THE INSTITUTE OF EDUCATION

Subject

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COURSE: Agricultural Science

ACADEMIC LEVEL: Leaving Certificate

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TOPIC: Cereal Crops

Cereal Crops

Cereal crops in Ireland are categorised as spring cereals or winter cereals depending on the time of the year they are drilled. Winter cereals comprising wheat, barley and oats are drilled in the autumn. Spring barley, oats and wheat are the three main spring cereals

Winter Cereals

Winter cereals is the term used to describe autumn drilled wheat, barley and oats. The area of winter cereals in Ireland was traditionally around 100,000 ha but has increased to around 150,000 ha in recent years, mainly due to an increase in the area of winter barley. Winter wheat and barley dominate the area with around 70,000 ha each, whereas only 10,000 ha of winter oats are drilled each year.

Spring Cereals

Spring Barley, Oats and Wheat are the three main spring cereal crops. Spring Barley is the largest spring crop with approximately 120,000ha sown each year. Average yields for the last five years are 7.2 t/ha. There is, approximately 12,000 hectares of Spring Wheat sown each year here, with an average yield of 7.9 t/ha. The total acreage of Spring Oats sown has increased in the last number of years, with on average 10,000 hectares of Spring Oats sown annually, yielding circa 7.3 t/ha

Spring Barley

Spring Barley is primarily used for feed production, with 87% going to the livestock sector. A significant proportion, 13%, is used for premium malting and roasting.

Spring Wheat

Spring Wheat is used for animal feed production, which accounts for 94% of output. Some, 6%, is sold to the milling market for human consumption, however this varies from year to year, due to difficulties meeting milling standards in our climate.

Spring Oats

Mainly used for the production of horse feeds and other animal feeds, some oats are used for milling, for human consumption, and also as seed for export. The demand for food grade oats is on the rise, on both domestic and international markets.

Barley **Oats**

Winter and Spring Varieties

- Spring varieties are sown in from February to March and harvested in August to September
- Winter varieties are sown in October/November and harvested in July. The ideal date is October 1st as it must be 8-10 cm tall before winter to become frost resistant. Sown too early increases lodging risks
- Winter varieties
    1. Have a longer growing period and 25% higher yields than spring
    2. Spread out the workload as spring can be busy eg lambing and calving
    3. Reduces the risks of bad weather in spring

Certified Seed

This is seed produced by the Dept. of Ag. under strictly controlled conditions

Properties

1. Minimum germination rate of 85%
2. Minimum analytical purity of 98%
3. Completely free of wild oats

4. Seed is treated with fungicide and insecticide

Every year the Department of Agriculture produces a list of recommended cereal varieties. Examples include Cocktail and Centurion. These are tested extensively for

a. Yield capacity
b. Shortness of straw
c. Strength of straw
d. Resistance to disease
e. Earliness of ripening

Relative yield of each variety is calculated as a percentage of control varieties. The average yield of the control varieties equals 100. Yield ratings are from trials carried out in accordance with good commercial husbandry practices.

Actual data is given for hagberg falling number, hectolitre weight, kernel content, protein content, screenings, straw height and thousand grain weight.

Assessment of other characteristics is based on a scale of 1 to 9; a high figure is desirable and indicates possession of the characteristic to a high degree.

For earliness of ripening a difference of one point represents 2 days.

Varieties with disease ratings of 8 or over are very resistant; 7 indicates good resistance and 6 moderate resistance; 5 indicates moderate susceptibility while 4 is rated susceptible; 1, 2 and 3 are very susceptible.

Cereal growth stages

Germination: GS00–GS09

Seedling growth: GS10–GS19

Tillering: GS20–GS29

Stem elongation: GS30–GS39

Booting: GS40–GS49

Ear emergence: GS50–GS59

Flowering: GS60–GS69

Milk development: GS70–GS79

Dough development: GS80–89

Ripening: GS90–GS99

An Roinn Talmhaíochta,
Bia agus Mara
Department of Agriculture,
Food and the Marine

