FAO INVESTMENT CENTRE / EBRD
COOPERATION PROGRAMME

REPORT SERIES - N. 14 - SEPTEMBER 2009

Kazakhstan

Technical Assistance to the Sunflower Seed Sector

Study Supported Under the Japan-Europe Cooperation Fund

Food and Agriculture Organization
of the United Nations

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ACRONYMS

CIS	Commonwealth of Independent States
EBRD	European Bank for Reconstruction and Development
FAO	Food and Agriculture Organization of the United Nations
N	nitrogen
P_2O_5	phosphorus oxide
KZT	Kazakh tenge
TC	Technical Cooperation

FOREWARD

Sunflower oil is by far the major vegetable oil consumed in Kazakhstan. The growing consumer demand has been largely met by imports rather than local production. From 2005 to 2007, the EBRD provided loans totalling USD 26 million to Turkuaz Edible Oil Industries, a subsidiary of Savola Group, to develop its vegetable oils production business in Aktobe. Results illustrated soon that sunflower yields could be increased if farmers used new sunfloweer seed hybrids even under low rainfall conditions. In 2007, FAO and the EBRD, with funding from the Government of Japan, agreed to provide technical assistance to help farmers in the region increase production and processing of sunflower seed using more efficient techniques.

To ensure that the best international expertise was provided to local farmers, FAO worked together with Cetiom/Agropol to transfer know-how and provide training. Topics covered included planting, fertilization, weed control and harvesting. Sunflower seed hybrids were provided from seed companies in France and Ukraine and partners in Kazakhstan provided locally available and imported hybrids for demonstartion trials. In 2008, demonstration trials were conducted in two locations in the Aktobe region and 30 hybrids from different seeds companies were tested.

ACKNOWLEDGEMENTS

This report was prepared by the Investment Centre Division of the Food and Agriculture Organization of the United Nations (FAO) under the FAO/European Bank for Reconstruction and Development (EBRD) Cooperation Programme. The Japan-Europe Cooperation Fund graciously made funds available to the EBRD for this project. The report summarises the results of a series of activities undertaken by FAO in North-Western Kazakhstan in cooperation with the EBRD and the Savola Group, its client.

The main authors of this report were Mr Dmitry Prikhodko, Economist, FAO, and Mr Alexander Nikishkov, FAO Consultant and Researcher from the Aktobe State Agricultural Research and Experiment Station. Mr Yannick Herbaudière, Mr Pierre Jouffret, Mr Frank Duroueix, Mr André Merrien and Mr Jean-Pierre Palleau from CETIOM, a French-based technical centre for oilseed crops, provided training materials and status reports. Their activities and the overall project were coordinated by Mr Jean-Louis Benassi from Prolea.

This project and report would not have been possible without the partnership and support provided by Mr Adil Kurmanaj, Deputy Director, and Mr Sagingaliy Zhuvanishev, Raw Materials Specialist of the Savola Edible Oil Plant in Aktobe, Kazakhstan.

Mr Emmanuel Hidier, Senior Economist, FAO provided overall guidance from the FAO side. Mr Mehmet Ilkin, EBRD Operation Leader for the project, and Ms Saida Abdushkurova, EBRD Analyst, coordinated the project from the EBRD side. Ms Nada Zvekic, Communications Officer, FAO, and Mr Massimo Latini, Communications Specialist (consultant), provided valuable communications support to the project.

The authors would like to thank Mr Ersain Azhibayev, Director, Department of Agriculture of Aktobe oblast, and Mr Amangos Tuleuov, Director of Stepnoye and Aktobe State Agricultural Experiment Station, for providing support and facilities for the training sessions and Mr Giovanni Adduci, Ms Eliane DiCinto, Ms Christiane Bosi, and Ms Lucia Farina for the effective administrative support rendered to the project team.

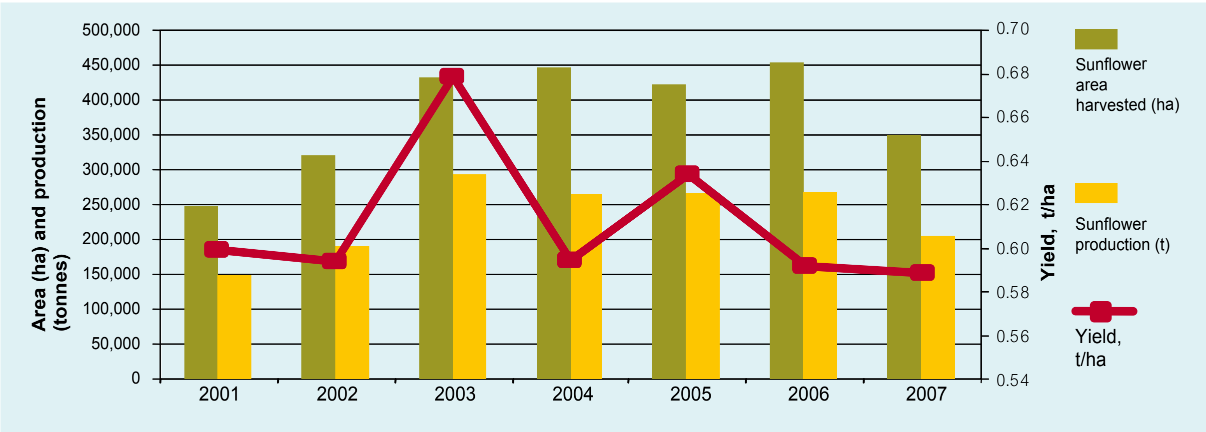
DISCLAIMER

INTRODUCTION

Sunflower seed oil is by far the major vegetable oil consumed in Kazakhstan. Sunflower production in Kazakhstan has been relatively small compared with Russia and Ukraine, which are the other major agricultural producers in the Commonwealth of Independent States (CIS).

Despite increasing domestic demand for sunflower seed oil, there have been no increases in sunflower seed area harvested, production, and yields.

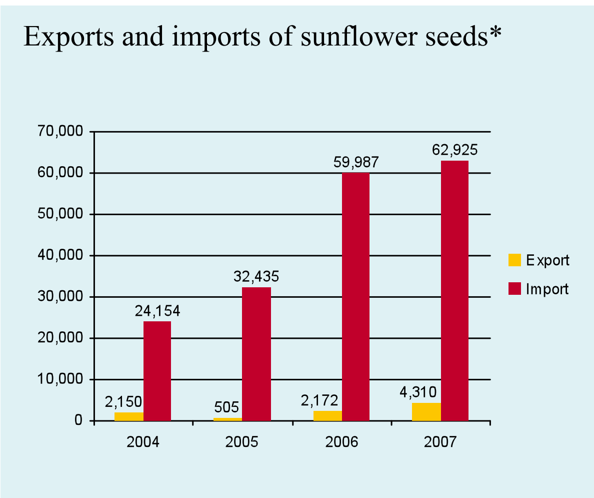
Figure 1. Sunflower seed production and yields in Kazakhstan, 2001-2007



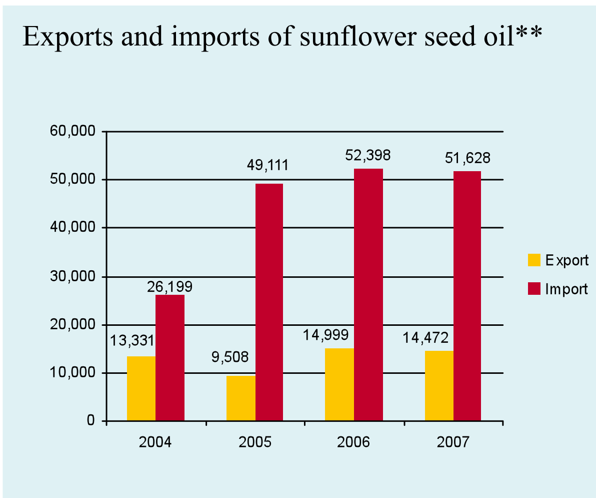
Source: FAOStat

Imports of both sunflower seeds for further processing and sunflower seed oils have increased in recent years in response to growing domestic demand. Russia is the main supplier of sunflower seeds and oil to Kazakhstan. Ukraine and Moldova are also important suppliers of sunflower seed oil.

Figure 2. Kazakhstan: Sunflower seed and sunflower seed oil imports and exports, tons



*Source: UNCOMTRADE, *HS 1206: Sunflower seeds, broken or unbroken.*



*Source: UNCOMTRADE, ** 1512: Sunflower seed, safflower, or cotton seed oil.*

In 2008, farmers significantly increased the area under sunflower seed in response to high oilseed prices. Official statistics report an increase from 365,000 hectares in 2007 to 570,000 hectares in 2008.

Vostochno-Kazakhstan (East Kazakhstan) and Pavlodar oblast are the major sunflower seed producing regions in the country.

Table 1. Sunflower seed area planted in 2008, '000 hectares

	All types of farm	Including:		
		Agricultural companies	Private/individual farmers	Households
Republic of Kazakhstan	**570**	**183**	**383**	**5**
Oblasts				
Akmola	18	16	2	
Aktobe	**25**	**11**	**14**	
Almaty	45	4	40	1
Atyrau	0		0	
Eastern Kazakhstan	259	75	183	1
Zhambyl	5	0	4	1
Western-Kazakhstan	26	8	17	
Karaganda	0		0	0
Kostanai	5	4	1	0
Kyzylorda	0		0	0
Pavlodar	168	52	116	0
Nothern Kazakhstan	14	13	1	
Southern Kazakhstan	7	2	4	1
2007 total, for comparison	**365**	**107**	**250**	**8**

Source: Statistics Agency of Kazakhstan

In 2005, EBRD provided a loan totalling EUR 18, 495 million to the Savola Group, to develop its vegetable oil production business in theAktobe oblast of Kazakhstan.At that time, only 5,000 hectares were under sunflower seed in the Aktobe region. As Savola increased its oilseed processing capacity, it experienced difficulties procuring sufficient quantities of sunflower seeds and began implementing various programmes with farmers, including cooperative efforts with seed and machinery suppliers to encourage farmers to grow sunflower instead of the dominant cereal crops.

In July 2007, FAO and the EBRD agreed to provide farmers in North-Western Kazakhstan with technical assistance in increasing the production and processing of sunflower seeds in the region. The objectives of the EBRD/FAO technical assistance project, implemented from July 2007 to December 2008 were:

- to train farmers in the Aktobe and Uralsk regions on best practices for growing sunflower and generating high production yields at harvest, and educate them on sunflower seed physiology, nutrient requirements, and the latest technologies and equipment for growing and harvesting sunflower seed;
- to organise variety tests and diagnostics of productivity on experimental fields and disseminate the results of these trials among farmers in Aktobe and Uralsk regions;

- to provide farmers with visual evidence of how different sunflower seed hybrids and varieties perform under different soil and climate conditions and TO educate them on the sources of different hybrids of seed.

A short video on the EBRD/FAO Sunflower Support Technical Cooperation (TC) project is posted on the www.eastagri.org portal.

Under this project, in 2008, FAO utilised experts from Prolea and CETIOM and arranged the supply and delivery of sunflower seed hybrids from well-known suppliers in France and Ukraine. Two seminars (one indoors and the other one in the experimental fields) were organised in Uralsk and Aktobe regions. Although the average sunflower yield in the Aktobe region is a rather low 0.5–0.6 tonnes/hectare, some hybrids tested in the demonstration trials in 2008 showed far better yield potentials of 1.0–1.4 tonnes/hectare. It is expected that farmers who have benefited from training will increase the area under sunflower seed and improve their production efficiency.

Sunflower seed currently accounts for about 60% of the total area planted with oilseeds in Kazakhstan. As sunflower seed has become a profitable alternative crop to cereals, the sunflower seed area expanded out of the major producing areas, including into the Aktobe and Uralsk regions, largely owing to the presence of local processors. The area under sunflower seed in Aktobe region has increased from 5,000 to nearly 24,000 hectares over the last four years and farmers in the regions neighbouring Aktobe are now interested in sunflower seed production. This interest has been supported by the Savola Group, which offers competitive prices for locally produced sunflower seed.

1. FARMER TRAINING

1.1 Indoor training

An indoor training session for farmers was conducted on 29 February–1 March 2008 in Uralsk[1] by Mr André Merrien and Mr Jean Pierre Palleau of Agropol-CETIOM. The training lasted a day and a half over a two-day period and was organised with the support of the local Department of Agriculture and the Savola Group. It covered the following major topics:

- the sunflower seed crop: the growth cycle, key periods and growth stages; yield components; soil preparation, focusing on minimum vs. conventional tillage; chemical and mechanical weed control; variety selection; planting; nitrogen, phosphate, boron, magnesium, and molybdenum fertilisation; growth regulators; and irrigation – (one presentation of 54 slides in total;)
- aspects of sunflower crop physiology: days required to reach different levels of maturity; identification of growth stages; flowering; seed filling; dry matter accumulation; leaf area establishment; dessication; efficient water use and adaptation to water shortage; photosynthesis; yield improvement; and irrigation strategy – (three presentations of 76 slides in total;)
- sunflower seed diseases

To improve efficiency for trainees, trainers, and translators, the presentations were projected simultaneously in Russian and English and participants received handouts prior to the training.

About 25 farmers and local government officials attended the training session. The participants represented very different profiles and technical levels, ranging from farmers to professional agronomists. Every effort was made to adapt the talks and presentations to a mixed audience, which proved challenging, given the very different profiles of the participants.

The participants showed great interest in all the topics covered. Debates focused on water, nitrogen (N) fertilisation and phytosanitary issues, mildew, sclerotinia, and the situation with *Orobanche* infestation.

The following were some of the main questions identified during the meeting:

− Is nitrogen a limiting factor for sunflower in Kazakhstan, given the uptake of 4.5 kg of N per 100 kg of seed produced?

Answer: Water is so scarce that N requirements are low; application of only phosphorus oxide (P_2O_5) may be sufficient. (Note: A quick balance shows that, depending on N availability in the soil, the maximum yield obtainable is 1–1.5 tons/hectare).

− Why do farmers apply the Agrostimulis* (a cocktail of fertilisers including macro- and micronutrients) at the four to six leaves stage?

Answer: We do not believe that this practice is very useful.

1.- The original training schedule included a session for farmers in Aktobe, but this could not be conducted owing to a severe and extended snow storm on 26 February–1 March in the Aktobe region.

*.- *a locally available plant growth regulator*

− What is the optimum plant density? Could slightly increased plant density lead to earlier and more homogenous maturity? What is the effect of plant heterogeneity on the line? Is sunflower able to compensate?

Answer: Trials have established an optimum plant density of 5.5–6 plants per square metre: farmers need to be advised more clearly about this. (Note: We do not agree that reducing the density is a good strategy under water shortage; when density is too low, the root system does not exploit the soil in the inter-row and plants remain green at maturity, delaying harvest. It also produces bigger heads with a greater sterile spot in the centre and delays maturity).

− How can the risk of *Orobanche cumana* in sunflower be managed in Kazakhstan?

Answer: There are only two ways of reducing this risk: i) through genetic resistance, although the durability of this is low given the multiple types of races; and ii) through the use of sunflowers that are resistant to herbicides (IMI or sulfonylureas). Contact should be made with BASF, Pioneer, and Dupont, which have representatives in Kazakhstan.

− Questions were asked about the structure of the settlement.

Answer: The structure of the settlement could be improved by reducing the distance between rows (from 70 to 55–60 cm), increasing plant density (by 15%), and reducing the speed of the drill (from 8–10 to 5–6 km/hour). This would lead to more regular plant distribution in a row. No more than five plants should be settled per linear metre.

− Questions were asked about the duration of the cycle and climatic considerations.

Answer: The maximum length of the growing cycle is 100–110 days in the concerned areas of Kazakhstan, which require very early varieties. Regarding water availability (soil reserves and rains), from crop management descriptions, it seems that more than 200 mm is available for the crop, mainly from soil reserves (100–150 mm). Sunflower is grown during a period of very low rainfall (18–42 mm according to available data); more precise data are needed about the exact distribution of rains during the cycle and in particular how they are positioned with regard to the flowering stage.

Other issues discussed included: What kind of driller is used in France? What are the gross margins for sunflower (and others crops) in France compared with Kazakhstan? What is the level of auto-fertility for hybrids in France? What role do bees have in sunflower fecundation?

1.2 Field day

The field day training was delivered in two parts in Stepnoye, Aktobe oblast, on 25 September 2008:

● a condensed version of the indoor training, focusing on fundamentals, particularly for trainees who had not been able to attend the indoor training in March;

● an outdoor training session at the demonstration plots, focusing on soil preparation, nutrition and fertilisation, plant density, weed control, plant protection, water requirements, yield, harvesting aspects, and variety behaviour, based on evaluation of the demonstration trials.

About 40 participants attended this training, most of whom were farmers, with a few farm agronomists from Aktobe Experimental Station.
The indoor session lasted for about two hours and had the following main speakers:
- Mr Vladimir Livochenko, Aktobe oblast Department of Agriculture;

- Mr Amangos Tuleulov, Director of Stepnoye Farm and Aktobe Experimental Station;
- Mr Sagingaly Zhuvanishev, Turkuaz/Savola;
- Mr Alexander Nikishkov, FAO Consultant, Aktobe Experimental Station;
- Mr Franck Duroueix and Mr Pierre Jouffret, CETIOM, France;
- Mr Yermagambetov Agybay, Syngenta Seeds;
- Mr Nurken Assanov, official distributor for Dupont and Pioneer.

The representatives of the Ministry of Agriculture and Turkuaz covered sunflower seed production trends and Mr Nikishkov presented 2007–2008 meteorological data and information on sunflower phenological development (Annex 1). The representatives of seed companies presented summary information on their varieties.


The Agropol-CETIOM presentation

The Agropol-CETIOM presentation focused participants' attention on planting, fertilisation, weed control, and harvesting:

● Mr Jouffret emphasised the importance of sowing early and using very early varieties (100-day varieties, when possible). These two conditions are necessary for making the best use of the water stored in the soil during autumn and winter and for ensuring that harvesting is carried out under good conditions. Mr Jouffret said that the trials carried out this year in Kazak conditions were very important in helping to identify the varieties that were best adapted to local conditions in terms of earliness and productivity. He also stressed the need to ensure an even distribution of plants in rows to avoid yield losses; trials have shown that a 20% shortage of plants leads to a 10% decrease in yield.

● The need to apply mineral fertilisers was noted. Fields should be fertilised to improve wheat and sunflowers yields in the near future. Applications of nitrogen and phosphorus are required to avoid deficiencies. The micronutrient boron is also very useful for sunflowers, particularly under warm and dry conditions.

