FUTURE OF BIOSTIMULANTS

Industry Analysis, Opportunities, and Competition

Executive Summary

Biostimulant Industry in the US has an estimated value of $300 million in annual revenue and growing by 12%. 70 competitive companies offer over 650 distinct products. Product prices, active ingredient, and benefit claims were analyzed. Average price per acre for biostimulants is $90 per acre per treatment across all segments. Opportunities exist in microbial and seed-treatment segments to grow market share. Competitive firms must find holistic ways to support growers directly to sustain profitability.

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1.0 INTRODUCTION

The motivation behind this report is to investigate the competitive landscape for biostimulants. Biostimulants are biological products that increase nutrient uptake, abiotic stress resistance and/or crop quality. The biostimulant industry is a high growth industry with CAGR estimated at between **11 and 13%**. Annual revenue in the United States biostimulant market is currently between **$400 and $500 million**. Aggressive forecasts estimate the US biostimulant market to reach **$1.3 billion in 2025**.[1]

The industry is currently fragmented with over **70 competitive companies** in different segments. Market leaders in the North American biostimulant market include Taminco, Isagro SPA, Italpollina SPA, Koppert Biological Systems, BioHuma Netics, ILSA SPA, Arysta Life Science, Trade Corp, and Valagro. Annual revenue from biostimulants is hard to calculate because (1) biostimulants don't have a universally understood and regulated definition, and (2) many companies combine biostimulant revenue estimates with other biological control or agricultural products. These estimates vary widely as there is great heterogeneity in the composition of companies in the industry from both a size and scope standpoint **(Figure 1)**. Acquisitions and other partnerships are increasingly common.

Company	Global Annual Biostimulant Revenue (USD millions)	Percent of Total Annual Global Revenue (USD millions)
BASF	$ 331.386	1 %
Monsanto	$ 14.142	0.1 %
Taminco	$ 144	27 %
Valagro	$ 56.832	48 %
Arysta	$ 100+*	4 %

Figure 1: Annual Revenue from Biostimulants and relationship to total annual global revenue for selected companies.

Over **650 top-performing biostimulants** on the market fall in a few different segments based on active ingredient. Organic and amino acid biostimulants have the highest market share of all biostimulants, followed by seaweed and microbial products. Most of these products have foliar, soil, or fertigation applications. The smallest and least-explored segment is seed treatments.

Biostimulants have an average price of $90 per acre per application. More stable, acid-based products cost the least, with average prices under $15 an acre for application. Microbial products have the highest prices—some in the thousands of dollars per acre—with an average of $662.88. Extract-based products—seaweed or plant- and animal-based nutrients—have mid-tier prices.

This report seeks to **identify main products available**, **key factors of differentiation**, and **pricing models** in the industry. The report is organized as follows:

- **2.0 Definition of Biostimulants:** modes of action, application, active ingredients, and other identifiers
- **3.0 Overview of Biostimulant Industry:** industry definition key market forces that affect growth
- **4.0 Available Biostimulant Products:** key players in the industry and their product lines**,** products currently on the market, product benefits or drawbacks, application, and other details relevant to product differentiation and selection
- **5.0 Conclusion and Recommendations:** key takeaways and next steps
- **Appendix:** figures expanding on analysis
- **Endnotes**

* Assumes at least 18% annual growth rate.

The biostimulant industry is attractive, especially in smaller segments that have not saturated like seed treatments and microbial-based products. However, industry rivalry is increasing as consolidation continues. Competitive firms must not only produce trial-tested and proven products but also find ways other ways to add value for customers.

2.0 DEFINITION OF BIOSTIMULANTS

The most accepted definition for a plant "biostimulant" is a product that contains microorganisms, extracts, or other compounds that stimulate natural processes. Biostimulants do not directly provide nutrients (NPK) for plant health. Instead, biostimulants are used in conjunction with other biological control methods such as pest management and fertilization. These products do not replaced fertilizers but boost fertilizer effects.[†]

Biostimulants	
DO	**DO NOT**
> stimulant natural processes	> replace fertilizers
> contain microorganisms, extracts or nutrients	> directly supply essential nutrients (NPK)

True biostimulants enhance plant growth, health, and productivity to increase yield (weight, seed, fruit set) by improving one of more of the following:[2]

- **Nutrient Uptake:** nutrient-use efficiency
- **Abiotic Stress:** abiotic stress tolerance (salinity, drought, temperature)
- **Crop Quality:** quality attributes (i.e. nutrient content, color, shape, shelf life)

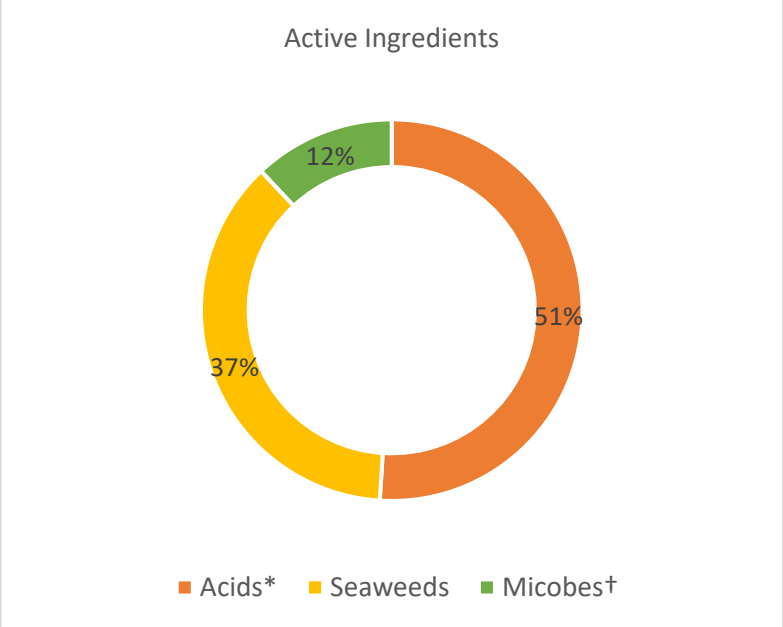


Figure 2: Biostimulant prevalence categorized by primary active ingredient.
**Humic, fulvic and free amino acids*
†Microbes and other nutrients including, chitin, plant extracts, vitamins, anti-transpirants, chemical elements, inorganic salts

Growers should be wary of claims about extensive plant growth regulation or unreasonable yield expectations. These claims are less verifiable and are not currently backed by scientific evidence.