WINTER BARLEY 2021

AGRONOMIC & QUALITY CHARACTERISTICS *	RECOMMENDED						PROVISIONALLY RECOMMENDED	
	BAZOOKA	BELFRY	KWS CASSIA	KWS INFINITY	KWS KOSMOS	PIXEL	LG CASTING	VALERIE
Relative Yield ♠	107	109	95	97	106	105	100	99
Varietal Type	6R(H)	6R(H)	2R	2R	6R	6R	2R	2R
Straw Height (cm)	100.0	91.0	83.5	80.5	90.1	86.3	79.1	79.6
Resistance to Lodging	6	7	7	7	6	7	(5)	(6)
Straw Breakdown	5	6	6	6	4	4	(5)	(6)
Earliness of Ripening	7	7	6	6	7	8	(7)	(8)
Resistance to:								
Mildew	6	6	5	5	8	7	(8)	(7)
Rhynchosporium	8	8	4	7	7	4	(5)	(7)
Brown Rust	6	7	7	6	7	7	(7)	(7)
Net Blotch	7	7	7	7	7	6	(7)	(7)
Grain quality:								
Screenings % (<2.2mm)	3.2	2.8	2.2	2.5	2.0	2.0	2.5	1.2
1000 grain weight (g)	46.8	46.5	53.3	54.4	49.5	46.8	52.4	58.4
Hectolitre weight (kg/hl)	68.2	67.8	69.8	67.6	66.5	66.7	68.4	69.6
Year First Listed	2019	2019	2011	2016	2018	2019	2020	2020

* Based on trial results from 2018, 2019 and 2020.
♠ Yields are expressed as a percentage of the mean of KWS Cassia, KWS Infinity and Belfry (100 = 9.68t/ha @ 15% moisture content).
( ) Limited Data.

An Roinn Talmhaíochta, Bia agus Mara
Department of Agriculture, Food and the Marine

