather than a universal effect.

Outcome profile

Growth	Rooting	Flower yield	Cannabinoids	Terpenes / aroma	Phenolics / defence
+2	+2	+4	+2	+1	+2

Directional score: +5 = large positive study response; +1 = weak or preliminary; 0 = no reliable positive effect or endpoint not measured; negative scores = measured downside. Scores are an editorial synthesis, not a meta-analysis.

Practical interpretation

This is the strongest first-pass candidate because the formulation is defined, the treatment is commercially reproducible and production endpoints were measured directly. Keep an untreated control, record substrate and lot, and do not use peroxide, chlorine or other root-zone sterilants in the microbial arm.

Evidence field	Reported value / context
Studied system	Drug-type cannabis in pure coco and peat/perlite potting mix.
Application anchor	0.25-0.50 mL/L every two weeks; first and final application 0.25 mL/L; final dose two weeks before harvest.
Measured outcome	Flower yield +12-16%; acidic cannabinoids +5-10%; total terpenes +5% in coco.
Main limitation	One product-specific consortium; response depended on substrate.

TRIAL CANDIDATE • Evidence grade A

A sensible first candidate, but not a reason to add unrelated microbial products or higher inoculum rates. The evidence is tied to strain identity, viable count, carrier and substrate.

Primary evidence: Lyu D, Ruan ED, Backer R, Gagné-Bourque F, Smith DL. Industrial Crops and Products 224 (2025) 120377. doi:10.1016/j.indcrop.2024.120377.

SECTION I • TRIAL CANDIDATES

BIO-BC2-01 GoS + Aloe vera + triacontanol (BC2)

Class	Route	Best-supported endpoint	Evidence grade
Carbohydrate / botanical / PGR complex	Root-zone	Yield + terpenes	B

What it is

A research complex containing galactooligosaccharides (GoS), Aloe vera extract and the long-chain alcohol triacontanol. It is not equivalent to any product that merely lists Aloe or triacontanol: the reported result belongs to the exact three-component research formulation.

Mode of action

The authors propose that GoS acts as a selective rhizosphere prebiotic, with carbohydrate-driven microbial stimulation eliciting plant stress responses. Aloe supplies a mixed botanical signal, while triacontanol can influence primary metabolism and stress-related gene expression. These components were not tested separately, so the dominant mechanism remains unresolved.

Evidence in cannabis / hemp

In a randomised hydroponic trial using a high-CBG cultivar and six plants per treatment, BC2 increased flower yield 2.22-fold and flower size 1.28-fold. Total terpenes increased 30%, including β-caryophyllene and limonene, while ocimene declined. CBD did not change significantly. This is a large response from a small, single-cultivar study and requires independent replication.

Outcome profile

Growth	Rooting	Flower yield	Cannabinoids	Terpenes / aroma	Phenolics / defence
+1	+1	+5	0	+4	+1

Directional score: +5 = large positive study response; +1 = weak or preliminary; 0 = no reliable positive effect or endpoint not measured; negative scores = measured downside. Scores are an editorial synthesis, not a meta-analysis.

Practical interpretation

Treat BC2 as a formulation-replication experiment, not a shopping category. Obtain a full formula, certificate of analysis and carrier information. Run it as a separate arm; do not stack it with microbes, amino acids or elicitors in the first trial.

Evidence field	Reported value / context
Studied formulation	1.25% w/v GoS + 2.5% v/v Aloe extract + 0.25 ppm triacontanol.
Application anchor	2 mL/L during crop weeks 5-12 - all eight flowering weeks in the study.
Measured outcome	Yield 2.22-fold; flower size 1.28-fold; total terpenes +30%; CBD unchanged.
Main limitation	n=6; one high-CBG cultivar; supplied research formulation; no retail equivalence established.

TRIAL CANDIDATE • Evidence grade B

The largest positive response in the evidence set, but not the strongest evidence. Replication and formulation identity matter more than the headline fold change.

Primary evidence: Wise K, Simovich T, Alengaden R, Gill H, Zandberg A, Selby-Pham J. Frontiers in Plant Science 17 (2026) 1842299. doi:10.3389/fpls.2026.1842299.

SECTION I • TRIAL CANDIDATES

BIO-BC1-01 Molasses + Aloe vera + fish hydrolysate (BC1)

Class	Route	Best-supported endpoint	Evidence grade
Carbon / botanical / protein hydrolysate complex	Root-zone	Selected phytochemicals	C

What it is

A three-component complex combining molasses, Aloe extract and fish hydrolysate. It supplies readily available carbon and organic nitrogen as well as botanical constituents, so it cannot be treated as a nutrition-neutral additive.

Mode of action

Molasses may stimulate rhizosphere microbes and endogenous stress responses. Fish hydrolysate provides peptides and amino acids that can alter nitrogen metabolism and defence signalling, while Aloe contributes mixed botanical signals. Because all three were supplied together, microbial, nutritional and elicitor effects cannot be separated.

Evidence in cannabis / hemp

In the same small high-CBG trial as BC2, BC1 increased yield by 17%, but the result was only marginally significant. A near-infrared estimate suggested increased CBD, while total terpene concentration rose 16% without statistical significance; selected volatiles changed. The signal is interesting but materially weaker than BC2.

