

Pest & Crop newsletter

Purdue Cooperative Extension Service and USDA-NIFA Extension IPM Grant

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General Biological Description

(Shaun Casteel)

In recent years, a new era in crop management has been centered around biologicals that have targets associated with pest control, improved nutrient supply and uptake, and overall plant growth and resiliency. These biologicals can be directly applied to the seed, delivered through in-furrow systems, broadcasted to soil surface, and foliarly applied. Beneficial microbes have claims around N supply through fixation (i.e., rhizobial and non-rhizobial), solubilizing P from soil minerals, and extending the reach of root systems and nutrient uptake. Other biological products are classified as biostimulants that include enzymes (e.g., phosphatase that break and release phosphorus bound to organic matter), humic or fulvic acids chelate cations in the soil to increase P and Zn availability, and marine extracts (e.g., seaweed) or sugars that stimulate microbes, roots, and shoots.

Purdue Soybean Extension will be evaluating 15 biological products in 2023 growing season, but there are nearly 100 products on the market. We want your input to determine which biologicals are of most interest to you to direct our evaluation. We have divided the biologicals into five categories: N Suppliers (non-rhizobial), P Suppliers, Humic/Fulvic Acids, Marine Extracts, and Combinations. We have a summary table for each category as well as the direct link to the company website describing that product to assist you in your selections.

Thank you for your time and consideration. We are also grateful for the support of Indiana Soybean Alliance to conduct this research.

https://purdue.ca1.qualtrics.com/jfe/form/SV_5o7gWCyUynGxCL4

Historical Corn Grain Yields in the U.S.

(Bob Nielsen)

- Corn grain yields in the U.S. have steadily increased since the late 1930's.
- Only two major shifts in U.S. corn yield trends have occurred since yield estimates were first published in 1866.
- Year-to-year departures from trend yield are influenced primarily by year-to-year variability in growing conditions.

Historical trends of grain yield improvement offer us a glimpse of yields yet to come, although, like the stock markets, past performance is no guarantee of the future. The historical yield data for corn in the U.S. illustrate the positive impact of improved crop genetics and improved crop/soil management practices.

American farmers grew open-pollinated corn varieties until the rapid adoption of hybrid corn began in the late 1930's. From 1866, the first year USDA began to publish corn yield estimates, through about 1936, yields of open-pollinated corn varieties in the U.S. were fairly stagnant and only averaged about 26 bu/ac (1.6 MT/ha) throughout that 70-year period (Fig. 1).

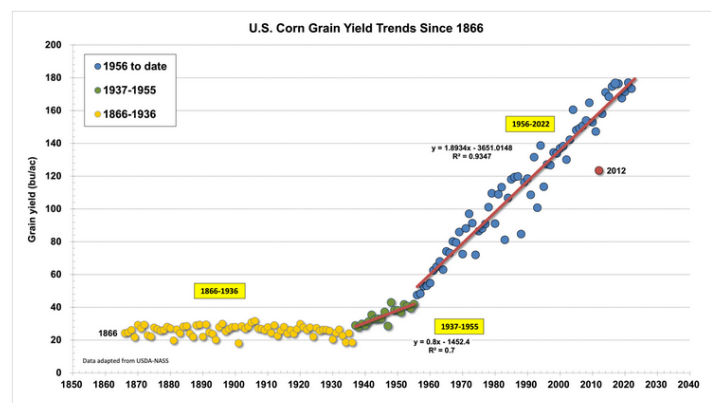


Fig. 1. Annual U.S. Corn Grain Yields and Historical Trends Since 1866. Data derived

from annual USDA-NASS Crop Production Reports.

It is amazing to me that there was no appreciable change in productivity over that 70-year time period, even though farmers' seed-saving practices represented a form of plant breeding that one would have expected to result in small increases in yield over 70 years. Kutka (2011) suggests that the absence of significant yield improvement in these open-pollinated varieties was not so much a result of ineffective plant breeding by farmers as it was the inability to produce, or maintain, high quality seed for the next year's planting and farmers' generally low adoption of agronomically sound crop and soil management practices.

Rapid adoption of double-cross hybrid corn by American farmers began in the late 1930's, in the waning years of the U.S. Dust Bowl and Great Depression. Within a very few years after that, the national yield estimates indicated that a genuine "miracle" of corn grain yield improvement had occurred. The annual rate of yield improvement, which heretofore had been about zero, increased to about 0.8 bushels per acre per year from about 1937 through about 1955 (Fig. 1). This dramatic improvement in yield potential must have truly seemed like a miracle to American farmers.

Hybrid Adoption Trivia: An interesting premise put forward by Sutch (2011) is that even though early hybrids had been shown to yield better than open-pollinated varieties prior to the 1930s, "...the drought of 1936 sped the process of adoption after it revealed the drought resistance of hybrid corn." In other words, the yield advantage of hybrids over open-pollinated varieties under severe drought stress was nothing short of "miraculous". The author further states... "After 1937, a new dynamic was set in motion. The explosion of demand for hybrid corn generated large profits for the major hybrid seed companies: Pioneer, Funk, and DeKalb. As a result, the companies invested heavily in research with new hybrid strains. They not only perfected the drought resistance of the plant but also found ways to permit increased planting density, increase the resistance to lodging, and increase responsiveness to artificial fertilizer. The result was a steady improvement in the yields per acre that hybrid corn could achieve. Once these post-1937 improvements were recognized, adoption of hybrid corn became economically advantageous; before 1937, it had not been so."