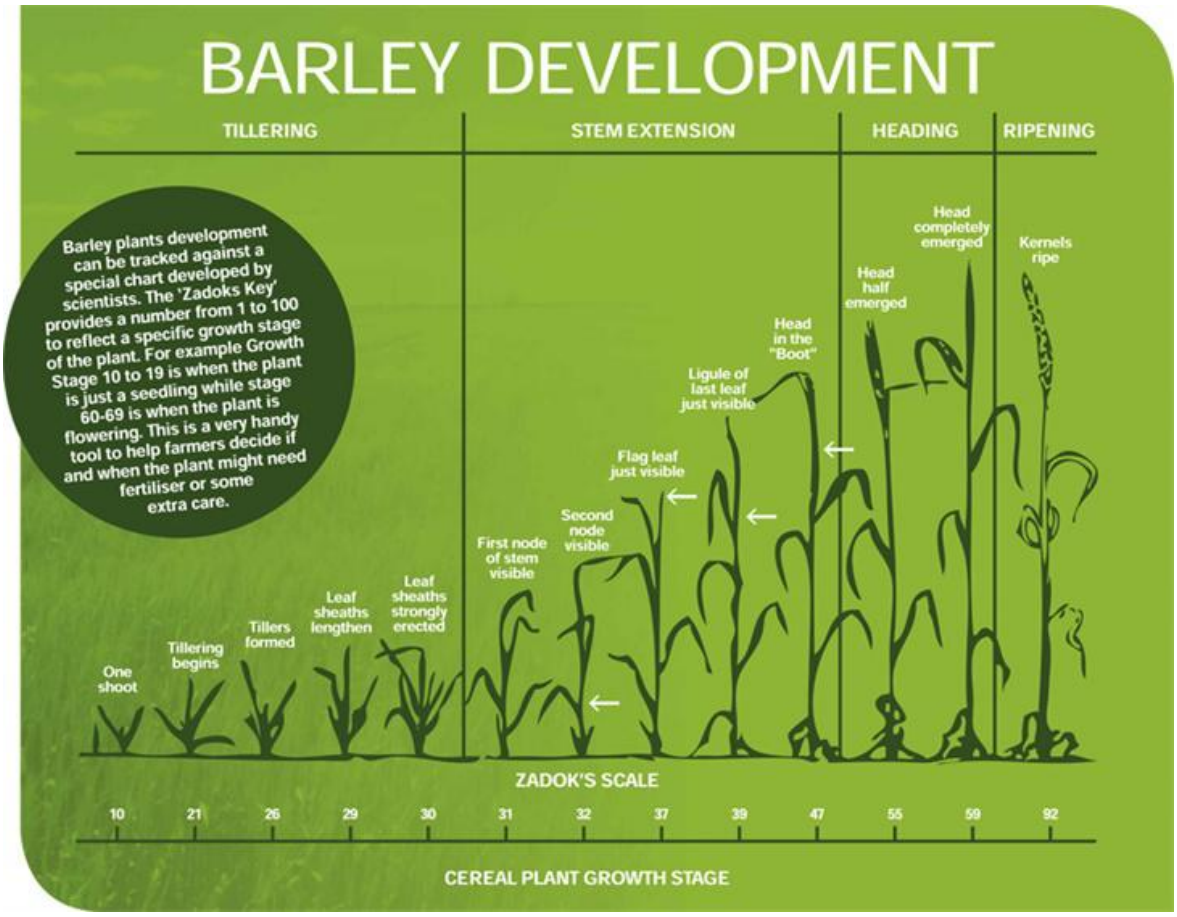
SPRING BARLEY 2020

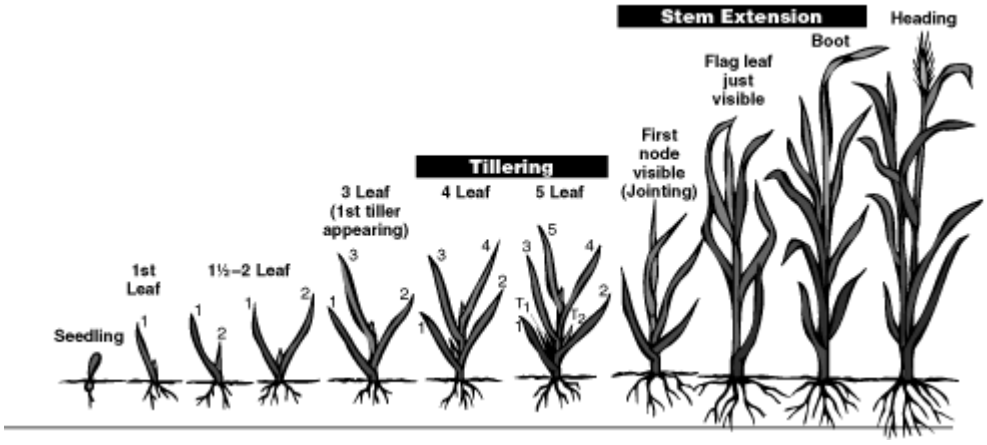
AGRONOMIC & QUALITY CHARACTERISTICS*	RECOMMENDED			PROVISIONALLY RECOMMENDED		
	GANGWAY	RGT PLANET	SY ERRIGAL	LIMONA	PROSPECT	SY ARDERIN
Relative yield ♦	98	102	101	96	100	100
Straw height (cm)	69.3	70.1	68.2	69.3	67.8	66.5
Resistance to lodging	6	5	7	7	6	5
Straw breakdown	7	4	6	6	6	7
Earliness of ripening	5	5	5	7	6	5
Resistance to:						
Mildew	8	8	8	8	8	8
Rhynchosporium	5	5	5	7	7	6
Brown Rust	6	5	7	5	5	6
Net Blotch	8	5	8	8	6	7
Quality:						
1,000 grain wt. (g)	47.2	50.0	49.6	46.6	46.3	51.0
Hectolitre wt. (kg/hl)	68.3	66.5	65.9	67.1	66.2	66.3
Screenings % (<2.2 mm)	1.8	1.6	1.6	3.0	2.3	1.3
Grain Protein %	11.2	10.8	11.1	11.4	11.3	11.3
Year First Listed	2018	2017	2019	2018	2019	2019