Outcome profile

Growth	Rooting	Flower yield	Cannabinoids	Terpenes / aroma	Phenolics / defence
0	0	+1	+1	+1	+2

Directional score: +5 = large positive study response; +1 = weak or preliminary; 0 = no reliable positive effect or endpoint not measured; negative scores = measured downside. Scores are an editorial synthesis, not a meta-analysis.

Practical interpretation

Use only after simpler arms. Quantify organic N and sulfur, measure dissolved oxygen and monitor biofilm. A matched vehicle or carbon-source control is valuable because the carrier itself can change the reservoir and root microbiology.

Evidence field	Reported value / context
Studied formulation	7% v/v of 10% w/v molasses + 2.5% v/v Aloe extract + 5% v/v fish hydrolysate.
Application anchor	2 mL/L during all eight flowering weeks.
Measured outcome	Yield +17% (p=0.097); selected volatile shifts; total terpenes +16% but not significant.
Main limitation	Small trial; complex organic input; NIR-based endpoints; oxygen and nutrient confounding.

CONDITIONAL • Evidence grade C

Potentially useful, but a poor first experiment because carbon, peptides, microbes and mineral nutrition can all move at once.

Primary evidence: Wise K et al. Frontiers in Plant Science 17 (2026) 1842299. doi:10.3389/fpls.2026.1842299.

SECTION I • TRIAL CANDIDATES

BIO-PGPR-01 Defined Pseudomonas + Bacillus consortia

Class	Route	Best-supported endpoint	Evidence grade
Strain-specific microbial consortium	Root inoculation	Whole-plant growth	B

What it is

Specific pairings of soil-derived Pseudomonas and Bacillus isolates tested individually and as consortia. The study is important because it shows that strain interaction - not the genus name on a label - determines the response.

Mode of action

Bacillus caused the largest shift in rhizosphere community structure, while Pseudomonas was more closely associated with plant growth promotion. The authors propose that Bacillus may facilitate colonisation or alter root exudation, enabling complementary Pseudomonas-plant interactions. These network effects are plausible rather than fully proven.

Evidence in cannabis / hemp

Selected consortia increased total dry plant weight by roughly 30% in several treatments and by as much as 70% in the strongest comparison. Single-strain treatments did not reproduce the benefit. A double-dose Bacillus treatment was detrimental, demonstrating that more inoculum is not necessarily better.

Outcome profile

Growth	Rooting	Flower yield	Cannabinoids	Terpenes / aroma	Phenolics / defence
+5	+4	+2	0	0	+3

Directional score: +5 = large positive study response; +1 = weak or preliminary; 0 = no reliable positive effect or endpoint not measured; negative scores = measured downside. Scores are an editorial synthesis, not a meta-analysis.

Practical interpretation

Use this page to evaluate fully identified products, not to prepare informal bacterial cultures. A commercial candidate should disclose strain IDs, viable count, carrier, shelf life and a study-equivalent dose. Do not extrapolate from “contains Bacillus and Pseudomonas”.

Evidence field	Reported value / context
Studied system	Cannabis in Promix and Canna coco; two Pseudomonas and three Bacillus isolates.
Application anchor	Study-specific strain combinations and inoculation protocol; no generic retail dose.
Measured outcome	Consortia increased total dry weight; single strains did not; high Bacillus dose could be detrimental.
Main limitation	No validated commercial equivalent; response was strain-pair and dose specific.

RESEARCH CONTEXT • Evidence grade B

High biological potential, low retail transferability. Strain identity and consortium design are the treatment.

Primary evidence: Comeau D, Balthazar C, Novinscak A, Bouhamdani N, Joly DL, Filion M. Frontiers in Microbiology 12 (2021) 715758. doi:10.3389/fmicb.2021.715758.

SECTION I • TRIAL CANDIDATES

BIO-ROOT-01 Fish hydrolysate + Aloe vera + kelp root complex

Class	Route	Best-supported endpoint	Evidence grade
Root-architecture complex	Root-zone	Root branching + nutrient uptake	C

What it is

A combined fish-hydrolysate, Aloe and kelp treatment investigated in substrate-free cannabis systems. The research complex altered root architecture, but the current commercial formulation also contains fertiliser salts and is not neutral to the base recipe.

Mode of action

Kelp and Aloe induced general stress-response signals; fish hydrolysate induced pathogen-defence-associated mechanisms. When combined, the profile resembled a phosphorus-deficiency response and was accompanied by increased phosphorus uptake. Root branching and total length increased, expanding the interface for nutrient acquisition.

Evidence in cannabis / hemp

The complex significantly increased root branching and total root length and increased plant phosphorus and potassium uptake. It demonstrated a root and nutrient-acquisition mechanism rather than a clean final-flower yield or terpene benefit.

Outcome profile

Growth	Rooting	Flower yield	Cannabinoids	Terpenes / aroma	Phenolics / defence
+3	+5	+1	0	0	+3

Directional score: +5 = large positive study response; +1 = weak or preliminary; 0 = no reliable positive effect or endpoint not measured; negative scores = measured downside. Scores are an editorial synthesis, not a meta-analysis.

