

OPTINYTE® TECHNOLOGY vs. DICYANDIAMIDE (DCD)

(Nitropryrin) Optinyte® technology	Length of control	Positive impact on yield?	Relative amount of active ingredient needed per acre	Positive environmental impact	Soil stability
Dicyandiamide (DCD)	1-2 weeks 	Data does not support ¹	up to 30X 	Data does not support ²	susceptible to leaching
Optinyte® technology	up to 8 weeks 	YES	YES	YES	stable

¹NutrientStar: Dicyandiamide (DCD). <http://nutrientstar.org/tool-finder/dcdd>
²Yang, M., Y. Fang, D. Sun, and Y. Shi. 2016. Efficiency of two nitrification inhibitors (dicyandiamide and 3,4-dimethylpyrazole a phosphate) on soil nitrogen transformations and plant productivity: a meta-analysis. www.nature.com/articles/srep22075.pdf

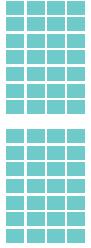


LENGTH OF CONTROL

OPTINYTE® TECHNOLOGY (Nitrapyrin)

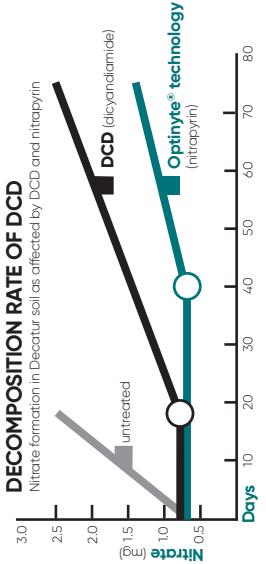
N-Serve®, Instinct NXTGEN® and Vindicate® nitrogen stabilizers

up to 8 weeks



Instinct NXTGEN and N Serve were superior to DCD as a nitrification inhibitor in the Decatur soil, delaying nitrification longer and, once nitrification began, maintaining a slower nitrification rate.

Source: Decomposition rate of dicyandiamide and nitrification inhibition | Communications in Soil Science and Plant Analysis



In a summary of nitrification inhibitor studies, Optinyte technology (nitrapyrin), the active ingredient in N-Serve and Instinct NXTGEN, was the most effective inhibitor, followed by DCD. The summary also suggested if you need an inhibitor, use the strongest one available.

Source: North Dakota State University | R. Jay Goos

Instinct NXTGEN, which has the most extensive history of inclusion in research trials, significantly delayed nitrification up to 84 days and in greater amounts than the other tested products.

Source: Corn and Wheat Yields as a Function of Nitrogen Rates and Fertilizer Types or Additive in Three Physiographic Regions of North Carolina | Shelby Renae Rajkovich

DCD (Dicyandiamide)

1-2 weeks



At 70 F, DCD lasts only approximately 7 to 14 days in the soil. “The rapid decomposition at 71.6 F suggests that DCD might not be a suitable nitrification inhibitor for summer crops.”

Source: Decomposition rate of dicyandiamide and nitrification inhibition | Communications in Soil Science and Plant Analysis

DCD is not a good inhibitor for early spring or fall.

Source: What agronomists need to know about nitrogen enhancers and stabilizers, University of Minnesota Fabián G. Fernández

"AT 70 F, DCD LASTS ONLY APPROXIMATELY 7 TO 14 DAYS IN THE SOIL."

DCD should be applied when soils are relatively cool to maximize its longevity. This makes DCD products less than ideal for Midwest corn growing states unless extended delayed nitrification is less desirable.

Source: The temperature dependence of dicyandiamide (DCD) degradation in soils | Soil Biology and Chemistry Goos, R.J. - Nitrogen Fertilizer Additives - Which ones work? Department of Soil Science North Dakota State University www.ndsu.edu/facadmin/soils/pdfs/goos-franzen-meeting-2.pdf Bronson, K. F., J. T. Touchton, and R. D. Hauck. 2008. Decomposition rate of dicyandiamide and nitrification inhibition. Communications in Soil Science and Plant Analysis 20:19-20. 2007-2008. DOI: 10.1080/001036298088201 Kelley, F. M., T. J. Clough, H. Clark, G. Rhys, and J. R. Sedlacek. 2008. The temperature dependence of dicyandiamide (DCD) degradation in soils: A data synthesis. Soil Biol Biochem. 40: 1878-1882