The second "miracle" of corn grain yield improvement began in the mid-1950's (Fig. 1) in response to continued improvements in genetic yield potential and stress tolerance plus increased adoption of nitrogen fertilizer, chemical pesticides, agricultural mechanization, and overall improved soil and crop management practices. The annual rate of corn yield improvement more than doubled to about 1.9 bushels per acre per year and has continued at that steady annual rate ever since, sustained primarily by continued improvements in genetics and crop production technologies (Fig. 1).

Some speculated that a third "miracle" of corn grain yield improvement would occur with the advent and rapid adoption of transgenic hybrid traits (insect resistance, herbicide resistance) by U.S. corn farmers beginning in the mid-1990's. In fact, a number of seed industry 'experts' confidently promised that average US corn grain yield would approach 300 bushels per acre by 2030 due to these advances in biotechnology (Schill, 2007).

However, the USDA-NASS yield data show little to no evidence that the yield trend over the past 25 years has deviated from the long-term 1.9 bushels per acre per year (Fig. 1). The absence of a marked change in the yield trend line reflects the fact that currently available transgenic hybrid traits do not literally increase genetic yield potential above and

beyond "normal" genetic improvements in corn hybrids. Rather, these traits simply protect the inherent yield potential of modern hybrids while potentially reducing farmers' reliance on chemical pesticides. A true third "miracle" of corn yield improvement remains "somewhere over the rainbow".

Trend Line Trivia: Historical trend lines offer a useful way to visualize changes over time. The historical trend yield lines shown in Fig. 1 are technically linear regression lines and represent the best "fit" method for describing the changes in U.S. corn yields over time. The equation associated with the trend line that begins in the 1950s can be used to predict U.S. corn yield for the current cropping year under "normal" growing conditions. Year-to-year departures (changes) from the trend line are caused primarily by year-to-year variability in growing conditions. However, significant changes in the trend line itself (i.e., the slope of the line) are usually caused by significant changes in the adoption of farming technologies (e.g., hybrids, pest control, soil management, mechanization, precision ag. technologies). Irwin and Hubbs (2020) offer an interesting read on how these trend lines are affected by what year you choose to begin the estimation. In particular, one must be cautious when using short time periods because of the greater effects unusual individual years (e.g., drought of 2012) can have on that estimation. My personal preference is to use the time period beginning with 1956, which accounts for 93% of the variability in corn grain yields between then and now (Fig. 1).

Reliance on corn yield trend lines to estimate future corn grain yields is inherently not precise. Annual corn yields fluctuate above and below their respective historical trend lines (Fig. 2), primarily in response to variability in growing conditions year to year (e.g., weather and pests). The "Great Drought" of 2012 certainly resulted in dramatic and historic reductions in corn grain yield relative to trend yield (-22%), but the greatest negative departure from trend yield actually occurred more than 100 years earlier during the "Great Drought" of 1901 (-30%). Conversely, the greatest single positive departure from trend yield occurred in 1906 when the corn crop that year yielded 23% higher than the expected trend yield. The magnitude and range of annual departures from trend yield since the mid-1950's reinforce the evidence from Fig. 1 that the adoption of transgenic hybrid traits beginning in the mid-1990's has not resulted in yields unusually higher than the long-term yield trend.

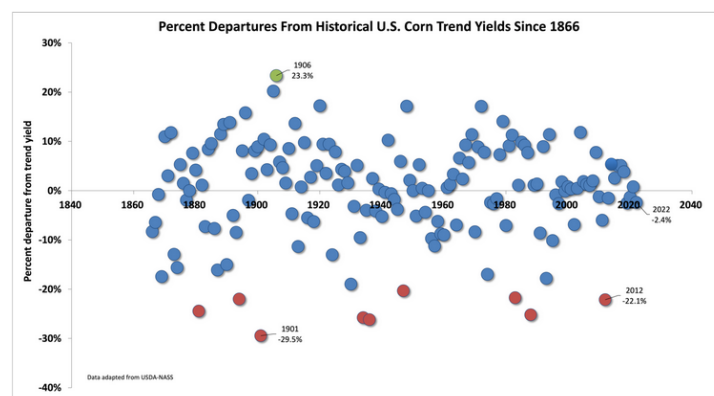


Fig. 2. Annual percent departures from estimated corn trend yields in the U.S. since 1866. Data derived from annual USDA-NASS Crop Production Reports with respect to historical trend lines depicted in Fig. 1.

Bottom Line

The GOOD NEWS is that corn grain yields in the U.S. have steadily increased since the 1950's at almost 2 bushels per acre per year. The

SOBERING NEWS is that, in order to support the ever-burgeoning world population in the years to come, a third “miracle” that dramatically shifts the annual rate of corn yield improvement will be required.

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Grain Yield Trend Lines: Don't Be Fooled

(Bob Nielsen)

- Historical yield trends offer a glimpse into the future.
- Yield trend lines are simple to calculate.
- Be aware that trend lines based on short-term data can be misleading.