Practical interpretation

The current Root Nectar-type formula contains DAP, MAP, MKP and KNO3, adding ammonium-N, nitrate-N, phosphorus and potassium. It conflicts with an unchanged zero-ammonium control. Build a separate nutrient-matched formulation before testing it.

Evidence field	Reported value / context
Studied systems	Aeroponics, deep-water culture and Root-TRAPR systems.
Application anchor	Research complex and current product guidance are not automatically equivalent.
Measured outcome	Increased root branching and length; increased P and K uptake.
Main limitation	Combined fertiliser and biostimulant; final yield and flower chemistry not isolated.

REBALANCE REQUIRED • Evidence grade C

A credible root treatment but not a drop-in additive. Its mineral contribution must be subtracted from the base recipe.

Primary evidence: Wise K, Selby-Pham J, Chai X, Simovich T, Gupta S, Gill H. Scientia Horticulturae 323 (2024) 112483. doi:10.1016/j.scienta.2023.112483.

SECTION I • TRIAL CANDIDATES

BIO-TRICO-01 Tricostimulant botanical extract

Class	Route	Best-supported endpoint	Evidence grade
Botanical elicitor complex	Foliar	Biomass + chemotype-specific cannabinoids	C

What it is

A proprietary botanical extract containing Centella asiatica, Echinacea purpurea, dandelion, nettle and fermented rice. The published formulation has a disclosed low mineral analysis, but the active botanical chemistry is not fully characterised.

Mode of action

The authors hypothesise that early stimulation improves resource allocation and metabolic flux toward CBGA, after which the cultivar's enzyme balance determines whether CBD- or THC-dominant products accumulate. This remains a hypothesis; gene expression, enzymes, trichomes and metabolomics were not used to establish the pathway.

Evidence in cannabis / hemp

Field trials reported increased biomass and chemotype-dependent cannabinoid responses. CBD-dominant material showed higher CBD and CBG, while THC-dominant material showed higher THC. Responses were strongest when the product was applied during vegetative growth. The study was product-linked and requires larger replicated trials.

Outcome profile

Growth	Rooting	Flower yield	Cannabinoids	Terpenes / aroma	Phenolics / defence
+3	0	+2	+3	0	+1

Directional score: +5 = large positive study response; +1 = weak or preliminary; 0 = no reliable positive effect or endpoint not measured; negative scores = measured downside. Scores are an editorial synthesis, not a meta-analysis.

Practical interpretation

Use only a labelled formulation matching the study and first test a small foliar area for phytotoxicity. Prefer a single late-vegetative or pre-flower treatment so harvested inflorescences are not routinely sprayed. Measure residues and use a vehicle control if a surfactant is involved.

Evidence field	Reported value / context
Studied formulation	Five botanical sources plus fermented rice; low declared NPK and trace-mineral content.
Application anchor	20 mL/L; approximately 100-150 mL diluted spray per plant; vegetative timing was most responsive.
Measured outcome	Increased biomass and chemotype-dependent cannabinoid accumulation.
Main limitation	Proprietary product-linked field evidence; underlying mechanism and replication remain limited.

CONDITIONAL • Evidence grade C

Promising as a pre-flower elicitor, but the claim should remain "chemotype modulation", not universal cannabinoid enhancement.

Primary evidence: A Novel Biostimulant for Enhancing Biomass and Therapeutic Compounds in Cannabis sativa. Plants/Seeds-style MDPI journal article 17(3) (2026) 18.

SECTION I • TRIAL CANDIDATES

BIO-SIPHI-01 Potassium silicate + phosphite complex

Class	Route	Best-supported endpoint	Evidence grade
Mineral biostimulant / stress-mitigation complex	Root-zone	Silicon uptake + possible yield	C

What it is

A defined complex containing potassium silicate and monopotassium phosphite. Silicon and phosphite are commonly discussed as stress-mitigation inputs, but phosphite is not phosphate nutrition and the tested product also contributed substantial potassium.

Mode of action

Silicon was taken up and deposited in plant tissues, where it can contribute to cell-wall reinforcement and stress signalling. Phosphite enters through phosphate transporters but cannot support normal phosphorus metabolism; it can act as a signalling compound and has activity against oomycetes. The cannabis trial did not show a clear chitinase-mediated defence mechanism.

Evidence in cannabis / hemp

Treatment increased leaf silicon 2.1-fold. Inflorescence fresh and dry weight rose about 1.2-fold, but only at marginal significance. Volatile composition and flower colour were unchanged. The result supports silicon bioavailability and a possible yield benefit, not an aroma enhancement.

Outcome profile

Growth	Rooting	Flower yield	Cannabinoids	Terpenes / aroma	Phenolics / defence
-1	0	+1	0	0	+3

Directional score: +5 = large positive study response; +1 = weak or preliminary; 0 = no reliable positive effect or endpoint not measured; negative scores = measured downside. Scores are an editorial synthesis, not a meta-analysis.

Practical interpretation

At 0.2 mL/L, a product containing 17.3% w/v potassium contributes about 34.6 mg/L K. Rebalance the base recipe, verify phosphite legality and add the product before final pH correction. Include a K-matched control where practical.