Active ingredients in biostimulants are extracted from natural sources. Broadly, these active ingredients can be divided into the following groups: (1) **Organic acids and amino acids (**2) **Seaweed extracts** and (3) **microbes or other nutrients extracted from plants/animals** (**Figure 2**).[3] Each ingredient stimulates a biological process (see Appendix A) once sprayed on plant foliage, applied to soil, or used as part of seed treatment (**Figure 3**).[4]

[†] This definition was used to identify biostimulant products. Products that were NPK based were excluded from analysis even if they were labelled as a biostimulant in the product description.

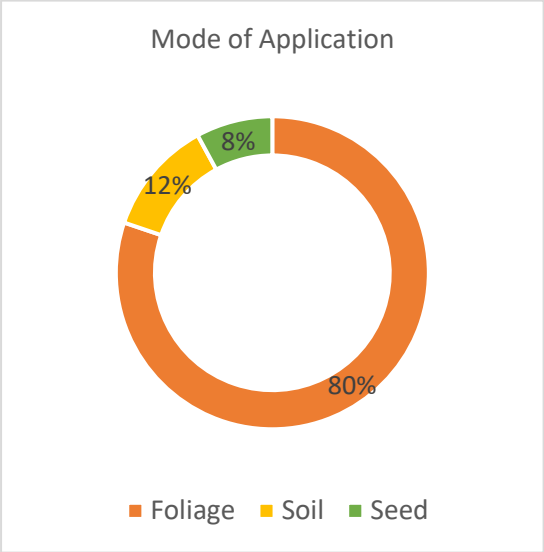


Figure 3: Biostimulant prevalence by mode of application. Processes includes foliar spray, soil applications, and seed treatments. Increasingly, foliar products can also be adapted for soil or irrigation treatment. Soil application represented in the above category refer mainly to microbial inoculants, not adapted foliar treatments.

3.0 OVERVIEW OF BIOSTIMULANT INDUSTRY

3.1 INDUSTRY BOUNDARIES

In 2016, the biostimulant industry was valued at between **$1.5 and $2.0 billion worldwide**.‡ By 2021, the worldwide biostimulant industry will have an **expected value of $3.084 billion**, with a possible range between $2.5 billion and $3.3 billion. Estimated **CAGR ranges** from **11%** (conservative) and **+13%** (aggressive) (**Figure 4**). Europe has the largest market for biostimulants, with an estimated global market share between 37%[5] and 42%.[6]

The US and China follow Europe with steady to high growth (**Figure 5**). US growth may exceed 13% if favorable labelling legislation passes allowing products to be directly marketed as "biostimulants."[7] The **US market** is currently valued between **$400 and $500 million.** Aggressive forecasts estimate the US biostimulant market to reach **$1.3 billion in 2025**.[8]

While the US market is experiencing steady growth, biostimulants are still small compared to the entire US biological control industry. Growth rate for biopesticides are higher than biostimulants, estimated between 14% and 18% over the next five years.[9] A successful biostimulant product yields $10 million while a biopesticide may

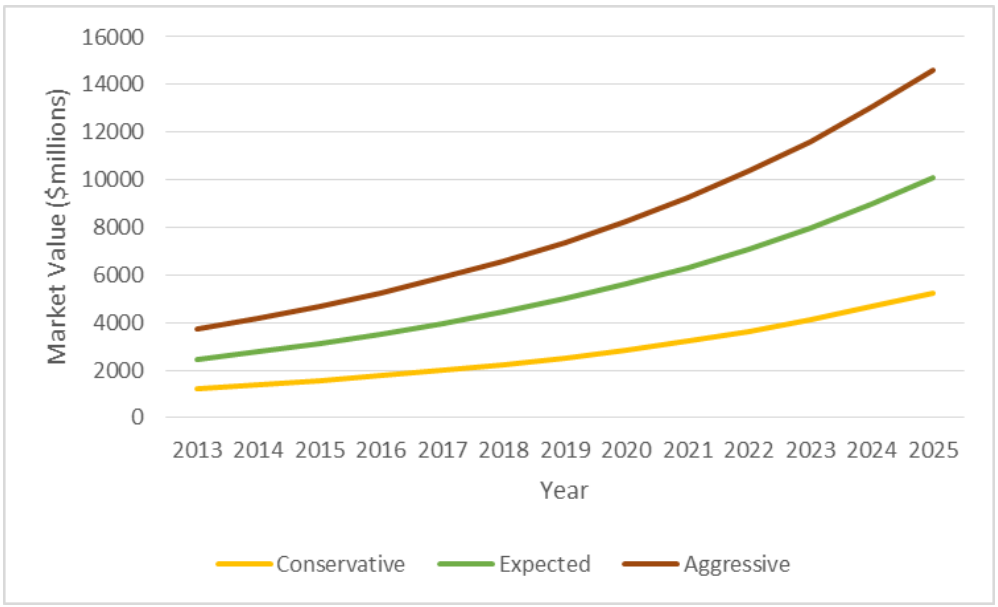


Figure 4: Conservative, expected, and aggressive projections for Global Biostimulant Market Value. See Appendix XX for growth rate and value estimate derivations.

‡ Valuation based on estimated sales revenue from biostimulants. See Appendix B.

