UC CE UNIVERSITY OF CALIFORNIA Agriculture and Natural Resources UC Cooperative Extension

Imperial County Agricultural Briefs

January 2024 (Volume 27 Issue 1)

Features from your Advisors

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NEW/RECENT NITROGEN FIXING BACTERIAL PRODUCTS FOR AGRICULTURE

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Most agricultural producers are well aware that current nitrogen prices have been erratic and reaching at some fairly high levels the past 2 years. Although the current nitrogen price is now somewhat lower than in the recent past, there is still concern that prices will continue to increase due to repercussions from the Ukraine-Russia conflict (Schnitkey et al., 2022).

Due to the higher prices, there is much interest in biological products that can contribute nitrogen as part of the production process. Increased research focusing on nitrogen fixing bacteria over the past several decades has resulted in several new products across a range of bacterial genera that are now commercially available for usage in agriculture, and are no longer restricted to just legumes.

With multiple new products available now available for usage in agriculture, many people may be surprised to learn these new/recently available bacterial products function very differently compared to the nitrogen fixing nodulating bacteria (sometimes referenced as legume nodulating bacteria or LNB) historically utilized in agriculture, and represent a wide range of bacterial genera and species that most people have not previously encountered.

LEGUME NODULATING BACTERIA

Local legumes such as alfalfa have long been known to have a symbiotic relationship with the bacterium *Sinorhizobium meliloti* (also referred to as *Rhizobium meliloti*). This bacterial species creates nodules on alfalfa roots, after the plants have reached 3-4 leaves in size, and is estimated to make slightly over 300 lbs./acre of nitrogen available via fixation.

Each individual legume species is usually paired with a specific symbiotic nodulating bacteria species and strain for nitrogen production, with the amount of nitrogen produced differing by legume species.

In addition to the *Sinorhizobium* used in alfalfa, two other legume nodulating bacteria (LNB) genera are commercially used in U.S. agriculture – *Bradyrhizobium* and Rhizobium. There is often additional specificity for the bacterial stain within the bacterial species and the legume species.

These bacteria can capture and fix significant amounts of nitrogen for their host plants.

Table 1. Amount of nitrogen fixed by symbiotic bacteria in various legume crops.

		Estimates of nitrogen (lbs./acre)	
Crop	**Genus / species**	**Low**	**High**
Alfalfa	*Sinorhizobium meliloti*	44	308
Cowpeas	*Bradyrhizobium*	44	132
Dry Beans	*Rhizobium leguminosarum* bv *phasioli*	50	150
Garbanzo Beans	*Bradyrhizobium*	25	81
Peas	*Rhizobium leguminosarum* bv. *viciae*	53	305
Soybeans	*Bradyrhizobium japonicum*	53	265

(estimates from Erker and Brick, 2014)

FREE LIVING SOIL BACTERIA

AZOTOBACTER

The past several years have noted increasing awareness and usage of *Azotobacter*. This genus is not new, being discovered in 1901, with *Azotobacter chroococcum* noted as first aerobic free-living nitrogen fixing bacteria.

The nitrogen fixing action is very different than that of the *legume nodulating bacteria which provide nitrogen after they have infected the root and fix nitrogen there at that location versus Azotobacter,* which live freely in the soil and do not colonize roots. *Azotobacter* bacteria utilize atmospheric nitrogen gas for their cell protein synthesis. This cell protein is then mineralized in soil after the death of *Azotobacter* cells, which then becomes available nitrogen for crops. Research has indicated that this species is capable of fixing an average of 17.8 lbs. of nitrogen/acre per year (Kizilkaya, 2009).

Azotobacter chroococcum product labeling from one supplier (*https://doraagri.com/product/azotobacter-chroococcum/)* notes that this bacterial species grows best when temperatures are 77-86ºF, with growth inhibited when temperature is lower than 50ºF or higher than 104ºF.

While air temperatures may exceed these levels, soil temperatures for most of the year in the low desert are within these ranges. It is sensitive to acidic pH, with best pH value ranging from 7.4-7.6 (which should be a good fit in the low desert), but sensitivity to high salts is known.

