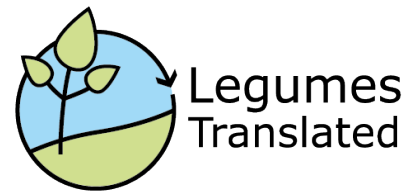


Growing soya in north-western Europe

Experience from Ireland



Sheila Alves, Kevin Murphy, Brendan Burke, Michael Hennessy and Jürgen Recknagel

The cultivation of soybean has increased considerably in Europe in the last decade supported by the development of cultivars adapted to high latitude and shorter or cooler growing seasons. These cultivars are now grown in countries where climatic conditions were considered unsuitable for soybean production until very recently, such as in southern England, Lithuania and Denmark. However, reports on the soybean cultivation at high latitudes (above 52°N) in maritime areas where cool and wet conditions occur remain scarce. This practice note is about the experience of growing soybean at Oak Park Research Farm, Teagasc in Carlow, Ireland. The trials at Oak Park showed that the soybean cultivars tested did not mature early enough for harvest under suitable conditions. From these observations, we can say that these new early cultivars are not well-adapted to Irish conditions for the production of grain for feed and food markets. However, soybean was successful grown as a whole crop, harvested while still green/immature. Bird feeding of emerging seedlings caused very significant damage in the Teagasc trials.

The potential for adapting soybean adaptation to north-western Europe

The cultivation of soybean in Europe has increased considerably aided by cultivars that mature early. Matching cultivar to location combined with optimal agronomic practices (sowing date, seed rate, and distance between rows) is fundamental to viable and profitable soybean production in any environment. Soybean is a warm season legume, with growth interrupted when temperature drop below 8°C. It is also a short-day crop. This means that flower development is suppressed in the long-day conditions of summer in most of Europe above 45°N, unless the cultivar is day-neutral. The crop requires a sufficient number of warm days to mature, usually expressed by growing



Soybean flowering. Photograph: Sheila Alves (Teagasc)

degree-days (GDD), using 10°C as the base temperature. Crop heat units (CHU) are also used. The calculation of CHU uses 10°C and 4.4°C as the daytime and night-time base temperatures respectively. The minimum reported values for soybean are 933–1,041 GDD (base 10°C) and about 2,300 CHU. This requirement for heat and for day neutral cultivars makes the production of soybean above about 52°N (approximately the line from Cork in Ireland to London across to Berlin) particularly challenging, especially in north-west Europe where long summer days are combined with relative cool maritime conditions, such as in Ireland.

The first requirement for cultivation under the conditions described above is to use day

Table 1. Characteristics of soybean cultivars sown in Oak Park over 2 seasons (2019 and 2020). Density (seeds/m²) is the seeding rate recommended by seed suppliers.

Cultivar	Supplier (breeder, country)	Density (seeds/m ²)	Maturity group
Aurelina	Saatbau (Saatbau Linz, Austria)	85	000
Abelina	Saatbau (Saatbau Linz, Austria)	85	000
Merlin	Saatbau (Saatbau Linz, Austria)	85	000
Rosa	AgroBioInstitute (OSS Pavlikeni, Bulgaria)	60	II
Richy Puzu	AgroBioInstitute (OSS Pavlikeni, Bulgaria)	60	II
Avigeya	AgroBioInstitute (OSS Pavlikeni, Bulgaria)	60	I
Srebrina	AgroBioInstitute (OSS Pavlikeni, Bulgaria)	60	II
Line MP*	AgroBioInstitute (OSS Pavlikeni, Bulgaria)	60	Very early
Royka	Prograin Zia (Czech Republic)	100	VR (000)
Marzena	Prograin Zia (Czech Republic)	100	SR (00)
Mayrika	Prograin Zia (Czech Republic)	125	VR (000)
ES Favor (ESG 152)	SeedTech (Euralis, France)	85	000
ES Comandor	SeedTech (Euralis, France)	85	000
ES Governor (ESG 1711)	SeedTech (Euralis, France)	85	000
Siverka*	Quinns of Baltinglass (Soya UK, UK)	85	000-0000 (000 to TTP)

*Only sown in 2019

length neutral cultivars. This is met by cultivars classified in the zero maturity groups (0, 00, 000, and 0000). The second requirement is rapid progress through all development stages to reach maturity in September under relatively cool conditions. The cultivars that most meet this requirement are commonly classified as 000 cultivars, with a few even earlier than these (0000).