Historical trends in grain yield are of interest to a wide range of folks involved with row crop agriculture, from farmers to global grain marketing specialists. Personally, I have always been mesmerized by the historical changes in national corn grain yield that USDA first began to publish in 1866 (Nielsen, 2023).

Changes in grain yield over time tend to be linear in nature, with the occasional change in the slope or rate of linear increase in response to changes in genetics or other agricultural technologies. Consequently, “trend lines” tend to be calculated using simple linear regression methodologies with widely available spreadsheet software like Microsoft Excel.

For example, the linear trend for corn grain yield improvement in the U.S. since 1956 has been 1.9 bu/ac/yr (Fig. 1). That trend line calculation accounts for 93% of the historical year-to-year variability in grain yields. In other words, that trend line is a very good “fit” to the data.

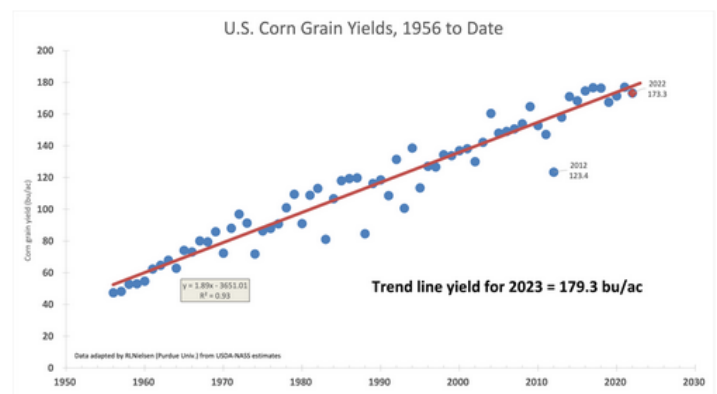


Fig. 1. U.S. Corn Grain Yields, 1956 to 2022.

As with any use of statistics, there are certain precautions one should take to minimize the risk of drawing incorrect conclusions. One such precaution relative to grain yield trends is understanding the impact of the length of the time period used in estimating the yield trend line. Irwin and Hubbs (2020) addressed this issue from a somewhat different perspective. I want to illustrate the need for precautions using a few simple examples.

The year I graduated from high school was the end of a 10-year run of impressive improvements in national corn grain yields, with the exception of the 1970 southern corn leaf blight epidemic. The linear yield trend calculated for that 10-year time period was a pretty good

“fit” to the data ($R^2 = 0.72$) and indicated that grain yield had increased at a rate of 2.9 bu/ac/yr (Fig. 2). There were undoubtedly agricultural “experts” at the time who confidently proclaimed that the third “miracle” of corn yield improvement had occurred and that by the year 2023 the average U.S. national corn grain yield would be close to 237 bu/ac. (See my [earlier article](#) that references the previous historical “miracles” of corn yield improvement.)

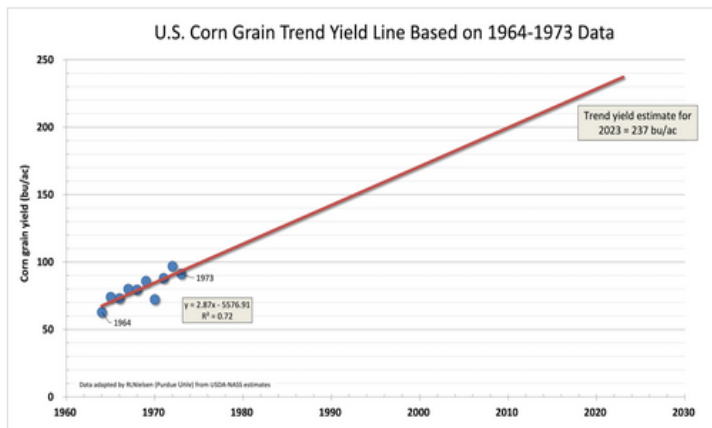


Fig. 2. U.S. Corn Grain Yield Trend Line. Based on 1964-1973 Yield Data.

Similarly, the advent of hybrid corn with transgenic traits (so-called GMO or biotech hybrids) in the mid-1990s was loudly hailed as the precursor of the third “miracle” of corn yield improvement (e.g., [Schill, 2007](#)). Such proclamations were based, in part, on simple trust in the power of biotechnology. Others pointed to the 10-year trend line beginning in 1996 that seemingly showed the historical trend in corn yield improvement (beginning in the mid-1950s) of 1.9 bu/ac/yr had “miraculously” increased to 2.7 bu/ac/yr (Fig. 3). That apparent increase in the linear rate of corn yield improvement predicted an average national corn grain yield of 200 bu/ac by 2023.