● Mr Duroueix noted that weed control is very important, especially under the dry weather conditions of Kazakhstan, where sunflowers and weeds compete for water and mineral nutrients. French trials have demonstrated that yield losses are higher under dry conditions (e.g. sandy soils) than when there is no water stress (e.g. deep clay soils). He also announced that a new and efficient technology for weed control – herbicide-tolerant varieties – will likely soon be available from major seed supppliers.

● **Harvesting**: Combine harvesters must be properly adjusted to avoid losses. Mr Duroueix had observed several non-harvested fields where the sunflowers had overmatured. The consequences of late harvesting are losses to wind and birds. He described the best time for harvesting as being when the sunflower head is a yellow to brown colour, a few leaves are still green, and the stalk colour is beige.

Mr Vladimir Livochenko (Department of Agriculture)
Mr Amangos Tuleuov (Stenoye)
Mr Sagingaly Zhuvanishev (Turkuaz)
Mr Franck Duroueix and Mr Pierre Jouffret (CETIOM)

Mr Alexander Nikishkov comments on the demonstration field after the seminar

The field training that followed the indoor seminar and was carried out in the demonstration field by Mr Alexander Nikishkov was especially beneficial in demonstrating the benefits of using early and very early hybrids with concrete examples.

All the presentation materials and the list of participants are provided in English and Russian in Annex 4 to this report.

2. DEMONSTRATION TRIALS

2.1 Demonstration test methodology and selection of sunflower seed hybrids/varieties

Demonstration trials of 32 approved and new hybrids were conducted in May–October 2008 to provide farmers with visual evidence of performance under Kazak conditions. Of the 29 hybrids approved by the Kazakhstan State Register of Plant Varieties, the following seven were tested in demonstration trials: Zarya variety (approved in 1969), Sibisrkiy 91 hybrid (1995), Printasol hybrid (2007), Arena hybrid (2008), NK Rocky, Sanluca, PR 63 and A90 hybrids (conditional approval in 2008, final approval expected in 2009). The following hybrids were obtained by FAO, CETIOM, and Savola from seed companies and used for testing and demonstration trials under the project (**Table 2**): A-90, A-91, Ant, Arena, Dariy, ES Isabella, Etyud, Frankasol, Harkovskiy-49, Kiy, Kovcheg, Kronos, Leila, Mas 94c, Mas 97A, Milonga, NK Rocky, Oskil, Pacific, Poglyad, PomarRM, Printasol, RA 1001735, RA 1001753, RA 1004049, Sanay, Sanluca, Sibirskiy 91, Siver, Svitoch, Yason.

The trials were carried out at Stepnoye LLC in Kargalinskiy district and Kyzyl Zhar PK in Martukskiy district, Aktobe region by the Savola Group representatives and Mr Alexander Nikishkov, researcher from the Aktobe Agricultural Research and Experiment Station.

The trials were conducted using standard farm equipment. No fertilisers or plant protection chemicals were applied, in accordance with prevailing farm practices in the region. The protocols for these trials were discussed by FAO and CETIOM experts after their missions to Kazakhstan in September 2007 and February 2008 and were closely monitored and followed by Mr Nikishkin and the Savola Group.

Kyzyk Zhar demonstration plot

CETIOM experts visiting the demonstration plot at Stepnoye LLC

Table 2 lists the sunflower hybrids tested at each location, the number of rows and the time of planting. All the varieties/hybrids were tested at both demonstration sites, apart from Sibirsky 91, which was planted at Kyzyl Zhar only, and NK Rocky and Zorya, which were planted at Stepnoy only, owing to limited seed availability and/or technical issues at the time of planting. All hybrids were planted in 4, 12, or 24 rows in one replication at each location.

Table 2. Demonstration plots at Stepnoye and Kyzyl Zhar

Commercial name of hybrid	Company/country of origin	Registered in Kazakhstan (year)	Stepnoye, number of rows	Kyzyl Zhar, number of rows
A-90	Pioneer	2008 provisional; 2009 final (pending)	24	12
A-91	Pioneer		24	12
Ant	Ukraine/Yuriev Institute UAAN, Kharkov		24	12
Arena	Syngenta	2008	12	4
Dariy	Ukraine/Yuriev Institute UAAN, Kharkov		24	12
ES Isabella	Euralis/France		24	12
Etyud	Ukraine/Yuriev Institute UAAN, Kharkov		12	12
Frankasol	Monsanto		24	12
Harkovskiy-49 (Har.-49)	Ukraine/Yuriev Institute UAAN, Kharkov		24	12
Kiy	Ukraine/Yuriev Institute UAAN, Kharkov		24	12
Kovcheg	Ukraine/Yuriev Institute UAAN, Kharkov		24	12
Kronos	Ukraine		24	12
Leila	Euralis/France		24	12
Mas 94c	Maisadour/France		12	12
Mas 97A	Maisadour/France		24	12
Milonga	Maisadour/France		24	12

NK Rocky	Syngenta	2008 provisional; 2009 final (pending)	12	X
Oskil	Ukraine/Yuriev Institute UAAN, Kharkov		24	12
Pacific	Euralis/France		12	12
Poglyad	Ukraine/Yuriev Institute UAAN, Kharkov		24	12
PomarRM	Euralis/France		12	12
Printasol	Monsanto	2007	24	12
RA 1001735	Ragt/France		12	4
RA 1001753	Ragt/France		12	4
RA 1004049	Ragt/France		12	4
Sanay	Syngenta		12	4
Sanluca	Syngenta	2008 provisional; 2009 final (pending)	12	4
Sibirskiy 91	Russia/VNIIMK	1995	X	12
Siver	Ukraine/Yuriev Institute UAAN, Kharkov		24	12
Svitoch	Ukraine/Yuriev Institute UAAN, Kharkov		24	12
Yason	Ukraine/Yuriev Institute UAAN, Kharkov		24	12
Zarya (variety)	Russia	1969	24	X

Sunflower hybrids were planted at Stepnoye LLC on 7 May 2008, according to the following scheme:

Area of plot: 24 rows, 16.8 m x 125 m = 2,100 m^2
12 rows, 8.4 m x 125 m = 1,050 m^2

Planting at Kyzyl Zhar PK was done in May 26 in accordance with the following scheme:

Area of plot (depending on seeding rate): 12 rows, 8.4 m x 250 m = 2,100 m^2
4 rows, 2.8 m x 250 m = 700 m^2

A short description of some of the sunflower seed hybrids tested in 2008 is provided in the Annexes (in Russian only).

2.1.1 Information recording protocol

The following data recording protocol was established for demonstration trial tests and observations:

- determination of the soil humidity before seeding, at the flowering stage, and before sunflower harvesting in different soils layers (at 10 cm–1 m depth);
- phenological observations of plant growth and development;
- calculation of plant density based on seeding rates and plant density before harvesting;
- record of meteorological data in each phase of sunflower growth;
- determination of sunflower biometric values;
- determination of the humidity of sunflower seeds at full ripeness;
- record of sunflower seed yield from each demonstration plot;
- determination of oil content in the seeds (at the Savola laboratory).

Fairly good distribution of plants in rows

Visiting the farmers

2.1.2 Soil type

Soils at the Stepnoye LLC test plot are dark-chestnut, solonetzic, and medium loamy. Humus content is about 2.8%, with low phosphorous and potassium content.

Soils at Kyzyl Zhar PK are southern chernozem (black soil). These are medium loamy with humus content of 3.6%, medium phosphorous and high potassium contents.

2.1.3 Agro-meteorological conditions in the 2008 spring crop season

The Aktobe region (oblast) is situated in North-Western Kazakhstan. Its climate is characterised by great temperature contrasts: cold winters and hot summers with low precipitation levels. The sum of the effective temperatures over 10 °C is 2,600–2,800 °C. About 127–160 mm of precipitation falls during this period and average annual precipitation is 135–320 mm. The frost-free period is 127–140 days per year. Relative air humidity during daylight hours in the summer drops to 30–35%, and there are 13–15 days of intensive hot winds over the warm period, with southern and south-eastern winds dominating.

Information on the major meteorological indicators for 2008 is provided in the Annexes and is based on the data from the Martukskiy and Badamshinskiy meteorological centres of the Aktobe Regional Meteorological Station.

In 2008, precipitation was not distributed evenly through the growing season. Substantial precipitation deficit was observed in autumn, with only 44.4 mm compared with a normal level of 77 mm. The average daily air temperature in autumn was 5 °C and was lower than normal in the winter. At 69.5 mm, however, winter precipitation levels were within the norm, based on long-term data for the winter months.

The main meteorological factor in 2008 was that 42–44% of total precipitation fell in spring, totalling 136.5–155.2 mm, compared with a normal rate of 82 mm. The average daily air temperature in spring was 5.5.°C higher than that established from long-term data. The warmest months were March and April.

At Stepnoye LLC, the summer month with the most favourable hydrothermal conditions was June. Average daily temperatures were similar to the long-term norm and, at 40.4 mm, precipitation exceeded the normal rate. July's precipitation was similar to the long-term norm and August was arid and hot. Precipitation over the vegetative period was 324.6 mm, 27.6 mm more than the long-term average. The average daily temperature exceeded the long-term average by 1.8 °C.

Information on meteorological conditions at Stepnoye and Kyzyl Zhar is provided in the Annexes.

At Kyzyl Zhar PK, the monthly distribution of precipitation was similar to that observed at Stepnoye LLC, but the general precipitation level was higher. Cumulative precipitation over the year was 352.9 mm, 55.9 mm higher than the long-term average. In general, the hydrothermal conditions for the 2007–2008 agricultural year can be considered average for sunflower plant development.

Plots with weeds

Fairly good distribution of plants in rows

Romanian-made precision pneumatic drill (Mecanica Cealhau)

2.2 Soil preparation and seeding

The pilot tests on sunflower hybrids at Stepnoye LLC and Kyzyl Zhar PK were performed on fallow fields. Spring harrowing was carried out on 23–28 April 2008 to break the upper soil layer and prevent moisture evaporation. Tooth harrowing to a depth of 6–8 cm was performed before seeding with the SPCh-6 seeder. The speed of the seeder was 5 km/hour. The seeding rate was 64,900 seeds per hectare or 4.5 seeds per linear metre. Rows were spaced 70 cm apart.

At Stepnoye LLC, harrowing and two inter-row cultivations were conducted after the sunflower emerged, using a KRN-4.2 harrow. Pre-emergence harrowing and one inter-row cultivation were performed at Kyzyl Zhar PK. Mineral fertilisers and herbicides were not applied, in line with prevailing farming practices in the region. Yields were assessed/measured on 8 October at Kyzyl Zhar PK and on 29 October at Stepnoye LLC, using the direct combining method (SK-5 combine) and the sunflower harvesting equipment (header) produced by MTS Traktor JSC.

3. ANALYSIS OF THE TRIAL RESULTS

3.1 Earliness

Due to the late planting date at Kyzyl Zhar PK (May 26), this site was particularly interesting for testing the earliness of sunflower seed hybrids. When the trial field was visited on 23 September, late maturity and significant variation among different hybrids planted at the same time were observed. This made it possible to identify hybrids with the potential for planting without significant risk in Aktobe region.

As the trial field in Stepnoye was sown in early May, all the hybrids were mature by 23 September. Early and very early hybrids/varieties are well adapted to the Aktobe region; the following hybrids should be considered:

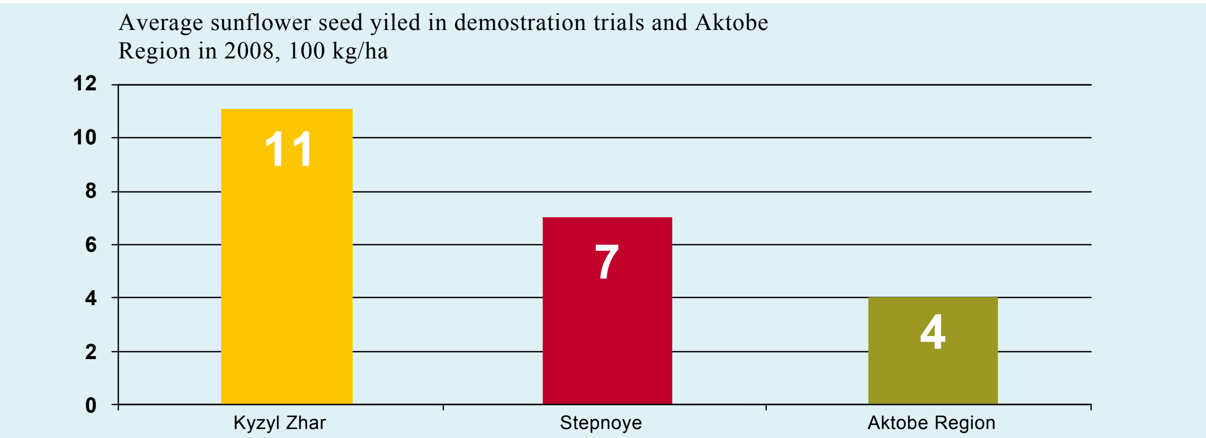
Early varieties: Sanluca, PomarRM, A90, Es Isabella, and Milonga.
Very early varieties: A91, Printasol, Kharkiv-49, Kiy, and others.

Other varieties (middle–early) should be considered only for planting in late April–early May or if they have specific characteristics such as herbicide or disease tolerance. According to the information available, the first herbicide-tolerant hybrids to become commercially available to farmers in Kazakhstan will be Express (Pioneer/Dupont) and Eurolightning/Intervix (BASF), which are middle–early varieties (as is the Sanay hybrid tested in 2008).

3.2 Yields

Although the average sunflower yield in the Aktobe region is 0.5–0.6 tonnes/hectare, some hybrids tested in the demonstration trials in 2008 showed yield potentials of 1.0–1.4 tonnes/hectare. The average yield in Kyzyl Zhar was 1.1 tonnes/hectare, compared with 0.7 tonnes/hectare at Stepnoye. This is owing to the higher soil moisture and weight of 1,000 seeds at Kyzyl Zhar.

Figure 3. Average yields at Stepnoye and Kyzyl Zhar in 2008, '00 kg/ha



** Average yield = simple average.*
Median yield = mid-point of a set of yields; half the yields at the location had values that are greater than the median, and half had values that are less.

Table 3. Summary of yield results at Stepnoye and Kyzyl Zhar in 2008

Location	Indicator	Results, ('00 kg /ha)	Description/explanation
Kyzyl Zhar	**Average yield, 100 kg/ha**	**11.10**	**Simple average**
Kyzyl Zhar	Median yield, 100 kg/ha	**10.25**	Half the yields were greater than this, and half were less
Kyzyl Zhar	Mode yield, 100 kg/ha	**10.10**	The most frequently occurring yield in the range of yields
Kyzyl Zhar	Standard deviation of yield, tonnes/ha	**1.87**	The dispersal of the yield values from the average value (the mean)
Stepnoye	**Average yield, 100 kg/ha**	**7.01**	**Simple average**
Stepnoye	Median yield, 100 kg/ha	**6.60**	Half the yields were greater than this, and half were less
Stepnoye	Mode yield, 100 kg/ha	**6.50**	The most frequently occurring yield in the range of yields
Stepnoye	Standard deviation of yield, tonnes/ha	**1.00**	The dispersal of the yield values from the average value (the mean)

The following varieties performed well at both locations: PomarRM, Milonga, Sanay, Es Isabella, Leila, Sanluca, A90, Arena, Kiev, and Siver. There was no evident link in the trials between hybrid/variety earliness and yields, apart from very early varieties, which did not perform well under dry conditions. Detailed yield results for each hybrid tested are provided in Figure 4 and Annex 2.

From the varieties that are currently commercially available, A90, Sanluca, and Arena showed the best performance. The very early varieties (100-days) did not appear to perform well under dry weather conditions. It will be necessary to continue identifying very-early and early hybrids in the future. 100-day varieties can be sown in the last decade of May and still ripen before harvesting time. The use of early hybrids is justified by the need to harvest the crop before the first freezing temperatures in October (see following photos).

A very (too) late variety (frost damage on leaves)

A very early variety (overmatured)

Although A90, Sanluca, and Arena showed the best performance, farmers should follow the results of official trials in Kazakhstan and select hybrids that pass these trials and best suit their conditions for plantings, fieldwork, harvesting, and other needs. For instance, it is likely that sunflower broomrape-resistant hybrids (e.g. Leila, which was tested in the demonstration trials) will become commercially available in the near future.

The densities observed in the demonstration trials were 40,000–60,000 plants/hectare, which was sufficient to obtain an estimated yield of 1.5–2 tons/hectare in the dry climatic conditions of Kazakhstan. Great attention should be paid to the proper adjustment of seeding equipment to avoid doubles or losses of plants in a row. Under large-scale farming conditions in Kazakhstan, sowing equipment seems to be a limiting factor. Even the most modern six-row sowing units are not well suited to planting sunflower on fields of 400 hectares and more.

Two low-cost ways of completing sunflower seed sowing as quickly as possible should be considered after local trials:

- increasing the number of row units (to 8–10) on existing drills, with a corresponding switch to more powerful tractors to enable sowing at greater speed (7–10 km/hour). Row spacing of 60–70 cm would allow harrowing between the rows;

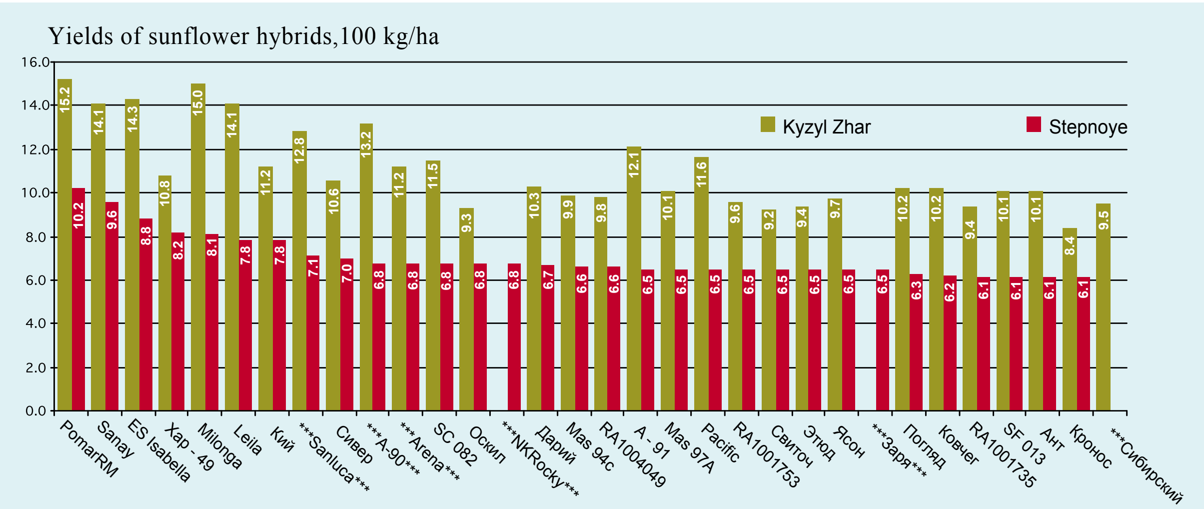
- testing wheat drills for sunflower sowing, as few drills are already adapted to this purpose; however, to avoid uneven seed distribution in rows, row spacing would have to be reduced to 30–40 cm, which would make harrowing between rows impossible and chemical weed control methods essential.