While the average summer soil temperatures from the Ripley CIMIS weather station near Ripley (shown below for 2019 and 2021), don't exceed these thresholds, higher temperatures should be expected for bare soils, especially in the top 4 inches. While average temperatures are shown, daily peaks beyond these should be expected from solar radiation.

A very interesting aspect of this species is the production of multiple beneficial plant growth substances (primarily hormones and amino acids) which have been documented to help increase plant growth far beyond the levels due to nitrogen alone. These aspects are thought by some to be more beneficial for plant growth than the nitrogen fixed in the soil by *Azotobacter*.

AZOSPIRILLUM

Azospirillum bacteria have been studied among the associative symbiotic nitrogen fixers because of their association with different grasses. Currently, 17 species of *Azospirillum* have been reported and among them, *Azospirillum lipoferum* and *Azospirillum brasilense* are the most studied (Kour et al., 2020). These species have been isolated from the soil as well as from the aerial parts of plants having nitrogen-fixing abilities. Accolade® (Verdesian Life Sciences) contains the free-living, nitrogen-fixing bacteria *Azospirillum brasilense*, which can be used on more than just grass crops, and in different methods (root drenches, etc.)

Apart from nitrogen fixation *Azospirillum* bacteria can also produce various plant hormones such as indole acetic acid (IAA), cytokinins, and gibberellins. It has been reported that *Azospirillum* also helps plants to survive during stress conditions by promoting changes in cell wall elasticity and osmotic adjustments (Groppa, Benavides, & Zawoznik, 2012). Saritha and Tollamadugu (2019) reported this bacterial species can produce 18-36 lbs. nitrogen/acre in addition to the various plant hormones.

NON–LEGUME ROOT COLONIZING BACTERIA

KLEBSIELLA (Raoultella), KOSAKONIA

There are several non-legume nitrogen fixing bacteria that colonize roots that are now commercially available. These bacteria are available in products such as ProveN, ProveN40, and ReturN. These products are marketed by Pivot Bio, and target usage on grass grain/silage crops (corn, corn silage, sorghum, wheat) and are usually applied at planting or directly to the seed prior to planting.

ProveN was the first product of these products released by Pivot Bio. It contained the bacteria *Klebsiella variicola* strain 137, and was expected to provide 20 lbs./acre of nitrogen. The marketplace has since had ProveN 40 become available, which is expected to provide 40 lbs./acre of nitrogen. ProveN 40 contains two bacterial species (*Kosakonia sacchari, Klebsiella variicola).*

ReturN contains *Klebsiella variicola,* which is expected to provide up to 25 lbs./acre of nitrogen. It is marketed for on-seed or in-furrow applications for wheat, sorghum and other small grains.

The response of sudangrass and/or other crops to these bacteria under low desert conditions has not yet been documented by land grant university research.

PIVOT BIO PROVEN

PIVOT BIO PROVEN40

PIVOT BIO RETURN

FOLIAR/NON-SOIL N FIXING BACTERIA

There are now several products that are commercially available in which the bacterial species differs from the previously discussed species as to the plant part (foliage) it infects. Instead of being in the soil and/or on plant roots. One advantage of these products is that they can be applied to foliage after plants have emerged, rather than being restricted to pre-plant or at-planting applications.

Gluconacetobacter diazotrophicus

Envita™ (Azotic NA) contains the naturally occurring, food grade bacteria *Gluconacetobacter diazotrophicus*, a species that was originally discovered in sugarcane. Product literature for Envita notes that this bacterial species "forms a symbiotic relationship with the host plant and provides nitrogen to cells throughout the plant, both above and below ground, all season long". Envita™ can be applied in-furrow and/or to foliage.