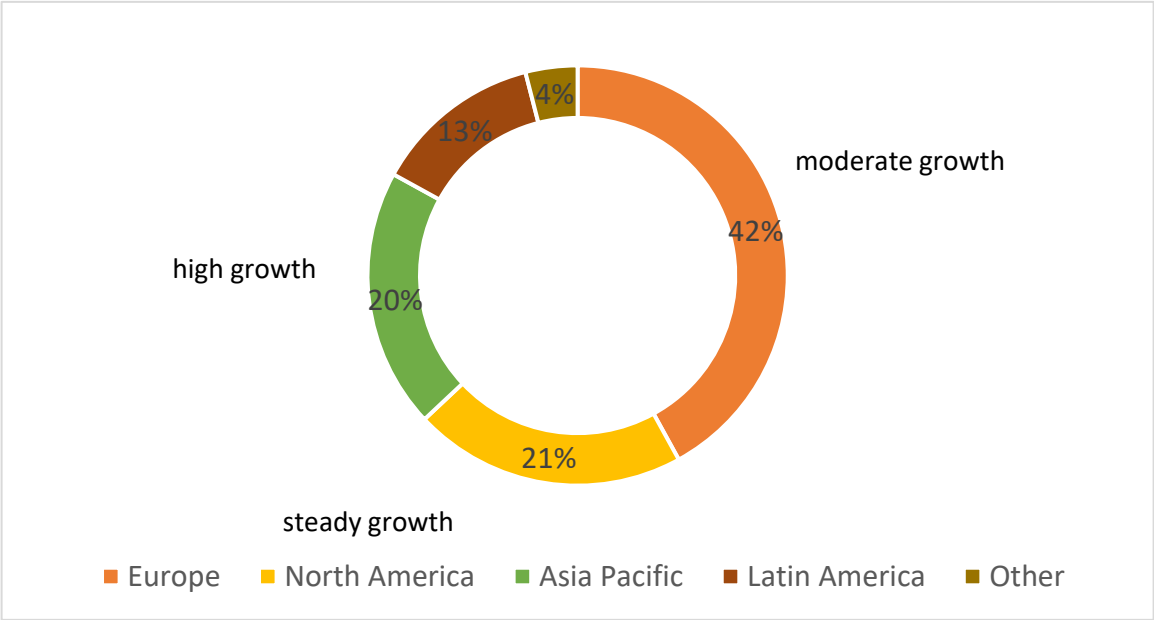


Figure 5: Biostimulant market segments by region, worldwide, and growth impressions. Europe currently has the highest market share and is home to some of the most competitive firms. However, markets are growing faster in Asia and Europe.

yield $100 million.[10] At $925 million, the biopesticide market is twice the size of the biostimulant market. For comparison, biopesticides make up an estimated 5% of the total pesticide market. [11]

3.2 KEY COMPETITIVE FACTORS

The boundaries of the biostimulant industry can be complex to define. For example, products with bacterial microbes that stimulate root development may be registered as a fungicide but labeled as a biostimulant (or both). Even with ambiguous labelling, the biostimulant industry is experiencing a period of steady to high growth in Europe, North America, and Asia Pacific. Consumer preference, abiotic pressures, and regulatory conditions in the environment impact market structure. Intensity of rivalry and low entry barriers drive growth.

3.2.1 ENVIRONMENT

Consumers have an increased preference for “eco-friendly” and organic products. Organic growers do use biostimulants, but growth is primarily driven by conventional growers. Many more conventional producers are adopting biostimulants as part of their integrated pest management program.[12]

As the population rises, increased demand for food puts pressure on crop yield, which biostimulants claim to increase.[13] Climate destabilization has led to more intense and erratic abiotic stresses, which biostimulants help mediate.[14] Soil degradation from industrial agricultural practices and poor water and nutrient management have sparked a renewed focus on microbial activity and soil structure, which can be stimulated by these products.[15] In response, investments in microbiology and plant biology for sustainable agriculture have increased.

The current regulatory environment impedes marketing channels. Growth in the market is currently limited by regulatory scrutiny and state-by-state standards. For example, in the state of California, the word “stimulate” has been prohibited on biostimulant labels. Without clear, strong marketing channels, farmers lack awareness about how to identify appropriate products.[16] Aggressive growth forecasts may become more probable if an EPA resolution standardizes biostimulant guidelines nationwide.[17]

3.2.2 STRUCTURE AND SEGMENTATION

The biostimulant market may be segmented in four general ways: region, active ingredient, application method, and crop (**Figure 6**). Acid-based ingredients have the largest market share because of the availability of raw materials and comparative efficiency.[18] Seaweeds may become the fastest growing segment, but acids will continue to dominate growth rates for some time.[19] Each type of application has different pros and cons.[§] Formulation is also a segmentation factor but is less significant. Products may be liquid, powder, granules, etc.

REGION	ACTIVE INGREDIENT	APPLICATION	CROP
Europe	Acid	Foliar	Row Crops
United States	Seaweed	Soil	Fruits & Vegetables
Asia Pacific	Microbe	Seed	Turf & Ornamentals
Latin America	Vitamins & Nutrients		

Figure 6: Biostimulant Market Segments with largest segment first. All other geographic areas not listed make control a very small market share. Products have more than on active ingredient, target crop, or application mode.

3.2.3 COMPETITIVE PRESSURES

Threat of new entrants in the industry is **very high** because of few barriers to entry. [20] Capital investment requirements are low, especially for companies already in the biological control industry. Active ingredients in biostimulants are low cost and widely available. [21] Because ingredients are extracted from naturally occurring sources, biostimulants are not generally patentable. This industry will be more attractive if a company creates an **extraction or manufacturing process that is patent eligible**. [22] Excess production capacity exists, and consolidation is evident through an increase in acquisitions.

Supplier bargaining power is **low**. Ingredients are often commodity grade and readily available. However, downstream, **buyer bargaining power** is a **strong force**. The intensity of this force is segment dependent. For example, different segments have vast differences in buyer education and consolidation. Buyer bargaining power will weaken if PCAs or distributors are either bypassed or pressured by end-users to carry certain products.

Threat of substitution is **low** in the biostimulant industry. Substitution is only a potential threat in circumstances where growers do not have strong ecological or consumer health motivations. Even so, conventional growers are motivated to use biostimulants to help increase fertilizer efficacy. While biostimulants are not meant to replace fertilizers, they have the potential to claim some market share because they decrease the amount of pesticides needed. Fertilizer prices are dropping, but the biostimulant industry continues to grow. Further, biostimulants may have the potential to outperform transgenic seeds, leading to growing revenue in the seed treatment segment.

Urea nitrogen stabilizers like AGROTAIN from Koch Agronomic Services present a substitution threat. While not biostimulants, these products help prevent nitrogen runoff and keep nitrogen available to the plant. AGROTAIN does not stimulate plant activities, but it does help growth and help prevent eutrophication downstream.

Industry rivalry is currently **moderate** because the industry is still forming. Low barriers to entry and low fixed costs are leading to more entrants in the market. In this analysis **70 companies** have been deemed **competitive**

[§] See section XX

based on revenue in different segments. [23] The industry is characterized by firms of vastly different sizes and market share.[**] Although these conditions exist, lack of a clear market leader is driving rivalry. An increase in consolidation and growth through acquisition is observed. With many indistinguishable products, switching cost is low for buyers if firms have sufficient evidence of success in product development trials.