The soybean field trials at Oak Park research farm in Carlow, Ireland

Fifteen varieties of soybeans (Table 1) were selected in consultation with the Soybean Network of the Legumes Translated project, soybean breeders and merchandisers. Seed was inoculated with rhizobium (LegumeFix, Legume technology, UK), and sown at a depth of 3–4 cm, using a Haldrup planter, on 22 May 2019 and on 7 May 2020. The total plot area was 18 m² (1.2 m x 15 m). Each cultivar was tested using two row widths: 40 and 60 cm. A randomised block design was used with 4 replicates. Details of the weather from March to October 2020 are presented in Figure 1.

In the 2019 season, white sprouts of the sprouting soybean in the field were observed about 3 weeks after sowing, without the cotyledons. Only one seedling has survived beyond the cotyledon stage. A flock of pigeons that earlier in the season grazed on an adjacent oilseed rape field may have been responsible for the unsuccessful trial.

In the 2020 season, emergence was observed from 20 May on. The emergence rate was low and not uniform, probably related to the cold period observed just after sowing (minimum air temperature from -0.9 to 5.7°C and soil temperature from 12 to 15°C, between the 10th and the 15th of May) and the relative low air temperature throughout the month of May (Figure 1). Some bird damage was also observed.

Flowering was observed in mid-August and pod development and seed filling from beginning of September on (Figure 2). Earlier flowering of cultivars with petals that not fully unfold may have escaped the untrained eye. In the cultivars that are not day neutral, such as the ones in maturity groups I and II, flower initiation may