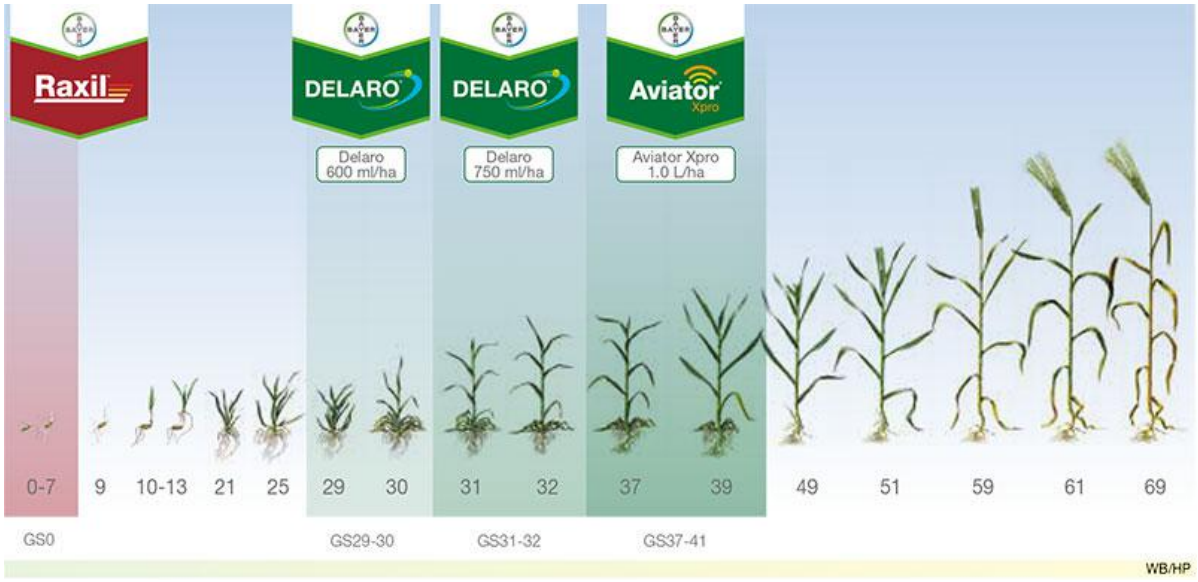
* Based on trial results from 2017, 2018 and 2019.

♦ Yields are expressed as a percentage of the mean of RGT Planet and Gangway. (100= 7.3t/ha @ 15% moisture content).

Growth Stages of Barley







- Crop development or its progress through its 'growth stages', is driven by temperature. The warmer the weather, the faster a crop will develop.
- Crop growth is dependent on the interception of sunlight and its conversion into crop biomass. The ideal conditions to maximise crop growth are therefore cool, bright, weather.
- The greater the crop's green area (canopy size), the higher the proportion of sunlight that will be intercepted by the crop, and the faster it will grow. However, light interception by a crop canopy follows the law of diminishing returns. For every additional unit of green area produced, a smaller amount of light is intercepted. There is a cost associated with the production of green area: nutrients for canopy growth; herbicides to control weed competition; fungicides to avoid leaf loss to disease. There is therefore a desirable canopy size and structure which optimises economic return to the grower, and that optimum is not necessarily the maximum possible. Thus, knowing how well a crop is growing and developing

is useful for growers. This knowledge will assist in the selection of the level of inputs required for an individual crop.

Leaf Emergence

- Leaf emergence is controlled by thermal time, each leaf will emerge at a set number of day degrees after the previous one. This thermal duration is known as the 'phyllochron' and is measured in ^{0}C days above a base temperature of 0 ^{0}C.

- When a seed starts to grow it produces leaf initials (buds) until mid-late tillering when it switches to reproductive development. From this point it produces spikelet primordia, which will eventually form the ear. The first leaf emerges soon after crop emergence and the crop then produces successive leaves at a set 'thermal rate'. Tiller production and survival are the most important factors determining yield in spring barley

- The phyllochron is the same for all the leaves in a crop but will vary slightly between crops; in different years, between varieties and is also influenced by sowing date. Generally the earlier a crop is sown the longer its phyllochron will be. For late-sown crops, plant development 'catches up' with earlier sown crops by producing fewer leaves and having a shorter phyllochron.

Average phyllochron = 82 ^{0}C days, range 73 - 92 ^{0}C days

Average days per new leaf in April = 10 Average days per new leaf in May = 7

Leaf Number

- Spring sown crops produce fewer leaves than autumn sown crops, the earlier a crop is sown the more leaves it will produce

Tillering

- Grain number is the key determinant of yield in spring barley. This is mainly influenced by ear number, which in turn is dependent on plant number and shoot number per plant.
- Shoot number per plant is determined by tiller production and tiller survival. Shoot survival is more important than shoot production in spring barley.
- Tiller emergence starts after the third leaf has emerged. Maximum tiller number is generally thought to occur around the start of stem extension, but tillering can continue beyond this or stop and re-start later in certain situations, such as if a period of drought or nutrient deficiency occurs.

- Shoot production is generally complete before ear emergence, but later-formed shoots can be produced e.g. when it rains following a period of drought, and will cause problems by remaining green when the rest of the crop is ready for harvest.
- Avoid nutrient deficiencies to maximise tiller production and reduce tiller death. Weeds compete with the crop for light and will reduce tiller production or survival.
- Target at least 950 ears/m2 .

