Cultural Weed Management

Planting Pattern, Row Spacing and Crop Density

Crops are planted in rows:

- Reduce seed costs
- Ease of managing stubble
- Limit soil disturbance
- Facilitate weed management, irrigation and drainage, etc.

Disadvantage: Reduced competition with weeds and in some cases – lower yield.

Increased crop density and closer row spacing

- increases competitiveness of the crop with weeds
- due to improved competition for light, water and nutrients

(Olsen et al, 2005. Increased density and spatial uniformity increase weed suppression by spring wheat. Weed Research 2005. 45:316-321)

- Results support the hypothesis that increases in crop density and spatial uniformity can increase weed suppression and grain yield.
- A very high degree of uniformity may not be necessary to achieve a major increase in weed suppression.
- If this is correct, a reduction in the degree of spatial aggregation may be sufficient to give major improvements in weed suppression.
- This can be achieved through a combination of reduced row spacing and increased uniformity within the rows.
- A high degree of uniformity seems to have small but significant positive effects on yield, however.
- Optimum degree of uniformity will depend on the costs of increasing uniformity in the field.

Adverse effects of densely planted crops?

Increased risk of lodging and disease

Reduced yield and quality (fruit and vegetable size). For root crops and vegetable crops where smaller produce receives a lower price or is unmarketable.

Planting Date and Delayed Seeding

- Planting date can affect the competitive balance between the crop and weeds that emerge after planting.
- Growth rates of both are affected by environmental conditions such as temperature and moisture, which can change within and between seasons.
- Characteristic emergence patterns of weeds in spring can give growers a weed management opportunity.
- For weeds that emerge early in spring-delay seeding until this first cohort or flush of seedlings can be controlled.

In the absence of weeds optimal planting date for agronomic crops:

- Earliest at which successful emergence occurs,
- Gives longer period of time to accumulate resources and thus gives greater yield.

Under weedy conditions:

- Early planted crops grow slowly and may not be competitive with weeds that are better adapted to those climatic conditions.
- Therefore, spring-planted row crops that are subtropical spp. eg corn, sorghum, soybean, and common bean may result in greater growth and yield when planting is delayed.
- However, crops that are adapted to the temperate zone such as spring-planted cereals
    - Adapted for germination at temperatures as low as 5 C and are adapted to cool wet conditions
    - Can incur yield losses when planting is delayed due to reduced tillering and because annual weeds are better adapted to the later planting dates than the earlier ones.

Stale and False Seedbeds

- An older technique developed for early to midseason weed control in direct-seeded crops.
- Used since before herbicides were available.
- Useful for small-seeded or slow to establish crops such as onion and carrot.
- Most applicable for later seeded crops, but may be adapted to many systems.

Method:

- Till the soil early, this encourages the weeds to germinate.
- Irrigate if necessary to stimulate weed germination.

- Soil should be completely ready for crop planting:
    - Apply nutrients according to soil test recommendations, thoroughly incorporate fertilizer and organic residues, and prepare a very smooth seed bed.
- After 2-3 weeks when the weeds have emerged – kill with minimal soil disturbance so that fresh weed seeds are not brought to the surface.
    - Stale:
    - Conventional – nonselective herbicides: Roundup, Gramoxone or Scythe
    - Organic - propane flamers
    - False: Organic - shallow cultivation.
    - Unlike with shallow cultivation of a stale seedbed, herbicides and flame weeding can continue even after a crop is direct seeded, so long as the crop has not emerged.

Limitations:

- Soil must be warm and moist enough to promote germination
- Soil is bare soil and loose for additional time – erosion
- Yield may be lost if delayed by preplant cultivation
- A new set of species may become physiologically ready to germinate.
    - Weed composition may shift without a change in abundance.

Crop Fertilization

Nitrogen Fertilizer can:

- Stimulate weed seed germination – increase weed densities.
- Favor the growth of weeds that are high N consumers and less is available for crop growth.
- Shoot and root growth of some weeds more responsive than crops to higher N and P levels – weeds more competitive.

Manipulate fertilizer placement, rate, dose, timing, availability (slow release)

- <u>Placement:</u>
    - fertilizer in bands next to or under the crop row rather than broadcast.
    - Effects more pronounced in bands buried 5-7 cm below the seed level than in a band on the soil surface.
- <u>Timing:</u>
    - N fertilizer applied in autumn cf spring application for spring-planted wheat resulted in significantly greater amounts of wild oat and common lambsquarter

seeds in the weed seedbank at the end of a 4-yr experiment. (no difference in green foxtail and wild mustard).