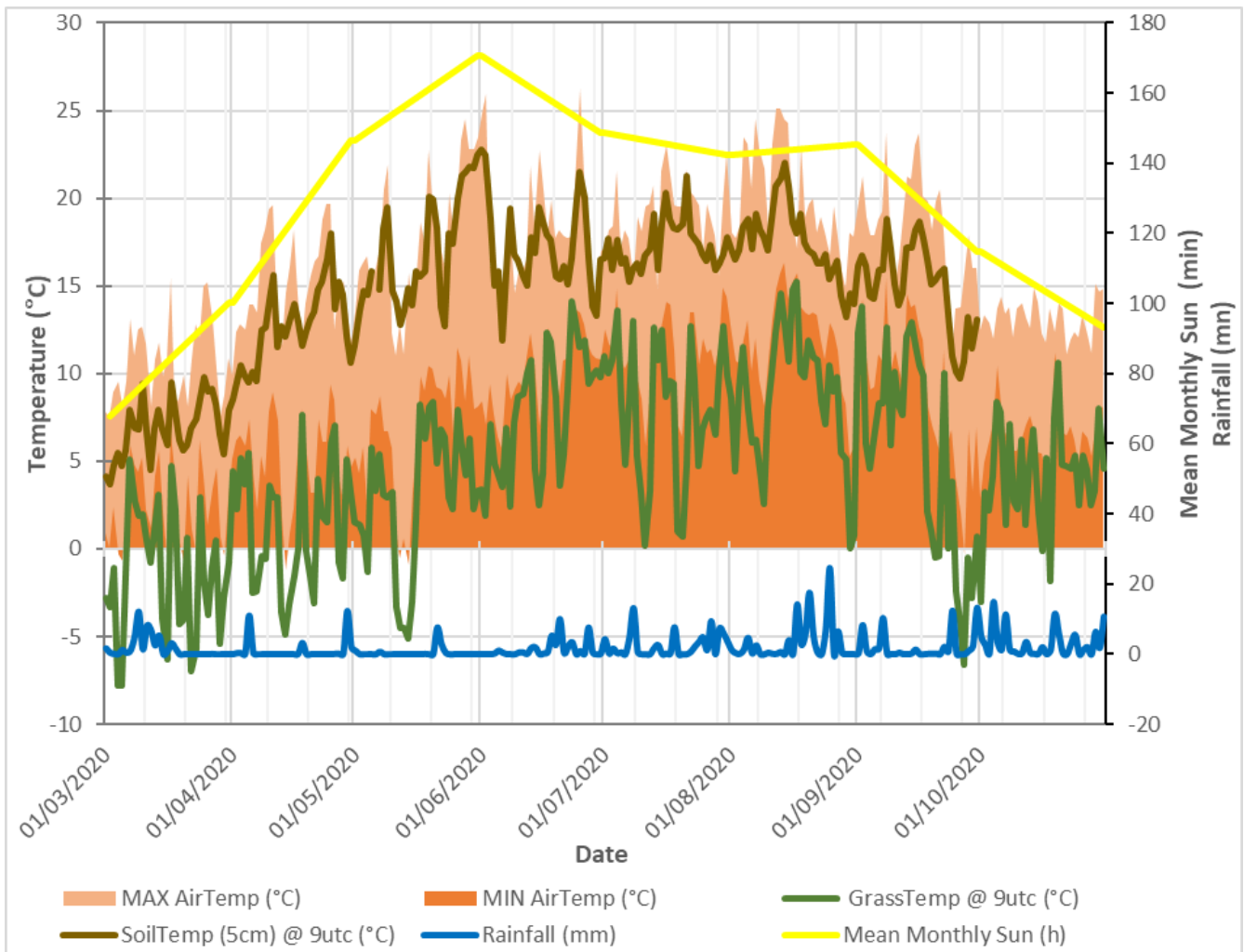


Figure 1. Daily weather data from Oak Park in Carlow, Ireland between the 1st of March and the 31st of October 2020. MAX AirTemp = maximum daily air temperature. MIN AirTemp = minimum daily air temperature. GrassTemp @9utc = temperature at the grass surface measured at 9am (UTC). SoilTemp (5 cm) @9utc = soil temperature measured at 5 cm depth at 9am (UTC). Rainfall (mm) is daily rainfall. Mean Monthly Sun (h) = mean monthly sun in hours. Source: Met Eireann, station 375, Oak Park, H 62 m, E27300, N179500, La525140, Lo65455 (Irish Grid).

have been inhibited by the long summer days and delayed until nights lengthened to a cultivar-specific minimum.

Although plants begin maturing between the months of September and October with hardening pods, there were still significant foliage in mid-October. 2,390 CHU were accumulated in the period between sowing and 30 September in 2020.

The weed-burden was high, related to the poor plant establishment resulting in poor plant competition throughout the season but also due to a lack of suitable herbicides registered in Ireland for weed control in soybean.

Soybean cultivation in Carlow for grain production may not be feasible as CHU only marginally

exceed 2,300 (growing season mean of 2,383 (1 May – 30 September), over the period of 2005–2021), considered as the minimum accumulated units for a feasible soybean crop. Lower CHU values are accumulated if the growing period is shortened due to later sowing and earlier harvest, as presented in Figure 3.

Relevance for other parts of north-western Europe

Considering the experience of other European countries such as Germany where soybean is cultivated, the potential growing season for soybean in Ireland and other north-western European countries lies between beginning of May and the end of September. However, the climate in Germany allows soybean sowing from beginning of May on when soil temperature

reaches 10°C and is rising steadily through May. The beginning of May is still quite cool over most of Ireland. Consequently, consistent and rising soil temperatures above 8–12°C, required for establishment, are reached only in the second half of May. Low early season temperatures reduce yield. On the other end of the growing season, the risk of rainfall in Ireland increases as autumn progresses. Harvesting in September rather than October reduces the risk of excessive moisture in the crop and grain. As a consequence, the growing season for soybean in certain regions in Ireland would most probably be shorter compared to in Germany. This reduces the period during which heat is accumulated by 200–300 CHU, depending on the year (Figure 3).

Based on these observations, the feasibility of soybean production could be assessed in the most promising locations. Only the earliest cultivars, usually classified in maturity groups

000 and 0000, are potentially suitable for Irish conditions. Based on authors' experience, about 2,600 CHU, or about 1150 GDD (base 10°C), are required from emergence to harvest. Based solely on CHU, soybean production may be feasible in areas of County Cork, such as around Cloyne, Linsaley, where calculated CHU were close to those observed in German soybean producing areas such as in Tailfingen (altitude 450 m) and Ochsenhausen (altitude 625 m) in Baden-Württemberg (Figure 3). In the other locations considered, the CHU were lower than the minimum required in at least 3 out of 10 years, and never surpassed 2,500. However, considering that more daylength may substitute some low temperature, it might be interesting to test soybean cultivation for several years also at those places and evaluate if this effect is sufficient for a sustainable production. Ideally, pea and/or faba bean will also be sown to get an idea about the relative performance of those 3 grain legumes at each site.

