Purdue University
Purdue e-Pubs

Midwest Vegetable Trial Reports | Purdue Fruit and Vegetable Connection

3-21-2024

Flowering of Spring-Planted Greens

Elizabeth Maynard
Purdue University - Main Campus, emaynard@purdue.edu

Marian M. Rodriguez-Soto
marian-rodriguez-soto@iaswcd.org

Rebecca Koetz
Purdue University, busser@purdue.edu

Follow this and additional works at: https://docs.lib.purdue.edu/mwvtr

 Part of the Agriculture Commons, and the Horticulture Commons

Recommended Citation

Maynard, Elizabeth; Rodriguez-Soto, Marian M.; and Koetz, Rebecca, "Flowering of Spring-Planted Greens" (2024). *Midwest Vegetable Trial Reports.* Paper 264.
https://docs.lib.purdue.edu/mwvtr/264

This document has been made available through Purdue e-Pubs, a service of the Purdue University Libraries. Please contact epubs@purdue.edu for additional information.

Flowering of Spring-Planted Greens

Elizabeth T. Maynard[1], Marian Rodriguez-Soto[2], and Rebecca Koetz[3]
[1]Purdue University, 1101 Glendale Blvd. Ste. 101-A, Valparaiso, IN 46383
emaynard@purdue.edu
[2]Indiana Assoc. of Soil and Water Conservation Districts, 225 S. East Street, Ste. 142, Indianapolis, IN 46202
[3]Purdue Extension–Lake County, 2293 N. Main Street, Crown Point, IN 46307

Introduction

Greens for salad or cooking are a significant part of the spring crop mix sold at Indiana farmers' markets. In 2020, for instance, greens represented 41% of the produce items from May through early June at markets included in a pricing survey (Anon 2024). Of those greens crops, roughly half were crucifers (Brassicaceae, or Mustard Family). These crops, and other greens crops, often bolt–the stem lengthens as flower buds develop and eventually bloom. If they didn't, growers could extend harvest from a single planting, rather than spending time and labor to make multiple plantings. Thus, we wanted to test crops and cultivars in Northwest Indiana to inform growers. We focused on crucifers because of the wide variety of crop species in that family, many of which have not been widely grown in this region until relatively recently. Also, many crucifers require vernalization–a period of cool temperatures above freezing–in order to bloom. In Indiana, spring-planted crops are often exposed to vernalizing temperatures.

Materials and Methods

To characterize which crops are quickest to bolt and how planting date influences time to bolt, 8 different crops were trialed with 5 planting dates approximately every 2 weeks during the Spring of 2023. To test if the presence of row cover influences time to bolt, treatments with and without row cover were included. We hypothesized that row cover might delay or prevent vernalization. The crops were arugula 'Adagio,' arugula 'Astro,' collard 'NC Yellow,' mizuna, mustard R2220, mustard 'Scarlet Frills,' shungiku, and turnip greens 'Sutton's Caledonian' (Table 1).

This crop trial was conducted near Wanatah, IN, at the Pinney Purdue Ag Center on a Tracy sandy loam soil. Environmental data for the season is available from the Purdue Mesonet Data Hub operated by the Indiana State Climate Office within a quarter mile of the trial (https://ag.purdue.edu/indiana-state-climate/purdue-mesonet/purdue-mesonet-data-hub/). The experiment was duplicated in two fields. Field 1 was managed following organic practices, and Field 2 was managed with conventional practices. Soil tests performed in May 2023 showed 2.3% and 1.7% organic matter, pH 6.5 and 6.2, 240 and 110 ppm phosphorus (P), 244 and 89 ppm potassium (K), 22.4 and 22.9 ppm magnesium (Mg), and 55.5 and 56.3 ppm calcium (Ca) in Field 1 and Field 2, respectively.

Each field had 5 planting dates randomly assigned to one 42-ft long bed (Table 2). Beds were 4 ft on center with a bed top of 32 inches and 16-inch alleys. Two rows of greens were planted per bed, spaced 12 inches apart. Within each planting date, there were 2 row cover treatments, each 20 ft long: one with no cover, and one with lightweight (19 g/m^2) spunbonded row cover. Row covers were applied on dates listed in Table 2 and removed on 13 July. The covers were also temporarily removed for thinning, weeding, and data collection, but otherwise were left on. Planting dates 4 and 5 did not include row cover treatments. By then, temperatures had already

warmed up, and vernalization was unlikely. Within each 20-ft bed section, 8 cultivars were randomly assigned to one 5-ft-long section of one row. There were a total of 192 5-ft rows, or plots, 96 per field.

Each bed was fertilized prior to seeding. Nitrogen (100 lb/A) and potassium (K2O at 100 lb/A) were applied using Nature Safe®13-0-0 and Allganic® granular potassium sulfate (0-0-51) for Field 1, and Menards Premium Lawn Food® 30-0-3 and potassium chloride (0-0-60) for Field 2. The fertilizers were spread by broadcasting the products on each bed before incorporating with the power harrow implement on a walk-behind tractor set to a depth of 4 inches. We overseeded, and after emergence, we thinned plants to approximately 2 inches apart. Plants were hand-watered after seeding and later irrigated as needed through two lines of drip tape per bed.