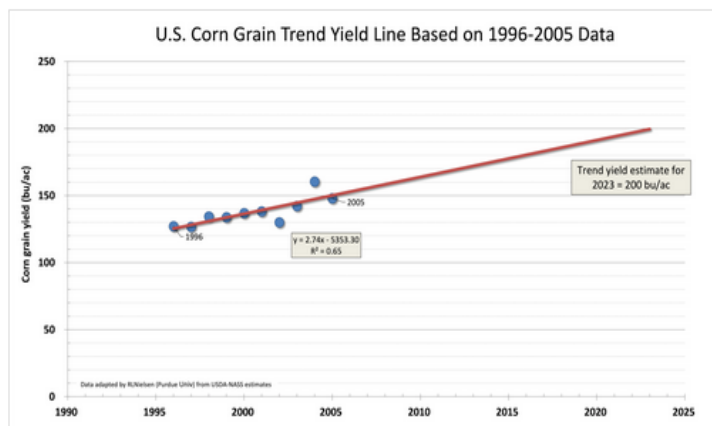


Fig. 3. U.S. Corn Grain Yield Trend Line. Based on 1996-2005 Yield Data.

Well, of course, neither short-term estimate of the trend in corn yield improvement has proven correct. The yield trend calculated from the past 67 years (since the beginning of the second “miracle” of corn yield improvement) still describes the rate of corn yield improvement very well ($R^2 = 0.93$). Interestingly, if one considers the 27-year period since the advent of hybrids with transgenic traits in the mid-1990s, the yield trend based on those data is also 1.9 bu/ac/yr (Fig. 4). I interpret that as being further evidence that the transgenic traits currently available to corn growers in the U.S. have not had any measurable effect on the annual rate of corn yield improvement.

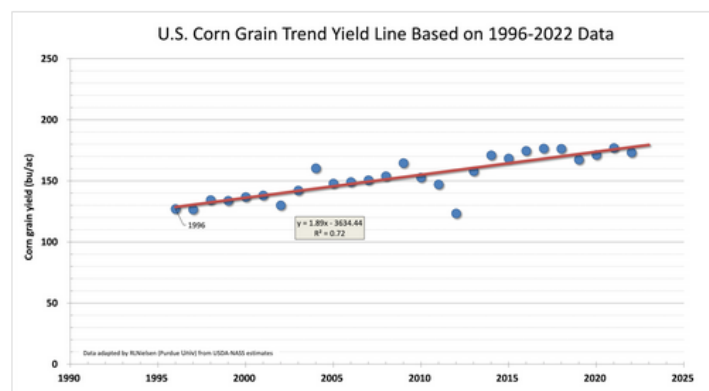


Fig. 4. U.S. Corn Grain Yield Trend Line. Based on 1996-2022 Yield Data.

Thus, the third “miracle” of corn yield improvement continues to be “just over the horizon”. That’s my opinion and you are entitled to it.

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Spring Herbicide Applications On Winter Wheat

(Tammy Luck, luck@purdue.edu) & (Marcelo Zimmer)

The warmer temperatures experienced in Indiana over the past few weeks and the forecast for warmer temperatures moving forward will allow winter wheat fields in Indiana to green up and resume growth. During winter wheat green-up, there are a few field activities that need to be considered, including winter wheat herbicide applications and winter annual weed burndown applications in no-till fields. The following information will outline winter annual weeds to look out for, weed scouting tips, crop stage restrictions, and herbicide recommendations.

Some common broadleaf weeds to scout for in your winter wheat are dandelion, purple deadnettle, henbit, chickweed, Canada thistle, wild garlic, and annual ryegrass if you are in the far southwest part of the state. These winter annual species emerge in the fall and can remain relatively inconspicuous through the winter; however, they become competitive and troublesome during the spring if not controlled early. Summer annual weeds such as ragweed will be of less concern in the early spring and will be outcompeted by the wheat crop if managed properly. Grass weeds to be aware of and scout for are: annual bluegrass, annual ryegrass, cheat, and downy brome.

Determining the severity of weed infestations in your wheat fields is key

in determining the necessity of a herbicide application. As with all agronomic crops, you should scout your entire field to determine what weed management practices need to be implemented and determine any areas of severe weed infestations. Wheat fields that contain uniform infestations of at least one broadleaf weed and/or three grass weeds per square foot should be taken into consideration for a herbicide application to avoid yield loss and harvest interference problems. Some fields that have less uniform infestations, but rather pockets of severe infestation should be managed to reduce weed seed production and future infestations.

When determining your herbicide program for spring applications, the stage of the wheat crop should be considered. The majority of wheat herbicides are labeled for application at certain wheat growth stages and some commonly used herbicides have very short windows in which they can be applied. The popular broadleaf weed herbicides 2,4-D and MCPA are efficient and economical, but can only be applied for a short period of time between tillering and prior to jointing in the early spring. Wheat growth stages and herbicide timing restrictions are outlined in Figure 1.

If weed infestations are severe enough to require a herbicide application, the use of liquid nitrogen fertilizer solution as a carrier is a popular option for applying herbicides and topdressing the wheat crop in a single pass over the field. Caution should be taken when using liquid fertilizer as a herbicide carrier as moderate to severe crop injury can result, especially in saturated soil conditions. Many POST-applied wheat herbicide labels allow for liquid nitrogen carriers but require different rates and types of surfactants than if the herbicide was applied with water as the carrier. Table 1 includes precautions to be taken when applying wheat herbicides using liquid fertilizer as a carrier; further details and directions can be acquired from the herbicide label.

Another consideration growers should take into account when planning early spring herbicide applications is the plant-back restrictions to double-crop soybeans. A large percentage of the herbicides listed in Table 1, especially those with activity on annual ryegrass and downy brome, have soybean plant back restrictions greater than the typical three-month time period between spring applications and double-crop soybean planting. The soybean plant back restrictions greatly reduce the number of options available to wheat producers who double-crop soybeans after wheat. Refer to Table 1 for more specific plant back timing restrictions.