Evidence field	Reported value / context
Studied formulation	7.4% w/v Si + 8.1% w/v phosphite + 17.3% w/v K.
Application anchor	0.2 mL/L throughout the 7- or 11-week experiments, before pH correction.
Measured outcome	Leaf Si 2.1-fold; inflorescence weight about 1.2-fold; volatiles unchanged.
Main limitation	Small combined-product study; yield p≈0.087; K and phosphite cannot be ignored.

REBALANCE REQUIRED • Evidence grade C

Useful only as a rebalanced mineral-biostimulant arm. It is not evidence for adding unaccounted potassium silicate to an already optimised recipe.

Primary evidence: Wise K, Simovich T, Gill H, Selby-Pham J. New Zealand Journal of Crop and Horticultural Science (2025). doi:10.1080/01140671.2024.2339494.

SECTION 2

Research-only and conflicting treatments

Useful mechanisms, difficult operating decisions

How to use this section

The treatments in this section changed valuable endpoints, but carrier effects, chemotype shifts, foliar residues or opposing chemical responses prevent conversion into a routine schedule.

Profiles in this section

- PGPR delivered in King's B growth broth
- PGPR as a cannabinoid-profile modulator
- Low-molecular-weight chitosan
- Methyl jasmonate

SECTION II • RESEARCH-ONLY / CONFLICTING

BIO-PGPR-02 PGPR delivered in King's B growth broth

Class	Route	Best-supported endpoint	Evidence grade
Microbial inoculant + nutrient-rich carrier	Root inoculation	Timing-specific yield and terpenes	C

What it is

Bacillus, Mucilaginibacter and Pseudomonas cultures delivered with King's B microbial growth medium. The carrier was deliberately retained to improve colonisation, making the treatment a bacteria-plus-broth system rather than a clean microbial comparison.

Mode of action

PGPR can improve nutrient availability, alter root signalling and influence secondary metabolism. The growth broth may support bacterial establishment but also supplies organic and mineral inputs. Because the broth itself produced positive trends, microbial and carrier effects are partly confounded.

Evidence in cannabis / hemp

Vegetative Mucilaginibacter inoculation increased flower dry weight 24%, total CBD 11.1% and THC 11.6%. Flower-stage Mucilaginibacter increased total terpenes 23%, while Pseudomonas increased them 18%. The response depended strongly on organism and timing.

Outcome profile

Growth	Rooting	Flower yield	Cannabinoids	Terpenes / aroma	Phenolics / defence
+2	+1	+3	+2	+3	+1

Directional score: +5 = large positive study response; +1 = weak or preliminary; 0 = no reliable positive effect or endpoint not measured; negative scores = measured downside. Scores are an editorial synthesis, not a meta-analysis.

Practical interpretation

Do not reproduce this by culturing organisms at home or substituting an unidentified bacterial product. Any follow-up requires a matched broth-only control, verified organism identity, viable count and microbiological containment.

Evidence field	Reported value / context
Studied material	cv. CBD Kush; Bacillus, Mucilaginibacter and Pseudomonas cultures in King's B broth.
Application anchor	10 mL culture at 1×10^8 CFU/mL; single inoculation at vegetative or flower stage.
Measured outcome	Flower dry weight +24%; cannabinoids +5-12%; total terpenes +18-23% depending on organism/timing.
Main limitation	Carrier-medium confounding and laboratory-culture requirements.

RESEARCH ONLY • Evidence grade C

Strong enough to guide product evaluation, not strong enough for a generic operating recipe.

Primary evidence: Lyu D, Backer R, Berrué F, Martinez-Farina C, Hui JPM, Smith DL. Journal of Agricultural and Food Chemistry 71 (2023) 7268-7277. doi:10.1021/acs.jafc.2c06961.

SECTION II • RESEARCH-ONLY / CONFLICTING

BIO-PGPR-03 PGPR as a cannabinoid-profile modulator

Class	Route	Best-supported endpoint	Evidence grade
Microbial chemotype modulator	Root inoculation	Acidic cannabinoid preservation / profile shift	B

What it is

Four PGPR taxa - Bacillus, Pseudomonas, Flavobacterium and Burkholderia - colonised roots of two high-THCA drug-type cultivars under a common hydroponic nutrient regime.

Mode of action

Nutrient supply was held constant, so the authors infer that root colonisation changed specialised metabolism through induced systemic resistance or microbial signalling. The data are consistent with altered cannabinoid-pathway allocation and reduced decarboxylation, but gene-level causation was not established.

Evidence in cannabis / hemp

There was no meaningful growth or yield effect. Across taxa and cultivars, CBGA increased 27.37% and Δ9-THC decreased 15.76%; CBGA/THCA and THCA/CBDA ratios shifted, and less THCA decarboxylation occurred in vivo and after harvest. This is a chemotype shift, not an unqualified improvement.

Outcome profile

Growth	Rooting	Flower yield	Cannabinoids	Terpenes / aroma	Phenolics / defence
0	+1	0	SHIFT	0	+2

Directional score: +5 = large positive study response; +1 = weak or preliminary; 0 = no reliable positive effect or endpoint not measured; negative scores = measured downside. Scores are an editorial synthesis, not a meta-analysis.