The yield results of the tested varieties are largely explained by their potential resistance to harsh weather conditions (heat stress and moisture deficit) rather than their yield potential. PomarRM is a good illustration of this. In the demonstration trials, this relatively old variety from Western Europe surpassed the new hybrids in terms of yields, while other old varieties (registered between 1980 and 1990) such as SF 013 (Frankasol) and SC 082 (Printasol) did not produce high yields. It is believed that PomarRM performed well at both locations because of its tolerance to harsh weather, which can be explained by the depth and strength of its root system.

A good rooting system at the field trials

Figure 4 provides information on sunflower seed yields at both testing locations.

Figure 4. Yields of the hybrids from each location



The results of the trials in 2008 suggest that the new hybrids performed better than existing approved hybrids at both locations. For example, the median yields of new varieties were 36%–51% higher at Kyzyl Zhar and 22%–56% higher at Stepnoe. The lowest-yielding of the top five new hybrids, Leila, performed better (14.1 tonnes/hectare) than the best performing existing variety, A-90 (13.2 tonnes/hectare).

The full list of hybrids used and yields produced at both locations is presented in Annex 2. The results of the trials and recommendations were summarised and disseminated to the farmers through the leaflet presented in Annex 3 (in Russian only).

3.3 Phenological observations

Sunflower varieties and hybrids were divided into four groups: very early-maturing, in 100–104 days; early-maturing, in 111–114 days; middle–early-maturing, in 116–118 days; and middle–late, in 120–126 days. Harkovskiy 49 hybrid was included in the early-maturing group.

The early-maturing group contains the following hybrids: Kiy, A-91, Sanluca, Yason, Kronos, Oskil, Siver, Etyud, Sanay, Svitoch, Printasol, and RA 1001735. The middle–early group includes Ant, Kovcheg, Poglyad, Dariy, Sibirskiy 91, Arena, A-90, Milonga, Pacific, PomarRM, Leila, ES Isabella, and NK Rocky. The middle–late group contains Mas 97A, Mas 94 C, RA 1004049, RA 1001753, Frankasol, and Zarya.

The sunflower sprouted 14 days after planting on 7 May, with average daily temperature of 14.2 °C. The seeds sown on May 25 emerged after 12 days, with average daily temperature of 17.2 °C. The amount of precipitation in the period between seeding and emergence was 21.4–48.5 mm.

Favourable weather conditions for sunflower growth and development were observed between the emergence and flowering stages. Average daily temperatures were 19.2–23.9 °C; precipitation at Stepnoye LLC was 71.3 mm and at Kyzyl Zhar PK 75.2 mm. Information on the weather conditions at the main development stages in each location is provided in the Annexes.

The critical period for sunflower in terms of moisture availability is during the flowering and seed filling stages. The period from flowering to complete ripeness of Harkovskiy 49 hybrid was 50–51 days. For the early-maturing group it was 48–51 days, the middle–early group, 49–50 days, and the middle–late group, 53–57 days. Precipitation over this period, depending on its duration, was 15.8–25.8 mm at Stepnoye LLC and 23.6–41.6mm at Kyzyl Zhar PK. In general, the sunflower's vegetative period was characterised by relatively high average daily temperatures and insufficient precipitation. The sums of the effective temperatures over 10 °C during sunflower growth and development were as follows: for very early-maturing hybrids, 2,276–2,325 °C; for early-maturing hybrids, 2,380–2,498 °C; for middle–early hybrids, 2,404–2,538 °C; and for middle–late hybrids, 2,452–2,680 °C. At Kyzyl Zhar, seeds of the middle–late hybrids Mas 97A, Mas 94 C, RA 1004049, and RA 1001753 PK were frost-damaged (-3– -6 °C) before harvesting.

Phenological observations of its development indicate that sunflower can tolerate the impact of the air drought in Northern Kazakhstan, making it one of the most promising crops for the Aktobe region.

Detailed information on sunflower seed development stages for the different maturing rates of hybrids, and the corresponding weather information for both testing locations in provided in Annex 1.

3.4 Dynamics of productive humidity and water consumption

Sunflower is a more drought-resistant crop than cereals. It can use soil moisture that is not accessible to other crops because of its well-developed root system, which reaches depths of 150–250cm. The productive soil moisture content in the 1 m soil layer at Stepnoye LLC was 114 mm, compared with 126 mm in the southern chernozem of Kyzyl Zhar PK.

The researchers estimated total water consumption to be 228.4–249.6 mm at Stepnoye LLC and 246.9–264.2 mm at Kyzyl Zhar PK. The lack of precipitation in August resulted in maximum use of available soil moisture at the seed ripening/maturity phase.

The most effective use of soil humidity and precipitation over the vegetative period was observed in the crops of early-maturing and middle–early hybrids. Water consumption to produce 100 kg of seeds from the sunflower crops at Kyzyl Zhar PK was far lower than that at Stepnoye LLC (see the yield and water use tables in Annex 1). A high water consumption ratio indicates that the temperature regime during the vegetative period promoted greater evaporation, moisture loss, and low nutrient supply from the dark-chestnut soil. The most efficient water consumption to produce 100 kg of seeds was observed for the hybrids PomarRM, Milonga, Leila, ES Isabella, Sanay, Sanluca, and A 90. The water consumption of these hybrids at Kyzyl Zhar PK was 17.3–20.0 mm/100 kg of seeds.

3.5 Biological characteristics and productivity

The biological characteristics of sunflower hybrids from different environmental and geographical origins were more diverse in the soil and climatic conditions of Stepnoye LLC. The greatest productivity was associated with PomarRM (1,021 kg of seeds per hectare) and the Syngenta Company's Sanay hybrid (960 kg per hectare). Yields from these hybrids exceeded those from Zarya (the reference variety used for official trials in Kazakhstan) by 370 and 310 kg per hectare, respectively. Plants of PomarRM hybrid were 108 cm in height, head diameter was 13.2 cm, the mass of seeds from each head was 37.5 g, at 1,036 seeds per head, and 1,000 seeds had a mass of 36.2 g. The corresponding figures for plants of Sanay hybrid were 124 cm, 14.8 cm, 36.5 g, 892, and 40.9 g. Harkovskiy 49, Kiy, Milonga, and Leila also exceeded the performance of Zorya.[2]

The productivity of all hybrids was higher in the southern chernozem of Kyzyl Zhar PK than at Stepnoye LLC, and their potential was more clearly demonstrated in Kyzyl Zhar PK. The yields of PomarRM hybrids and Milonga were 1,520 and 1,500 kg per hectare, respectively, which were higher than those of Sibirskiy 91 (the reference hybrid in this demonstration trial) by 570 and 550 kg per hectare. Plants of PomarRM hybrid were 136 cm in height, head diameter was 13.7 cm, the mass of seeds from each head was 39.2 g, at 1,059 seeds per head, and 1,000 seeds had a mass of 37.0 g. Corresponding figures for plants of Milonga hybrid were 120 cm, 15.6 cm, 41.6 g, 1,134 and 36.7 g. ES Isabella, Leila, Euralis, and Sanay hybrids exceeded the standard varieties. Hybrids A90 and Sanluca also showed fairly good productivity at 1,320 and 1,280 kg per hectare. According to the seed companies, these hybrids will be listed in the State Register of Plant Varieties to be used in Kazakhstan from 2009. The reference hybrid yield was exceeded by between 200 and 260 kg per hectare by hybrids A91, Printasol (registered in 2007), and Pacific.

Annex 2 provides more information about hybrids' characteristics and yields at both testing locations.

3.6 Oil content and productivity

As processors of sunflower seed face shortages of the raw material for processing, they do not yet apply premiums or discounts for the seeds' oil content mostly to avoid discouraging farmers from producing sunflower seeds. It is likely that processors will differentiate prices based on oil content as local production increases.

High oil content was observed in seeds from the hybrids of Maisadour (50.5–52.3% oil content), Euralis (50.3–52.5%) and Ragt (49.8–52.5%) measured as a percentage of absolute dry matter. The best combinations of oil content and yield were provided by hybrids PomarRM, Milonga, ES Isabella, and Euralis (as indicated in the Table "Oil yield in Stepnoye and Kyzyl Zhar"Annex 2). Overall, weather conditions in 2008 favoured the production of seeds with a high oil content.

2.- See Table 2 for the sources of these hybrids and Annex 2 for more detailed charachteristics.

4. RECOMMENDED MEASURES FOR IMPROVING YIELDS

To obtain stable yields, it is necessary to adopt agricultural methods that comply with the biological requirements of sunflower and the local soil and climatic conditions and to introduce new varieties and hybrids adapted to conditions in Aktobe region. Hybrid demonstration tests by seed companies from France, Switzerland, the United States, Ukraine, and Russia were useful in promoting visual demonstration of potential results.

The following issues are very important in improving sunflower yields under the conditions of North-Western Kazakhstan.

4.1 Varieties

It is necessary to continue identifying very early and early hybrids. Variety trials must be carried out every year under regional conditions. 100-day varieties allow harvesting at the right time, even when planting occurs in the last decade of May.

It is also recommended that new herbicide-tolerant varieties be tested. This new technology seems very efficient according to recent experiences in other countries.

4.2 Planting

The densities observed in the demonstration trials were between 40,000 and 60,000 plants per hectare. This was probably sufficient to obtain 1.5 to 2 tonnes per hectare in the dry climatic conditions of Kazakhstan. Concerning plant distribution in the rows, farmers must be careful when adjusting their drills to avoid doubles or losses of plants.

For large-scale farming, the sowing equipment available to farmers in the region seems to be a limiting factor. New drills (most of which are made in Romania) with only six row units do not seem suitable for sunflower fields of 400 hectares and more.

To complete sunflower seed planting as quickly as possible, the following two possible solutions should be considered, after further local trials:

- Increasing the number of row units (to 8–10) per drill and switching to more powerful machinery to sow at faster speeds (7–10 km/hour): in these conditions, fields can be sown with row spacing of 60–70 cm, which would allow harrowing between the rows.

- Testing the use of certain wheat drills for sowing sunflowers: only a few wheat drills would be appropriate, but they are worth testing. However, to avoid uneven seed distribution in the rows, it would be necessary to decrease the row spacing to 30–40 cm, which would make harrowing between rows impossible and chemical weed control essential.

4.3 Weed control

Sunflower is very sensitive to competition with weeds, especially under dry conditions. Herbicides are rarely used in Kazakhstan; farmers use mainly mechanical control, but this is not always sufficiently efficient. Chemical and mechanical controls should complement each other for good weed management.

If farmers plant sunflower in fields where it has been planted previously, they will have to pay particular attention to two weeds that are very competitive and already exist in Kazakhstan:

- Sunflower broomrape: This weed can multiply very quickly. If this happens, the use of broomrape-resistant varieties (e.g. Leila) or herbicide-resistant varieties such as Eurolightning/Intervix (BASF) will be necessary.

- Wild sunflower: This weed is easy to control in wheat fields, but very difficult to control in sunflower fields. In the future, it would be useful to control this weed by using herbicide-resistant varieties such as Eurolightning/Intervix (BASF) or Express (Pioneer/Dupont).

Sunflower broomrape

Wild sunflower

4.4 Fertilisation

It will be necessary to apply light rates of nitrogen and phosphorus, especially on chestnut soils, to avoid nutrient deficit and the consequent yield losses. The climatic conditions of Kazakhstan (cold winters and dry summers) do not permit the high mineralisation of nitrogen, so sunflowers are likely to have insufficient nitrogen to produce more than 1.5 tons per hectare (70 units of N are necessary). After 20 or 30 years without phosphorus application, soils are generally deficient in this nutrient.

Field trials have proven the efficiency of applying small quantities of N-P fertiliser in the rows, with special equipment adapted to the drills.

4.5 Soil tillage

The structure of the soil is good for sunflower seed, as no compaction is observed. The rooting system of all hybrids is well developed and deep. The traditional practice of deep cultivation before winter and top cultivation in spring seems well adapted for sunflower seed production in North Eastern Kazakhstan.

4.6 Harvesting

Some fields with overmatured sunflowers were observed. Farmers will need to pay particular attention to identify plants that are at the right stage for harvesting to avoid losses to wind and birds (see following photo).

Crow damage to overmatured sunflowers

5. ECONOMIC CONSIDERATIONS OF YIELD INTENSIFICATION BASED ON THE TESTED HYBRIDS

An increase in yield of 310–370 kg per hectare from the existing average yields would generate additional income of KZT 14,700–17,600 per hectare; increases of 460–480 and 550–570 kg per hectare would generate income increases of KZT 21,800–22,800 and KZT 26,100–27,000 per hectare respectively.

Table 4: Economic efficiency of sunflower varieties and hybrids in Aktubinsk district

Variety/hybrid	Company, origin	Yield, kg/ha	Revenue, T/ha	Costs, T/ha	Net income, T/ha	Profitability (revenue/cost, %)
Sibirsky 91	Russia	950	45,125	12,876	32,249	250.4
PomarRM	Euralis	1,520	72,200	17,426	54,774	314.3
Milonga	Maisadour	1,500	71,250	17,386	53,864	309.8
ES Isabella	Euralis	1,430	67,925	17,246	50,679	293.8
Leila	Euralis	1,410	66,975	17,226	49,749	288.8
Sanay	Syngenta	1,410	66,975	17,226	49,749	288.8
A-90	Pioneer	1,320	62,700	16,746	45,954	274.4
Sanluca	Syngenta	1,280	60,800	17,026	43,774	257.1

6. CONSIDERATIONS FOR DEMONSTRATION TRIALS IN THE FUTURE

The future demonstration trials programme should have the following two objectives:

- **Objective 1: continue identifying the varieties that are best adapted to local conditions.**

It seems very useful to go on testing early and very early varieties to identify the varieties best suited to Kazakhstan conditions.

In 2009, the varieties that appeared most productive according to the 2008 trial results should be tested again and new varieties should be added, possibly including those adapted to Mediterranean conditions (e.g. varieties that are well-adapted to Andalusia). Some of these varieties are resistant to broomrape, a weed that exists in Aktobe region.

The type of trials carried out in 2008 – demonstration field trials without replication – are suitable for this purpose, but it would also be useful to control the soil homogeneity in the trials. For this, it is recommended that each variety be sown in three plots of the trial field, one on each outer border and one in the middle.

As in 2008, at least two trials must be carried out, one on chestnut soil and the other on deep black soil (chernozem).

- **Objective 2: test the effectiveness of mineral fertilisation**

Because of severe water shortage, nitrogen requirements are low, but it would be useful to test the effect of light rates of nitrogen (30 kg per hectare) on yields. The testing of phosphorus applications would also be very interesting.

These trials should be carried out at different locations, with at least one on poor soil such as the chestnut soils.

Trials of nitrogen and phosphorous fertilizers should be carried in two replications.