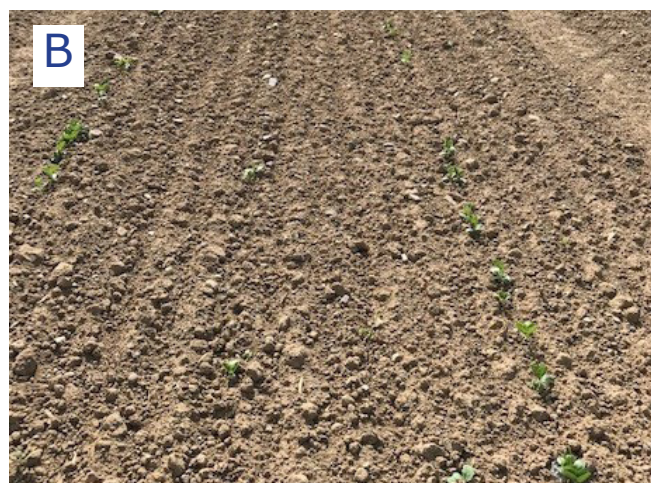


Figure 2. Pictures of soybean at different growth stages in 2020 at Oak Park research farm in Carlow, Ireland. A: Emergence (20/05/2020); B: Establishment (01/06/2020); C: Flowering (14/08/2020); D: Maturing plants (01/10/2020).

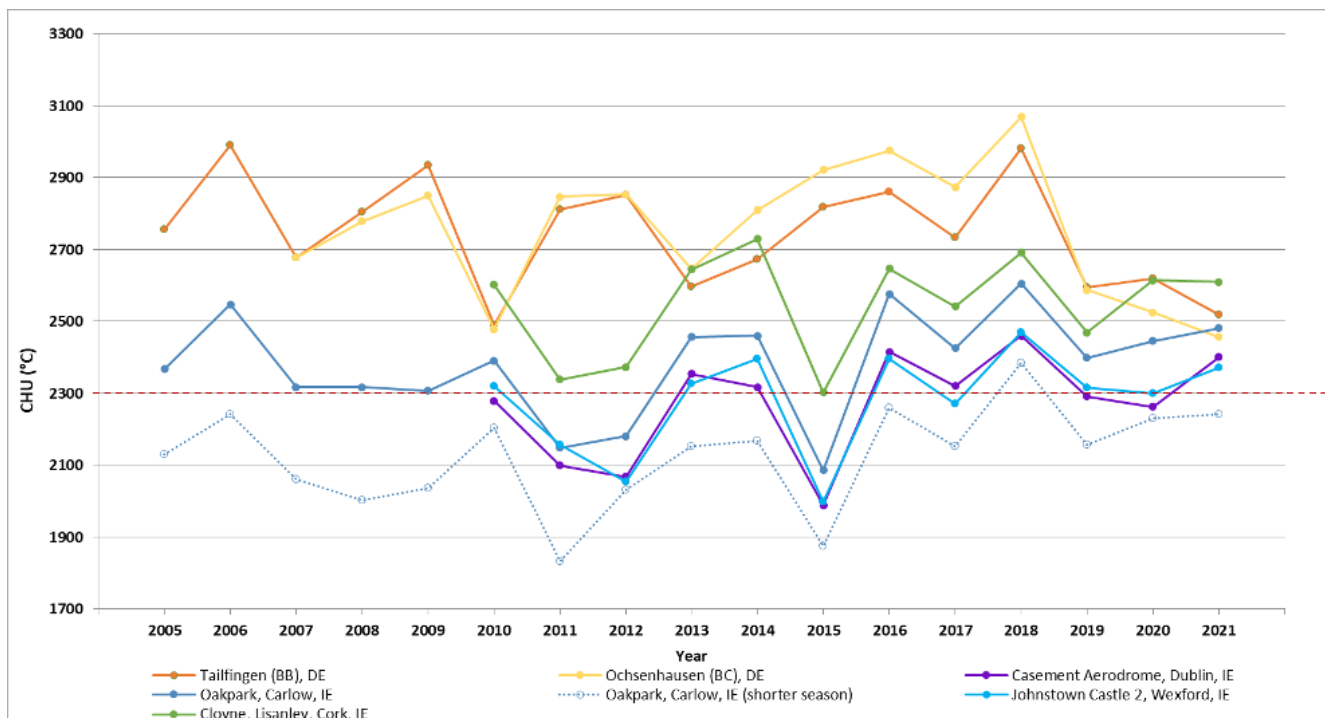


Figure 3. Crop Heat Units (CHU) for soybean, between the 1st of May and the 30th of September, in the period of 2005–2021. CHU were calculated for 4 Irish and 2 German locations, based on the max and min daily air temperatures as described by Bootsma et al. (2007). The CHU series named Oak Park, Carlow, IE (shorter season) was calculated for the period between the 15th of May and the 20th of September.