Practical interpretation

A desirable result depends on the target product. More CBGA and preserved acidic cannabinoids may be useful, while reduced Δ9-THC may be undesirable. Predefine the analytical objective before inoculation and do not score this as a yield booster.

Evidence field	Reported value / context
Studied system	Amnesia Haze and Gorilla Glue; soilless hydroponics; eight replicates per bacterial treatment.
Application anchor	Study-specific isolates; common fertigation and shared controlled environment.
Measured outcome	CBGA +27.37%; Δ9-THC -15.76%; acidic-cannabinoid ratios shifted; phenotype unchanged.
Main limitation	No generic product equivalence; beneficial direction is chemotype-dependent.

CAUTION • Evidence grade B

The key lesson is that microbes can alter chemistry without changing appearance. Define the desired cannabinoid profile before calling the shift beneficial.

Primary evidence: Tonolo F, Sewalt B, Vrieling K, Choi YH. Physiologia Plantarum 178 (2026) e70756. doi:10.1111/ppl.70756.

SECTION II • RESEARCH-ONLY / CONFLICTING

BIO-CHT-01 Low-molecular-weight chitosan

Class	Route	Best-supported endpoint	Evidence grade
Polysaccharide elicitor	Foliar	Phenolics + antioxidant activity	B

What it is

Chitosan is a deacetylated chitin derivative used as a plant elicitor. The strongest hemp response in the cited field study came from low-molecular-weight chitosan at 50 mg/L, not from the highest concentration.

Mode of action

Chitosan is perceived as a defence-associated signal and can activate the phenylpropanoid pathway, including phenylalanine ammonia-lyase and downstream enzymes that produce phenolics and flavonoids. The hemp study demonstrated metabolite accumulation but did not directly verify every gene or enzyme step in inflorescences.

Evidence in cannabis / hemp

Across chitosan treatments, total phenolics increased 36-69%, tocopherols increased and antioxidant activity rose 12-28%. At 50 mg/L, flavonoids such as vitexin and orientin also increased. The study did not establish a dependable increase in flower yield, cannabinoids, terpenes or flavour.

Outcome profile

Growth	Rooting	Flower yield	Cannabinoids	Terpenes / aroma	Phenolics / defence
0	0	0	0	0	+5

Directional score: +5 = large positive study response; +1 = weak or preliminary; 0 = no reliable positive effect or endpoint not measured; negative scores = measured downside. Scores are an editorial synthesis, not a meta-analysis.

Practical interpretation

Classify this as an antioxidant/phenolic elicitor, not a terpene booster. The research solution used 0.5% acetic acid and pH adjustment; a vehicle control is therefore essential. Foliar film, residues and microbiological implications must be validated for harvested inflorescences.

Evidence field	Reported value / context
Studied material	Monoecious hemp cv. Codimono in a randomised field trial.
Application anchor	50 mg/L low-MW chitosan; foliar every 10 days from BBCH65 to BBCH69.
Measured outcome	Phenolics +36-69%; tocopherols +35-82%; antioxidant activity +12-28%.
Main limitation	Industrial hemp; non-terpene endpoints; foliar residue and formulation variables.

RESEARCH ONLY • Evidence grade B

A credible elicitor for phenolic and antioxidant endpoints, but not evidence of improved aroma or cannabinoid potency.

Primary evidence: Berti R et al. Plants 12 (2023) 3692. doi:10.3390/plants12213692.

SECTION II • RESEARCH-ONLY / CONFLICTING

BIO-MEJA-01 Methyl jasmonate (MeJA)

Class	Route	Best-supported endpoint	Evidence grade
Jasmonate signalling PGR / elicitor	Foliar	Dose-dependent cannabinoid elicitation	B

What it is

MeJA is a volatile derivative of jasmonic acid used experimentally to activate defence and secondary-metabolism signalling. Its effects are strongly concentration-, genotype- and endpoint-dependent.

Mode of action

MeJA engages the jasmonate signalling network, reallocating resources toward defence-associated metabolism. In cannabis, low-dose treatment changed cannabinoid accumulation without increasing trichome density or expression of the final cannabinoid-biosynthesis genes measured, implying upstream or growth-mediated regulation rather than a simple “more trichomes” mechanism.

Evidence in cannabis / hemp

In one medical-cannabis study, 0.1 mM MeJA increased inflorescence CBDA by 15.6% and was associated with improved growth-related cannabinoid yield. A later hemp study found no CBD increase and reported 23-54% lower total terpenes at 1-10 µM, while 100 µM increased phenolics, flavonoids and antioxidant activity. The chemistry trade-off is real.

Outcome profile

Growth	Rooting	Flower yield	Cannabinoids	Terpenes / aroma	Phenolics / defence
+1	0	+2	+3	-3	+4

Directional score: +5 = large positive study response; +1 = weak or preliminary; 0 = no reliable positive effect or endpoint not measured; negative scores = measured downside. Scores are an editorial synthesis, not a meta-analysis.

Practical interpretation

Use only as a controlled elicitor experiment with a surfactant-only spray control. Do not combine a cannabinoid-focused MeJA arm with a terpene-quality claim. Establish residue, worker-exposure, phytotoxicity and stop-interval controls before spraying inflorescences.