Ear Number

- A proportion of the shoots produced will never survive to form ears. Generally the later formed shoots die first due to a lack of light, nutrients, or water. Final shoot (ear) number is set by the time the crop flowers.
- Crops with a low ear number will generally have a low yield potential even if there is a favourable grain filling period.

Canopy formation and light interception

- The formation of the crop's green canopy is the most important factor in crop growth as it is critical for light interception and dry matter production.
- Canopy size is determined by plant population, tillering, leaf emergence and leaf size.
- Crop canopy refers to all of the green components of the crop which are photosynthetic; including leaves, stems and ears.
- Canopy size is measured as green area index (GAI).
- GAI is the area of green material (laid out flat) per unit of ground area.
- GAI can be measured over any area of ground; i.e. m2 of green material per m2 of ground or acres of green material per acre of ground.

Canopy Size and Light Interception

- The amount of incident light per day increases during the spring and reaches a maximum in late June/early July
- The proportion of incident light (total solar radiation) intercepted by the crop increases rapidly as the canopy area starts to expand.

BIOMASS PRODUCTION AND PARTITIONING

- Biomass production is driven by the amount of light intercepted by the crop.
- Development, or the crops progress through its lifecycle, is driven by temperature. Total crop growth is greatest in cool bright conditions.

Biomass Partitioning

- First most of the biomass produced goes into leaf formation.
- Next most of the biomass produced goes into stem formation with a much smaller amount going into the formation of the ear within the stem. Then, leaf growth ceases and leaf biomass declines as lower leaves begin to die. Stems continue to grow very rapidly and ear growth accelerates.
- Eventually stem growth has ceased and all of the biomass is going into grain growth. Stem weight declines as soluble carbohydrates stored in the stem prior to grain filling are relocated into the developing grains. By harvest, 54% of total biomass (harvest index) is located in the grain. There is a total of 4.9 t DM/ha of biomass as stems, although only about 60-70% of this will be harvestable as straw due to a proportion remaining as stubble and baler inefficiency

CROP HEIGHT

- The crop will have reached only 57% of its final height by flag leaf emergence.
- Crop height is an important factor in lodging risk. With tall crops, the force of wind hitting the ear will exert a stronger leverage on the base of the plant

Stem Extension

- The growing point of the crop remains at ground level until the stem starts to extend.
- Once the stem starts to extend the crop becomes much more susceptible to frost damage to the growing point.
- Maximum crop height is reached soon after ear emergence and declines during grain filling as the ear 'necks over'.
- Excessive nitrogen will increase crop height and lodging risk. Early season chlormequat-containing growth regulators have a limited effect on final crop height due to 'bounce back'. Late season growth regulators have a significant effect on final crop height, but can be damaging if the crop is under stress.
- Check 'resistance to lodging' when choosing varieties, tall varieties are not necessarily more lodging prone. Delayed sowing can lead to taller crops.

EAR FORMATION AND GRAIN FILLING

- Grain number per m^2 is the primary determinant of spring barley grain yield in Ireland.
- Grain number is a product of the number of ears per m^2 and the number of grains per ear.

- Achieving a high number of ears/m^2 is reliant on maximising the survival of fertile shoots produced early in the vegetative stage of development. This is achieved by preventing deficiencies in nutrients and avoiding periods of drought and flooding.

Grain Filling

- During the grain filling period, the products of leaf, stem and ear photosynthesis, along with the assimilate previously stored in the stem, are distributed to the grains for storage.
- Avoid nutrient deficiencies early in the growing season to prevent tiller death and resulting lower ear numbers per m^2 .
- Maximise the duration of green canopy through adequate leaf and ear protection from disease to avoid limiting assimilate production and storage. Ensure the crop is suitably ripe before harvesting.
- Soon afterwards grain filling slows and the crop ripens as the moisture content of the grain decreases and the crop senesces fully.

Barley

- There are two types of Barley grown in Ireland, these are two-row or six row
- Two –row has 2 rows of seeds on the inflorescence spike and six – row has 6 rows of seeds on the spike
- Spring barley are two- row and Winter Barley can be either two or six row.