Table 1. Spring applied wheat herbicide rates, crop stage restrictions, weed control spectrum, soybean plant back timing, and liquid fertilizer carrier recommendations (Source: 2023 Weed Control Guide for Ohio, Indiana and Illinois).

Active Ingredient	Trade Name(s)	Rate Per Acre	Application Timing	Winter Annual Weeds Controlled	Liquid Fertilizer Carrier Recommendations	Soybean Plant Back Restriction
2,4-D	Various	1 to 2 pts.	Tillering to before jointing	Prickly and wild lettuce, mustards, field pennycress, shepherd's purse, horseweed (marestail), dandelion*	The use of liquid fertilizer as a carrier will increase the risk of crop injury	No restriction for early spring applications
Bromoxynil	Buctril, Moxy	1 to 2 pts.	Emergence to boot stage	Mustards, henbit, field pennycress, shepherd's purse	UAN used as a carrier in early spring may increase leaf burn, do not use fertilizer carrier after jointing	No restriction for early spring applications
Bromoxynil + bicyclopyrone	Talinor	13.7 to 18.2 oz.	Fall or spring from the 2-leaf to pre-boot crop stage	Winter and summer annual broadleaf weeds	Apply with CoAct+ adjuvant plus COC (1% v/v) or NIS (0.25% v/v). Do not add AMS or severe crop injury may occur.	10 to 12 Months

Bromoxynil + pyrasulfotole	Huskie	13.5 to 15 oz.	After the 1-leaf stage up to flag leaf emergence	Purple deadnettle, henbit, prickly and wild lettuce, horseweed (marestail), mustards, field pennycress, shepherd's purse, chickweed, Henbit, horseweed (marestail), mustards, field pennycress, shepherd's purse, Canada thistle, Henbit, horseweed (marestail), mustards, field pennycress, shepherd's purse, Canada thistle, Horseweed (marestail), Canada thistle, dandelion*, prickly and wild lettuce, Prickly and wild lettuce, mustards, field pennycress, UAN can be used as a liquid fertilizer carrier	Can be applied in a liquid fertilizer solution that does not exceed 50% nitrogen and is not being applied above 30 lb./Acre	4 Months
Bromoxynil + fluroxypyr + 2,4-D	Cleansweep D	1 to 1.5 pts.	Tillering to before jointing	field pennycress, shepherd's purse, Canada thistle, Henbit, horseweed (marestail), mustards, field pennycress, shepherd's purse, Canada thistle, Horseweed (marestail), Canada thistle, dandelion*, prickly and wild lettuce, Prickly and wild lettuce, mustards, field pennycress, UAN can be used as a liquid fertilizer carrier		4 Months
Bromoxynil + fluroxypyr + MCPA	Cleansweep M	1 to 1.5 pts.	2-leaf to flag leaf emergence	field pennycress, shepherd's purse, Canada thistle, Horseweed (marestail), Canada thistle, dandelion*, prickly and wild lettuce, Prickly and wild lettuce, mustards, field pennycress, UAN can be used as a liquid fertilizer carrier		4 Months
Clopyralid	Stinger	0.25 to 0.33 pts.	After 2-leaf stage until boot stage	field pennycress, UAN can be used as a liquid fertilizer carrier		10.5 Months
Clopyralid + 2,4-D	Curtail	1 to 2.67 pts.	Tillering to jointing	shepherd's purse, Canada thistle, dandelion*, horseweed (marestail), Control of broadleaf weeds, including hemp dogbane, ragweeds, Canada thistle, marestail, and cocklebur	Foliar-applied liquid fertilizers, used as a carrier for WideMatch can cause yellowing or leaf burn of crop foliage	10.5 Months
Clopyralid plus pluroxypyr	WideMatch/Truslate	1 to 1.3 pts.	3-leaf growth stage up to and including flag leaf emergence	Downy brome, cheat, and annual ryegrass	Can be applied using UAN as the spray carrier, and the rate of UAN determines the rate of surfactant. Include a NIS (0.125 to 0.5% v/v).	6 months for STS soybeans and 18 months for non-STs soybeans and corn
Chlorsulfuron and metsulfuron	Finesse	0.2 to 0.5 oz.	Preplant, preemergence, or fall postemergence	Prickly and wild lettuce, horseweed (marestail), shepherd's purse, dandelion*, Prickly and wild lettuce, chickweed, field pennycress, shepherd's purse, mustards, Hemp dogbane, common ragweed, and a few other broadleaf weeds	Conduct compatibility test as outlined by label prior to application	No restriction for early spring applications
Dicamba	Banvel, Clarity, Sterling Blue, others	0.125 to 0.25 pt.	Emergence to before jointing	field pennycress, shepherd's purse, dandelion*, Prickly and wild lettuce, chickweed, field pennycress, shepherd's purse, mustards, Hemp dogbane, common ragweed, and a few other broadleaf weeds		9 Months
Florasulam + MCPA	Orion	17 oz.	3-leaf to preboot stage	field pennycress, shepherd's purse, mustards, Hemp dogbane, common ragweed, and a few other broadleaf weeds		4 Months
Fluroxypyr	Starane Ultra	0.3 to 0.4 pt.	2-leaf growth stage up to and including flag leaf emergence	Broadleaf weeds		4 Months
Fluroxypyr, 2,4-D ester, and dicamba	Scorch	0.5 to 1.3 pt.	After tillering and before the joing stage			4 Months