Evidence field	Reported value / context
Medical-cannabis anchor	0.1 mM MeJA in 0.01% Tween 20; weekly flowering applications; final application one week before harvest.
Positive endpoint	Inflorescence CBDA +15.6% in one type-II cultivar.
Conflicting endpoint	Hemp: total terpenes -23% to -54% at 1-10 µM; 100 µM increased non-terpene phytochemicals.
Main limitation	Genotype and dose interaction; conflicting cannabinoid, terpene and antioxidant objectives.

RESEARCH ONLY • Evidence grade B

MeJA is an elicitor, not a general quality booster. Select one analytical objective and accept that another may move in the opposite direction.

Primary evidence: García et al. Frontiers in Plant Science 13 (2023) 1082554. doi:10.3389/fpls.2022.1082554; Agronomy 16 (2026) 157. doi:10.3390/agronomy16020157.

SECTION 3

Trade-offs and negative evidence

When one target improves and another declines

How to use this section

These profiles belong at the back because the most visible gain can obscure a material loss, or because the treatment cannot be separated from a changed nutrient programme. They should not be folded into a general additive schedule.

Profiles in this section

- Amino-acid biostimulant supplement
- Triacontanol with altered NPK
- Humic acid supplementation

SECTION III • TRADE-OFFS / NEGATIVE EVIDENCE

BIO-AA-01 Amino-acid biostimulant supplement

Class	Route	Best-supported endpoint	Evidence grade
Organic N / amino-acid input	Root-zone	Monoterpenes - with cannabinoid penalty	C

What it is

A mixed amino-acid supplement added to hydroponic nutrient solution. It functioned as both a biostimulant and an additional organic nitrogen/sulfur source, so its effect cannot be separated from changed mineral nutrition.

Mode of action

Amino acids can be absorbed intact, influence nitrogen assimilation, carbon-nitrogen signalling, chelation and oxidative-stress responses. In this trial, the treatment materially changed the ionome: tissue N and S increased while Ca and Fe declined. The metabolite response is therefore inseparable from nutrient rebalancing.

Evidence in cannabis / hemp

Limonene increased by up to 81-123% and β-myrcene by 139-167%, depending on irrigation system. At the same time, flower cannabinolic-acid content fell 44%, and system-level maturity and THCA yield differed sharply. This is a strong aroma-versus-cannabinoid trade-off, not a broad quality improvement.

Outcome profile

Growth	Rooting	Flower yield	Cannabinoids	Terpenes / aroma	Phenolics / defence
0	0	-1	-4	+5	0

Directional score: +5 = large positive study response; +1 = weak or preliminary; 0 = no reliable positive effect or endpoint not measured; negative scores = measured downside. Scores are an editorial synthesis, not a meta-analysis.

Practical interpretation

Do not stack it onto the current nitrogen target. A valid experiment would replace equivalent mineral N/S and include an N/S-matched control. Monitor Ca, Fe, dissolved oxygen and biofilm. Routine use is not justified when cannabinoid output is a priority.

Evidence field	Reported value / context
Studied system	High-THCA cv. McLove; recirculating versus drain-to-waste hydroponics.
Application anchor	2 mL/L for the final 24 hours before each weekly reservoir change from crop week 2.
Measured outcome	Limonene and β-myrcene increased; flower cannabinolic acids -44%; tissue N/S up, Ca/Fe down.
Main limitation	Organic-N and nutrient-system confounding; no nutrition-neutral control.

TRADE-OFF / RESEARCH ONLY • Evidence grade C

A high-terpene signal accompanied by a large cannabinoid penalty. It belongs in the trade-off section, not in a standard additive schedule.

Primary evidence: Malík M, Velechovský J, Praus L, Janatová A, Kahánková Z, Klouček P, Tlustoš P. Frontiers in Plant Science 13 (2022) 868350. doi:10.3389/fpls.2022.868350.

SECTION III • TRADE-OFFS / NEGATIVE EVIDENCE

BIO-TRIA-NPK-01 Triacontanol with altered NPK (PKT regimen)

Class	Route	Best-supported endpoint	Evidence grade
PGR + altered fertigation	Root-zone	Yield - with quality trade-offs	C

What it is

A preliminary fertigation regimen combining triacontanol with reduced nitrogen and increased phosphorus and potassium during flowering. The treatment is not evidence for triacontanol alone because all four variables changed together.

Mode of action

Triacontanol can influence primary and secondary metabolism, photosynthesis and nutrient use. In this study, the authors also note that the adjusted N, P and K concentrations moved toward yield-supporting ranges reported elsewhere. The observed response may therefore arise from nutrient optimisation, triacontanol or their interaction.

Evidence in cannabis / hemp

With only three plants per treatment, cured flower yield increased 1.79-fold while CBD fell to 0.70-fold. Total terpenes rose modestly and selected volatiles shifted, but odour modelling predicted lower floral, green and tropical notes and poorer consumer impressions. The treatment demonstrates divergence between yield and perceived quality.

Outcome profile

Growth	Rooting	Flower yield	Cannabinoids	Terpenes / aroma	Phenolics / defence
0	0	+4	-3	+1	0

Directional score: +5 = large positive study response; +1 = weak or preliminary; 0 = no reliable positive effect or endpoint not measured; negative scores = measured downside. Scores are an editorial synthesis, not a meta-analysis.