Growing Barley

Feeding Barley

- Used for animal feed suitable for all livestock. Some farmers retain it on their own farm. Most is sold to animal feed manufacturers who mix it with other ingredients to produce animal feeds

Malting Barley

- Used for brewing and distilling
- Grown on contract
- Only grown on best soils and grain quality is essential
- The embryo inside must not be killed during harvest or storage
- Protein content should not be too high between 8.8 and 10.8% (avoid excess N)

Cultivation

1. Soil and climate

- Malting barley requires the best soils eg. Grey Brown Podzols
- Feeding barley can grow on a range of soils but grows best on best soils
- Good drainage
- pH 6.5 ideal
- Dry conditions needed at sowing and especially at harvest to dry the grain
- Steady supply of moisture required and drought lowers yields

2. Rotation

- Not seriously affected by soil borne diseases or pests
- Can be grown continuously
- However higher yields are produced in rotation

3. Seedbed Preparation

The type and intensity of soil cultivation used impacts on:

1. crop establishment
2. nutrient uptake
3. yield
4. weed growth
5. soil structure
6. greenhouse gas emissions
7. production costs.

- Ploughing remains the most reliable establishment system for spring crops on most soils.
- Min-till is fast and can reduce costs but is not suited to all soils and requires careful management to avoid grass weed, compaction, and yield loss challenges.
- Whatever the system, good seed/soil contact, and the appropriate aggregate size and soil structure, in and below the seedbed, will optimise crop performance.

- Min-till systems with their less intensive cultivation, lower power requirement, and fast work-rate are worth considering as a lower-cost, sustainable establishment system. A short growing season and grass weed control presents challenges on many soils.
- Plough early to allow weathering assist tilth formation. Only cultivate as deep as needed. Ploughing at 175mm rather than 250mm can reduce costs by 30%.
- Cultivate seedbeds only when the soil is dry enough to produce a good tilth and to support traffic.
- Use the minimum number of passes to reduce both costs and soil structure damage.
- Cultivation/sowing accounts for about 20% of production costs but varies widely. Select machines carefully and avoid over-capacity. Hire, share, or use a contractor if ownership is not economic

4. Sowing

- Spring Barley should be sown as early as possible ie. Jan-April
- Sown to 3-5cm depth with a one pass seeder in lines 18 cm apart
- Early sowing gives higher yields
- Seeding rate 125-140 kg/ha
- Aim is to have 300 plants per metre squared established and these will tiller to 900 ears at harvest.
- Tillering happens with all Graminae plants, the main shoot produces a number of side shoots, each develops its own root system although still attached to the main plant
- Loose seedbeds should be gently rolled after sowing (not necessary in softer soil conditions)

SEED RATE AND ESTABLISHMENT

- Establishing the correct number of barley plants is essential for the crop to achieve high yields. Adjusting seed rate for individual seed lots and field conditions is essential to achieve the desired plant stand. Barley will compensate somewhat for higher or lower plant numbers by producing higher or lower tiller numbers but there is a limit to how much a crop can adjust.

<u>Seed Quality</u>

- Buying Irish Certified Seed will ensure guaranteed germination %, weed free seed and a low risk of seed borne diseases. Seed quality is the most important element of good establishment.
- The main seed quality factors are: germination capacity, thousand grain weight (TGW) and disease levels on the seed.

Germination capacity

- Can be reduced by a wet harvest, excessive heat during drying or where a large disease burden is present. As a minimum, all home saved seed should have the germination capacity and disease level checked.
- Germination capacity should be as high as possible, ideally over 85%, and certified seed must have a germination capacity of at least 85%.

Thousand grain weight (TGW)

- Refers to the weight of 1000 grains.
- Generally plumper grain will weigh more than shrivelled grain therefore seed with plumper grains will require higher seed rates. Some seed suppliers display TGW on each lot number making seed rate calculations easier.

Seed-borne diseases of barley include: net blotch, Rhynchosporium, seedling blights caused by Microdochium nivale, bunt, ergot and loose smut.

Seed Rate

- Seed rate will directly affect yield components in barley as plants/m2 influence shoots/m2 which in turn influences the total grain numbers/m2 .
- To calculate the seeding rate start with the number of plants you want to establish. This should be adjusted to take into account all the factors affecting how many seeds will eventually produce plants

Calculating the Seed Rate The seed rate is calculated by completing the following:

$$\text{kg of seed/ha} = \frac{\text{Target plant population X TGW}}{\text{Estimated establishment \%}}$$

Example Calculation

- TGW =50
- Target plant Population = 280
- % Establishment = 70

50 X 280 = 200kg/ha

70

- Seedbed conditions, pest burden and fertility of the soil should also be considered before reaching a final seeding rate. Earlier sown spring crops will produce more leaves. The plant has the capacity to produce a tiller from the base of each leaf. Later sown crops develop faster and enter stem extension more quickly, limiting the number of leaves and potential tillers. Consequently, later sown crops should be sown to achieve a higher plant stand compared to earlier sown crops.