However, proof of concept alone will not be a source of sustained competitive advantage. Successful firms must **differentiate** in terms of **services offered** as products are creeping towards **commodity status**. In response, firms have started marketing more integrated support approaches for crop management programs beyond providing products in isolation. The following companies have started positioning themselves as providers of these services:

→ Syngenta, Crop Enhancement Initiative
→ Arysta, Biosolutions Division
→ BASF, Functional Crop Care Unit
→ Bayer Cropscience, Crop Efficiency Research

Competitive firms will only capture economic profit in this industry if they can either **(1) provide systemic, integrated crop management and biological control services**, or (**2) find unique synergies with other product offerings** that give their products an advantage. Differentiation can come from positioning products as stimulators for marginal land and areas with marginal water. Seeing biostimulants as a complement product to other biological controls as part of a larger management program may be a better approach to drive consumer demand.

4.0 AVAILABLE BIOSTIMULANT PRODUCTS

Biostimulants are labeled under many names including elicitors, strengtheners, enhancers, etc.[††] Because of this broad labeling characterization, determining which products qualify as biostimulants is up to interpretation. For the purposes of this analysis, the definition outline in Section 3.0 was used to identify products: biological-based active ingredients acting as a fertilizer enhancer to improve nutrient cycling, abiotic stress tolerance, or other quality attributes.

Over 650 unique biostimulant products were found as part of approximately 460 distinct product lines. For the 70+ companies identified, companies have on average 7 distinct products lines. Valagro has the highest number of product lines at 41 because its subsidiaries—Helena, Maxicrop, and SriBio— also produce biostimulants.

Section 4.1 outlines key firms, their parent companies, number of product lines, and example products for the North American Market Leaders and Global Market Leaders. Other major players and competitive firms can be found in Appendix C.

→ North American Market Leaders: 9 companies, 135 product lines

→ Global Market Leaders: 6 companies, 48 product lines

→ Major Players: 14 companies, 101 product lines

→ Competitive Firms: 39 companies, 186 product lines

[**] Median annual revenue for parent companies (from all operations) was $75 million. Average annual revenue was much higher at $4.123 billion because of an outlying revenue of $65.990 billion USD. Minimum revenue also had a outlier, though less impactful, at $200,000.

[††] For a full list of names, please see Appendix C

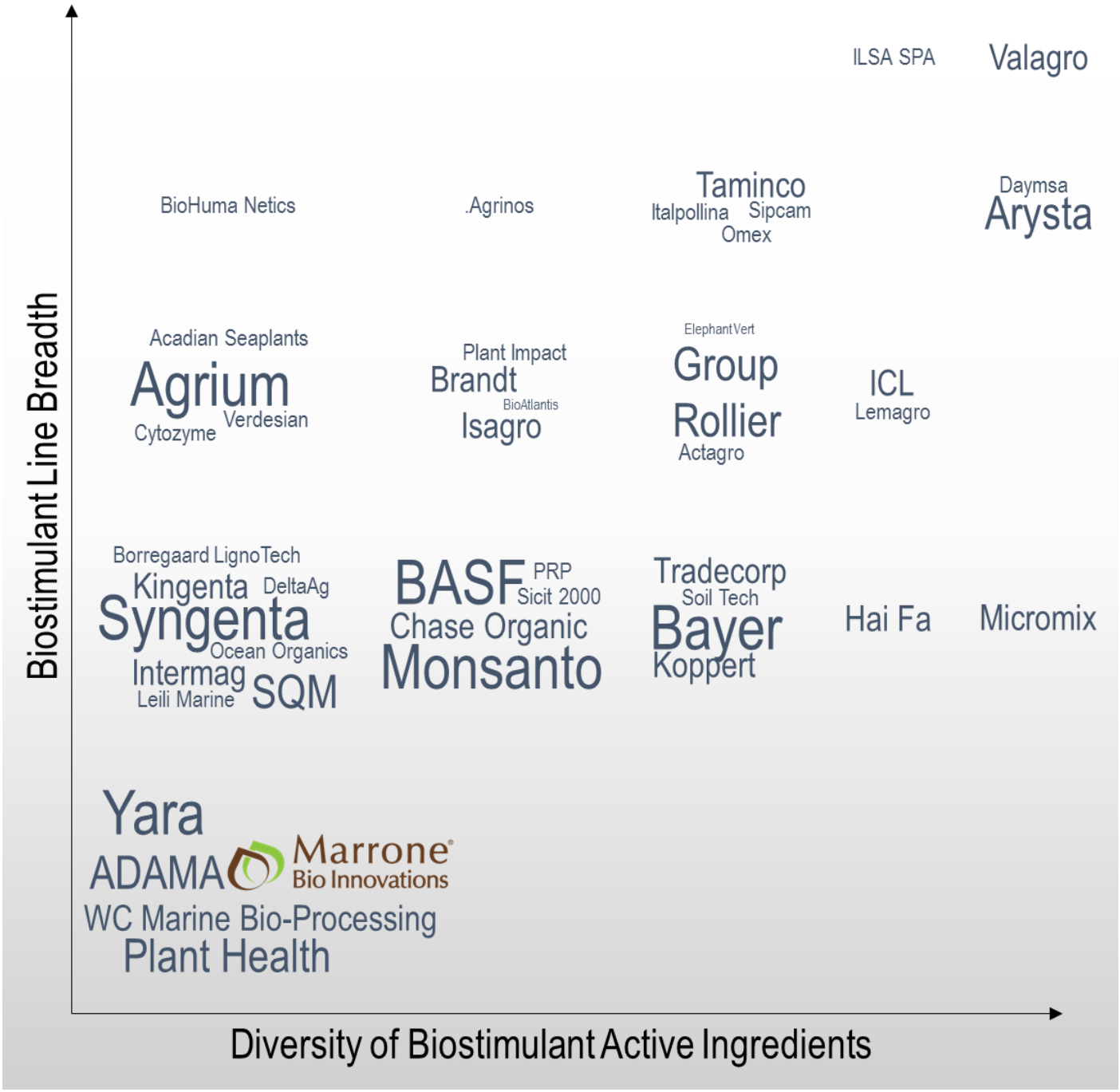


Figure 7: Map of industries producing or selling biostimulants. Size of name is proportional to overall size of company (not sales of biostimulants). Diversity of Biostimulant Active Ingredients refers to number of different types of active ingredients across all product lines (microbe, nutrient, organic acid, seaweed, and amino acids). Biostimulant Line Breadth refers to the number of different product lines. Product lines may be distinguished by formulation, crop, or geographic region sold.