Fernandez, F. G. 2016. What Agronomists Need to Know About Nitrogen Enhancers and Stabilizers. https://umanitoba.ca/faculties/arts/regionomists.com/media/Fernandez_NitrogenAdditivesWinnipegDec162016.pdf



POSITIVE IMPACT ON YIELD

OPTINYTE® TECHNOLOGY (Nitrapyrin
N-Serve®, Instinct NXTGEN® and Vindicate® nitrogen stabilizers

YES

DCD (Dicyanodiamide)

Data does not support¹

The effect of nitrapyrin on grain yield consisted of 189 observations comprising 437 mean comparisons across 158 locations – years of experiments, with 141 of 189 observations showing a positive effect of nitrapyrin on yield. The grand mean represents a relative yield increase from nitrapyrin of 7.0% when used with fall nitrogen applications and of 5.2% when used with spring applications.



Source: Wolt, J. D. 2004. A meta-evaluation of nitrapyrin agronomic and environmental effectiveness with emphasis on corn production in the Midwestern USA.
Nutr. Cycl. Agroecosyst. 69: 23–41. doi:10.1023/B:NRES.00000025287.52563.99.

While holding fertilizer rate and other management characteristics constant, nitrapyrin treatment increases average grain yield for both corn and wheat in North America. These yield benefits suggest that nitrapyrin increases nitrogen use efficiency. Such action could reduce environmentally harmful nitrogen losses. Given its demonstrated ability to increase crop yield, nitrapyrin promises to be an important component of improved management practices.

Source: NutrientStar

With the data available, and in the conditions studied, DCD did not have any beneficial yield impacts for either wheat or corn.¹ Some of the studies reporting yield decline may not have fully considered the potential for phytotoxicity with certain application methods. Therefore, if DCD is to be recommended as a product for improving N use efficiency, more research (or increased accessibility of existing field data) is needed to determine the climate and soil characteristics or other management practices most likely to see such benefits.

Source: NutrientStar

"DCD did not have any beneficial yield impacts for either wheat or corn."

Source: NutrientStar | www.nutrientstar.org



NutrientStar

NutrientStar is a science-based review program for nutrient management. A nutrient management tool or product earns a spot on the NutrientStar website when its independent review panel assesses available data on the product's ability to increase nutrient use efficiency during field trials. They use a scientifically rigorous, transparent method for measuring efficiency that allows the review panel to assess tools by their level of performance.

¹ NutrientStar: Dicyanodiamide (DCD), <http://nutrientstar.org/tool-finder/dcd/>



RELATIVE AMOUNT OF ACTIVE INGREDIENT NEEDED PER ACRE

OPTINYTE® TECHNOLOGY (Nitrapyrin)
N-Serve®, Instinct NXTGEN® and Vindicate® nitrogen stabilizers

DCD (Dicyandiamide)

1X

up to
30X 

**"Nitrapyrin
is quite
effective even
at relatively
low rates."**

**"Dicyandiamide
is required at a
significantly larger
concentration
to be effective."**

Dicyandiamide is required at a significantly larger concentration to be effective. Zacherl and Amberger (1990) found that DCD had to be applied at concentrations of 300 ppm to inhibit the activity of Nitrosomonas. Nitrapyrin is quite effective even at relatively low rates. Rates as low as 0.1 ppm have been shown to effectively inhibit certain strains of Nitrosomonas, but rates of 10 ppm has been shown to be effective against most strains (Belser and Schmidt, 1981).

Source: Robert Mullen | Nitrogen additives: What is what, and do they work?

**"DCD is effective only at certain rates; however, the
rates used typically are not high enough to be effective."**

Source: North Dakota State University | Dave Franzén

Mullen, Robert W. 2010. Nitrogen additives: What is what, and do they work?" Proceedings of the Integrated Crop Management Conference 23. <https://ib.dri.state.edu/cmc/2010/proceedings/23>

Franzen, D. 2017. Chemistry to Enhance Nitrogen and Phosphorous Efficiency. Indiana CCA Conference, 12 December, 2017, North Dakota State University.



POSITIVE ENVIRONMENTAL IMPACT

OPTINYTE® TECHNOLOGY (Nitrapyrin)
N-Serve®, Instinct NXTGEN® and Vindicate® nitrogen stabilizers

YES

Data does not support²

Optinyte technology in Instinct NXTGEN and N-Serve nitrogen stabilizers was awarded the Presidential Green Chemistry Challenge Award stating that the technology added about 50 million bushels of additional corn equating to over \$205 million in additional production revenue for U.S. corn growers; and reduced carbon dioxide emissions by about 664,000 metric tons.