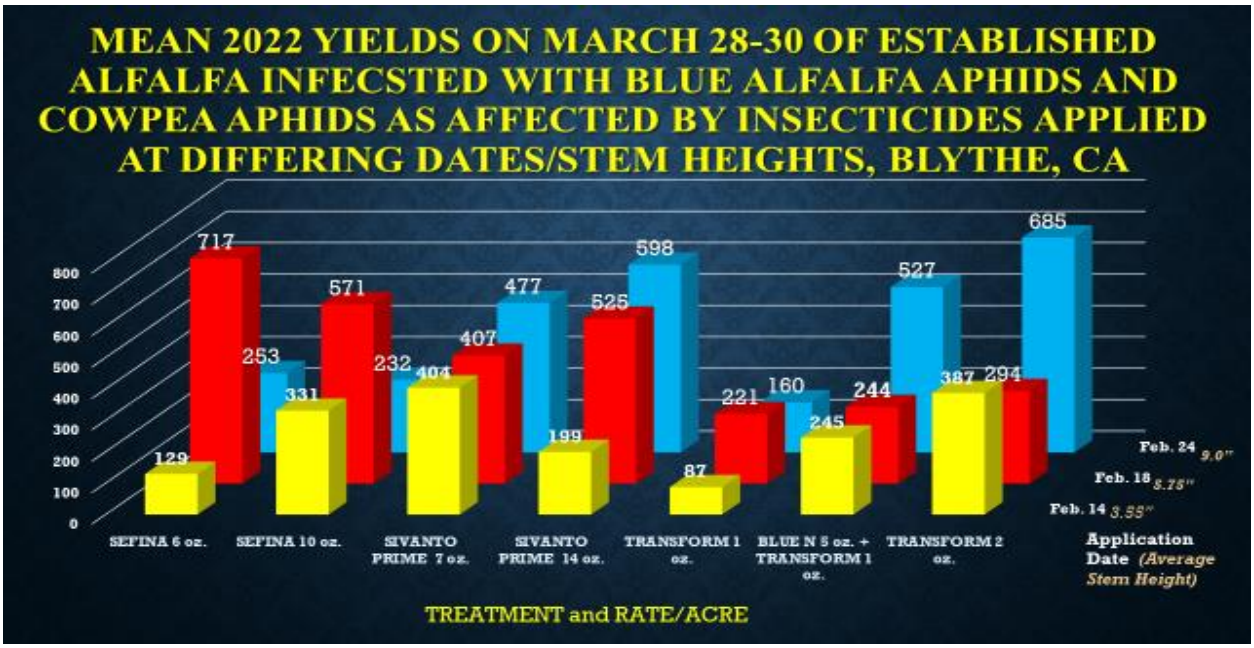
A North Dakoka State University report abstract noted that this tropical bacteria is known to fix up to 150 lbs. of nitrogen/acre in sugar cane (Yuja, 2023). Amounts produced under low desert conditions and for the many individual crops with different growing season lengths have not been researched. Local UCCE research with this product in the Palo Verde Valley was initiated on bermudagrass hay, but storms and associated winds moved the commercial field windrows and reliable hay yields were unable to be obtained.

Methylobacterium symbioticum

Another species of nitrogen fixing bacteria is *Methylobacterium symbioticum*. This bacterial species differs from the previously discussed species in the part of the plant it infects. Instead of being in the soil and/or on plant roots, *Methylobacterium symbioticum* provides ammonical nitrogen through the leaves via infection

through their stomates. Products that contain *Methylobacterium symbioticum* include Symborg (Blue N) and Corteva Agrisciences (Utrisha N). The latter product has a certified organic label (OMRI).

There are some low desert data for plant response to application of *Methylobacterium symbioticum.* An alfalfa trial in 2022 evaluated application of 1 oz./acre of the insecticide Transform to alfalfa with and without Blue N. Increases in alfalfa yield associated with addition of *M. symbioticum* (as Blue N) were noted to range from 19-367 lbs. of alfalfa hay/acre in just a single cutting, and also averaged 5-6 points higher in relative feed value (RFV) in this experiment when both cowpea and blue alfalfa aphids were present. Yields and quality for subsequent yields were not obtained.



Utrisha-N is being evaluated on other low desert crops. Final cotton lint yield and quality data from a local 2023 field trial with Utrisha-N are not yet available. Mixed results have been noted from local experimentation with usage of Utrisha-N on garlic and bermudagrass (applied to stubble) when just evaluating the plant responses as leaf nitrogen levels. This may be partially due to the upright leaf orientation and potential lack of thorough coverage (one experiment was applied via aerial application).