4.1 KEY PLAYERS

North American Market Leaders are predominantly based in Europe. While based overseas, these companies sell the most products in the Canada, the US, and Mexico. Some North American Market Leaders are also Global Market Leaders but are not listed twice. These dual-category companies include Isagro SPA, Italpolina SPA, Arysta Life Science (Platform Specialty Products), and Valagro.

4.1.1 NORTH AMERICAN MARKET LEADERS

Company	Parent Company or Partner	Lines	Example Product
***Taminco**	Eastman Chemical Company	12	Ceraide
Isagro SPA	Isagro SPA	6	Ergostim
Italpolina SPA	Italpolina SPA	16	Auxym
Koppert Biological Systems	Koppert Biological Systems	4	Fortafol
HUMA GRO SPA	BioHuma Netics (BHN)	11	Activol
ILSA SPA	ILSA SPA	24	Ilsamin N90 Biostimulant
Arysta Life Science	Platform Specialty Products	12	Opeteine
Beem Biologics (Arysta)	Platform Specialty Products	2	Pilatus
Goemar (Arysta)	Platform Specialty Products	2	BM Start
Tradecorp	Tradecorp	5	Phylgreen Range
Valagro SPA	Valagro SPA	10	T-Wave
Helena	Valagro SPA	17	Hydra-Hume
Maxicrop USA	Valagro SPA	1	Algamin Kelp Meal
SriBio	Valagro SPA	13	Radifarm
TOTAL	9	135	

*Market Leader

4.1.2 GLOBAL MARKET LEADERS

Company	Parent Company or Partner	Lines	Example Product
ADAMA	ADAMA	1	ExpertGrow
Becker Underwood	BASF	7	BioGain WSP
Embrapa	BASF	1	*(not found)*
Biolchim Concimi Speciali	Biolchim Concimi Speciali	13	Bio Energy Veg
Biostadt India Limited	Biostadt India Limited	15	Biozyme
Lallemand Plant Care	Lallemand Plant Care	8	Bioreveil
Novozymes A/S	Monsanto	3	Ratchet
TOTAL	6	48	

4.2 PRODUCTS

4.2.1 PRODUCT BENEFIT EVALUATION

Product claims for biostimulants drive their value. Companies have made a few types of propositions relating to biostimulant value, either through increasing value or amount of crop or decreasing associated costs:[24]

1. Yield increase: some claim biostimulants can benefit yield by 5-10%. This is a broad, generalized claim.
2. Quality improvements: some biostimulants are claimed to increase size or quality by 25%:
    a. Higher quality, stronger crops lead to less post-harvest handing waste saving money.
    b. More attracted, uniform, nutritious crops lead to higher priced sales.
3. Fertilizer cost: biostimulants claim to increase fertilizer (NPK) uptake efficiency by 5%. This increased efficiency allows growers to use 5% less fertilizer, saving on costs. Microbial products claim a 50 to 70% reduction in fertilizer, or an elimination of the need for fertilizer entirely.
4. Pesticide cost: some biostimulants are claimed to improve stress tolerance and resistance so much, pesticide use can by decreased by 10-25%, saving on pesticide costs.[25]

The variety of benefit claims make it difficult for a uniform per acre valuation of biostimulants because product-specific modes of action influence different costs and revenue opportunities. Further, many product claims lack regulated, standardized, or verified benefits. Claims may describe accurate stimulation of biological processes but not appropriate value these metabolic or microclimate changes. For example, a humate product has claimed a 40% increase in nutrient uptake. A fulvate product by the same manufacturer claims a 2000x increase in microflora in 25 days. However, the implications in terms of cost and revenue changes are not explained. The following cases show the variety of outcomes the simulated biological processes might create:

- A corn study for an organic acid based biostimulant revealed an increase in soil nitrates, resulting in stronger and thicker stalks. As a result, there was less wind damage. However, while mass increased in the corn by 10%, actual bushel-per-acre yield did not increase
- A melon study reported increased melon size for 40% of the plants. The other 60% of the plants did not have greater melon yield because foliage growth was stimulated too much. Pollinators could not find blossoms through the full foliage.
- A grasses study indicated increases in smooth brome yield by 600 to 700 pounds. However, alfalfa yield was lower with the biostimulant, showing crop-specific differences.
- A soy study found elongated pods with biostimulant use. While some of the pods were discolored, more pods were reported per plant. In some instances, this increase led to 52 to 62 more bushels per acre.[26]

4.2.2 PRICING

Currently, biostimulants continue to be priced at a per gallon/per pound rate. Publicly available prices do not describe any “pay per yield increase” programs. Pricing information is difficult as protected trade information. Of the approximately 650 products identified, Prices, for 51 have been identified so far. Not enough data is present for accurate statistical analysis. Consequently, the following trends should be treated as qualitative observations until additional pricing data is collected.

Active Ingredient	Minimum Price per Acre	Maximum Price per Acre	Average Price per Acre
Amino Acid	$ 4.44	$ 24.75	$ 14.60
Microbe	$ 3.75	$ 1966.98	$ 662.88
Nutrient	$ 0.47	$ 204.74	$ 39.65
Organic Acid	$ 0.06	$ 150.49	$ 23.45
Seaweed Extract	$ 1.40	$ 510.00	$ 130.94

Biostimulants containing microbial ingredients are higher priced than other biostimulants. These products are more difficult to manufacture and store. Microbial ingredients also contribute to long-term soil structure and the health of soil-plant relationships. Claims of fertilizer and pesticide reduction for these products are greater. Depending on soil cultivation style, use of any inputs over time may decrease. These factors lead to higher prices for microbial products.

Seaweed-based products appear to be the second highest priced biostimulants with an average price of $130.94 per acre. However, an important characteristic of this data is outlying prices for name-brand products. Acadian Seaplants products are priced significantly higher than off-label seaweed biostimulants. All other products cost on average $12.97 per acre per application, which is actual the lowest average price of all the biostimulants.

Nutrient-based biostimulants are in the mid-tier price range. As with Seaweed products, a specialty product inflates this average price—a nutrient-based biostimulant derived from earthworm castings. Without this $205 product, nutrient based biostimulants are also around $12 an acre as with seaweed. This price similarity is relevant to nutrient extraction from a similar source: shellfish.