After planting, notes on emergence were taken. The number of emerged seedlings was rated as none, poor, fair, good or very good corresponding to estimated emergence percent of 0%, less than 25%, 25% to 50%, 50% to 75%, and more than 75%, respectively. Number of plants with visible buds that had not yet bloomed and the number of plants that had at least one open flower (bloomed) were recorded at approximately weekly intervals. Once 50% of the plants in a plot had bloomed, the total number of plants present in that plot was recorded, and data were no longer regularly collected. These counts were used to calculate the percent of plants with buds but not blooms, the percent of plants that had bloomed, and percent of plants that remained vegetative.

These data were used to determine the number of weeks after seeding (WAS) until first bud (1stBud), 50% at or beyond the bud stage (Bud50), first open flower (1stBloom), and 50% at open flower stage (Bloom50) for each plot. The first week an open flower was observed, or the first week at least 50% of plants had bloomed was considered the week the event occurred. Means of these values for each crop were determined for each planting date, with or without row cover for the first three planting dates.

Results

Environmental conditions during this trial are summarized graphically in Fig. 1A-B. From the first to third planting dates, the average air temperature was usually below 60 °F and the minimum temperature was below 40 °F on most nights. After the third planting date, the minimum temperature did not drop below 40 °F and average daily temperature was usually between 60 and 75 °F. The maximum temperature exceeded 90 °F on only 1 day in late July. The daylength ranged from about 13 hours in mid-April to more than 15 hours in late June, before declining (Fig. 1A). Soil moisture at the nearby unirrigated weather station and precipitation were both low at the start of the season (Fig. 1B). Despite hand-watering and drip irrigation in the experiment, dry conditions may have delayed emergence, especially for planting date 4. In addition, water stress was observed in some plots when plants got large.

The duration of chilling, measured as hours during which the temperature was 35 to 45 °F, is shown for the five planting dates in Fig. 1C. Often two or more weeks of chilling temperatures are required for vernalization of cruciferous crops. Only planting dates 1 and 2 received more than 1 week (168 hours) of chilling.

Crop growth rates are strongly correlated with the accumulation of growing degree days. In Fig. 1D, growing degree day accumulation is shown for the five planting dates. A base temperature for growth of 40 °F was used to calculate growing degree days because the crops are cool season crops.

Emergence ranged from poor to very good, with variation among crops (Fig. 2). Turnip emergence was so poor that there were not enough plants to collect meaningful data. Shungiku emergence was also frequently poor. On the fifth planting date, we ran out of collard and mustard seed before planting all plots, and that is why emergence is rated as 'none' in some instances for those crops.

The percent of plants that had reached the bud or bloom stage at each observation date is illustrated in Fig. 3. The different crops show different patterns. For example, for the first planting date, less than 1/4 of 'Adagio' arugula plants had bloomed by the second observation (Fig. 3A), while for 'Astro' arugula, nearly all the plants had bloomed by that date (Fig. 3B). These graphs could be used to estimate how long a crop would remain vegetative—and therefore harvestable as a leafy green—based on the planting date. For example, to have vegetative mizuna available through early July, the graph in Fig. 3C suggests that planting every two weeks beginning in mid-April would be desirable.

Fig. 4 illustrates the percent of plants that had reached the bud or bloom stage by a given number of weeks after seeding. For all crops, the 13 Apr seeding took longer to bloom than the seeding on 25-26 Apr. This is probably because low temperatures limited growth more in the earlier planting. Later seedings sometimes bloomed more quickly and sometimes took longer, depending on the crop. This is probably because the crops differ in what conditions lead to initiation and development of flowers.

The number of weeks to reach first bud (1stBud), 50% at or beyond the bud stage (Bud50), first open flower (1stBloom), and 50% at open flower stage (Bloom50) varied among crops (Table 3). Nearly all crops progressed through the reproductive stages faster when seeded on 25-26 Apr than on 13 Apr. For later planting dates, the time to flowering increased for some crops and decreased for others. For some crops and planting dates, the row cover hastened reproductive development and for others it had no effect or delayed it (Table 4). The next section of this report provides a crop-by-crop summary of results provided in Tables 3 and 4.

Arugula 'Adagio' without row cover took 9 weeks to reach 50% bloom when planted on 13 Apr, 8 weeks when planted on 25-26 Apr, and more than 10 weeks for later planting dates. The row cover appeared to delay bloom by a week or more when the crop was planted in late April or early May. These results suggest that this cultivar requires cool temperatures to initiate flower development, and if the requirement is not met, it will not bloom or will take much longer to bloom. In several years of planting 'Adagio' arugula, we have observed it to remain vegetative throughout the summer if planted after temperatures have warmed up. To avoid bloom in this crop, plant after night temperatures exceed 45°F most of the time. If it does get cool at night using a row cover might extend the vegetative stage by a week.

Arugula 'Astro' without row cover took 8 weeks to reach 50% bloom when planted on 13 Apr, 6.5 weeks when planted on 25-26 Apr, and close to 8 weeks for later plantings. The row cover appeared to delay bloom by half a week when the crop was planted in late April or early May. These results suggest that although cool temperatures may cause initiation of flowers earlier in crop development, the plants will bloom regardless of chilling. To avoid bloom in 'Astro' arugula, plan to harvest within 7 weeks of planting.