5. Weed Control

- Where a weed challenge is significant, yield responses of over 1.2 t/ha can be expected from herbicides.
- Target herbicide applications early for maximum effect. Crop growth and ultimately, yield, is driven by green leaf area. Weeds compete with the crop for light, water and nutrients, all of which can reduce the crop's ability to amass green leaf area.
- Ear number is a key determinant of yield and weed competition can reduce the shoot number especially during early tillering.
- Barley can tolerate low levels of weeds as it will compete well where barley plant numbers are high. Weeds differ in their ability to compete with barley.
- Wild oats and charlock are the most competitive with corn marigold, poppy, fat hen, fumitory, chickweed, redshank, and knotgrass less competitive, dead nettles and field pansy are least competitive.

6. Diseases

- Include Rhynchosporium, net blotch, Ramularia, powdery mildew.
- Diseases reduce both yield quality and quantity. Use cultural techniques and varietal resistance as well as chemical control to minimised yield loss due to disease.
- Disease early in the season can significantly reduce yield potential. There are a wide range of fungicides with good activity for disease control in barley. Avoid over use of individual fungicides to reduce the risk of resistance development.

- For effective disease control in barley it is important to utilise all available control measures as part of an integrated pest management system. Over reliance on any one tool will be ineffective and unsustainable.
- The avoidance of a 'green bridge' through the early destruction of volunteers from previous crops.
- Varieties should have good disease resistance (refer to DAFM recommended list) and seed should be certified and disease free.
- Fungicides have a key role, the timing and choice of which is important to ensure optimum control.

7. Fertiliser

- P and K application rates are decided after soil test results
- Fertilisers can be applied with seeds at sowing or broadcast onto the soil
- N is only applied in the spring and summer when crops are actively growing (no N applied when sowing winter cereals)
- The amount of N applied depends on recent cropping history and amount of organic matter in soil (low amounts needed after grass or legume, higher applications necessary after continuous barley crops)
- No more than 75kg/ha of N should be applied at sowing. Further applications should be applied as split dressings when 2-3 leaves are produced
- Excessive N
    1. Can cause lodging (stem breaks and plants fall over)
    2. Make the crop more prone to disease
    3. Increase protein and seed may be unsuitable for malting

8. Pests

- Wireworms – problem after grass not intensive tillage – spray insecticide before sowing
- Leatherjackets – insecticides
- Aphids/greenfly- insecticides and ladybirds
- Birds – attack ripening crops causing lodging – controlled by baits, scarecrows ,bangers and shotgun
- Rabbits – eat emerging plants – controlled by baits and rifle

9. Harvesting

- When fully ripe
    a. Straw becomes dry and bleached yellow
    b. Grain becomes dry and hard (moisture below 20%)
    c. Ear bends over and lies parallel to the stem

- Barley harvested by a combine which threshes the crop (separates the seeds from the stem. Its important that it is working correctly to minimise grain loose and damage
- Spring Barley harvested in August- September and Winter Barley harvested in July
- Yields spring barley 5-7 tonnes per ha winter barley= 10 tonnes/ha plus approximately 3 tonnes/ha straw

10. Storage

- Important to stop germination, bacterial, fungal or pest attack
- Most at risk when moisture is high
- Drying is carried out by merchants, grain must be dried to 14% moisture. Farmers are paid more for grain the closer its moisture content is to 14% as the higher the moisture the greater the expense in drying.
- Acid treatment – carried out by farmers storing smaller amounts of grain
    - propanoic or sulphuric acid is dripped onto grain at 3-5 litres per tonne. This kills the embryo and stops germination and also the acidity protects against bacteria, fungi or pests
    - not done on malting barley

11. Feeding

- **Ruminants –** grain is rolled to break outer shell or husk and allow the starch inside to be digested
- **Monogastrics-** grain must be ground into flour before it can be digested

CROP MANAGEMENT

THE CROP MANAGEMENT SEASON