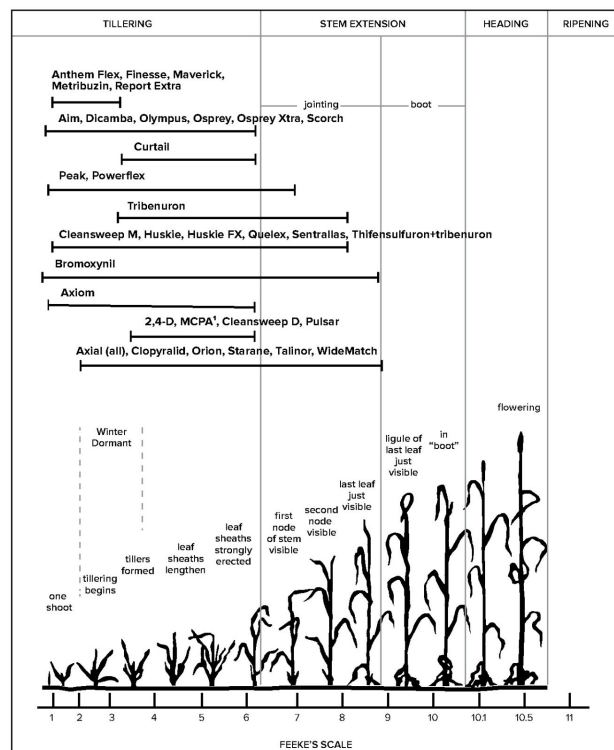
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Active Ingredient	Trade Name(s)	Rate Per Acre	Application Timing	Winter Annual Weeds Controlled	Liquid Fertilizer Carrier Recommendations	Soybean Plant Back Restriction
Fluroxypyr and thifensulfuron	Sentriallas	7 to 14 oz.	Fall or spring once wheat has reached 2-leaf stage, and prior to flag leaf emergence	Annual broadleaf weeds and wild garlic	Apply with NIS (0.06-0.25% v/v) or COC (1% v/v) plus AS (2 lbs./A)	4 Months
Halaluxifen-methyl + florasulam	Quelex	0.75 oz.	2-leaf to flag leaf emergence	Horseweed (marestail), henbit, chickweed, field pennycress, purple, mustards Field pennycress, shepherd's purse, mustards pigweed, prickly lettuce, horseweed (marestail)	Maximum of 0.25% v/v NIS should be used when applying with a liquid shepherd's fertilizer	3 Months
MCPA	Chiptox, Rhomene, Rhonox, others	1 to 4 pts.	Tillering to before jointing	Ryegrass, bluegrass, wild oat, field pennycress, wild oat	The use of a liquid fertilizer as a carrier will increase the risk of crop injury	No restriction for early spring applications
Mesosulfuron-methyl	Osprey	4.75 oz.	Emergence to preboot stage	Ryegrass, bluegrass, wild oat, field pennycress, wild oat	Can be applied in a liquid fertilizer solution that does not exceed 15% nitrogen fertilizer. Maximum of 0.25% v/v NIS should be used when applying with a liquid fertilizer	90 Days
Pinoxaden	Axial XL	16.4 oz.	2-leaf to preboot stage	Ryegrass	Can be applied in a liquid fertilizer solution that does not exceed 50% nitrogen fertilizer. Crop injury may be possible.	120 Days
Pinoxaden + fluroxypyr	Axial Star	16.4 oz.	2-leaf to preboot stage	Ryegrass	Can be applied in a liquid fertilizer solution that does not exceed 50% nitrogen fertilizer. Crop injury may be possible.	4 Months
Propoxycarbazone-sodium	Olympus	0.6 to 0.9 oz.	Emergence to before jointing	Cheat downy brome, purple deadnettle, horseweed (marestail), mustards, field pennycress, shepherd's purse, Cheat, downy brome, purple deadnettle, v/v NIS should be used when applying	Maximum of 0.25% v/v NIS should be used when applying with a liquid fertilizer and 24" of carrier. Temporary crop injury may occur.	12 Months
Propoxycarbazone-sodium + mesosulfuron-methyl	Olympus Flex	3 to 3.5 oz.	1-leaf to before jointing	mustards, field pennycress, annual bluegrass, ryegrass Mustards, field pennycress, prickly and wild lettuce, shepherd's purse, wild garlic, wild onion Cheat, downy brome, ryegrass, chickweed, mustards, field pennycress, shepherds' purse	Carrier solutions should not contain more than 15% nitrogen fertilizer	5 Months and 18" of precipitation
Prosulfuron	Peak	0.5 oz.	Emergence to second node visible	Cheat, downy brome, ryegrass, chickweed, mustards, field pennycress, shepherds' purse	Apply with NIS at 1-2 qt./100 gal. when using a liquid fertilizer carrier	10 Months
Pyroxulam	PowerFlex, PowerFlex HL	3.5 oz.	3-leaf to jointing	Cheat, downy brome, ryegrass, chickweed, mustards, field pennycress, shepherds' purse	Can be applied in a liquid fertilizer solution that does not exceed 50% nitrogen and is not being applied above 30 lb./Acre. NIS at 0.25% v/v should be added to solution.	3 Months