Mizuna without row cover took 8 weeks to reach 50% bloom when planted on 13 Apr, 6.5 weeks when planted on 25-26 Apr, 7 weeks when planted on 5 May, 7.8 weeks when planted on 18-19 May, and 6.3 weeks when planted on 31 May. There was no consistent pattern of increasing or

decreasing time to bloom with later plantings. Generally, mizuna bloomed readily at all planting dates. Row cover appeared to speed bloom by a few days for the two early plantings. For mizuna, the results suggest a producer should plan to harvest within 6 weeks of planting, except for the earliest plantings.

Mustard R2220 without row cover took 8 weeks to reach 50% bloom when planted on 13 Apr, 6.5 weeks when planted on 25-26 Apr, 6 weeks when planted on 5 May, 7 weeks when planted on 18-19 May, and 6.5 weeks when planted on 31 May. Row cover did not have a consistent effect on time to bloom. For this mustard line, results suggest harvesting within 6 weeks of planting except for the earliest plantings.

Mustard 'Scarlet Frills' took longer to reach 50% bloom from the first planting than the other crucifers: 9.5 weeks without row cover. The second planting took 7.5 weeks, and later plantings took 7.8 to 8.3 weeks. Row cover hastened bloom in the first planting but appeared to delay bloom in the second planting. For 'Scarlet Frills' mustard, results suggest harvesting within 7.5 weeks of seeding, except for the earliest plantings.

Shungiku data is less reliable because of the low emergence and missing replications. Despite this, it is apparent that its bloom pattern differs from that of the crucifers. One key difference is the longer time to bloom for all planting dates. The first planting took 12 weeks to reach 50% bloom; the second and third plantings without row cover took 10 and 11 weeks, respectively. Later plantings did not reach 50% bloom during the experiment. Row cover did not have a consistent effect on time to bloom. A second difference is the greater length of time between the stage of first bud and 50% bloom. For crucifers, this was usually 1 to 2 weeks; for shungiku the shortest period was 3 weeks, and 4 weeks or more was common. This could be due in part to plant anatomy: buds of crucifers were not readily visible before the flowering stem lengthened, while shungiku buds were readily visible at the top of the growing stem. Shungiku leaves could be harvested while buds developed into flower, but development of additional leaves for harvest would require growth of new stems or branches. This is a new crop for the research team and the best timing of harvest in relation to buds and bloom is not clear.

Discussion

This trial began with the goals of determining how planting date influences time to bloom for various spring-planted greens crops, and whether row cover installed over crops would influence the time to bloom. For most of the crops, there was no clear pattern related to planting date, other than slower bloom with the earliest planting, and no clear effect of row cover. An exception was 'Adagio' arugula since it had the largest variation in time to bloom with planting date, ranging from 8 weeks to more than 12 weeks. When chilling temperatures occurred with a few weeks of seeding 'Adagio' bloomed more quickly, but when planted later in the season it did not bloom by the end of July. For 'Adagio', row cover tended to delay bloom about a week when covered shortly after seeding in mid- or late April. In contrast, 'Astro' arugula reached 50% bloom within 6.5 to 8 weeks no matter when it was planted, and row cover tended to delay bloom by about half a week for seedings through April. Mizuna and mustard R2220 reached 50% bloom within 6 to 8 weeks of seeding with no obvious pattern related to planting date, other than the earliest date being the slowest. For mizuna, row cover generally hastened bloom by less than a week. For mustard R2220, there was no clear effect of row cover. 'Scarlet Frills' mustard reached 50% bloom within 7.5 to 9.5 weeks after seeding, also with no clear pattern relating to planting date

other than the earliest date being the slowest. Row cover had no clear effect. Shungiku took at least 9 weeks to reach 50% bloom, and May plantings did not bloom by the end of the trial.

We expected that planting date would influence time to bloom through the effects of temperature and photoperiod on initiation of flowers and of temperature on rate of development. We expected those influences to follow a predictable pattern because average temperatures warm as spring progresses and photoperiod changes predictably. Patterns were not as clear as we expected. Factors that could have interacted with or covered up the influence of temperature and photoperiod include soil moisture, competition from weeds, crop plant population, and nutrient availability. We did not manage to keep these factors constant across all plantings, they are known to influence the rate of crop development, and it is likely that they did in this trial. While that prevents identification of trends that rely on temperature and photoperiod, the variability is representative of conditions that could be found in farm production, and so the observed results are useful in illustrating the range of time to bloom that might be expected under variable conditions.

Summary and Conclusions

Practical implications from this trial include the following. Expect the cruciferous crops in this trial to reach 50% bloom within 6 to 8 weeks after seeding, with the exception of 'Adagio' arugula. Mid-April plantings of these crucifers will take longer to bloom than later plantings. Multiple sequential plantings will probably be necessary to maintain vegetative plants for harvest. Mixed plantings of crops may be difficult to harvest because they are likely to bloom at different times.

For 'Adagio,' expect 50% bloom by 8 or 9 weeks after seeding if chilling temperatures occur soon after planting. If planted after chilling temperatures have ended, it may not bloom at all during the summer.

For both 'Adagio' and 'Astro' arugula, row cover can probably delay bloom in the early planted crops by a few days to a week. For other crops, delay in bloom is not likely, and row cover might speed bloom.

Expect shungiku to form buds within 6 to 8 weeks after seeding, but take another 4 to 8 weeks before reaching 50% open blooms.