Without the highest priced biostimulant for organic acids, the average price for biostimulant in this category would drop from $23.45 to $16.76 per acre. Acid products that claim to increase nutrient uptake tended to have higher prices than those claiming abiotic stress tolerance as the main product benefit.

5.0 CONCLUSION AND RECOMMENDATIONS

The biostimulant industry is vastly heterogenous and growing. Several opportunities exist to stake out a position as the industry continues to form. Competitive firms will only capture economic profit in this industry if they can either (1) provide systemic, integrated crop management and biological control services, or (2) find unique synergies with other product offerings that give their products an advantage.

Recommendations:

1. Continue to gather pricing information on available products. With more data, it will be possible to statistical analysis. Further analysis will help distinguish relationships between active ingredient, company size, certification status, claims, and price. Specifically, further explore the seed treatment and microbial ingredients or nutrient extracts.
2. With more information on product line-availability and competitor program, map out the industry further. Develop strategy around blank spaces in the industry that pivot on regarding product variety, active ingredient, product line compatibility, and customer support (including R&D)
3. Convene conversations on if and how entering partnerships to develop more biostimulant products play to competitive advantage. Will biostimulants cannibalize biopesticide sales and to what degree?

Growth in this market will continue to be promising both in terms of revenue and acres of land cultivated with biostimulants. Each year, 50% of growth is driven by first time customers. This indicates untapped potential to funnel existing customers into the product channel.

Seeing biostimulants as a complement product to other biological controls as part of a larger management program may be a better approach to drive consumer demand. Microbial and seed-treatment products are valid areas of exploration.

APPENDIX

Appendix Contents:

- ➔ Appendix A: Biostimulant Ingredients
- ➔ Appendix B: Growth Rate and Market Value Estimations
- ➔ Appendix C: Common Alternative Labelling Terms for Biostimulants
- ➔ Appendix D: Competitive Firms & Product Lines
- ➔ Appendix E: All Product and Pricing Data (attached .xlsx)

Appendix A: Biostimulant Ingredients and their Biological Processes

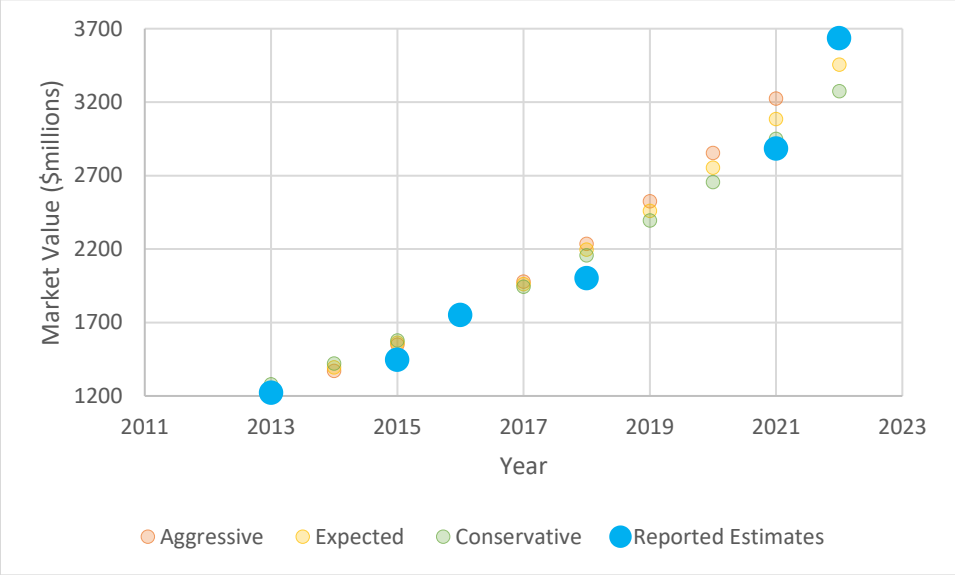
Acids & Compounds	1° Action	Promotes	Prevents	Sources/Seen With
Amino Acid	nutrient uptake	supplies nitrogen, peptides, amino acids, nutrient uptake, flowering, fruiting	nitrate leaching, disease	L-amino acids from vegetables
Citric Acid	nutrient uptake	chelation, pH reduction	abiotic stress	
Salicylic Acid	abiotic stress	strengthens cell walls and stem strength, cholorphyll production, integrated systemic response (ISR)	disease (pathogen signalling resonse), abiotic stress	
Phosphite (Phi)	abiotic stress	biocide & abiotic stress mediator: abiotic response, productivity and quality	abiotic stress	
Potassium Silicate	abiotic stress	abiotic stress mediator, strength, growth	mineral and climate stress	
Fulvic Acid	nutrient uptake	chelation: penetrates plant stoma to promote nucleic acid production, photosynthesis, respiration, microflora growth & microbial activity	abiotic stress	
Humic acid	nutrient uptake	chelation: fertilizer uptake, soil structure & water retention, metabolism regulation	premature death and disease	Leonardite

Other Organic Acid	crop quality	vigor, balanced plant nutrition, plant colore, development, production, improved shelf life, uniformity, strength		
Microbes	**Action**	**Promotes**	**Prevents**	**Sources/Seen With**
Azospirillum basilense	nutrient uptake	disease tolerance, root structure and development	transplant shock, nitrogen leaching	
Rhizosphere bacteria	crop quality	metapolism, plant development, fruit quality, yield	climatic pressure, disease	rhizosphere bacteria glomus intraradices, G mosseae, Trichoderma atroviride
Bacillus subtilis	crop quality	fungicidal: colonize root systems	disease (fungicidal)	saprophytic bacterium, produces lipopeptide antibiotics (iturins)
Arbuscular Mycorrhizal Fungi (AMF)	nutrient uptake	absorbtion and translocation of nutrients, secondary metabolism changes, phytohormone balance, plant development, faster germination, root development, nutrient-dense harvest	abiotic stress, disease	pisolithus, rhizopogon, scleroderma, laccaria, glomus , gigaspora
Nutrients	**Action**	**Promotes**	**Prevents**	**Sources/Seen With**
Chitosan	nutrient uptake	strengthens root systems, faster germination	abiotic stress	shelfish
Vermi-compost	nutrient uptake	increases nutrient availability, soil water retention, root initiation and development, growth	abiotic stress	humic acid from earth worm castings
Seaweed	**Action**	**Promotes**	**Prevents**	**Sources/Seen With**
Cytokinin (Kinetin)	nutrient uptake	increases cell division, leaf expansion, fruit size & uniformity, blossoms, branching, appearance	leaf aging	Laminaria, fucus serratus, ascophyllum nodosum
Kelp and Soluble Seaweed	nutrient uptake	provides polysaccharide, fatty acid, vitamins, phytohormones, mineral nutrients, plant growth	abiotic stress	brown marine macroalgae, Ascophyllum Nodosum, Norwegian Kelp