Sulfosulfuron	Outrider	0.66 oz.	Fall or spring, from preemergence up to jointing	Suppress or control grass weeds in wheat	Apply with NIS (2 qts./100 gal.)	3 to 12 months depending on soil pH, precipitation, and soybean genetics (STS or non-STS)
Thifensulfuron + tribenuron	Harmony Extra TotalSol	0.45 to 0.9 oz.	After 2-leaf stage but before flag leaf becomes visible	Wild garlic and onion, field pennycress, mustards, chickweed, henbit, shepherd's purse, prickly and wild lettuce, horseweed (marestail), purple deadnettle	Include a surfactant at 0.5-2 pts./100 gal. when applying in a carrier that consist of less than 50% nitrogen fertilizer	45 Days
Tribenuron	Express TotalSol	0.25 to 0.5 oz.	After 2-leaf stage but before flag leaf becomes visible	Chickweed, deadnettle, henbit, wild lettuce, mustards, field pennycress, shepherd's purse	Liquid fertilizer carriers should have 0.06-0.25% v/v NIS added. Temporary crop yellowing and stunting may occur when applied in liquid fertilizer. This injury is occasionally severe, and risk of severe injury may increase under saturated soil conditions.	45 Days

*The highest labeled herbicide rates should be used to achieve control of dandelion plants with spring applications.

Figure 1. Wheat Growth Stages and Herbicide Application



*Labels of some 2,4-D products allow application after jointing but before early boot. (See text for more information.)

Wheat: Harvest Aid

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Figure 1. Feeke's scale of winter wheat stages and herbicide application timings (Source: 2023 Weed Control Guide for Ohio, Indiana, and Illinois).

2023 Popcorn Agri-Chemical Handbook

(Steven Antolick) & (Genny Bertalmio)

The 2023 update of the Popcorn Agri-Chemical Handbook is now available for the mobile app. If you have not received an in-app push notification to update, you can update to the 2023 data by clicking on the hamburger menu (three horizontal lines) and selecting **About this app**. Choose **Check updates** to trigger the update to the 2023 edition.

The handbook is published annually to ensure everyone in the popcorn industry is informed about products registered for use on popcorn or in popcorn storage facilities. The handbook lists agri-chemicals registered and regulatory status or special use restrictions. It notes the Mode or Mechanism of Action (MOA) numerical classification of each listed chemical when used on a product label. The classification schemes are published by the Insecticide Resistance Action Committee, the Herbicide Resistance Action Committee and the Fungicide Resistance Action Committee. The handbook also highlights the Signal Word "Danger" when used on a product label as required by the EPA's Label Review Manual.

In addition, the handbook provides appendix information on residue tolerances as found in the [BCGlobal Pesticide MRL Database](#), which includes popcorn (corn, pop) and denotes established levels by the U.S., Codex and over 150 markets.

We urge you to provide this [one-page reference sheet](#) to growers and encourage them to download and use the app.

Included in the app are links to product labels (where available), providing additional key information. The Popcorn Agri-Chemical Handbook Mobile App is a native app, meaning that once you download and log into the app for the first time, you will not need a data connection to continue accessing the content in the app – great for use in the field where data connections might sometimes be unreliable. The only exception to this is with the links to product labels – you will need a data connection for these links to work. Once you use a link to access a product label, that label should be downloaded to your device and should be accessible to you in the future.

Another handy feature of the Popcorn Agri-Chemical Handbook Mobile App is the Search Handbook function available from the main screen of the app, which allows you to search in the app for any keyword, including all or part of a chemical name, common name, product name, or manufacturer name.

If you have any questions or comments about the handbook, app or its use, do not hesitate to contact our office, gbertalmio@popcorn.org.

Meteorological Winter Ends, It Looks Like Spring, So What's On Tap For The Rest Of March?

(Austin Pearson)

As meteorological winter officially ended on Feb 28, we still have a few more official days of winter left. Winter has been mostly warm and wet as statewide temperatures ran 6.1°F above normal and precipitation averaged 115 percent of normal (Figure 1). The warmer temperatures have limited snowfall accumulations to less than half of normal for a large portion of the state (Figure 2). The largest deviations are near lake Michigan as snowfall totals are 20-25 inches below normal for the winter.

Climate Division Data by State between Two Dates
From [Midwestern Regional Climate Center](#)

Indiana 12/ 1/2022 to 2/28/2023							
cd	Temperature			prcp	Precipitation		
	temp	norm	dev		norm	dev	percent
1	31.7	26.4	5.4	7.82	6.21	1.60	126
2	32.2	26.4	5.9	8.02	6.63	1.38	121
3	32.4	26.2	6.3	8.70	6.45	2.26	135
4	34.4	28.5	5.9	7.64	7.41	0.23	103
5	34.9	28.5	6.4	8.34	7.60	0.74	110
6	34.6	27.8	6.7	7.71	7.31	0.40	105
7	39.1	33.0	6.1	11.14	9.41	1.73	118
8	39.3	32.9	6.4	11.10	9.58	1.52	116
9	38.1	32.1	6.0	9.93	9.22	0.71	108
State	35.2	29.1	6.1	8.97	7.77	1.20	115

Midwestern Regional Climate Center
MRCC Applied Climate System
Generated at:
Thu Mar 9 09:15:47 CST 2023

Figure 1: Indiana temperatures, normal temperatures, temperature deviations, precipitation, normal precipitation, precipitation deviations, and percent of normal precipitation by climate division for December 1, 2022 – February 28, 2023.