These conclusions apply to the planting period studied in this trial: April - May. Earlier and later plantings are likely to exhibit different patterns due to variation in temperature fluctuations and daylength.

Acknowledgments

H. Banas, J. Clemens, and M. Jackson assisted in field operations and data collection. Farmer focus group participants: C. Aquino, L. Aquino, D Appel, M. DeJong, D. Perkins, and A. Massie. Heirloom Collard Project donated collard seeds https://heirloomcollards.org/.

Literature Cited

Anonymous. 2024. Farmers Market Price Report. https://www.purdue.edu/hla/sites/hortbusiness/prices/price-reports/ . Accessed 8 Feb 2024.

Indiana State Climate Office. 2023. Purdue Mesonet Data Hub. https://ag.purdue.edu/indiana-state-climate/purdue-mesonet/purdue-mesonet-data-hub/. Accessed 17 Aug 2023.

US Navy Astronomical Applications Department. 2023. Duration of Daylight/Darkness Table for One Year. https://aa.usno.navy.mil/calculated/durdaydark?year=2023&task=0&lat=41.43&lon=-86.89&label=Wanatah+41.43°N+86.89°W&tz=5&tz_sign=-1&submit=Get+Data. Accessed 6 Oct 2023.

Table 1. Crops and seed sources used in spring greens trial, Wanatah, IN, USA, 2023.

Crop/Cultivar	Scientific Name	Family	Seed Source
1. Arugula 'Adagio'	*Eruca sativa*	Mustard	Purdue University, W. Lafayette, IN, USA
2. Arugula 'Astro'	*Eruca sativa*	Mustard	High Mowing Seeds, Wolcott, VT, USA
3. Collard 'North Carolina Yellow'	*Brassica oleracea*	Mustard	Heirloom Collard Project, heirloomcollards.org/
4. Mizuna	*Brassica rapa var. japonica*	Mustard	Seeds Savers Exchange, Decorah, IA, USA
5. Mustard R2220	*Brassica juncea*	Mustard	USDA North Central Region PI Station, Ames, IA, USA
6. Mustard 'Scarlet Frills'	*Brassica juncea*	Mustard	Johnny's Selected Seeds, Winslow, ME, USA
7. Shungiku	*Glebionis coronaria*	Aster/Sunflower	Johnny's Selected Seeds
8. Turnip greens ‘Sutton’s Caledonian’	*Brassica rapa var. rapa*	Mustard	USDA North Central Region PI Station

Table 2. Planting and thinning dates and dates of row cover application for spring greens trial, Wanatah, IN, USA 2023.

Plant Date	Thin Date	Row Cover On
1. April 13	June 1	April 27
2. April 25-26	June 2	April 27
3. May 5	June 9	May 18
4. May 18-19	June 22	None
5. May 31	June 22	None