ANNEX 1: DETAILS ON THE 2007–2008 AGRICULTURAL YEAR AT THE TRIAL SITES

Meteorological conditions in 2007–2008 agricultural year, Stepnoye LLC

Month	Average daytime air temperatures, ˚C						Precipitation, mm					
	Decades			Monthly average	Long-term average	± to the long-term average	Decades			Monthly average	Long-term average	± to the long-term average
	I	II	III				I	II	III			
September 2007	19.8	13.6	12.0	15.1	13.4	+1.7	0.0	10.0	0.0	10.0	20.0	-10.0
October	8.0	7.4	1.7	5.6	4.4	+1.2	0.0	0.0	0.0	0.0	30.0	-30.0
November	-1.0	-5.4	-10.8	-5.7	-5.6	-0.1	18.5	10.5	5.4	34.4	27.0	+7.7
AUTUMN				**5.0**	**4.1**	**+0.9**				**44.4**	**77.0**	**-32.6**
December	-11.6	-17.3	-18.8	-16.0	-12.4	-3.6	1.2	2.1	6.7	10.0	27.0	-17.0
January 2008	-19.7	-18.6	-15.4	-17.8	-15.7	-2.1	3.7	10.6	7.4	21.7	22.0	-0.3
February	-15.7	-14.8	-4.5	-11.9	-15.2	+3.3	3.0	21.4	13.4	37.8	17.0	+20.8
WINTER						**-0.8**				**69.5**	**66.0**	**+3.5**
March	-1.6	-0.5	7.4	2.0	-8.1	+10.1	21.7	27.9	7.5	57.1	21.0	+36.1
April	11.5	8.0	10.2	9.9	4.3	+5.6	0.0	16.5	1.5	18.0	32.0	-14.0
May	10.9	14.6	20.4	15.5	14.5	+1.0	22.0	26.5	12.9	61.4	29.0	+32.4
SPRING						**+5.5**				**136.5**	**82.0**	**+54.5**
June	14.0	23.7	21.7	19.8	19.6	+0.2	8.9	0.0	31.5	40.4	33.0	+7.4
July	22.9	25.6	26.2	24.9	22.2	+2.7	18.0	7.7	0.0	25.7	24.0	+1.7
August	20.0	26.4	22.9	23.1	20.9	+2.2	6.0	0.0	2.1	8.1	24.0	-15.9
SUMMER				**22.6**	**20.9**	**+1.7**				**74.2**	**81.0**	**-6.8**
AGR. YEAR				**5.38**	**3.55**	**+1.83**				**324.6**	**297.0**	**+27.6**

Meteorological conditions in 2007–2008 agricultural year, Kyzyl Zhar PK

Months	Average daytime air temperatures, ªC						Precipitation, mm					
	Decades			Monthly average	Long-term average	± to the long-term average	Decades			Monthly average	Long-term average	± to the long-term average
	I	II	III				I	II	III			
September 2007	19.8	13.6	12.0	15.1	13.4	+1.7	0.0	10.0	0,0	10.0	20.0	-10.0
October	8.0	7.4	1.7	5.6	4.4	+1.2	0.0	0.0	0,0	0.0	30.0	-30.0
November	-1.0	-5.4	-10.8	-5.7	-5.6	-0.1	18.5	10.5	5.4	34.4	27.0	+7.7
AUTUMN				**5.0**	**4.1**	**+0.9**				**44.4**	**77.0**	**-32.6**
December	-11.6	-17.3	-18.8	-16.0	-12.4	-3.6	1.2	2.1	6.7	10.0	27.0	-17.0
January 2008	-19.7	-18.6	-15.4	-17.8	-15.7	-2.1	3.7	10.6	7.4	21.7	22.0	-0.3
February	-15.7	-14.8	-4.5	-11.9	-15.2	+3.3	3.0	21.4	13.4	37.8	17.0	+20.8
WINTER						**-0.8**				**69.5**	**66.0**	**+3.5**
March	-1.6	-0.5	7.4	2.0	-8.1	+10.1	21.7	17.7	4.9	44.3	21.0	+23.3
April	11.5	8.0	10.2	9.9	4.3	+5.6	0.0	18.5	14.5	33.0	32.0	+1.0
May	10.9	14.6	20.4	15.5	14.5	+1.0	27.0	29.5	21.4	77.9	29.0	+48.9
SPRING						**+5.5**				**155.2**	**82.0**	**+73.2**
June	14.0	23.7	21.7	19.8	19.6	+0.2	4.8	0.0	31.5	36.3	33.0	+3.3
July	22.9	25.6	26.2	24.9	22.2	+2.7	24.0	14.9	0.0	38.9	24.0	+14.9
August	20.0	26.4	22.9	23.1	20.9	+2.2	6.0	0.0	2.6	8.6	24.0	-15.4
SUMMER				**22.6**	**20.9**	**+1.7**				**83.8**	**81.0**	**-2.8**
AGR. YEAR				**5.38**	**3.55**	**+1.83**				**352.9**	**297.0**	**+55.9**

Sunflower development (phenological) phases at Stepnoye LLC, 2008

Hybrid	Development phase									
	Seeding	Emergence	1st pair of leaves	3rd pair of leaves	5th pair of leaves	Head formation	Flowering	Seed filling	Physiological maturity	Complete ripeness
1.Zarya	07.05	21.05	25.05	02.06	19.06	04.07	27.07	11.08	05.09	18.09
2.Oskil	07.05	21.05	25.05	02.06	19.06	30.06	25.07	09.08	27.08	11.09
3.Siver	07.05	21.05	25.05	02.06	19.06	30.06	25.07	09.08	27.08	11.09
4.Har.-49	07.05	21.05	25.05	02.06	19.06	30.06	14.07	29.07	21.08	02.09
5.Kiy	07.05	21.05	25.05	02.06	19.06	30.06	20.07	05.08	25.08	09.09
6.Svitoch	07.05	21.05	25.05	02.06	19.06	30.06	20.07	05.08	25.08	11.09
7.Ant	07.05	21.05	25.05	02.06	19.06	02.07	25.07	09.08	27.08	13.09
8.Kovcheg	07.05	21.05	25.05	02.06	19.06	30.06	25.07	09.08	27.08	14.09
9.Dariy	07.05	21.05	25.05	02.06	19.06	04.07	29.07	14.08	05.09	18.09
10. Yason	07.05	21.05	25.05	02.06	19.06	30.06	20.07	05.08	25.08	09.09
11.Mas 97A	07.05	21.05	25.05	02.06	19.06	04.07	29.07	14.08	05.09	18.09
12. Mas 94c	07.05	21.05	25.05	02.06	19.06	30.06	25.07	09.08	05.09	18.09
13.Milonga	07.05	21.05	25.05	02.06	19.06	30.06	29.07	14.08	29.08	14.09
14.Pacific	07.05	21.05	25.05	02.06	19.06	30.06	25.07	09.08	27.08	14.09
15.PomarRM	07.05	21.05	25.05	02.06	19.06	30.06	29.07	14.08	30.08	16.09
16.Leila	07.05	21.05	25.05	02.06	19.06	30.06	25.07	09.08	30.08	16.09
17.ES Isabella	07.05	21.05	25.05	02.06	19.06	30.06	25.07	09.08	30.08	16.09
18.RA1001753	07.05	21.05	25.05	02.06	19.06	30.06	29.07	14.08	05.09	25.09
19.RA1004049	07.05	21.05	25.05	02.06	19.06	30.06	29.07	14.08	05.09	25.09
20.RA1001735	07.05	21.05	25.05	02.06	19.06	30.06	25.07	09.08	27.08	11.09
21.SC 082	07.05	21.05	25.05	02.06	19.06	30.06	25.07	09.08	27.08	11.09
22.SF 013	07.05	21.05	25.05	02.06	19.06	30.06	29.07	14.08	05.09	18.09
23.A-90	07.05	21.05	25.05	02.06	19.06	30.06	29.07	14.08	05.09	16.09
24.A-91	07.05	21.05	25.05	02.06	19.06	30.06	18.07	02.08	24.08	05.09
25.Sanluca	07.05	21.05	25.05	02.06	19.06	30.06	20.07	05.08	25.08	09.09
26.Arena	07.05	21.05	25.05	02.06	19.06	30.06	29.07	14.08	05.09	18.09
27.Sanay	07.05	21.05	25.05	02.06	19.06	30.06	25.07	09.08	29.08	16.09
28.NK Rocky	07.05	21.05	25.05	02.06	19.06	30.06	29.07	14.08	30.08	16.09
29.Etyud	07.05	21.05	25.05	02.06	19.06	30.06	25.07	09.08	27.08	11.09
30.Poglyad	07.05	21.05	25.05	02.06	19.06	30.06	25.07	09.08	27.08	11.09
31.Kronos	07.05	21.05	25.05	02.06	19.06	30.06	20.07	05.08	25.08	09.09

Sunflower development (phenological) phases at Kyzyl Zhar PK, 2008

Hybrid	Development phase									
	Seeding	Emergence	1st pair of leaves	3rd pair of leaves	5th pairs of leaves	Head formation	Flowering	Seed filling	Physiological maturity	Complete ripeness
1.Oskil	25.05	06.06	11.06	20.06	03.07	15.07	06.08	20.08	08.09	24.09
2.Etyud	25.05	06.06	11.06	20.06	03.07	15.07	06.08	20.08	08.09	24.09
3.Siver	25.05	06.06	11.06	20.06	03.07	15.07	06.08	20.08	08.09	24.09
4.Har.-49	25.05	06.06	11.06	20.06	03.07	15.07	24.07	07.08	04.09	16.09
5.Kiy	25.05	06.06	11.06	20.06	03.07	15.07	04.08	18.08	06.09	22.09
6.Svitoch	25.05	06.06	11.06	20.06	03.07	15.07	04.08	18.08	08.09	24.09
7.Mas 97A	25.05	06.06	11.06	20.06	03.07	17.07	10.08	25.08	14.09	30.09
8. Mas 94c	25.05	06.06	11.06	20.06	03.07	15.07	06.08	20.08	14.09	30.09
9.Milonga	25.05	06.06	11.06	20.06	03.07	15.07	10.08	25.08	10.09	26.09
10.Pacific	25.05	06.06	11.06	20.06	03.07	15.07	06.08	20.08	10.09	26.09
11.PomarRM	25.05	06.06	11.06	20.06	03.07	15.07	10.08	25.08	10.09	28.09
12.Leila	25.05	06.06	11.06	20.06	03.07	15.07	06.08	20.08	10.09	28.09
13.ES Isabella	25.05	06.06	11.06	20.06	03.07	15.07	06.08	20.08	10.09	28.09
14.RA1001753	25.05	06.06	11.06	20.06	03.07	15.07	10.08	25.08	18.09	05.10
15.RA1004049	25.05	06.06	11.06	20.06	03.07	15.07	10.08	25.08	18.09	05.10
16.RA1001735	25.05	06.06	11.06	20.06	03.07	15.07	06.08	20.08	08.09	24.09
17.SC 082	25.05	06.06	11.06	20.06	03.07	15.07	06.08	20.08	08.09	24.09
18.SF 013	25.05	06.06	11.06	20.06	03.07	15.07	10.08	25.08	10.09	30.09
19.A-90	25.05	06.06	11.06	20.06	03.07	15.07	10.08	25.08	10.09	28.09
20.A-91	25.05	06.06	11.06	20.06	03.07	15.07	28.07	12.08	06.09	22.09
21.Sanluca	25.05	06.06	11.06	20.06	03.07	15.07	04.08	18.08	06.09	22.09
22.Arena	25.05	06.06	11.06	20.06	03.07	15.07	10.08	25.08	10.09	28.09
23.Sanay	25.05	06.06	11.06	20.06	03.07	15.07	06.08	20.08	08.09	24.09
24.Ant	25.05	06.06	11.06	20.06	03.07	17.07	06.08	20.08	10.09	26.09
25.Poglyad	25.05	06.06	11.06	20.06	03.07	15.07	06.08	20.08	08.09	26.09
26.Kovcheg	25.05	06.06	11.06	20.06	03.07	15.07	06.08	20.08	08.09	26.09
27.Dariy	25.05	06.06	11.06	20.06	03.07	17.07	08.08	23.08	10.09	28.09
28. Yason	25.05	06.06	11.06	20.06	03.07	15.07	06.08	20.08	08.09	22.09
29.Kronos	25.05	06.06	11.06	20.06	03.07	15.07	04.08	18.08	06.09	22.09
30.Sibirskiy 91	25.05	06.06	11.06	20.06	03.07	15.07	06.08	20.08	10.09	28.09

Weather information by sunflower development periods and hybrid earliness, 2008

Period	Very early group, 100-104 days		Early group, 111-114 days		Middle–early group, 116–118 days		Middle–late group, 120–126 days	
	Air temperature, ⁰C	Precipitation, mm	Air temperature, ⁰C	Precipitation, mm	Air temperature, ⁰C	Precipitation, mm	Air temperature, ⁰C	Precipitation, mm
Stepnoye LLC								
Seeding emergence	14.2	48.5	14.2	48.5	14.2	48.5	14.2	48.5
5th pair of leaves, emergence	19.2	21.8	19.2	21.8	19.2	21.8	19.2	21.8
5th pair of leaves, flowering	22.9	49.5	23.6	49.5	23.9	49.5	23.9	49.5
Flowering, complete ripeness	23.9	15.8	23.5	15.8	21.6	15.8	20.8	25.8
Seeding, complete ripeness		135.6		135.6		135.6		145.8
Kyzyl Zhar PK								
Seeding emergence	17.2	21.4	17.2	21.4	17.2	21.4	17.2	21.4
5th pair of leaves, emergence	21.4	36.3	21.4	36.3	21.4	36.3	21.4	36.3
5th pair of leaves, flowering	24.8	38.9	24.3	38.9	24.0	44.9	24.0	44.9
Flowering, complete ripeness	21.8	23.6	20.2	41.6	19.1	35.6	18.6	35.6
Seeding, complete ripeness		120.9		138.2		138.2		138.2

Water consumption of sunflower varieties and hybrids, and yield formation, 2008 (sorted by yield at Stepnoye)

Variety, hybrid	Company, country	Stepnoye LLC			Kyzyl Zhar PK		
		Total water consumption, mm	Yield, '00 kg/ha	Water consumption ratio, mm/100 kg	Total water consumption, mm	Yield, '00 kg/ha	Water consumption ratio, mm/100 kg
Sibirskiy 91	Russia	-	-	-	254.2	9.5	26.8
PomarRM	Euralis	239.6	10.2	23.5	264.2	15.2	17.3
Kronos	Ukraine	239.6	6.1	39.3	254.2	8.4	31.0
Frankasol	Monsanto	249.8	6.1	41.0	264.2	10.1	26.1
RA1001735	Ragt	239.6	6.1	39.3	254.2	9.4	27.0
Ant	Ukraine	239.6	6.1	39.2	254.2	10.1	25.1
Kovcheg	Ukraine	239.6	6.2	38.6	254.2	10.2	24.9
Poglyad	Ukraine	239.6	6.3	38.0	254.2	10.2	24.9
Etyud	Ukraine	239.6	6.5	36.8	254.2	9.4	27.0
A-91	Pioneer	228.4	6.5	35.1	254.2	12.1	21.0
RA1001753	Ragt	249.8	6.5	38.4	264.2	9.6	27.5
Pacific	Euralis	239.6	6.5	36.8	254.2	11.6	21.9
Mas 97A	Maisadour	249.8	6.5	38.4	264.2	10.1	26.1
Yason	Ukraine	239.6	6.5	36.8	254.2	9.7	26.2
Svitoch	Ukraine	239.6	6.5	36.8	254.2	9.2	27.6
Zarya	Russia	239.8	6.5	36.7	-	-	-
RA1004049	Ragt	249.8	6.6	37.8	264.2	9.8	26.9
Mas 94c	Maisadour	249.8	6.6	37.8	264.2	9.9	26.7
Dariy	Ukraine	249.8	6.7	37.3	264.2	10.3	25.6
NK Rocky	Syngenta	239.6	6.8	-	-	-	
Arena	Syngenta	249.8	6.8	36.7	264.2	11.2	23.6
A-90	Pioneer	239.6	6.8	35.2	264.2	13.2	20.0
Printasol	Monsanto	239.6	6.8	35.2	254.2	11.5	22.1
Oskil	Ukraine	239.6	6.8	35.2	254.2	9.3	27.3
Siver	Ukraine	239.6	7.0	34.2	254.2	10.6	23.9
Sanluca	Syngenta	239.6	7.1	33.7	254.2	12.8	19.8
Leila	Euralis	239.6	7.8	30.7	264.2	14.1	18.7
Kiy	Ukraine	239.6	7.8	30.7	254.2	11.2	22.7
Milonga	Maisadour	239.6	8.1	29.6	264.2	15.0	17.6
Har.-49	Ukraine	228.4	8.2	27.8	246.9	10.8	22.8
ES Isabella	Euralis	239.6	8.8	27.2	264.2	14.3	18.4
Sanay	Syngenta	239.6	9.6	24.9	254.2	14.1	18.0

ANNEX 2: CHARACTERISTICS OF SUNFLOWER HYBRIDS AND YIELDS, 2008

Characteristics Of Sunflower Hybrids And Yields in Kyzyl Zhar, 2008

Variety, hybrid/ Сорт, гибрид	Heitgh of the plant/ Высота растений	Diameter of the head/Диаметр корзинки	Weight of seeds from one head/ Масса семян с корзинки	Number of seeds per one head/ Количество семян в корзинке	Weight of 1000 seeds/Масса 1000 семян	Yield, 100 kg/ha	Deviation from mode yield, %
	см	см	gram/г	ш/seeds	gram/г	ц/га 100kg/ha	%
PomarRM	136	13,7	39,2	1059	37	15,2	48%
Milonga	120	15,6	41,6	1134	36,7	15,0	49%
ES Isabella	138	14,4	34,1	842	40,5	14,3	42%
Sanay	162	16	42,5	950	44,7	14,1	40%
Leila	137	14,2	32	933	34,3	14,1	40%
A-90	124	14,5	38,7	1108	34,9	13,2	31%
Sanluca	154	15,5	40,3	1052	38,3	12,8	27%
A-91	108	15,3	39,5	821	48,1	12,1	20%
Pacific	130	13,9	31,4	742	42,3	11,6	15%
SC 082	130	12	32,1	903	33,4	11,5	14%
Arena	138	14,5	34,6	1149	30,1	11,2	11%
Кий	118	13,5	31,4	709	44,3	11,2	11%
Хар-49	85	14,3	27,4	801	34,2	10,8	7%
Сивер	128	12,8	26,8	845	31,7	10,6	5%
Дарий	128	14,7	32,7	844	38,7	10,3	2%
Ковчег	125	14,5	31,2	832	37,5	10,2	1%
Погляд	132	14,8	32,6	848	38,4	10,2	1%
Aнт	136	14,7	32,9	798	41,2	10,1	0%
SF 013	138	14,7	33,4	985	33,9	10,1	0%
Mas 97A	112	13,5	31	801	38,7	10,1	0%
Mas 94c	118	12,5	28	740	37,8	9,9	-2%
RA1004049	118	14,5	32,2	894	36	9,8	-3%
Ясон	132	14	30,7	820	37,4	9,7	-4%
RA1001753	115	13,5	30	845	35,5	9,6	-5%
Сибирский 91	138	14	32	842	38	9,5	-6%
RA1001735	131	12,3	26,3	873	30,1	9,4	-7%
Этюд	118	12,8	26,5	786	33,7	9,4	-7%
Оскил	114	12,6	26,4	815	32,4	9,3	-8%
Свиточ	120	12,7	26,7	864	30,9	9,2	-9%
Кронос	108	13,2	28	723	38,7	8,4	-17%

Characteristics of sunflower hybrids and yields at Stepnoye, 2008

Variety, hybrid/ Сорт, гибрид	Heitgh of the plant/ Высота растений	Diameter of the head/Диаметр корзинки	Weight of seeds from one head/ Масса семян с корзинки	Number of seeds per one head/ Количество семян в корзинке	Weight of 1000 seeds/Масса 1000 семян	Yield, 100 kg/ha	Deviation from mode yield, %
	см	см	gram/г	ш/seeds	gram/г	ц/га 100kg/ha	%
PomarRM	108	13,2	37,5	1036	36,2	10,2	57%
Sanay	124	14,8	36,5	892	40,9	9,6	48%
ES Isabella	108	14,5	35,6	868	41	8,8	35%
Хар-49	77	14,3	36,1	811	44,5	8,2	26%
Milonga	112	14,8	33,7	1036	32,5	8,1	25%
Кий	101	14,7	38	824	46,1	7,8	20%
Leila	114	14,2	34,9	969	36	7,8	20%
Sanluca	112	14	33,2	871	38,1	7,1	9%
Сивер	111	13,8	32,4	743	43,6	7	8%
Оскил	118	13,1	31	912	34	6,8	5%
SC 082	108	13,6	31,8	873	36,4	6,8	5%
A-90	104	13,7	31	863	35,9	6,8	5%
Arena	103	13,7	31,3	920	34	6,8	5%
NK Rocky	102	14	30,9	890	34,7	6,8	5%
Дарий	107	13,4	31,9	820	38,9	6,7	3%
Mas 94c	122	13,6	32,9	810	40,6	6,6	2%
RA 1004049	106	12,8	30,6	845	36,2	6,6	2%
Заря	120	14,1	31,2	798	39,1	6,5	0%
Свиточ	108	14	31,4	887	35,4	6,5	0%
Ясон	111	13,2	30,1	831	36,2	6,5	0%
Mas 97A	118	13,8	30	869	34,5	6,5	0%
Pacific	102	13,7	30,7	816	37,6	6,5	0%
RA 1001753	104	13,5	31	826	37,5	6,5	0%
A-91	75	14,3	32,1	862	37,2	6,5	0%
Этюд	102	13,2	30,9	844	36,6	6,5	0%
Погляд	104	13,8	31,5	923	34,1	6,3	-3%
Ковчег	106	14,5	30,2	782	38,6	6,2	-5%
Ант	108	12,3	28,1	644	43,6	6,1	-6%
RA 1001735	108	12	27	752	35,9	6,1	-6%
SF 013	103	13,3	30,9	870	35,5	6,1	-6%
Кронос	101	13,8	30,2	867	34,8	6,1	-6%