Practical interpretation

Do not copy the regimen onto the existing recipe. A proper follow-up needs separate arms for nutrient change alone, triacontanol alone and the combination. Cannabinoid yield per plant, not concentration alone, should be reported alongside sensory data.

Evidence field	Reported value / context
Studied design	n=3; altered NPK plus 0.125 ppb triacontanol during flowering weeks 5-10.
Measured outcome	Cured flower yield 1.79-fold; CBD 0.70-fold; total terpenes about 1.15-fold; odour-quality modelling declined.
Interpretation	Yield improved while cannabinoid concentration and predicted sensory quality worsened.
Main limitation	Very small study and complete confounding of PGR with NPK changes.

CONFOUNDED / CAUTION • Evidence grade C

Useful as a hypothesis generator, not a triacontanol recommendation. Factorial separation is required before the active cause can be identified.

Primary evidence: Wise K, Simovich T, Selby-Pham J. New Zealand Journal of Crop and Horticultural Science 54 (2026) e70167. doi:10.1002/nzc2.70167.

SECTION III • TRADE-OFFS / NEGATIVE EVIDENCE

BIO-HUMIC-01 Humic acid supplementation

Class	Route	Best-supported endpoint	Evidence grade
Humic substances	Root-zone	Chemical uniformity - at a potency cost	A

What it is

A commercial humic-acid treatment applied daily in an open-cycle medical-cannabis fertigation study. Humic substances can affect nutrient availability and root signalling, but their chemistry varies greatly among products.

Mode of action

The cannabis study did not identify a definitive pathway. Humic acid reduced the normal vertical cannabinoid gradient, possibly through altered nutrient relations or accelerated degradation where cannabinoid concentrations were highest. The mechanistic explanation remains unresolved.

Evidence in cannabis / hemp

Humic acid made cannabinoid distribution more spatially uniform but reduced top-flower THC by 37% and CBD by 39%. Minor cannabinoids were also generally lower. This is direct evidence of a quality penalty when top-flower cannabinoid concentration is the objective.

Outcome profile

Growth	Rooting	Flower yield	Cannabinoids	Terpenes / aroma	Phenolics / defence
0	0	0	-5	0	0

Directional score: +5 = large positive study response; +1 = weak or preliminary; 0 = no reliable positive effect or endpoint not measured; negative scores = measured downside. Scores are an editorial synthesis, not a meta-analysis.

Practical interpretation

Exclude humic acid from the first-pass yield or cannabinoid-quality programme. It may have a niche where chemical uniformity is explicitly valued over peak concentration, but that must be designed as a separate standardisation objective.

Evidence field	Reported value / context
Studied treatment	200 mL per pot per day of a 1:10 dilution of a commercial 12% humic-acid product.
Measured outcome	Top-flower THC -37%; CBD -39%; spatial variability reduced.
Potential niche	More uniform chemistry along the canopy, but lower peak cannabinoid concentration.
Main limitation	One cultivar/product; humic materials are highly variable - but the negative direction was substantial.

DO NOT PRIORITISE • Evidence grade A

Direct negative evidence outweighs generic horticultural claims. Do not add humic acid routinely to a cannabinoid-quality trial.

Primary evidence: Bernstein N, Gorelick J, Zerahia R, Koch S. Frontiers in Plant Science 10 (2019) 736. doi:10.3389/fpls.2019.00736.

FROM HANDBOOK TO EXPERIMENT

Controlled trial design

The cleanest first experiment uses one shared control and separate treatment arms. Every treatment should occupy the same crop cycle, randomised block and environmental envelope. Do not pool data from different rooms, harvests or recipe versions as if they were one control.

Minimum design

- Genetically matched clones or a tightly characterised seed population; identical substrate lot and container volume.
- At least six independent biological replicates per exploratory arm; use an a-priori power calculation for formal publication work.
- Randomise and rotate positions only according to a written protocol; predefine exclusion criteria before seeing results.
- Use one additive per first-pass arm. Add combination arms only after individual effects are established.
- Use carrier-only, surfactant-only, broth-only or nutrient-matched controls whenever the formulation makes them relevant.
- Record manufacturer, exact formulation, strain IDs, viable count, batch/lot, expiry, dose, route and every application date.

Report concentration and output

Endpoint	Minimum measurement	Why it matters
Production	Dry inflorescence yield per plant	Separates a real production gain from concentration changes.
Cannabinoids	Concentration and grams per plant	A lower percentage can coexist with greater total compound yield.
Volatiles	Total and individual terpenes plus sensory analysis	A treatment can increase total terpenes while making the aroma profile less desirable.

Operational measurements

Record feed and drain/reservoir pH and EC, solution temperature, dissolved oxygen where relevant, root and plant-health scores, maturity date, adverse events, and laboratory sample/certificate identifiers. For live-microbial arms, document sanitation exclusions and microbial product storage.

DECISION SUPPORT

Compatibility and selection matrix

The most common experimental error is treating a complex product as if it contributes no nutrients, carbon, microbes or residue risk. The matrix below shows the control architecture each class requires.