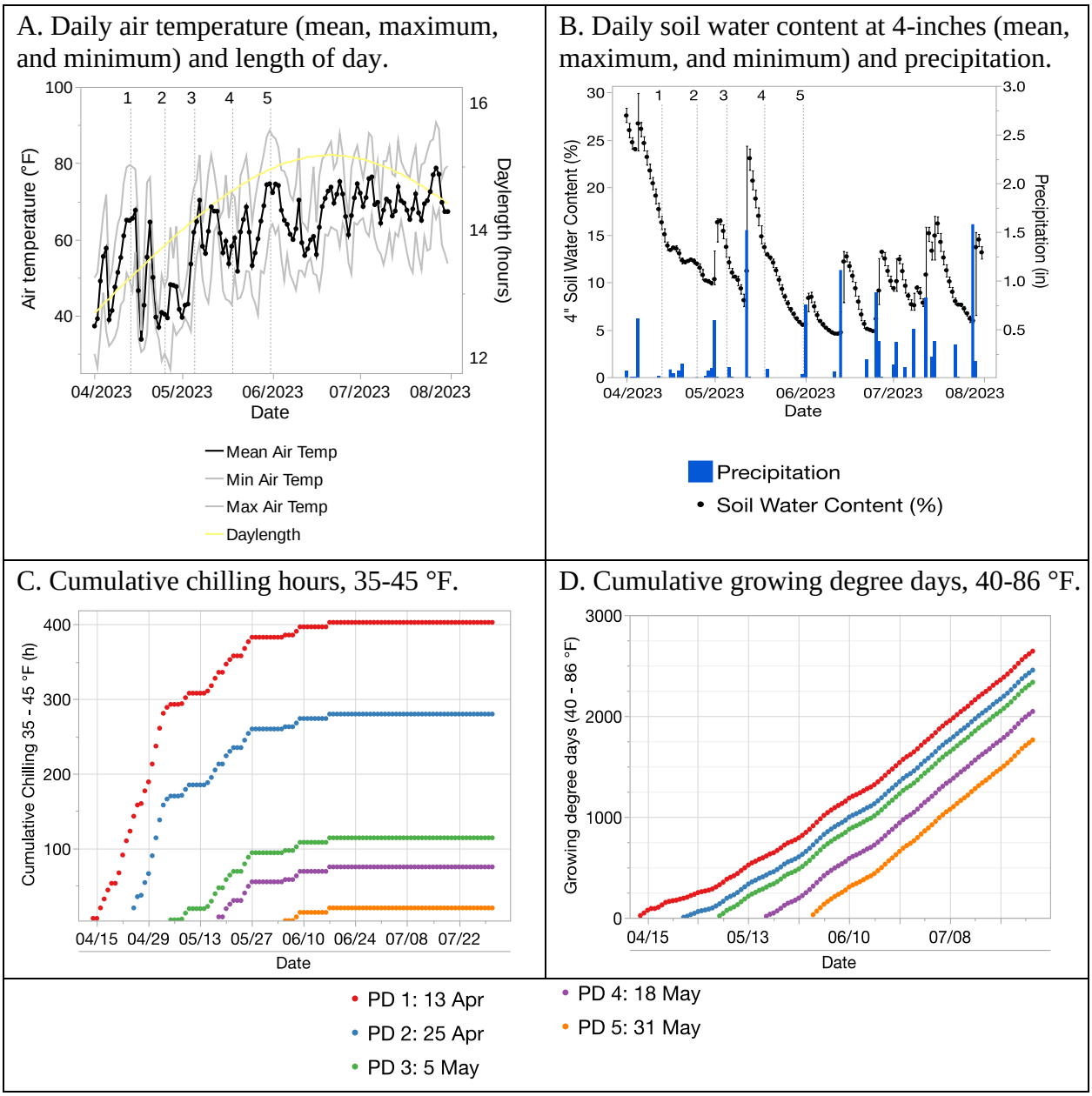

Fig. 1. Air temperature and length of day (A), soil water content at 4-inch depth and precipitation (B), and accumulated chilling hours (35-45 °F) (C) and growing degrees days (40-86 °F) (D) from April through July 2023 at the Pinney Purdue Ag Center, Wanatah, IN, USA. A, B: Vertical dotted lines indicate planting dates 1 through 5. C, D: PD=Planting date. Data sources: Indiana State Climate Office. 2023. Purdue Mesonet Data Hub. https://ag.purdue.edu/indiana-state-climate/purdue-mesonet/purdue-mesonet-data-hub/. Accessed 17 Aug 2023. Daylength from US Navy Astronomical Applications Department. 2023. Duration of Daylight/Darkness Table for One Year. https://aa.usno.navy.mil/calculated/durdaydark?year=2023&task=0&lat=41.43&lon=-86.89&label=Wanatah+41.43°N+86.89°W&tz=5&tz_sign=-1&submit=Get+Data. Accessed 6 Oct 2023.