Productivity and oil content of sunflower hybrids, 2008
(sorted by oil output per hectare at Stepnoye)

Variety, hybrid	Company, country	Oil content, %	Stepnoye LLC		Kyzyl Zhar PK	
			Yield, '00 kg/ha	Oil, kg/ha	Yield, '00 kg/ha	Oil, kg/ha
PomarRM	Euralis	51.7	10.2	485	15.2	723
ES Isabella	Euralis	50.3	8.8	407	14.3	662
Sanay	Syngenta	45.2	9.6	399	14.1	586
Milonga	Maisadour	52.3	8.1	390	15.0	722
Leila	Euralis	52.5	7.8	377	14.1	681
Kiy	Ukraine	50.1	7.8	360	11.2	516
Har.-49	Ukraine	46.4	8.2	350	10.8	461
Siver	Ukraine	49.2	7.0	317	10.6	480
RA1001753	Ragt	52.5	6.5	314	9.6	464
Mas 97A	Maisadour	52.0	6.5	311	10.1	483
RA1004049	Ragt	50.9	6.6	309	9.8	459
Sanluca	Syngenta	47.1	7.1	308	12.8	555
Svitoch	Ukraine	51.5	6.5	308	9.2	436
Mas 94c	Maisadour	50.5	6.6	307	9.9	460
Dariy	Ukraine	49.6	6.7	306	10.3	470
Oskil	Ukraine	48.4	6.8	303	9.3	414
Printasol	Monsanto	47.9	6.8	300	11.5	507
Pacific	Euralis	50.1	6.5	300	11.6	535
Arena	Syngenta	47.1	6.8	295	11.2	485
A-90	Pioneer	46.4	6.8	290	13.2	563
Yason	Ukraine	47.4	6.5	283	9.7	423
Poglyad	Ukraine	48.6	6.3	282	10.2	456
NK Rocky	Syngenta	44.6	6.8	279	-	-
RA1001735	Ragt	49.8	6.1	279	9.4	431
Kovcheg	Ukraine	48.0	6.2	274	10.2	450
Zarya	Russia	45.5	6.5	272	-	-
Etyud	Ukraine	45.3	6.5	271	9.4	392
Ant	Ukraine	47.9	6.1	269	10.1	445
A-91	Pioneer	44.2	6.5	264	12.1	492
Frankasol	Monsanto	45.4	6.1	255	10.1	422
Sibirskiy 91	Russia	48.9	-	-	9.5	427
Kronos	Ukraine	47.6	6.1		8.4	

ANNEX 3: SHORT DESCRIPTION OF CERTAIN SUNFLOWER HYBRIDS TESTED IN THE DEMONSTRATION TRIALS IN 2008 (in Russian only as reported by seed companies)

Краткая характеристика некоторых гибридов подсолнечника, протестированных в демонстрационных опытах в 2008 г (по данным компаний).

Институт растениеводства им. В.Я. Юрьева УААН
http://www.yuriev.com.ua

ГИБРИД ПОДСОЛНЕЧНИКА «АНТ®»

Простой межлинейный гибрид масличного направления.
Скороспелый, длительности вегетационного периода до 100 сут.
Высота растений 130-140 см.
Устойчивый к ложной мучнистой росе, волчку, стойкий к серой и белой гнили
Потенциальная урожайность 3,82 т/га.
Содержание масла в семенах 50,0-52,5 %.

ГИБРИД ПОДСОЛНЕЧНИКА «ОСКИЛ®»

Простой межлинейный гибрид масличного направления.
Простой межлинейный гибрид масличного направления.
Скороспелый, длительности вегетационного периода до 105 сут.
Высота растений 160-165 см.
Имеет высокий уровень устойчивости к засухе, полеганию, основным болезням.
Потенциальная урожайность 4,09 т/га.
Содержание масла в семенах 49,1-49,6 %.
В производственный условиях 2007 года в Украине этот гибрид обеспечил урожайность до 2,7 т/га.

ГИБРИД ПОДСОЛНЕЧНИКА «ХАРЬКОВСКИЙ 49»

Простой межлинейный гибрид масличного направления.
Скороспелый, длительности вегетационного периода до 95 діб.
Высота растений 90-120 см.
Устойчивый к ложной мучнистой росе, волчку, стойкий к фомопсису и гнилям.
Потенциальная урожайность 3,90 т/га
Содержание масла в семенах 50,5-52,6 %

ГИБРИД ПОДСОЛНЕЧНИКА «КИЙ»

Трехлинейный гибрид масличного направления
Скороспелый, длительности вегетационного периода до 105-106 сут.
Высота растений 165-170 см.
Потенциальная урожайность 4,00 т/га.
Содержание масла в семенах 49,8-50,2 %.

ГИБРИД ПОДСОЛНЕЧНИКА «СВИТОЧ»

Простой межлинейный гибрид масличного направления
Скороспелый, длительности вегетационного периода до 105 сут.
Высота растений 130-150 см.
Устойчивый к ложной мучнистой росе, волчку, стойкий к серой и белой гнили, фомопсису.
Потенциальная урожайность 4,50 т/га.
Содержание масла в семенах 50,5-52,6 %.

ГИБРИД ПОДСОЛНЕЧНИКА «КОВЧЕГ®»

Простой межлинейный гибрид масличного направления
Скороспелый, длительности вегетационного периода до 105 сут.
Высота растений 160-170 см.
Устойчивый к ложной мучнистой росе, волчку, стойкий к серой и белой гнили
Потенциальная урожайность 3,55 т/га.
Содержание масла в семенах 51,2-52,6 %.
Рекомендован к выращиванию в в Луганской области (характеризующейся особо засушливыми погодными условиями Степной зоны Украины .

ГИБРИД ПОДСОЛНЕЧНИКА «ПОГЛЯД»

Простой межлинейный гибрид масличного направления
Скороспелый, длительности вегетационного периода до 105-108 сут.
Высота растений.
Имеет высокий уровень устойчивости к полеганию и основных болезней
Потенциальная урожайность 4,20 т/га.
Содержание масла в семенах 50,0-51,5 %.

ГИБРИД ПОДСОЛНЕЧНИКА «ЯСОН®»

Трехлинейный гибрид масличного направления
Скороспелый, длительности вегетационного периода до 108 сут.
Высота растений 175-180 см.
Имеет генетически обусловленную устойчивость к волчку и ложной мучнистой росе.
Потенциальная урожайность 4,16 т/га. В производственных условиях 2007 г гибрид обеспечил урожайность до 3,51 т/га.
Содержание масла в семенах 49,7-50,1 %.

ГИБРИД ПОДСОЛНЕЧНИКА «ДАРИЙ®»

Трехлинейный гибрид масличного направления, олеинового типу.
Средне-ранний с продолжительностью вегетационного периода 107-110 сут.
Высота растений 175-180 см.
Имеет генетически обусловленную устойчивость к волчку и ложной мучнистой росе, устойчивый к белой гнили.
Потенциальная урожайность 4,21 т/га.
Содержание масла в семенах 50,9 %.
Содержание олеиновой кислоты в масле 76,0 %.
В производственных условиях 2006-2007 г гибрид обеспечил урожайность до 3,2 т/га на значительных площадях.

ГІБРИД СОНЯШНИКУ «ЭТЮД»

Простой межлинейный гибрид масличного направления
Скороспелый, длительности вегетационного периода до 100 сут.
Высота растений 120-140 см.
Потенциальная урожайность 4,84 т/га.
Содержание масла в семенах 48,2-52,3 %.

SYNGENTA

Арена ПР

Стабильность из года в год

- **Среднеранний гибрид.**
- Хороший потенциал урожайности и высокая пластичность.
- Гибрид умеренно интенсивного типа, хорошо отзывается на плодородные почвы.
- Устойчив к заразихе рас A, B, C, D, E.
- Устойчивый к ложной мучнистой росе.
- Имеет отличную толерантность к фомозу, корзиночной и стеблевой форме белой и серой гнилей.
- Рекомендуется сеять в оптимальные сроки с использованием классической технологии обработки почвы.
- Не рекомендуется использовать высокие дозы азотных удобрений.
- Густота к моменту уборки 42-48 тыс./га.

Санлука

Раннеспелость прежде всего

- **Раннеспелый гибрид.**
- Гибрид с хорошими темпами роста на начальных этапах органогенеза.
- Хороший потенциал урожайности и хорошая засухоустойчивость.
- Адаптирован к зонам возделывания подсолнечника с коротким вегетационным периодом.
- Устойчив к заразихе рас A, B, C, D, E.
- Благодаря ранним срокам созревания, может быть хорошим предшественником для озимых зерновых.
- Пластичен, высокостабильный гибрид.
- Возможно возделывать при «минимальной» и «нулевой» обработке почвы.
- Густота к моменту уборки 45-50 тыс./га.

НК Роки

Чемпион среди ранних

- **Раннеспелый гибрид.**
- Отличный потенциал урожайности, высокая масличность.
- Пластичный к срокам посева.
- Хорошая устойчивость к засухе.
- Средняя толерантность к белой и серой гнилям.
- Устойчив к заразихе рас A, B, C, D, E.
- Рекомендуемая густота к моменту уборки 45-50 тыс./га.

MONSANTO

Принтасол

Простой скороспелый гибрид. Зарегистрирован в России с 1999 года по Западно-Сибирскому и Уральскому регионам.

Морфологические характеристики:

Стебель и листья:

- стебель средней длины (160-165 см)
- светло-зеленые листья

Корзинка:

- среднего размера
- диаметр 14 – 18 см
- тонкая, слабовыпуклая
- быстро высыхает при созревании

Семена:

- удлиненно-округлой формы
- черного цвета
- потенциал урожайности в производстве 29-32 ц/га

Период вегетации (от посева до физиологической спелости зерна) 95 – 98 дней

<table>
<tr><td colspan="2">РЕКОМЕНДАЦИИ:

Густота к уборке:
50000-55000 шт/га (засушливые условия)
55000-60000 шт/га (достаточное увлажнение)

Элементы урожая:</td><td rowspan="2">ПРЕИМУЩЕСТВА:

1. Высокая скороспелость
2. Хорошая урожайность в зонах с укороченным периодом роста
3. Толерантность к склеротинии
4. Высокое содержание масла
5. Технологичность в производстве</td></tr>
<tr><td>Выполненность корзинки (%):
Содержание масла (%):
Масса 1000 зерен (г):</td><td>92 - 94
49 - 50
60 - 75</td></tr>
</table>

EURALIS

ЛЕЙЛА

Очень ранний
Устойчивый к заразихе

Новый чемпион урожайности в областях, подверженных заразихе!

Идентификация

Тип гибрида: трехлинейный
Количество дней всхожесть-цветение: 70 дней
Количество дней всхожесть-уборка: 106 дней

Структура урожайности

178 см
22 см
Вес 1000 зерен: 62 гр
Наклон шляпки: вниз

Потенциал урожайности
40-45 ц/га

Содержание масла
Масличность: 51%

Агрономические характеристики

Энергия при всходе	7
Стрессоустойчивость	8
Устойчивость к полеганию	7
Устойчивость к фомопсису	6
Устойчивость к склеротиниозу	8
Устойчивость к Rhoma	6
Устойчивость к заразихе от А до Е	

0=низкая
10=высокая

ЕС ИЗАБЕЛЛА

Очень ранний
Устойчивый к заразихе

Превосходная устойчивость к заразихе, терпимость к новым расам и высокий потенциал урожайности

Идентификация

Тип гибрида: трехлинейный
Количество дней всхожесть-цветение: 70 дней
Количество дней всхожесть-уборка: 109 дней

Структура урожайности

180 см
22 см
Вес 1000 зерен: 65 гр
Наклон шляпки: вниз

Потенциал урожайности
43-48 ц/га

Содержание масла
Масличность: 50%

Агрономические характеристики

Энергия при всходе	7
Стрессоустойчивость	7
Устойчивость к полеганию	6
Устойчивость к фомопсису	6
Устойчивость к склеротиниозу	7
Устойчивость к Rhoma	6
Устойчивость к заразихе	-

от А до Е толерантный к расе F
0=низкая
10=высокая

Рекомендуемая плотность посева

Лесостепь: 65 000 - 70 000 зерен/га
Степь: 55 000 - 60 000 зерен/га

ПОМАР

ранний

Ранний гибрид с устойчивым стеблем, резистентный к фомопсису

Идентификация

Тип гибрида: простой
Количество дней всхожесть-цветение: 71 дней
Количество дней всхожесть-уборка: 104 дней

Структура урожайности

175 см
20 см
Вес 1000 зерен: 58 гр
Наклон шляпки: вниз

Потенциал урожайности
40-45 ц/га

Содержание масла
Масличность: 49%

Агрономические характеристики

Энергия при всходе	7
Стрессоустойчивость	8
Устойчивость к полеганию	10
Устойчивость к фомопсису	10
Устойчивость к склеротиниозу	8
Устойчивость к Rhoma	7

0=низкая
10=высокая

Рекомендуемая плотность посева

Лесостепь: 65 000 - 70 000 зерен/га
Степь: 60 000 - 65 000 зерен/га

ANNEX 4: PRESENTATIONS AND MATERIALS

Presentations and training materials (English and Russian)

Presentations (indoor training session, Uralsk, 29 February–1 March 2008)

Posters (field day, Stepnoye, Aktobe Oblast, 25 September 2008)

Aspects of sunflower crop physiology (English)

The plant

Cycle : 120 to 150 days according to earliness

Temperature requirements : 1570 to 1700 °c (base 6)
According to earliness of the variety
(3 classifications in France)

Flowering takes place 65 to 70 days after emergence

Cycle : 5 Key-periods could be identified :

1- From sowing to emergence
2- From emergence to 5 leaves stages
3- From 5 leaves stages to begin. of flow.
4- Flowering time
5- Seed filling period