APPENDIX B: GROWTH RATE AND MARKET VALUE ESTIMATIONS

Blue figures are estimated current valuations and future growth rates reported by industry experts. Aggressive, Expected, and Conservative base values were identified from these industry estimates. Future value was extrapolated using Aggressive, Expected, and Conservative growth rates. Each predicted value was compared to the industry reported estimates. Top matches were labeled in dark green and light green. Based on the prevalence of matches using the Expected base estimate, Projections were made using the base estimation of 1.75 billion in revenue globally in 2016 and growth rates at 11, 12, and 13%. These expected estimates were also plotted in a growth curve below against industry expert expectations for fit.

			2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
BASE ESTIMATE	GROWTH RATE	RATE	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8
Aggressive	Aggressive	13%	1386	1566	1770	2000	2260	2554	2886	3261	3685	4164	4705	5317	6008
Aggressive	Expected	12%	1424	1594	1786	2000	2240	2509	2810	3147	3525	3948	4421	4952	5546
Aggressive	Conservative	11%	1462	1623	1802	2000	2220	2464	2735	3036	3370	3741	4152	4609	5116
Expected	Aggressive	13%	1213	1371	1549	1750	1978	2235	2525	2853	3224	3643	4117	4652	5257
Expected	Expected	12%	1246	1395	1563	1750	1960	2195	2459	2754	3084	3454	3869	4333	4853
Expected	Conservative	11%	1280	1420	1577	1750	1943	2156	2393	2657	2949	3273	3633	4033	4477
Conservative	Aggressive	13%	1040	1175	1327	1500	1695	1915	2164	2446	2764	3123	3529	3988	4506
Conservative	Expected	12%	1068	1196	1339	1500	1680	1882	2107	2360	2644	2961	3316	3714	4160
Conservative	Conservative	11%	1097	1217	1351	1500	1665	1848	2051	2277	2528	2806	3114	3457	3837
Reported	Reported		1221		1446	1750		2000			2884	3634			



APPENDIX C: COMMON ALTERNATE LABELLING TERMS FOR BIOSTIMULANTS[27]

Elicitor	Plant Strengthener	Plant Conditioner	Phytostimulant
Phytoprotectant	Biofertiliser	Bioactivator	Soil Enhancer
Bio-stimulant	Yield Enhancer	Crop Enhancer	Plant Growth Enhancer

APPENDIX D: COMPETITIVE FIRMS

North American Market Leaders

Company	Parent Company or Partner	Lines	Example Product
***Taminco**	Eastman Chemical Company	12	Ceraide
Isagro SPA	Isagro SPA	6	Ergostim
Italpolina SPA	Italpolina SPA	16	Auxym
Koppert Biological Systems	Koppert Biological Systems	4	Fortafol
HUMA GRO SPA	BioHuma Netics (BHN)	11	Activol
ILSA SPA	ILSA SPA	24	Ilsamin N90 Biostimulant
Arysta Life Science	Platform Specialty Products	12	Opeteine
Beem Biologics (Arysta)	Platform Specialty Products	2	Pilatus
Goemar (Arysta)	Platform Specialty Products	2	BM Start
Tradecorp	Tradecorp	5	Phylgreen Range
Valagro SPA	Valagro SPA	10	T-Wave
Helena	Valagro SPA	17	Hydra-Hume
Maxicrop USA	Valagro SPA	1	Algamin Kelp Meal
SriBio	Valagro SPA	13	Radifarm
TOTAL	9	135	

*Market Leader

Global Market Leaders

Company	Parent Company or Partner	Lines	Example Product
ADAMA	ADAMA	1	ExpertGrow
Becker Underwood	BASF	7	BioGain WSP
Embrapa	BASF	1	*(not found)*
Biolchim Concimi Speciali	Biolchim Concimi Speciali	13	Bio Energy Veg
Biostadt India Limited	Biostadt India Limited	15	Biozyme
Lallemand Plant Care	Lallemand Plant Care	8	Bioreveil
Novozymes A/S	Monsanto	3	Ratchet
TOTAL	6	48	

Major Market Players

Company	Parent Company or Partner	Lines	Example Product

Acadian Seaplants Limited	Acadian Seaplants Limited	8	Stimplex Crop Biostimulant
Winfield US	Acadian Seaplants Limited	1	Toggle 0-0-1
Actagro, LLC	Actagro, LLC	8	Proximus
Agrinos A/S	Agrinos A/S	13	Agrinos 5-0-0
BioAtlantis Ltd.	BioAtlantis Ltd.	8	Algac Omplex
Borregaard LignoTech	Borregaard LignoTech	2	BorreGro HA-2
Brandt Consol. Labs., Inc.	Brandt Consol. Labs., Inc.	6	Brandt Biomaster
CH Biotech	CH Biotech	3	MegaGro L
Cytozyme Laboratories, Inc.	Cytozyme Laboratories, Inc.	7	Cytozyme Granules
DeltaAg Formulations	DeltaAg Formulations	4	CropKarb
Headland Crop Nutrition	FMC Corp	1	Seamac Gold
Agricen	FMC Corp	4	Titan XC
Agrium	FMC Corp	3	Validate
InnovakGlobal	InnovakGlobal	7	RadiGrow
Micromix Plant Health Ltd.	Micromix Plant Health Ltd	10	Prodigy Seed Treatment
Ocean Organics	Ocean Organics	2	Guarantee Organic
Omex Agrifluids Ltd.	Omex Agrifluids Ltd.	13	OMEX Seastar-F
Kelp Products	Omex Agrifluids Ltd.	1	Kelpak
Verdesian Life Sciences	Verdesian Life Sciences	11	Avail
TOTAL	14	112	