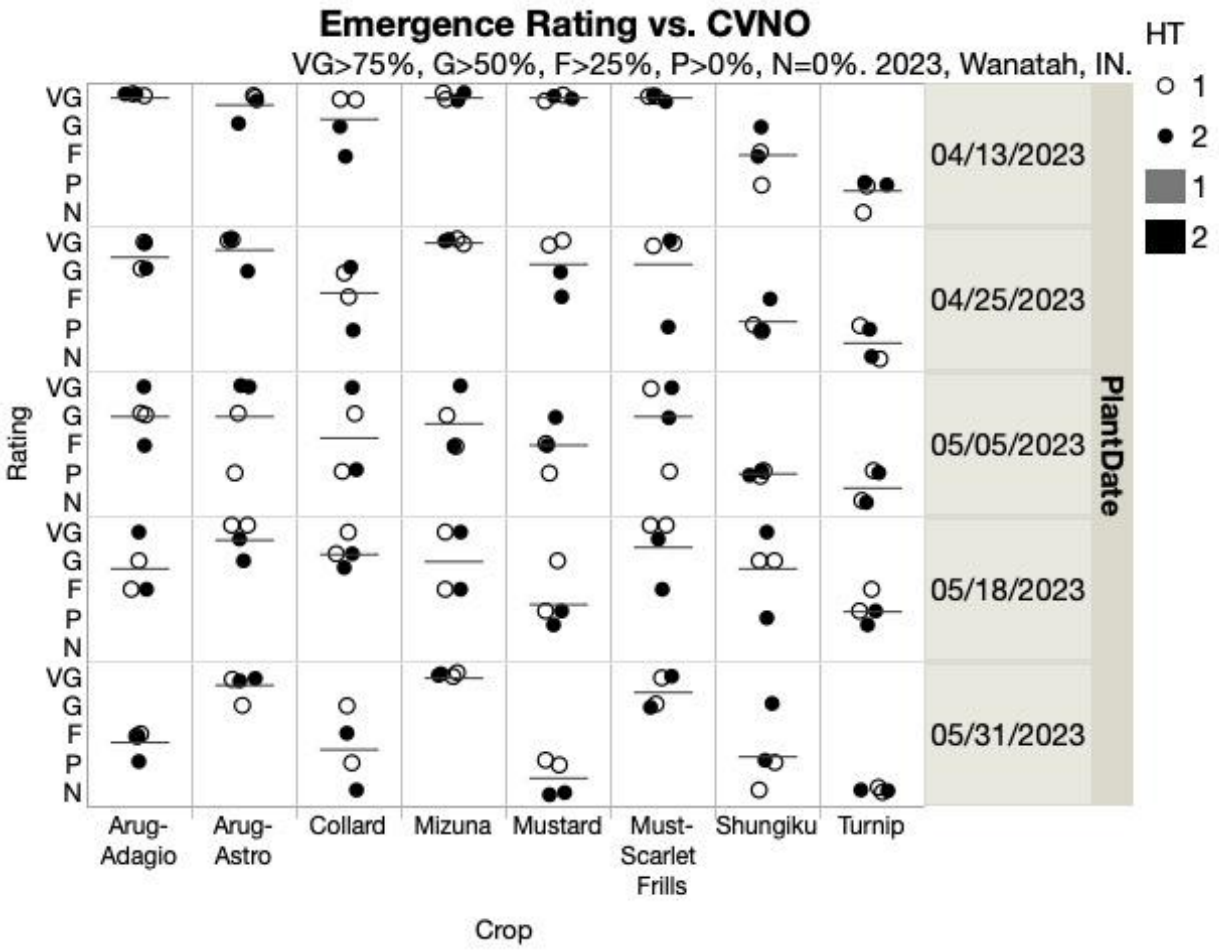

Fig. 2. Emergence ratings for 8 crops seeded on five dates in Wanatah, IN, USA. Ratings are based on estimated percentage of seeds that emerged: N = 0%, P = 0% to 25%, F = 25% to 50%; G = 50% to 75%, VG = more than 75%. Horizontal line represents mean of four plots. Points represent individual plots in Field 1 (open circles) and Field 2 (solid circles). Arug = Arugula; Must = Mustard.

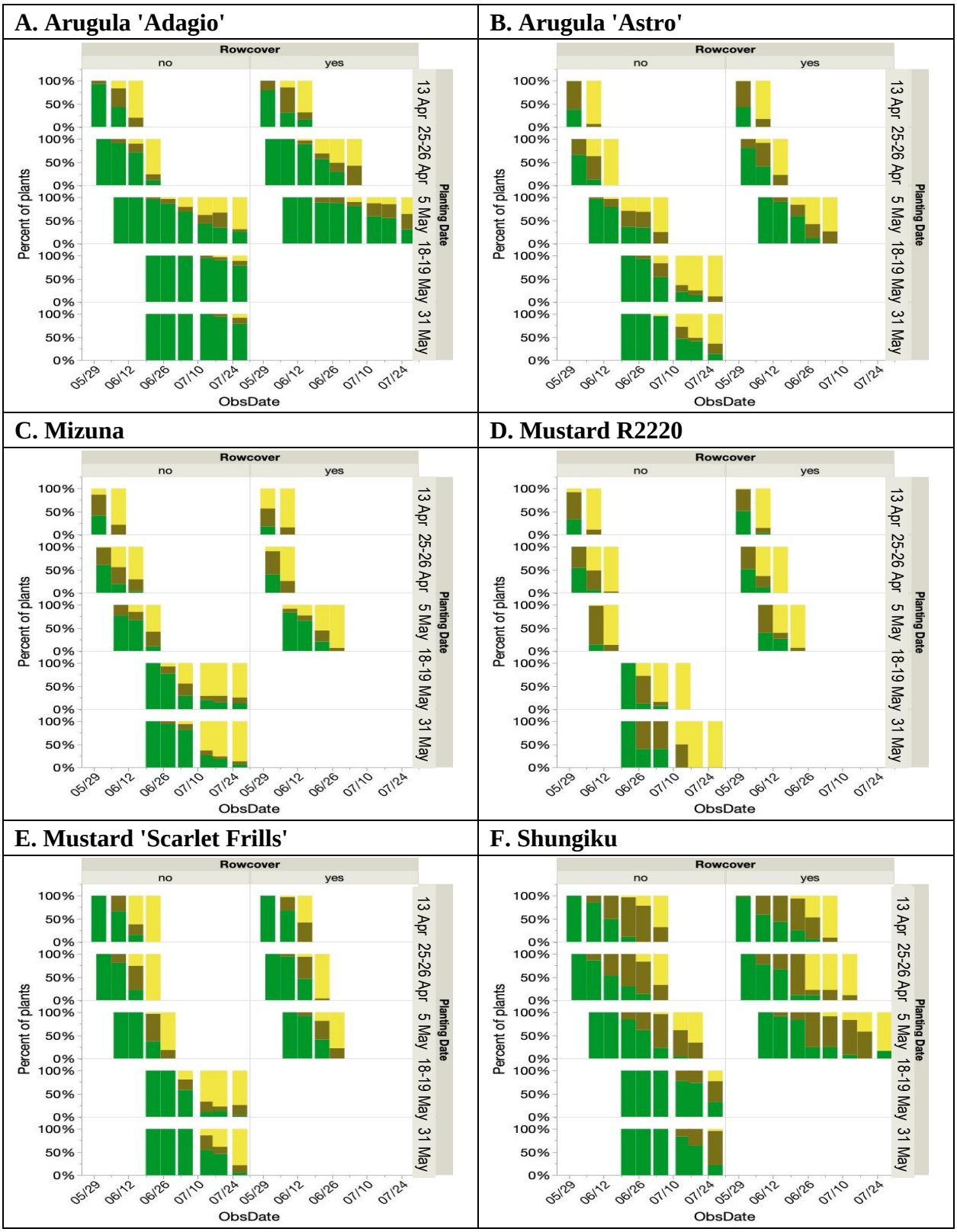

Fig. 3. Percent of plants vegetative (green), or with buds (brown) or open flowers (yellow) on each observation date for six crops planted at Wanatah, IN, USA, on 13 Apr, 25-26 Apr, 5 May, 18-19 May, and 31 May, 2023, with or without row cover on the first three planting dates.