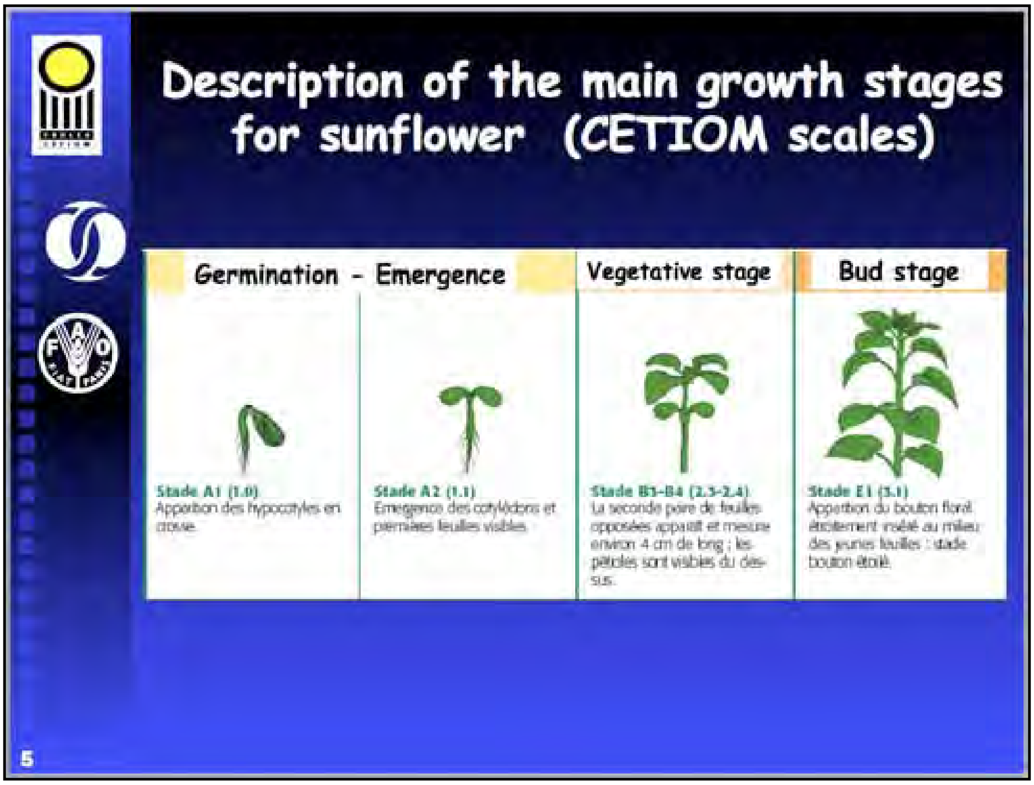
3

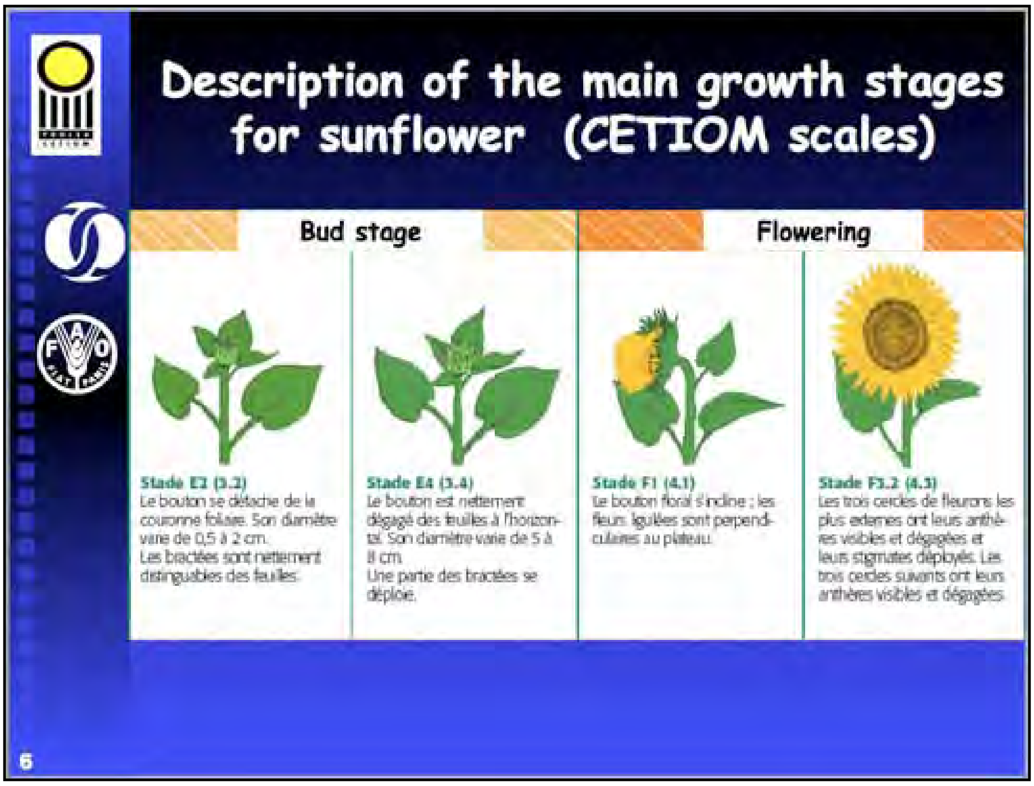
Scales for Sunflower GDD requirements

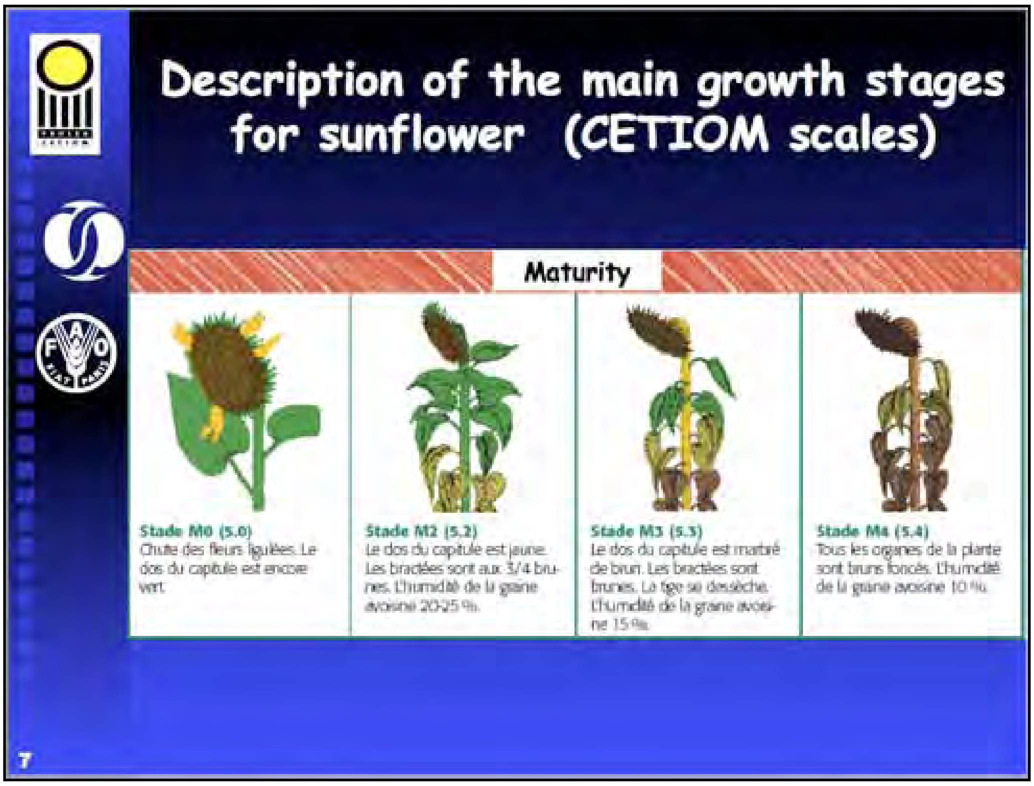
Stage / Earliness group	Sowing to emergence	Beginning of flowering	End of flowering	Maturity
Early	90	790	990	1570
Mid - early	90	840	1040	1640
Mid - late	90	900	1100	1700

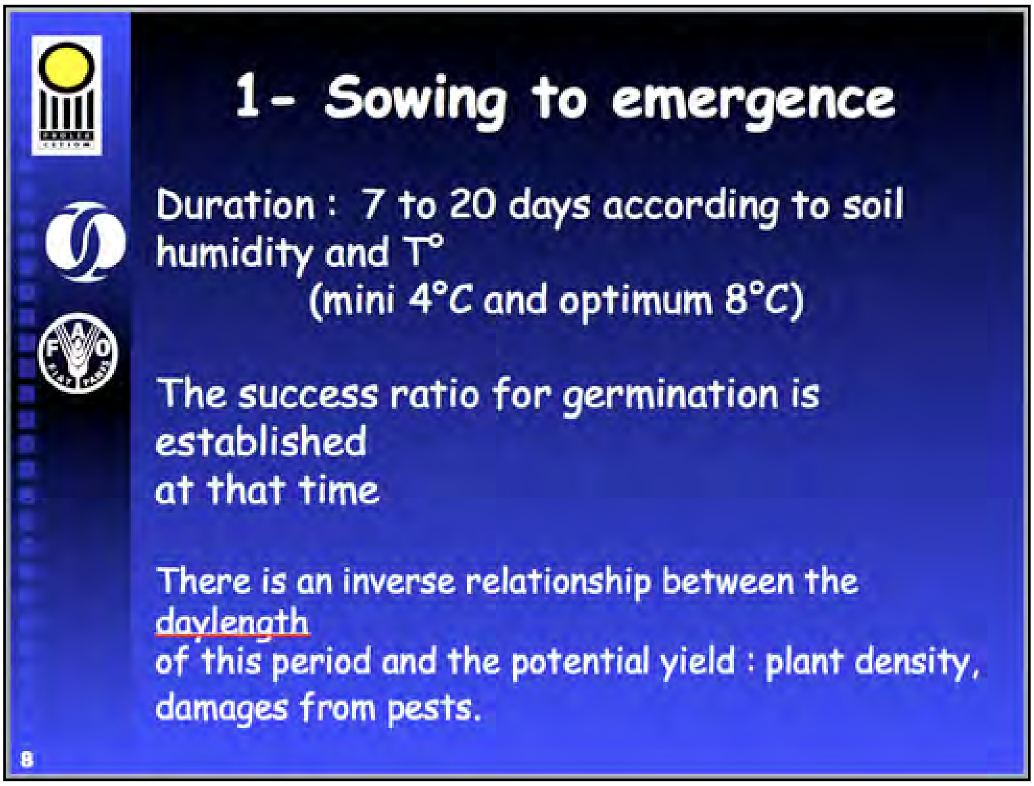
GDD : Growing degrees days in °C base 6
Cumulative values required to reach the stage

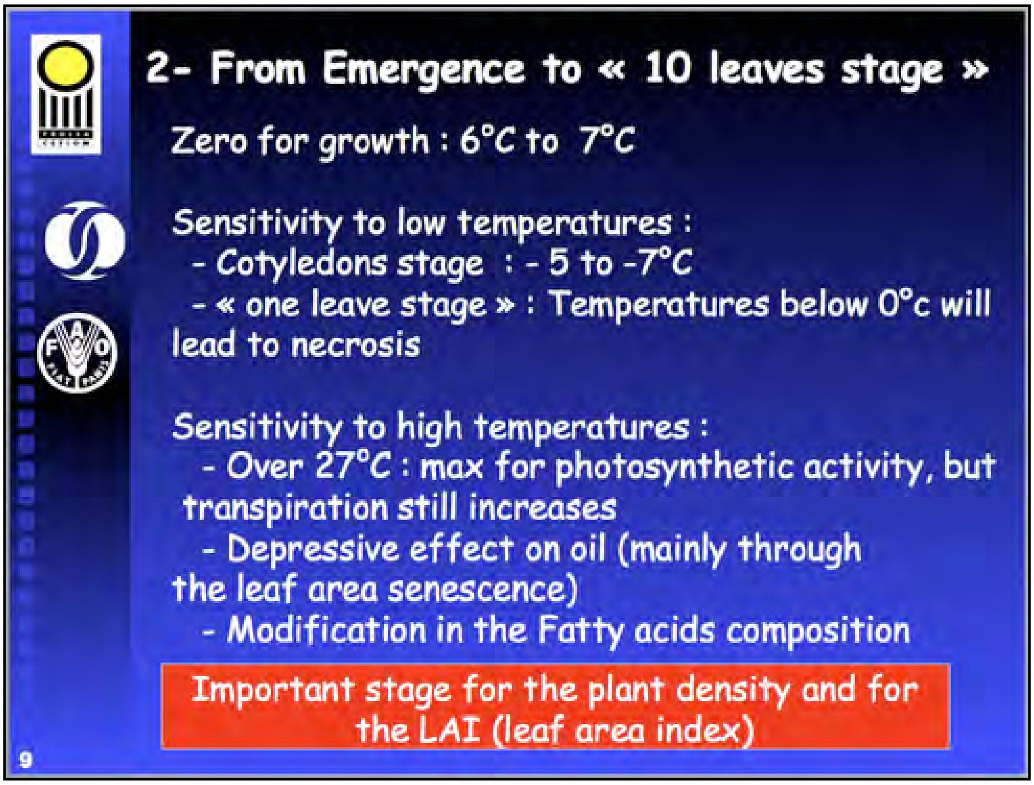
4

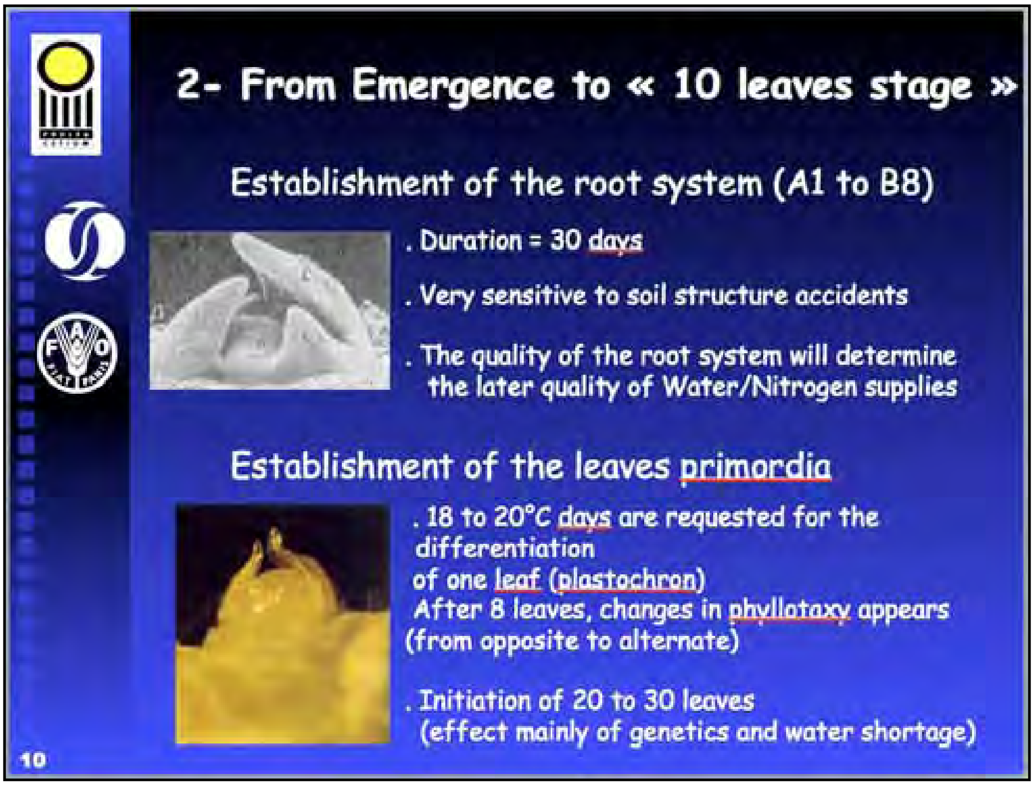

Description of the main growth stages for sunflower (CETIOM scales)
Germination - Emergence
Vegetative stage
Bud stage
Stade A1 (1.0)
Apparition des hypocotyles en crosse.
Stade A2 (1.1)
Emergence des cotylédons et premières feuilles visibles.
Stade B1-B4 (2.3-2.4)
La seconde paire de feuilles opposées apparaît et mesure environ 4 cm de long ; les pétioles sont visibles du dessus.
Stade E1 (3.1)
Apparition du bouton floral étroitement inséré au milieu des jeunes feuilles : stade bouton étoilé.
5

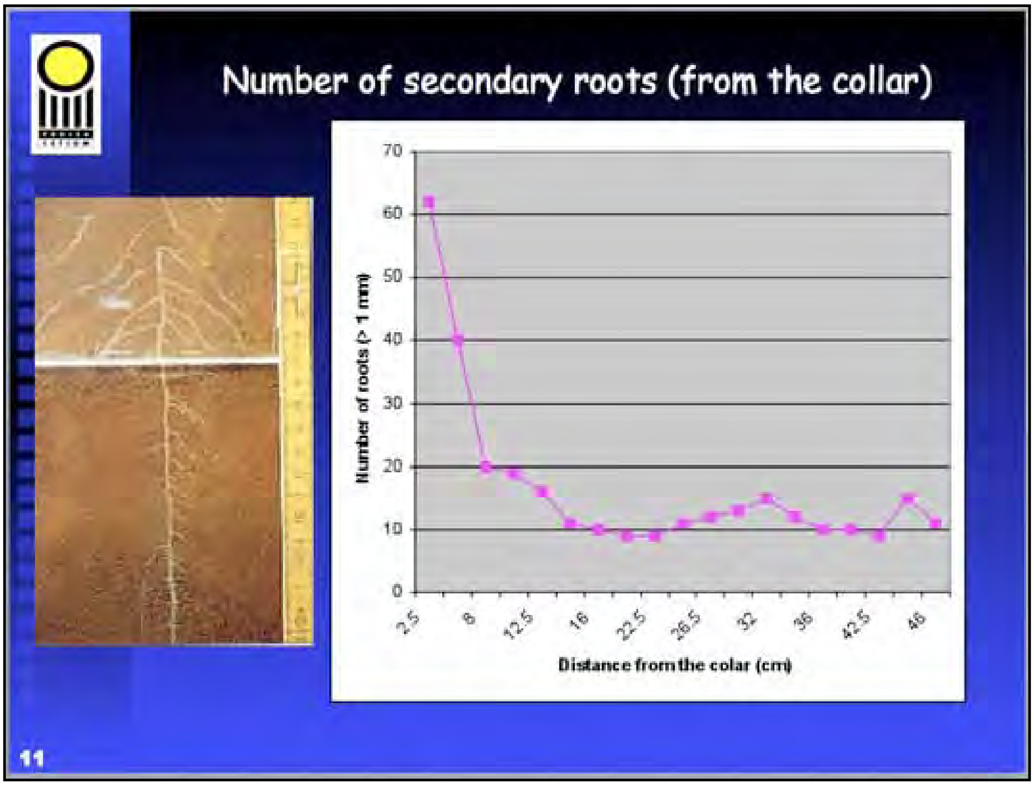

Description of the main growth stages for sunflower (CETIOM scales)
Bud stage
Flowering
Stade E2 (3.2)
Le bouton se détache de la couronne foliaire. Son diamètre varie de 0,5 à 2 cm.
Les bractées sont nettement distinguables des feuilles.
Stade E4 (3.4)
Le bouton est nettement dégagé des feuilles à l'horizontal. Son diamètre varie de 5 à 8 cm.
Une partie des bractées se déploie.
Stade F1 (4.1)
Le bouton floral s'incline ; les fleurs ligulées sont perpendiculaires au plateau.
Stade F3.2 (4.3)
Les trois cercles de fleurons les plus externes ont leurs anthères visibles et dégagées et leurs stigmates déployés. Les trois cercles suivants ont leurs anthères visibles et dégagées.
6

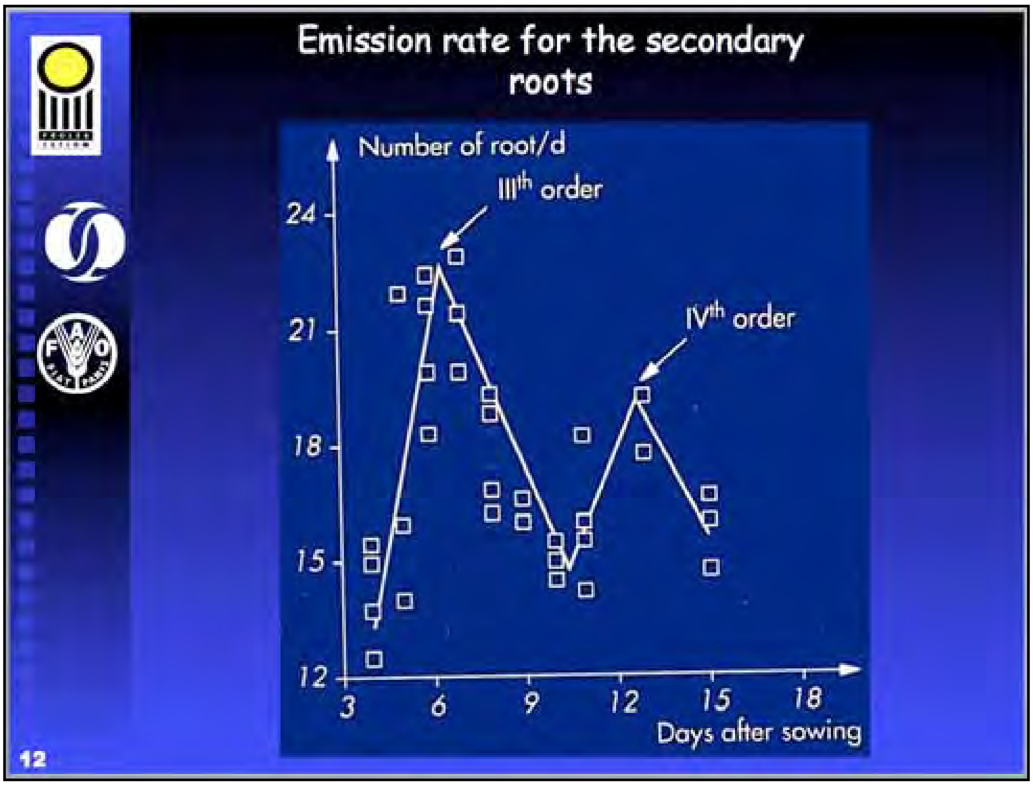

Description of the main growth stages for sunflower (CETIOM scales)
Maturity
Stade M0 (5.0)
Chute des fleurs ligulées. Le dos du capitule est encore vert.
Stade M2 (5.2)
Le dos du capitule est jaune. Les bractées sont aux 3/4 brunes. L'humidité de la graine avoisine 20-25 %.
Stade M3 (5.3)
Le dos du capitule est marbré de brun. Les bractées sont brunes. La tige se dessèche. L'humidité de la graine avoisine 15 %.
Stade M4 (5.4)
Tous les organes de la plante sont bruns foncés. L'humidité de la graine avoisine 10 %.
7