Key practice points

- We did not succeed in growing soybean for grain in Carlow, Ireland. The crop did not mature in time to avoid wet conditions and high grain moisture at harvest.
- Research results from Ireland do not support growing of soybean until more suitable cultivars are proven. Further studies are needed in Irish conditions with earlier day neutral cultivars (maturity groups 000 - 0000) in regions that accumulate more CHU over the growing season.
- Sowing and harvesting dates need careful consideration to meet crop requirements, namely a soil temperature of 8–12°C at sowing followed by a consistent increase in soil temperature, and dry conditions at harvest, with implications in the length of the growing season.
- Herbicides are not available locally, although some of plant protection products registered for other purposes are suitable but do not carry clearance for use in Ireland. Local availability will remain a problem until sufficient soybean areas are grown.

- Bird damage in areas with known high bird density, in particular pigeons and crows, can significantly decrease the plant population in the field. In those areas, agronomic practices, such as adjusting time of sowing to enable rapid establishment in periods with lower bird activity, need consideration.

Sources

Bootsma, A., McKenney, D.W., Anderson, D., and Papadopol, P., 2007. A re-evaluation of crop heat units in the maritime provinces of Canada. *Canadian Journal of Plant Science*, 87(2), 281-287.

Donau Soja, 2015. Soybeans demo platform, Agriculture research & development station, Caracal, Romania. http://www.donausoja.org/fileadmin/user_upload/Activity/Projects/Demofields/DONAU_SOJA_Demo_Platform_-_ARDS_CARACAL_-_Caracal_-_Romania_-_2015_-_Report.pdf

Donau Soja, 2018. Soya cultivation in Europe. https://www.donausoja.org/fileadmin/user_upload/Downloads/Soya_cultivation_in_Europe_plus_DS_Benefits.pdf

Karges, K., Bellingrath-Kimura, S.D., Watson C.A., Stoddard, F.L., Halwani, M., Reckling, M., 2022. Agro-economic prospects for expanding soybean production beyond its current northerly limit in Europe. *European Journal of Agronomy*, 133, 126415.

Kühling, I., Hüsing, B., Bome, N., Trautz, D., 2018. Soybeans in high latitudes: effects of Bradyrhizobium inoculation in Northwest Germany and southern West Siberia. *Org. Agric.*, 8, 159–171.

PROTEIN2FOOD, 2019. Agronomic interventions (best management practices) for different European conditions, for each species defined. Deliverable D 1.10, Project No.: 635727 (H2020-SFS-2014-2015/H2020-SFS-2014-2). www.protein2food.eu/wp-content/uploads/Deliverable-1.10_FINAL-compressed-1.pdf

Recknagel, J., Rittler, L. and Murphy-Bokern, D., 2021. Choosing soybean cultivars. LTZ Augustenberg, Sojaförderring e.V. Legumes Translated Practice Note 30. https://www.legumehub.eu/is_article/choosing-soybean-cultivars/

Rittler, L. and Bykova, O., 2021. Sowing time for soybean. Legumes Translated Practice Note 11. https://www.legumehub.eu/is_article/sowing-time-for-soybean/

Soya UK, 2021. UK Soya: A Grower's Guide. www.soya-uk.com/wp-content/uploads/2021/11/SOYA-4-PAGE-LEAFLET-2021.pdf

Toleikiene, M., Slepetyš, J., Sarunaite, L., Lazauskas, S., Deveikyte, I., Kadziulienė, Z., 2021. Soybean development and productivity in response to organic management above the northern boundary of soybean distribution in Europe. *Agronomy*, 11, 214.

Walsh, S., 2012. A summary of climate averages for Ireland 1981-2010. Climatological note n. 14, Met Eireann, Glasnevin Hill, Dublin 9, May 2012. <https://www.met.ie/climate-ireland/SummaryClimAvgs.pdf>

About this practice note and Legumes Translated

Authors: Sheila Alves, Kevin Murphy, Brendan Burke, Michael Hennessy and Jürgen Recknagel

Publisher: The Agriculture and Food Development Authority (Teagasc)

Production: Donau Soja

Permalink: www.zenodo.org/record/6513600

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This practice note was prepared within the Legumes Translated project funded by the European Union through Horizon 2020, Project Grant Number 817634.

Citation: Alves, S., Murphy, K., Burke, B., Hennessy, M. and Recknagel, J., 2022. Growing soybean in north-western Europe. Teagasc. Legumes Translated Practice Note 74. www.legumestranslated.eu

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This project is funded
by the European Union

