Winter-Type Oilseed Pennycress Staging
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Oilseed Pennycress

- New crop for the central Midwest
- May have utility in summer annual cropping systems (corn-soybean)
  - Plant in September-October
  - Harvest in late-May to early June
- Standardized staging process is lacking
  - Past papers use BBCH method
  - May be too resolved for production purposes
- Developed an adapted staging system that is proposed for use

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Plant anatomical components

- Begins as a vegetative rosette
  - Established prior to dormancy
- Size of rosette is dependent on planting date

Pennycress rosettes formed prior to winter. Earlier planting dates will result in more robust rosettes, showing (A) 15 September, (B) 2 October, and (C) 14 October planting dates in Hoytville, OH in 2020. Images were all collected on 19 November 2020.
Plant anatomical components

- Rosettes overwinter
  - Resume growth in spring
- Produce secondary stems from crown called tillers
Plant anatomical components

- Rosettes overwinter
  - Resume growth in spring
- Produce secondary stems from crown called tillers
  - Tillers and main stem can experience branching
  - Amount of branching may be controlled by plant density
    - Greater densities will branch less
    - Lower densities branch more
Overall Growth Stage Progression

- Approximated calendar dates are for latitudes south of 42 degrees N

- Some numerical stages are not included at this point as they occur concurrent with or after a progressing stage
  - Included as placeholders in the event future varieties exhibit these traits
Stage 0: Germination

• Germination of seed through emergence
  • 0.0 – Dry Seed
    • Black seed types (wild types)
    • Golden seed types (some commercial cultivars)
  • 0.5 – Radicle emerged underground
  • 0.7 – Hypocotyl and cotyledons emerged from seed below the soil surface
  • 0.9 – Plant breaking through soil surface (emergence)

Stage 0.0 of golden seed type

Stage 0.9 showing an emerging plant
Stage 1: Leaf and Rosette Development

- Rosette forms initially
  - Leaves unfurl in pairs
  - Increase in size depending on planting date
  - For GDD accumulation use base of 28 °F
- Overwinters in this stage
- Tillers are not clearly evident until after stem elongation begins
Stage 3: Primary Stem Elongation

- Begins in spring when temperatures start to warm
- Elongation of main stem occurs first
  - Tillers elongate as well
- Substages set by approximate final height
  - Can be difficult to stage
  - Presence of developing flower buds (stage 5) occurs concurrently with stem and tiller elongation
- If flower bud formation is delayed in future varieties, Stage 4 may be necessary indicating tiller/secondary stem elongation
  - Current varieties does not necessitate having stage 4

Stage 3.0 Initial vertical growth of primary stem
Stage 3.2 primary stem is approximately 20% of final height
Stage 3: Primary Stem Elongation

• Good timing to broadcast fertilizer
  • N fertilizer use most common/necessary
  • Soil P and K (if adequate for annual crop production) are sufficient not to limit yield

• Future work is needed to better understand P and K removal for managing nutrient budgets into the future

Stage 3.1 pennycress with topdressed ureal prills near the rosette.

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Stage 5: Inflorescence Development

- Inflorescence development happens shortly after stem elongation (Stage 3)
  - Stage 5.0 indicates floral cluster is present but is enclosed by leaves
  - Substages denote flower buds on auxiliary stems are visible

Stage 5.3 with primary flower buds marked by red and auxiliary flower buds by blue arrows.

Stage 5.5 with primary flower buds marked by red and auxiliary flower buds by blue arrows.
Stage 6: Flowering Progression

- Stage 6.0 shows primary flowers starting to open
- Stage 6.5 shows 50% of all flowers (primary and auxiliary stems) open
  - Approximately 1-2 weeks after first flowers open, depending on variety and environmental conditions
- Stage 6.7 shows fruit set starting on main stem
- Stage 6.9 has fruit set starting on auxiliary stems

Pennycress at (A) stage 6.0, (B) stage 6.7 and (C) stage 6.9 of flowering progression.
Stage 6: Flowering Progression

- Plants can experience cold temperatures during this phase
  - Common plant responses are purpling of silicles
  - Stems may become wavy

- Rarely are exposed pods terminated by the plant, and does not typically cause yield reductions
Stage 7: Seed Fill

• Stage 7.0 – first pod is filled
  • Most pods contain between 10-14 seeds
• Substages progress based on the percent of pods filled
  • 7.2 = 20% of pods filled
  • 7.8 = 80% of pods filled
Stage 8: Ripening

• Pods begin to turn yellow in color and ripen
  • Leaves may senesce and fall off

• Seed oil profile goes through substantive changes in this stage
  • Application of a preharvest dessicant can limit oil yield

• Seed maturity is achieved some time between stage 8.4-8.8
  • Moisture content at maturity (approx. 40%) too high for harvest
Stage 8: Ripening

Stage 8.1 showing 10% of pods have yellowed

Stage 8.3 on the left, stage 8.5 shown in the middle of this image

Stage 8.9 showing 90% of pods having yellowed
Stage 9: Maturity

- Seeds are mature, but not ready to harvest at the beginning (Stage 9.0)

- Stage 9.7 indicates pods have achieved mature pod color
  - Brown, tan or gray
  - Depends on environment and variety
  - Seed losses can occur if harvest is delayed after this stage

Pennycress at (A) stage 9.0 and (B-C) stage 9.7 of maturity.