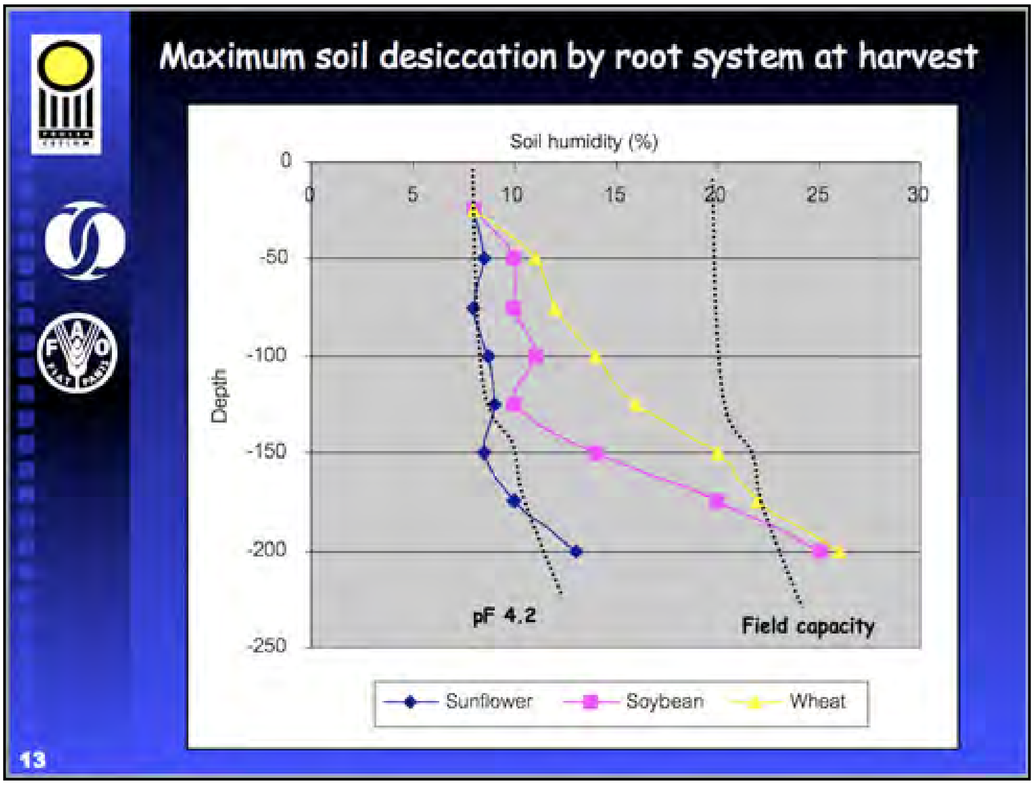

1- Sowing to emergence
Duration : 7 to 20 days according to soil humidity and T°
(mini 4°C and optimum 8°C)
The success ratio for germination is established
at that time
There is an inverse relationship between the daylength
of this period and the potential yield : plant density, damages from pests.
8

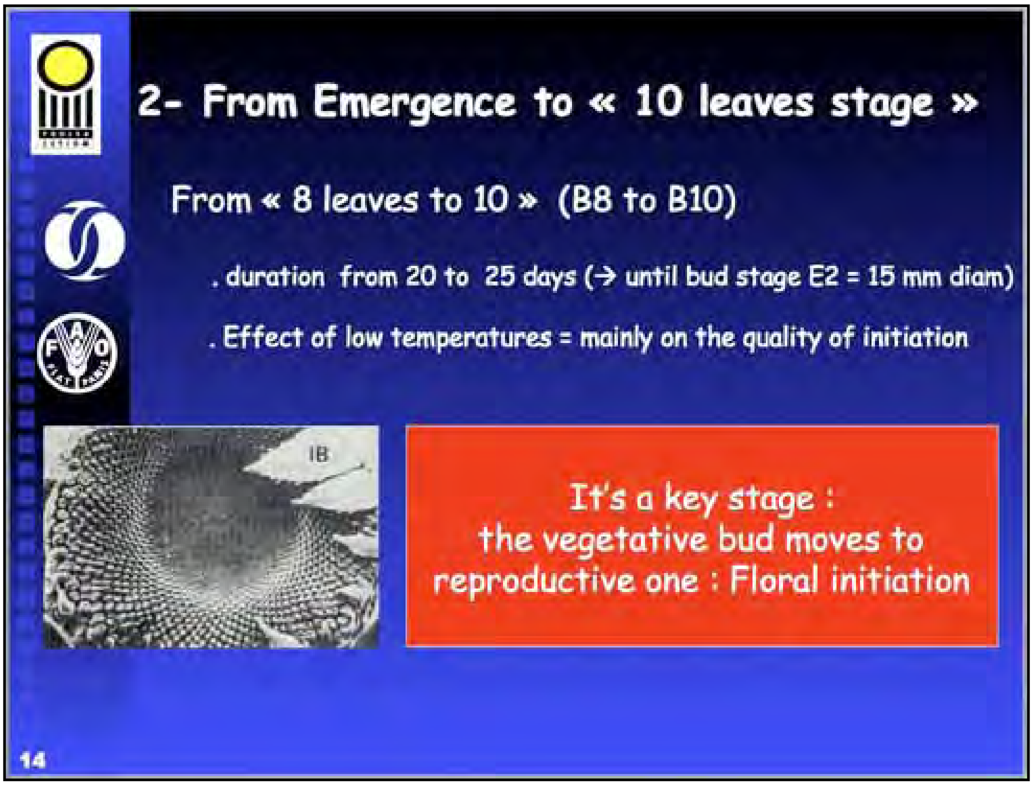

2- From Emergence to « 10 leaves stage »
Zero for growth : 6°C to 7°C
Sensitivity to low temperatures :
- Cotyledons stage : - 5 to -7°C
- « one leave stage » : Temperatures below 0°c will lead to necrosis
Sensitivity to high temperatures :
- Over 27°C : max for photosynthetic activity, but transpiration still increases
- Depressive effect on oil (mainly through the leaf area senescence)
- Modification in the Fatty acids composition
Important stage for the plant density and for the LAI (leaf area index)
9

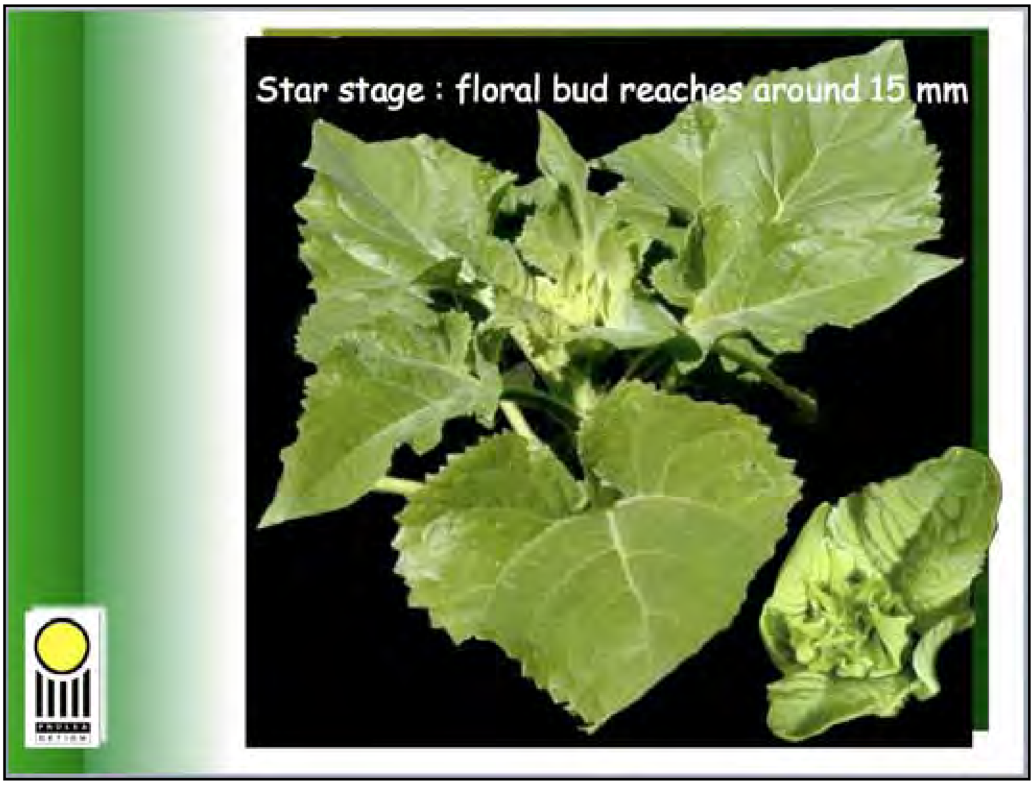

2- From Emergence to « 10 leaves stage »
Establishment of the root system (A1 to B8)
. Duration = 30 days
. Very sensitive to soil structure accidents
. The quality of the root system will determine the later quality of Water/Nitrogen supplies
Establishment of the leaves primordia
. 18 to 20°C days are requested for the differentiation of one leaf (plastochron)
After 8 leaves, changes in phyllotaxy appears (from opposite to alternate)
. Initiation of 20 to 30 leaves (effect mainly of genetics and water shortage)
10


Number of secondary roots (from the collar)
Number of roots (> 1 mm)
70
60
50
40
30
20
10
0
2.5
8
12.5
16
22.5
26.5
32
36
42.5
46
Distance from the colar (cm)
11

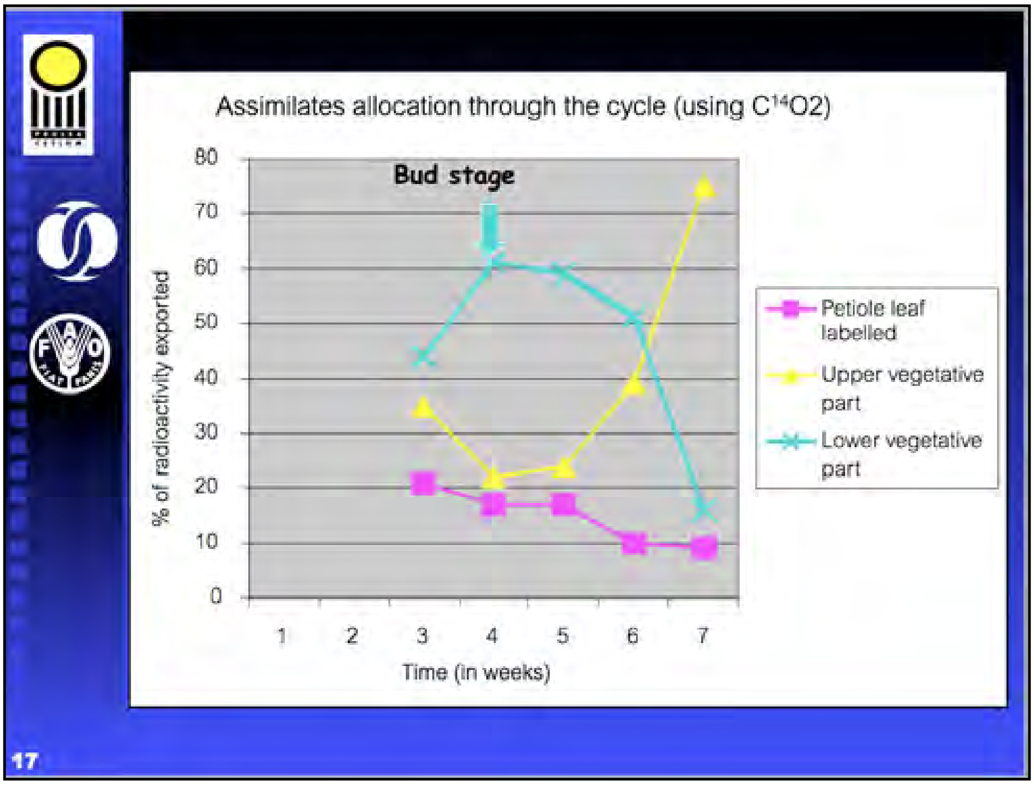

Emission rate for the secondary roots
Number of root/d
III th order
IV th order
24
21
18
15
12
3
6
9
12
15
18
Days after sowing
12


Maximum soil desiccation by root system at harvest
Soil humidity (%)
0
5
10
15
20
25
30
Depth
0
-50
-100
-150
-200
-250
pF 4,2
Field capacity
Sunflower
Soybean
Wheat
13


2- From Emergence to « 10 leaves stage »
From « 8 leaves to 10 » (B8 to B10)
. duration from 20 to 25 days (→ until bud stage E2 = 15 mm diam)
. Effect of low temperatures = mainly on the quality of initiation
IB
It's a key stage :
the vegetative bud moves to
reproductive one : Floral initiation
14

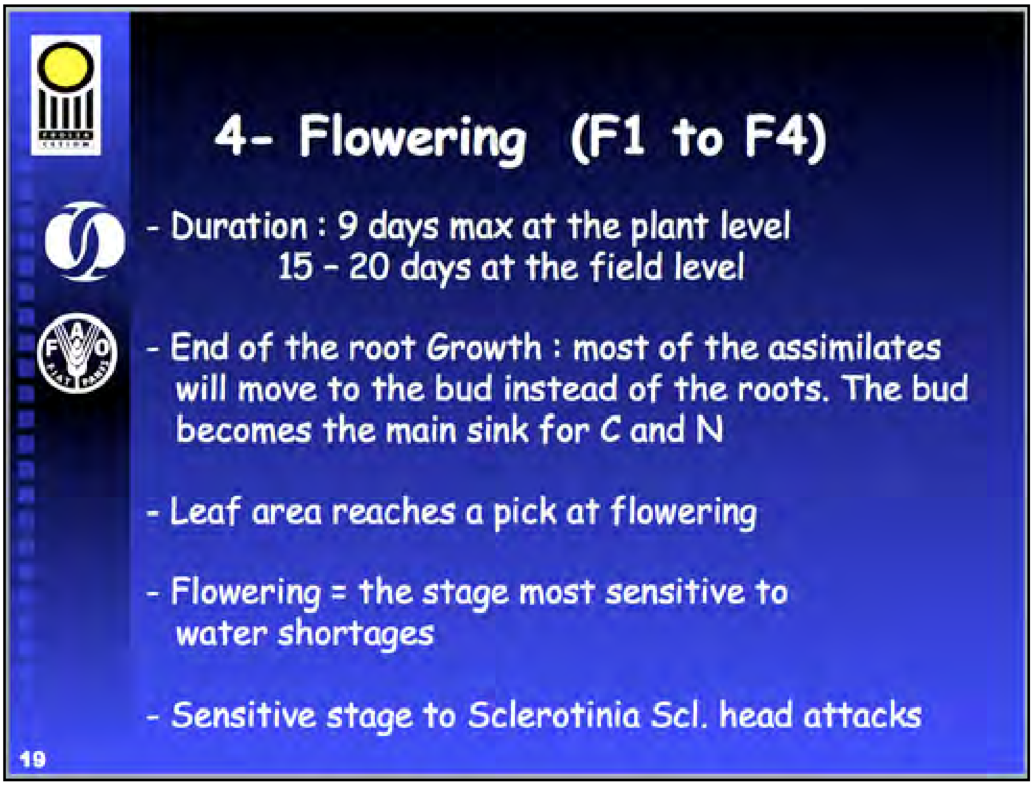

Star stage : floral bud reaches around 15 mm

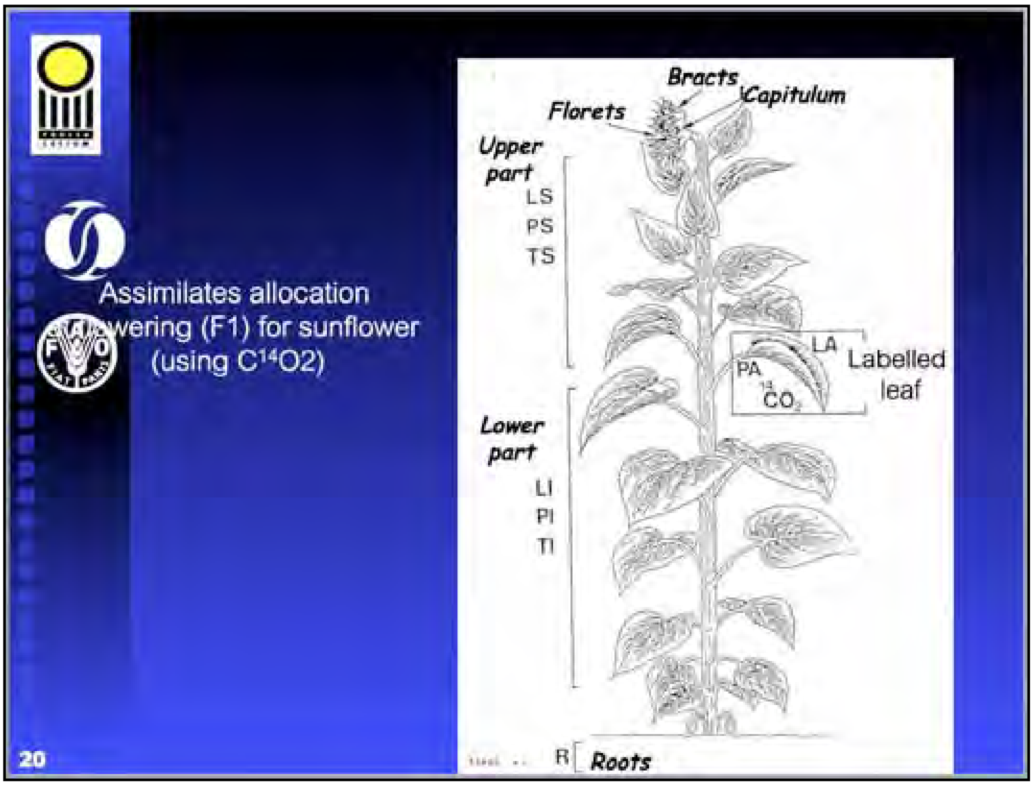

3- From « 10 leaves stages to Beginning of flowering)
- High requirements in nutrients
- High crop growth rate : 200 kg/ha/day
- Duration : 40-50 days
- High expansion rate for leaf area => establishment of the LAI
LAI = Leaf area per plant X plant density
The water and nitrogen availabilities will control the leaf area establishment but also duration
A moderation in leaf area will be looked for :
Optimum value at E2 = 1.7
Optimum value à F1 = 2.5
16