Competitive Firms

Company	Parent Company or Partner	Lines	Example Product
Ad Terram	Ad Terram	1	Optimum
Alder Agro SL	Alder Agro SL	5	Brotostim
Agrifutur	Agrifutur	11	AfriKelp
Agritecno Fertilizantes	Agritecno Fertilizantes	4	Tecamin Brix
Agronutrition	Agronutrition	5	Connectis
AgraQuest	Bayer	1	Serenade
Biagro	Bayer	4	Planton VS
Biovert	Biovert	12	Manvert Stimulant
Brandon Bioscience	Brandon Bioscience	4	Searootz
Chase Organics	Chase Organics	2	Cytex
COMPO GmbH & Co. KG	COMPO GmbH & Co. KG	4	Basofoliar Avant Natur SL
Daymsa S.A.	Daymsa S.A.	12	Naturestim

Elephant Vert	Elephant Vert	8	Bioradicante
Gat Fertilizers	Gat Fertilizers	1	Bio-Gat Algae 21
Green Has Italia SPA	Green Has Italia SPA	8	Expando
Grassland Agro	Groupe Roullier	2	Slurry Biostimulant
Setalg	Groupe Roullier	5	Algovert
Timac Agro USA	Groupe Roullier	3	Fertiactyl Kalibor
Hai Fa Group	Hai Fa Group	4	HaifaStim Foliamin
ICL Special Fertilizer+Everris	ICL Special Fertilizer+Everris	6	Vitalnova SeaMax
Intermag sp.z.o.o.	Intermag sp.z.o.o.	2	Aminoprim
KLAD	Kingenta	4	Potassiumm Fulvate
L. Gobbi S.r.l.	L. Gobbi S.r.l.	7	Alga Special
Leili Marine BioIndustry Inc.	Leili Marine BioIndustry Inc.	2	Algreen
Lemagro NV	Lemagro NV	8	GroGreen
Lida Plant Care	Lida Plant Care	13	Primarenc
Massagri	Massagri	3	Ceres
Plant Health Care	Plant Health Care	1	N-Hibit HX-209
Plant Impact Plc	Plant Impact Plc	6	Fortalis
PRP Technologies	PRP Technologie	4	Primeo
Rural Liquid Fertilizer	Rural Liquid Fertilizer	2	Interceptor XF
RNZ International FZE	RNZ International FZE	4	Humic Acid
Sicit 2000	Sicit 2000	5	Naturcal
Sipcam	Sipcam	4	Sipfol
Sofrapar	Sofrapar	1	Ecobios
Soil Tech	Soil Tech	4	Micro-Gro AG
SQM	SQM	2	Speedfol Amino Starter SC
Syngenta	Syngenta	2	Epivo Biostimulants
Van Iperen International	Van Iperen International	2	FoliaStim
W Coast Marine Bio-Proces.	W Coast Marine Bio-Proces.	1	Kelpgrow
Yara International	Yara International	1	YaraVita EZY-Mg Plus
TOTAL	39	180	

ENDNOTES

[1] http://www.croplife.com/special-reports/biostimulants-clamor-for-a-piece-of-the-row-crop-market/

[2] https://www.agricen.com/agricultural-biostimulants, http://ag.alltech.com/en/blog/athlete-style-nutrition-plant-science-biostimulants

[3] http://ag.alltech.com/en/blog/athlete-style-nutrition-plant-science-biostimulants

[4] http://www.smithersapex.com/news/2017/february/growth-forecast-for-the-biostimulants-market

[5] https://www.agricen.com/agricultural-biostimulants

[6] http://ag.alltech.com/en/blog/athlete-style-nutrition-plant-science-biostimulants

[7] http://www.croplife.com/special-reports/biostimulants-clamor-for-a-piece-of-the-row-crop-market/

[8] http://www.croplife.com/special-reports/biostimulants-clamor-for-a-piece-of-the-row-crop-market/

[9] https://globenewswire.com/news-release/2017/02/13/916335/0/en/Market-Forecasts-Modest-Growth-for-Synthetic-Pesticides-Big-Growth-for-Biopesticides-Reports-BCC-Research.html

[10] http://www.croplife.com/special-reports/biostimulants-clamor-for-a-piece-of-the-row-crop-market/

[11] http://www.croplife.com/special-reports/biostimulants-clamor-for-a-piece-of-the-row-crop-market/; https://globenewswire.com/news-release/2017/02/13/916335/0/en/Market-Forecasts-Modest-Growth-for-Synthetic-Pesticides-Big-Growth-for-Biopesticides-Reports-BCC-Research.html

[12] https://www.agra-net.com/agra/agra-europe/analysis/strong-market-growth-potential-seen-for-biostimulants-in-europe-and-us-470300.htm

[13] http://www.prnewswire.com/news-releases/global-biostimulants-market-expected-to-grow-at-112-cagr-during-2016---2022-ps-market-research-584255101.html

[14] https://globenewswire.com/news-release/2015/10/05/773428/10151648/en/Biostimulants-Market-to-Expand-at-10-9-CAGR-between-2015-and-2025-Report.html

[15] http://www.marketsandmarkets.com/Market-Reports/biostimulant-market-1081.html

[16] http://www.marketsandmarkets.com/Market-Reports/biostimulant-market-1081.html

[17] http://www.croplife.com/special-reports/biostimulants-clamor-for-a-piece-of-the-row-crop-market/

[18] https://globenewswire.com/news-release/2015/10/05/773428/10151648/en/Biostimulants-Market-to-Expand-at-10-9-CAGR-between-2015-and-2025-Report.html

[19] https://www.mordorintelligence.com/industry-reports/global-plant-biostimulant-market-industry

[20] http://www.marketsandmarkets.com/Market-Reports/biostimulant-market-1081.html

[21] http://www.marketsandmarkets.com/Market-Reports/biostimulant-market-1081.html

[22] https://www.agra-net.com/agra/agra-europe/analysis/strong-market-growth-potential-seen-for-biostimulants-in-europe-and-us-470300.htm

[23] https://www.mordorintelligence.com/industry-reports/global-plant-biostimulant-market-industry

[24] http://www.lancasterfarming.com/news/main_edition/biostimulants-can-improve-yields-but-not-always/article_31355460-502d-58a8-99f0-b41725358be8.html

[25] http://www.biostimulants.eu/wp-content/uploads/2013/04/Biostimulant_economics_17April2013.pdf

[26] https://agfundernews.com/the-changing-landscape-of-biostimulants-in-ag5377.html

[27] https://www.agra-net.com/agra/agra-europe/analysis/strong-market-growth-potential-seen-for-biostimulants-in-europe-and-us-470300.htm