Accumulated Snowfall: Percent of Mean
December 1, 2022 to March 9, 2023

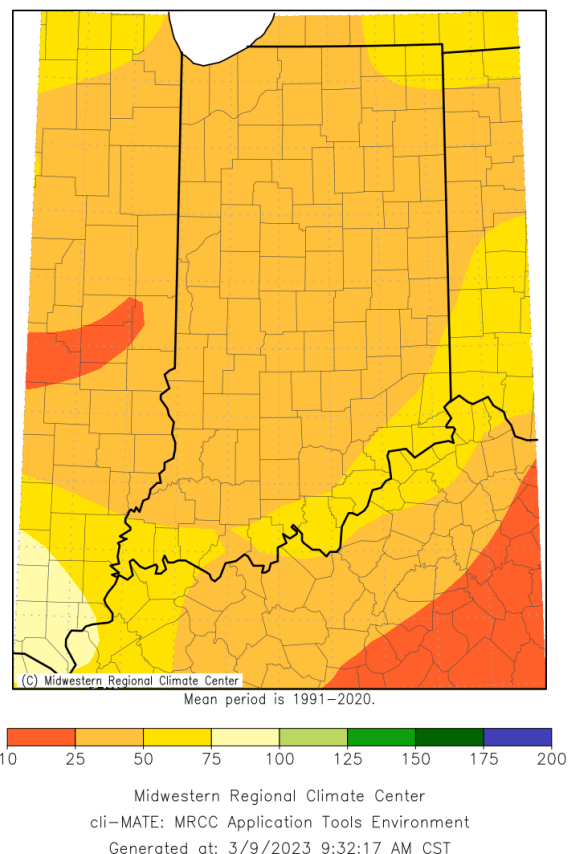


Figure 2: Accumulated snowfall for December 1, 2022 through March 9, 2023 represented as the percent of mean snowfall from the 1991-2020 normal snowfall.

February was exceptionally windy as the state contended with several storm events that passed through. Indianapolis had 17 days where wind gusts were greater than or equal to 30 mph, 6 days greater than or equal to 40 mph, and two days with winds in excess of 50 mph. February 9th had a 54-mph wind gust and February 27 observed a 56-mph wind gust.

Temperatures have been in the sweet spot for [chilling hours](#) to accumulate this winter and are running above normal across most of the state (Figure 3). What does this mean? It means that many of our perennial crops have reached the number of hours exposed to temperatures within an ideal range during dormancy. That's a good thing, right? Maybe. We still have a lot of time before the probability of a hard freeze/frost is eliminated and could cause trouble for perennial crops. Reports of bud-break on perennial crops are under way in southern Indiana. Over the coming weeks, there will likely be frost/freeze advisories creeping into southern Indiana.

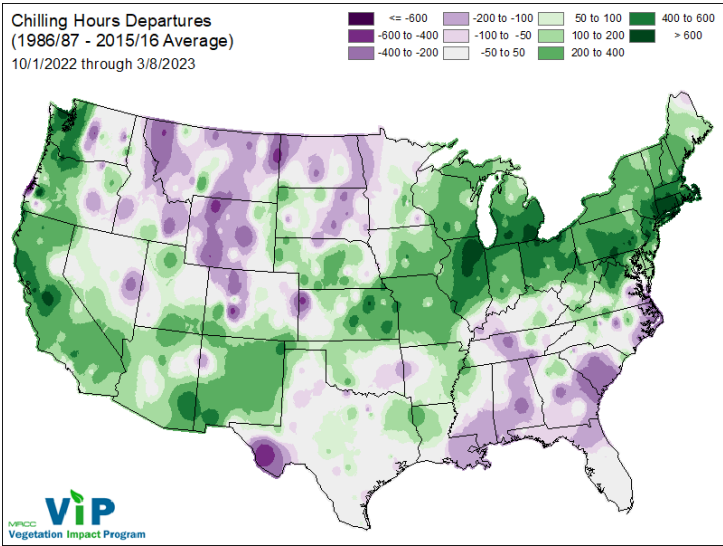


Figure 3: Accumulated chilling hours for October 1, 2022 through March 8, 2023 represented as the departure from the mean chilling hours accumulated between 1986/87-2015/16.

Below-normal temperatures are expected through the next 14 days along with near normal chances of precipitation. Weather models are indicating a significant cool down with low temperatures in the teens, statewide, during mid-March. It may look like early spring, but winter is not over yet! A full [spring outlook](#) was released last week, written by Hans Schmitz.

The good news... Indiana is officially drought free for the first time since May 17, 2022 with the March 9 US Drought Monitor release.

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