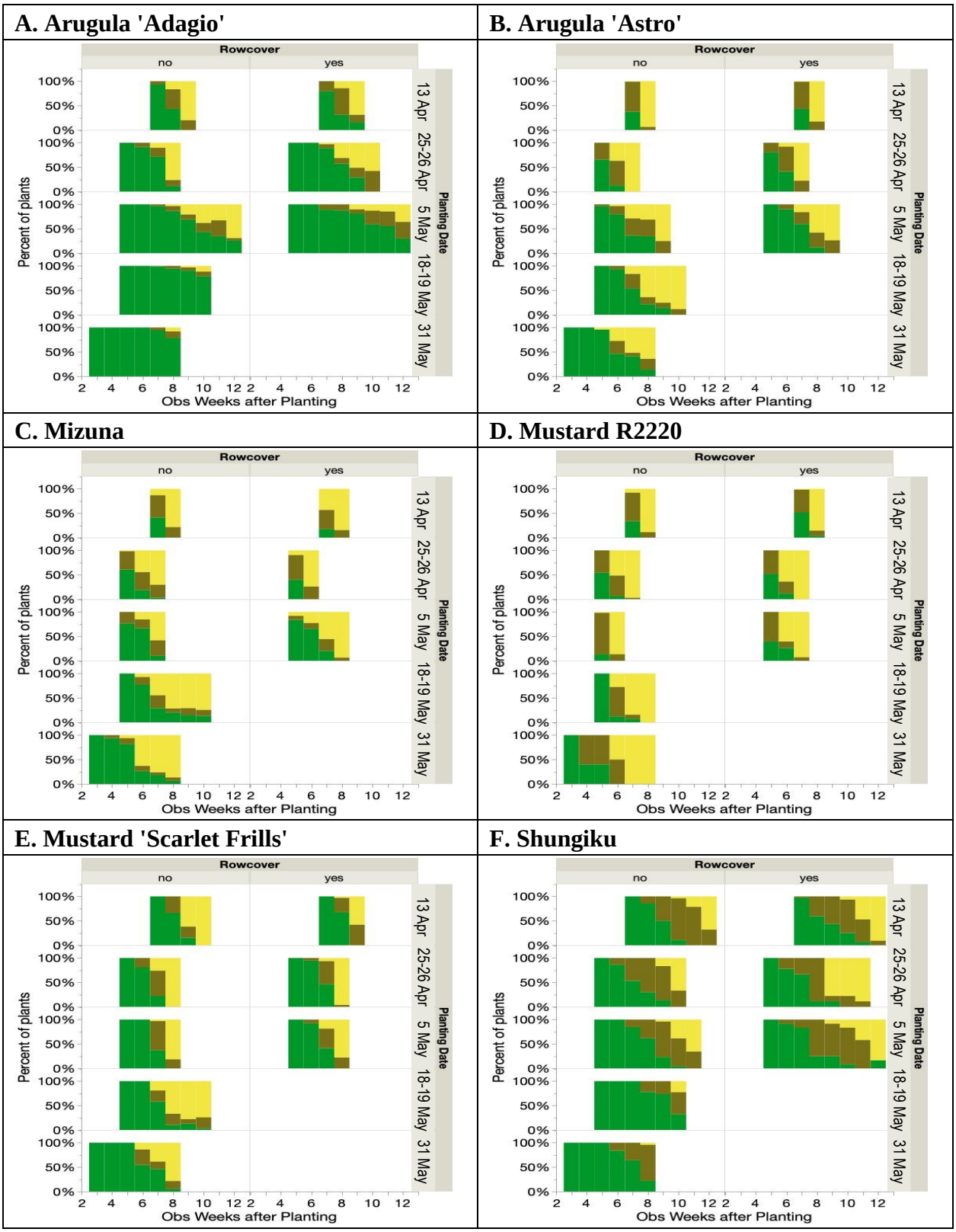

Fig. 4. Percent of plants vegetative (green), or with buds (brown) or open flowers (yellow) versus weeks after seeding for six crops planted on five dates in 2023 at Wanatah, IN, USA, with or without row cover on the first three planting dates.

Table 3. Weeks to first bud, 50% bud, first bloom, and 50% bloom for six crops seeded on five dates (PD), Wanatah, IN, USA.