Treatment class	Keep base recipe?	Essential matched control	Main incompatibility	Preferred first endpoint
Defined live microbes	Usually, after carrier review	Carrier-only where analytically meaningful	Peroxide, chlorine, sterilants	Yield + chemistry
BC2 exact complex	Only after full analysis	Vehicle/formulation control	Unverified retail substitution	Yield + terpene profile
Organic carbon / hydrolysates	No automatic assumption	Carbon/N/S-matched control	Biofilm, oxygen demand	Root health + chemistry
Silicate / phosphite	No - rebalance K	K-matched control	Unaccounted K and phosphite	Yield + leaf Si
Foliar elicitors	Root recipe can remain fixed	Surfactant/acid vehicle control	Residues and phytotoxicity	Target compound + residue
Humic substances	Not recommended first pass	Untreated control	Cannabinoid penalty	Uniformity only, if intended

Selection order

First pass

Control + five-strain Bacillus + exact BC2 as separate arms.

Second pass

BC1, Tricostimulant or silicon/phosphite after carrier, nutrient, residue and mass-balance review.

Research only / exclude from routine schedule

King's B broth cultures, chemotype-shifting PGPR, chitosan, MeJA, amino-acid supplementation, altered-NPK triacontanol and humic acid.

Unlabelled PGR products

Do not use an unidentified "PGR" or booster on consumable inflorescences. A usable research input must disclose every active, carrier, guaranteed analysis, lot and legal residue status. This handbook does not convert unknown mixtures into safe treatments.

REFERENCE INDEX

Primary scientific references

The profile pages use primary cannabis or hemp studies. DOI links below point to the source record or full text where available.

1. Lyu D, Ruan ED, Backer R, Gagné-Bourque F, Smith DL. Changes in morpho-physiological traits and phytochemical composition of Cannabis sativa L. treated with microbial biostimulants across different substrates. Industrial Crops and Products. 2025;224:120377. Source
2. Wise K, Simovich T, Alengaden R, Gill H, Zandberg A, Selby-Pham J. Comparison of two carbohydrate-based biostimulant complexes for their ability to enhance Cannabis sativa flower yield and quality. Frontiers in Plant Science. 2026;17:1842299. Source
3. Comeau D, Balthazar C, Novinscak A, Bouhamdani N, Joly DL, Filion M. Interactions Between Bacillus spp., Pseudomonas spp. and Cannabis sativa Promote Plant Growth. Frontiers in Microbiology. 2021;12:715758. Source
4. Lyu D, Backer R, Berrué F, Martinez-Farina C, Hui JPM, Smith DL. Plant Growth-Promoting Rhizobacteria with Microbial Growth Broth Improve Biomass and Secondary Metabolite Accumulation of Cannabis sativa L. Journal of Agricultural and Food Chemistry. 2023;71:7268-7277. Source
5. Tonolo F, Sewalt B, Vrieling K, Choi YH. Plant Growth-Promoting Rhizobacteria Colonize THCA Drug-Type Cannabis sativa Roots and Modulate Cannabinoid Metabolism. Physiologia Plantarum. 2026;178:e70756. Source
6. Wise K, Selby-Pham J, Chai X, Simovich T, Gupta S, Gill H. Fertiliser supplementation with a biostimulant complex of fish hydrolysate, Aloe vera extract, and kelp alters cannabis root architecture to enhance nutrient uptake. Scientia Horticulturae. 2024;323:112483. Source
7. A Novel Biostimulant for Enhancing Biomass and Therapeutic Compounds in Cannabis sativa. 2026;17(3):18. Source
8. Malík M, Velechovský J, Praus L, Janatová A, Kahánková Z, Klouček P, Tlustoš P. Amino Acid Supplementation as a Biostimulant in Medical Cannabis Plant Nutrition. Frontiers in Plant Science. 2022;13:868350. Source
9. Berti R et al. Impact of Chitosan-Based Foliar Application on the Phytochemical Content and the Antioxidant Activity in Hemp Inflorescences. Plants. 2023;12:3692. Source
10. García et al. Exogenous application of stress-related signaling molecules affect growth and cannabinoid accumulation in medical cannabis. Frontiers in Plant Science. 2023;13:1082554. Source
11. Exogenous Application of Methyl Jasmonate Affects the Phytochemical Accumulation and Antioxidant Activity in Hemp Inflorescences. Agronomy. 2026;16:157. Source
12. Wise K, Simovich T, Gill H, Selby-Pham J. Bioaccumulation of silicon and enhancement of cannabis inflorescence yield from fertiliser supplementation with silicate and phosphite. New Zealand Journal of Crop and Horticultural Science. 2025. Source
13. Wise K, Simovich T, Selby-Pham J. Altered NPK Fertigation With Triacontanol Supplementation Indicates Promising Improvements to Cannabis Flower Yield and Volatile Composition. New Zealand Journal of Crop and Horticultural Science. 2026;54:e70167. Source
14. Bernstein N, Gorelick J, Zerahia R, Koch S. Impact of N, P, K, and Humic Acid Supplementation on the Chemical Profile of Medical Cannabis. Frontiers in Plant Science. 2019;10:736. Source

Scope note

The literature is still dominated by single-cultivar, product-specific or small exploratory studies. The scores and schedules should be treated as a structured trial-selection framework, not as universally validated crop recommendations.