Source:
Environmental Protection Agency



Results showed that on average, greenhouse gas emissions decreased by 51 percent.

51% less greenhouse gas emissions

Source: Wolt, J. D. 2004.

A meta-evaluation of nitrapyrin agronomic and environmental effectiveness with emphasis on corn production in the Midwestern USA.

Nutr. Cycl. Agroecosyst. 69: 23–41. doi:10.1023/B:NFCES.0000025287.52565.99.

"The efficiency of DCD and DMPP under continuously application in one given site is needed to examine. Meanwhile, the impact of their toxicity on plant growth and human health is also needed to study after years of application. Furthermore, the environmental impact of DCD related to the release of [greenhouse gas emissions] from soil still needs more studies to confirm." This statement was in the conclusion of a meta-analysis conducted on DCD — 49 peer-reviewed publications could not determine the toxicity or the environmental benefit of DCD.

Source: Scientific Reports | nature.com

The microbes targeted by DCD, the ammonium oxidizing bacteria, were significantly affected by DCD with reductions in population size and altered activity. In field experiments, Instinct and N-Serve did not reduce numbers of ammonium-oxidizing bacteria (i.e., *Nitrosomonas*). This statement from peer-reviewed research demonstrates that Optinyte suppresses nitrifying bacteria in the soil, but does not kill bacteria.

Source: Soils and Plant Nutrition Department | Bacteriostatic action of nitrification inhibitors

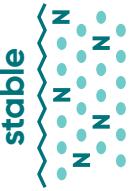
Rodgers, G. A., and J. Ashworth. 1982. Bacteriostatic action of nitrification inhibitors. Can J Microbiol. 28: 1093–1100.
Inoue, K., T. Sakamoto, J. Z. Min, K. Todoroki and T. Toyo'oka. 2014. Determination of dicyandiamide in infant formula by stable isotope dilution hydrophilic interaction liquid chromatography with tandem mass spectrometry. Food Chemistry. 156: 390–393.



SOIL STABILITY

OPTINYTE® TECHNOLOGY

N-Serve®, Instinct NXTGEN® and Vindicate™ nitrogen stabilizers



Results showed that on average, N leaching decreased by 16 percent and soil N retention increased by 28 percent. In more than 75 percent of individual comparisons, use of a nitrification inhibitor increased soil N retention and decreased N leaching and volatilization.

16%
less
leaching

28%
increase in
soil retention



DCD is water soluble and can leach away with the first significant rainfall event in contrast to Instinct and N-Serve, which remain in the root zone protecting your nitrogen from losses.

Source: Laboratory evaluation of dicyandiamide as a soil nitrification inhibitor | Communications in Soil

"DCD is readily leached, lowering its effectiveness."

Source: Wolt, J. D. 2004.
A meta-evaluation of nitrapyrin agronomic and environmental effectiveness with emphasis on corn production in the Midwestern USA.
Nutr. Cycl. Agroecosyst. 69: 23–41. doi:10.1023/B:NFCR.00000026287.52565.99.

Source: International Plant Nutrition Institute | Nitrification Inhibitors

McCarty G. W., and J. M. Bremner. 1989. Laboratory evaluation of dicyandiamide as a soil nitrification inhibitor. Comm. Soil Sci. Plant Anal. 20: 2049–2065.5
International Plant Nutrition Institute. Nitrification Inhibitors. [http://www.ipni.net/publication/nss.nsf/0/21B9084A341C98E05252753C007759EB/\\$FILE/NS-26%20Nitrification%20Inhibitors.pdf](http://www.ipni.net/publication/nss.nsf/0/21B9084A341C98E05252753C007759EB/$FILE/NS-26%20Nitrification%20Inhibitors.pdf)
Inoue, K., T. Sakamoto, J. Z. Min, K. Todoiroki and T. Toyo'oka. 2014. Determination of dicyandiamide in infant formula by stable isotope dilution hydrophilic interaction liquid chromatography with tandem mass spectrometry. Food Chemistry 156: 390–393.



Instinct[®] NXTGEN[®]

Optinyte™ technology

NITROGEN STABILIZER

N-Serve[®]

Optinyte™ technology

NITROGEN STABILIZER

Vindicate[®]

Optinyte™ technology

NITROGEN STABILIZER

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