		No row cover					With row cover [i]		
Crop/Cultivar	**Stage**	**PD 1[ii]**	**PD 2**	**PD 3**	**PD 4**	**PD 5**	**PD 1**	**PD 2**	**PD 3**
					(weeks)				
Arugula 'Adagio'	1st Bud	7.0	6.0	7.5	8.3	7.5	7.0	7.0	7.0
Arugula 'Adagio'	50% Bud	8.0	8.0	10.5	>10.0[iii]	> 8.0	8.0	8.5	11.0
Arugula 'Adagio'	1st Bloom	8.0	7.0	8.5	9.5	8.0	8.0	7.5	9.5
Arugula 'Adagio'	50% Bloom	9.0	8.0	11.0	> 10.0	> 8.0	9.0	9.0	> 12.0
Arugula 'Astro'	1st Bud	7.0	5.0	5.5	6.5	5.8	7.0	5.5	6.0
Arugula 'Astro'	50% Bud	7.5	6.0	7.5	7.5	6.8	7.5	6.0	7.5
Arugula 'Astro'	1st Bloom	7.0	6.0	6.5	7.0	5.8	7.5	6.5	7.0
Arugula 'Astro'	50% Bloom	8.0	6.5	8.0	8.0	7.8	8.0	7.0	8.5
Mizuna	1st Bud	7.0	5.0	5.0	6.0	5.0	7.0	5.0	5.0
Mizuna	50% Bud	7.0	5.5	7.0	7.0	6.0	7.0	5.5	6.5
Mizuna	1st Bloom	7.0	5.5	6.0	6.3	5.8	7.0	5.0	5.5
Mizuna	50% Bloom	8.0	6.5	7.0	7.8	6.3	7.5	6.0	7.5
Mustard	1st Bud	7.0	5.0	5.0	6.0	4.0	7.0	5.0	5.0
Mustard	50% Bud	7.0	6.0	5.5	6.0	5.0	7.0	5.5	5.5
Mustard	1st Bloom	7.5	6.0	5.5	6.3	6.5	7.5	6.0	6.0
Mustard	50% Bloom	8.0	6.5	6.0	7.0	6.5	8.0	6.0	6.5
Mustard 'Scarlet Frills'	1st Bud	8.0	6.0	7.0	7.0	6.0	8.0	6.0	6.0
Mustard 'Scarlet Frills'	50% Bud	8.5	7.0	7.0	7.8	7.3	8.5	7.5	7.5
Mustard 'Scarlet Frills'	1st Bloom	9.0	7.5	7.0	7.5	6.0	8.5	7.5	7.0
Mustard 'Scarlet Frills'	50% Bloom	9.5	7.5	8.0	8.3	7.8	9.0	8.0	8.0
Shungiku	1st Bud	8.0	6.0	7.0	8.0	6.7	7.0	6.0	6.0
Shungiku	50% Bud	9.0	9.0	9.0	> 9.3	7.7	9.0	8.0	8.0
Shungiku	1st Bloom	10.0	9.0	9.0	10.0	> 8.0	10.0	9.0	9.0
Shungiku	50% Bloom	12.0	10.0	11.0	> 10.0	> 8.0	12.0	9.0	12.0

[i] Spunbonded row cover applied over hoops after crop emergence on 27 Apr for planting dates 1 and 2 and on 18 May for planting date 3.

[ii] Planting date (PD) 1 = 13 Apr, 2 = 25-26 Apr, 3 = 5 May, 4 = 18-19 May, 5 = 31 May, 2023. Values are means of two reps for PD 1, 2, and 3, means of 4 reps for PD 4 and 5, except for shungiku which had one rep for PD 1, 2, and 3, and 3 reps for PD 4 and 5.

[iii] Greater than symbol means that the indicated bloom stage was not reached for one or more reps by the date of the last data collection.

Table 4. Difference in weeks to reach designated reproductive stage with and without row cover for six crops seeded on three planting dates (PD), Wanatah, IN, USA.

Crop/Cultivar	Stage	PD[i] 1	PD 2	PD 3
			(weeks)	
Arugula 'Adagio'	1st Bud	0.0	1.0	-0.5
Arugula 'Adagio'	50% Bud	0.0	0.5	0.5
Arugula 'Adagio'	1st Bloom	0.0	0.5	1.0
Arugula 'Adagio'	50% Bloom	0.0	1.0	1.0
Arugula 'Astro'	1st Bud	0.0	0.5	0.5
Arugula 'Astro'	50% Bud	0.0	0.0	0.0
Arugula 'Astro'	1st Bloom	0.5	0.5	0.5
Arugula 'Astro'	50% Bloom	0.0	0.5	0.5
Mizuna	1st Bud	0.0	0.0	0.0
Mizuna	50% Bud	0.0	0.0	-0.5
Mizuna	1st Bloom	0.0	-0.5	-0.5
Mizuna	50% Bloom	-0.5	-0.5	0.5
Mustard	1st Bud	0.0	0.0	0.0
Mustard	50% Bud	0.0	-0.5	0.0
Mustard	1st Bloom	0.0	0.0	0.5
Mustard	50% Bloom	0.0	-0.5	0.5
Mustard 'Scarlet Frills'	1st Bud	0.0	0.0	-1.0
Mustard 'Scarlet Frills'	50% Bud	0.0	0.5	0.5
Mustard 'Scarlet Frills'	1st Bloom	-0.5	0.0	0.0
Mustard 'Scarlet Frills'	50% Bloom	-0.5	0.5	0.0
Shungiku	1st Bud	-1.0	0.0	-1.0
Shungiku	50% Bud	0.0	-1.0	-1.0
Shungiku	1st Bloom	0.0	0.0	0.0
Shungiku	50% Bloom	0.0	-1.0	1.0

[i] Planting date (PD) 1 = 13 Apr, 2 = 25-26 Apr, 3 = 5 May, 2023. Spunbonded row cover applied over hoops after crop emergence on 27 Apr for planting dates 1 and 2 and on 18 May for planting date 3. Values are means of two reps, except for shungiku which had one rep.