CONCERNS REGARDING TYPICAL AREA PRODUCTION PRACTICES

Bacteria do very well in moist conditions, but arid low desert conditions may be challenging for the foliar applied bacteria products, especially during late spring-autumn, as the spray may dry before adequate infections of plants via leaf stomates occurs.

Another concern which is yet to be evaluated is the effect of glyphosate on bacteria in plants. It targets the key enzyme of the shikimate pathway (5-enolpyruvylshikimate-3-phosphate synthase (EPSPS), which synthesizes three essential aromatic amino acids (phenylalanine, tyrosine, and tryptophan) in plants. The shikimate pathway is also found in many prokaryotes and fungi.

This latter aspect also needs to be considered when using this product. Research with RoundUp Power Max in Nebraska for controlling alfalfa rust in RoundUp Ready alfalfa noted activity for almost 35 days after a top of label (44 oz./acre) application (Rethwisch and Willet, 2016a, 2016b), thus a glyphosate application shortly after and prior to a bacterial based product like *Methylobacterium symbioticum* may affect the bacterial levels and activity.

It should be noted that the Nebraska trials occurred in the fall when temperatures were very cool and alfalfa was growing very slowly. The duration of glyphosate activity after an application in low desert RoundUp Ready crops such as alfalfa and cotton is unknown. Levels of glyphosate in these plants after application would also be expected to be much lower due the rapid growth in warm conditions in the summer.

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PROGRESSIVE FARMERS

Speaker:

Dr. Jesse Richardson

Field Scientist-Crop Protection Discovery and Development,

Corteva AgriSciences

Topic:

Practical Approaches to Preventing and Managing Pesticide Resistance

When: Thursday, Jan. 18th, 2024
Time: 12 p.m. - 1 p.m.
Where: 235 N. Broadway, City of Blythe Multipurpose Room, Blythe, CA

Application is Approved for 1 hour CEU from California Dept. of Pesticide Regulation (Cal DPR), CCA (Certified Crop Advisor) and Arizona Dept. of Agriculture

Please **RSVP** to Suzanne at 760-921-5060 (leave a message) by **Wednesday** Jan. 17th for lunch

Nisha Noroian, President of the Progressive Farmers Group

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IMPERIAL VALLEY CIMIS REPORT AND UC WATER MANAGEMENT RESOURCES

Ali Montazar, Irrigation and Water Management Advisor, UCCE Imperial, Riverside, and San Diego Counties

The reference evapotranspiration (ET_o) is derived from a well-watered grass field and may be obtained from the nearest CIMIS (California Irrigation Management Information System) station. CIMIS is a program unit in the Water Use and Efficiency Branch, California Department of Water Resources that manages a network of over 145 automated weather stations in California. The network was designed to assist irrigators in managing their water resources more efficiently. CIMIS ET data are a good guideline for planning irrigations as bottom line, while crop ET may be estimated by multiplying ET_o by a crop coefficient (K_c) which is specific for each crop.

There are three CIMIS stations in Imperial County include Calipatria (CIMIS #41), Seeley (CIMIS #68), and Meloland (CIMIS #87). Data from the CIMIS network are available at: http://www.cimis.water.ca.gov/. Estimates of the average daily ET_o for the period of January 1st to March 31st for the Imperial Valley stations are presented in Table 1. These values were calculated using the long-term data of each station.

Table 1. Estimates of average daily potential evapotranspiration (ET_o) in inch per day

Station	January		February		March	
	1-15	16-31	1-15	16-28	1-15	16-31
Calipatria	0.09	0.10	0.12	0.13	0.16	0.19
El Centro (Seeley)	0.10	0.11	0.13	0.15	0.19	0.22
Holtville (Meloland)	0.09	0.10	0.12	0.14	0.17	0.21

For more information about ET and crop coefficients, feel free to contact the UC Imperial County Cooperative Extension office (442-265-7700). You can also find the latest research-based advice and California water & drought management information/resources through link below: http://ciwr.ucanr.edu/