- Also, wheat, barley, canola (*Brassica napus*) and peas (*Pisum sativum*) resulted in reduced weed biomass and increased yields with spring applied vs autumn applied fertilizer.
- Rigid ryegrass was less competitive when N was applied before the 3-leaf stage of wheat than at later stages.
- Split of NPK fertilizer applications (half at planting and half at corn ear emergence) resulted in 70% increase in crop biomass and 50% reduction in weed biomass that a single application of all the fertilizer at planting.
- Delayed application of fertilizer to wheat resulted in less competition from weeds that show early growth and development. With species in which growth and development are more closely synchronized with wheat

- Availability:
  - Nutrient availability from crop residues and some nutrient sources used in organic production. Soil inorganic nutrients are not usually as readily available as from synthetic fertilizers and may delay weed emergence and decrease weed density.
  - Residues of plants that break down and release their nutrients rapidly coinciding with weed growth stages may be as bad as or worse than synthetic fertilizer (applied in split applications, delayed, and in bands). Needs further research.

Water Management (See Liebman et al. 2001)

Excess or insufficient water can be used to prevent weed seed germination or to stress or kill weeds.

Nonselective methods in the absence of crops.

Selective methods when weeds and crops occur together.

Flooding:

Large volumes of water needed – adequate water source.

Appropriate soils.

Useful vs. weed seed, seedlings, and perennial storage organs that do not tolerate anaerobic conditions.

Nonselective flooding:

Advocated for control of johnsongrass (*Sorghum halepense*) in the lower Mississippi River valley.

Flood for 2 weeks during summer when water temperatures are high or 4 weeks in March or April.

Fall flooding and subsequent ice encasement killed all corms of *Alisma triviale*, an importantant broadleaf perennial weed that infests cultivated fields of wild rice (*Zinzania palustris*) in Northern Minnesota. Freezing alone is insufficient.

Selective flooding in rice:

- Useful for controlling weeds in rice because rice is tolerant of flooding but many weeds are not.

Everglades Agricultural Area (Curtis Rainbolt. 2005. Weed Management in Rice)

- Water management for weed control is effective in Florida because most of the weed species are semi-aquatic weeds and their growth can be retarded and ultimately controlled by standing water.
- To control rice weeds solely by water management, the grower must manage carefully to kill the weeds without killing the rice.
- The theory behind water management for weed control is that rice can tolerate submergence better than many weed species. Therefore, the grower must know what weed species are potential problems and whether or not these weeds are easily controlled by submergence. Rice, particularly drill-seeded rice, can also be killed by submergence.
- The water depth should be kept as shallow as possible while still keeping all of the weeds totally submerged. The maximum allowable submergence time for rice is dependent on the water temperature due to the direct effect of temperature on plant respiration rate. The higher the water temperature, the shorter the maximum survivable duration of submergence. Typically, on most light to medium textured muck soils, rice can tolerate submergence for approximately 48 hours. On heavier mucks and high mineral muck soils, rice will only tolerate shorter periods of flooding. After draining, the rice is allowed to recover for a week to 10 days and then the flood cycle is repeated once or twice before the permanent flood is applied.
- Heavy reliance can cause weeds shifts.
    - In California water-seeding and continuous flooding has been used to control *Echinochloa crus-galli*, which thrives under dry-seeding.
    - *E. oryzoides* and *E. phyllopogon*, formerly unimportant have increased in abundance under water-seeding. Only partially controlled by flooding.

- They have larger seeds and can germinate and emerge through deep water. *E. crus-galli* has smaller seeds and cannot emerge in deep water.
- CA growers advised to alternate between water- and dry-seeding.

Spatial Variation in Water Availability

- Localized placement of water using micro irrigation.
  - Irrigation water is limited to only a fraction of the soil surface and the crop rooting zone
  - Decreased incidence of weeds between rows
  - Subsurface drip irrigation – soil surface remains dry
    - very effective in arid and semi-arid regions
    - reduced dispersal of weed seeds compared with furrow and sprinkler irrigation runoff.
- Planting to moisture
  - In rain-fed agronomic crops optimum planting conditions:
    - When moisture below the surface is sufficient to permit crop germination.
    - But soil surface is too dry to permit weed germination until the next rain.
    - This condition can be artificially produced by creating a dust mulch – cultivating so that surface soil is loose and dries out easily not permitting rewetting by capillary action. Prevents moisture loss and weed seed germination.
  - In irrigated systems
    - irrigate prior to planting
    - Allow the soil surface to dry out
    - Weeds killed with shallow tillage
    - Larger crop seed permits deeper planting into moist soil
    - Crop emerges before the next weed cohort