Assimilates allocation through the cycle (using C14O2)
Bud stage
% of radioactivity exported
Time (in weeks)
Petiole leaf labelled
Upper vegetative part
Lower vegetative part
17

Bud reaches 5 to 10 cm
« artichoke stage »
Yellow bracts appear : F1
Yellow bracts are fully Expanded : F2
Florets are male on the 3 outer circles : F2

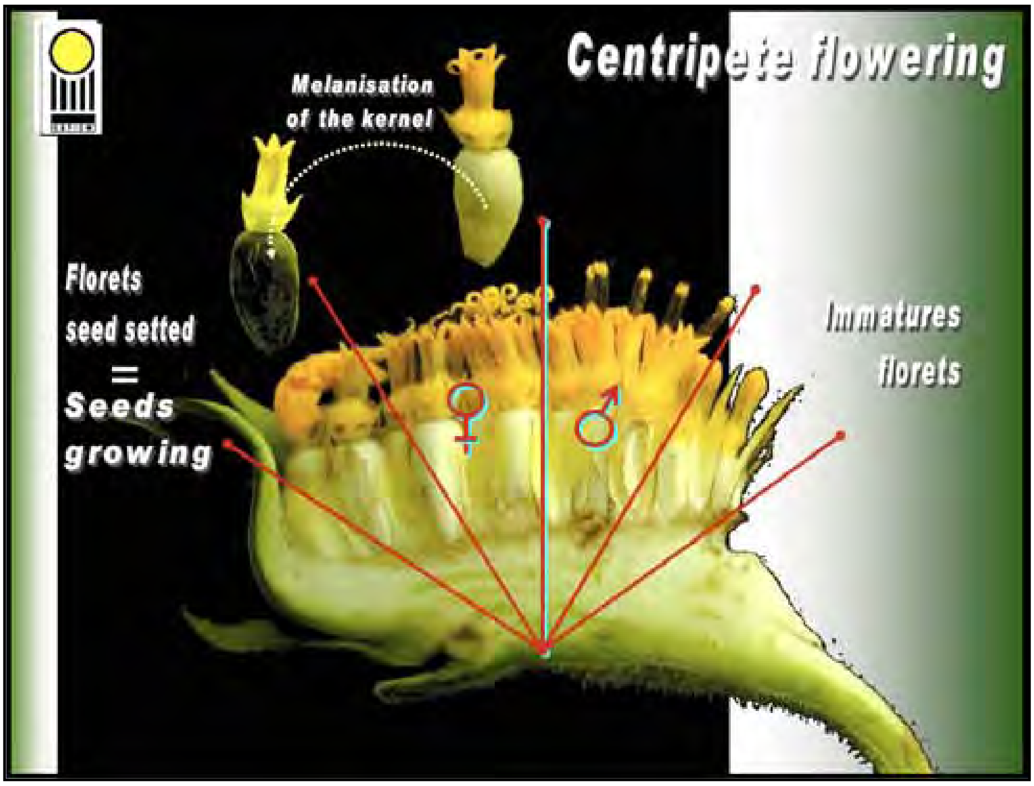

4- Flowering (F1 to F4)
- Duration : 9 days max at the plant level
15 – 20 days at the field level
- End of the root Growth : most of the assimilates will move to the bud instead of the roots. The bud becomes the main sink for C and N
- Leaf area reaches a pick at flowering
- Flowering = the stage most sensitive to water shortages
- Sensitive stage to Sclerotinia Scl. head attacks
19

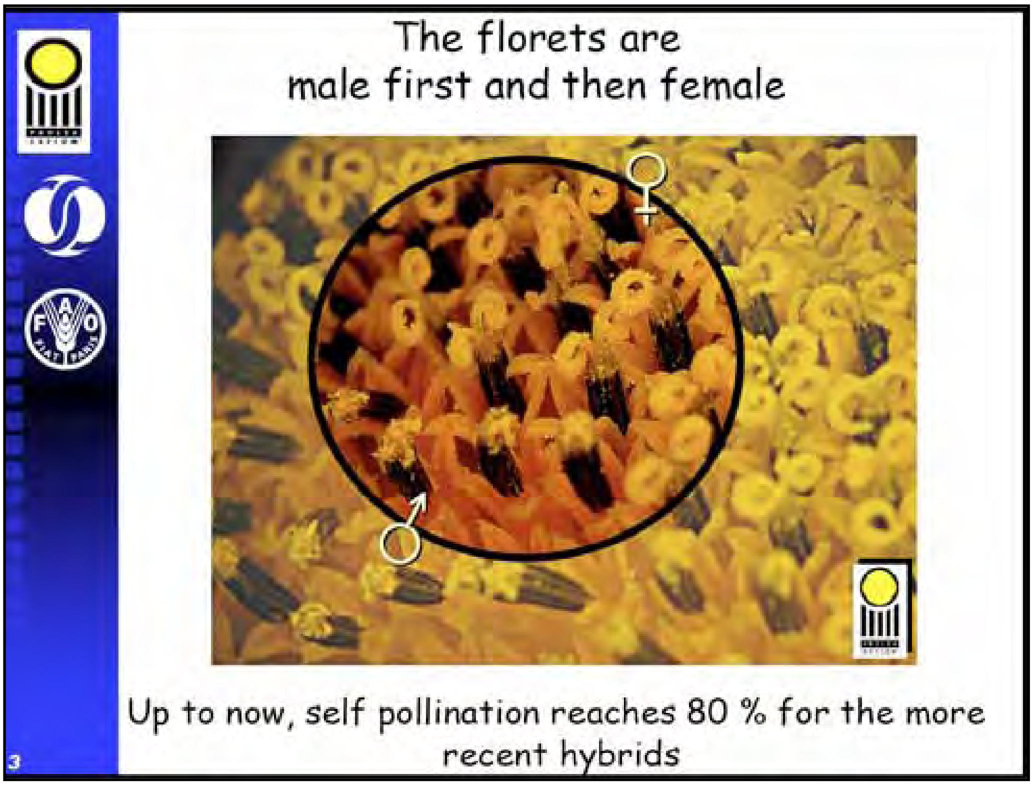

Assimilates allocation
wering (F1) for sunflower
(using C14O2)
Bracts
Capitulum
Florets
Upper part
LS
PS
TS
LA
PA
14CO2
Labelled leaf
Lower part
LI
PI
TI
R
Roots
20

Allocation of Labelled CO2 at flowering According to the time

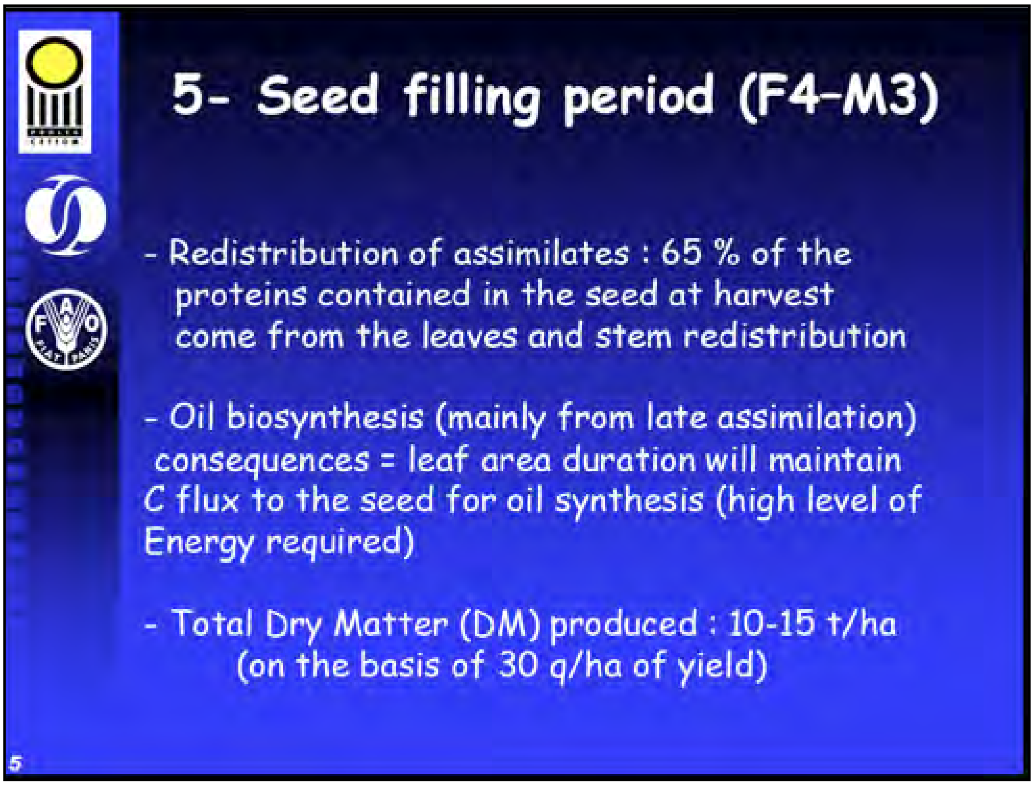
Organ / Time (h)	Labelled organ: La	Labelled organ: Pa	Lower part: LI	Lower part: PI	Lower part: TI	Upper part: LS	Upper part: PS	Upper part: TS	Br.	Cap	Flor
0	92	6	T	T	0.4	T	T	0.3	T	0.7	0.1
1	73	5	0.4	T	2.4	1.8	T	13	T	1.4	2.3
3	54	3	T	T	2.4	T	T	16	T	10	13
6	37	3	0.4	T	4.6	0.4	T	14	1	0.5	41
12	30	5	T	T	3.6	0.3	T	15	T	4	41

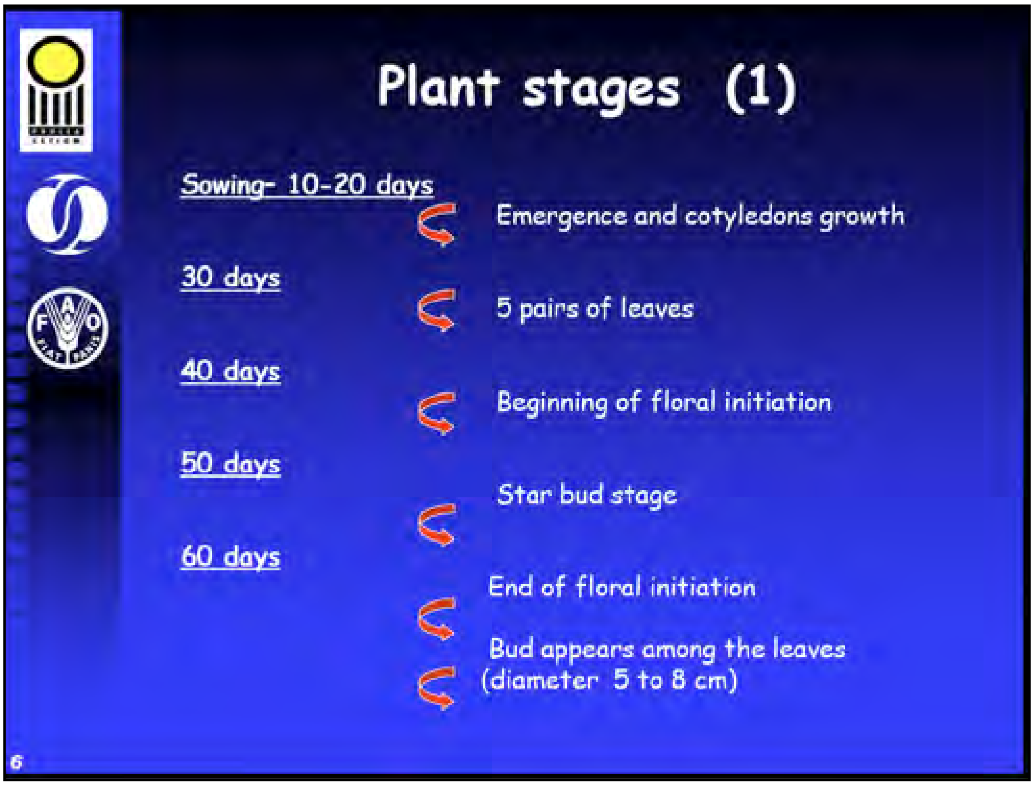
1

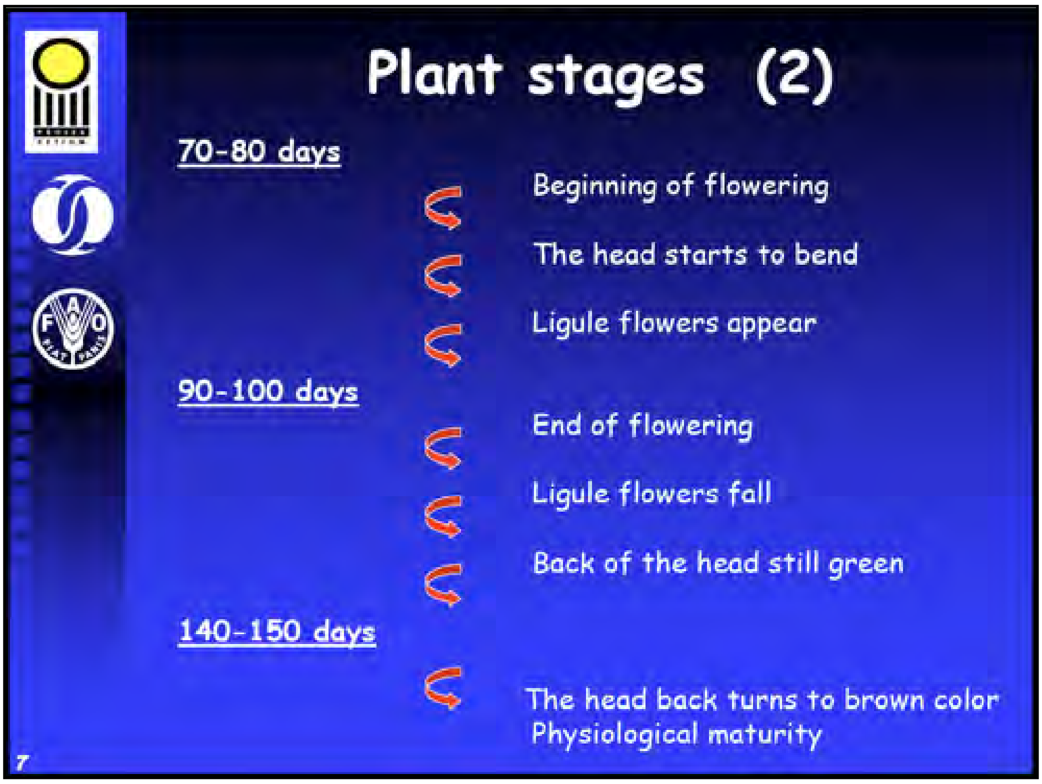


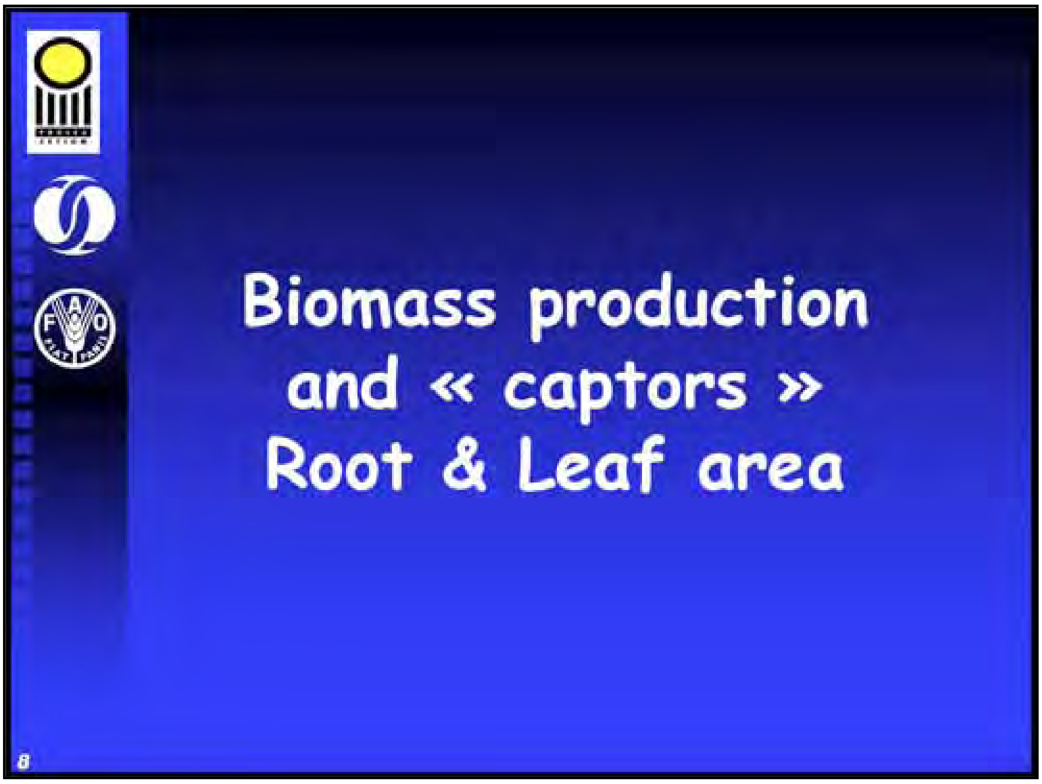

The florets are
male first and then female
Up to now, self pollination reaches 80 % for the more recent hybrids
3

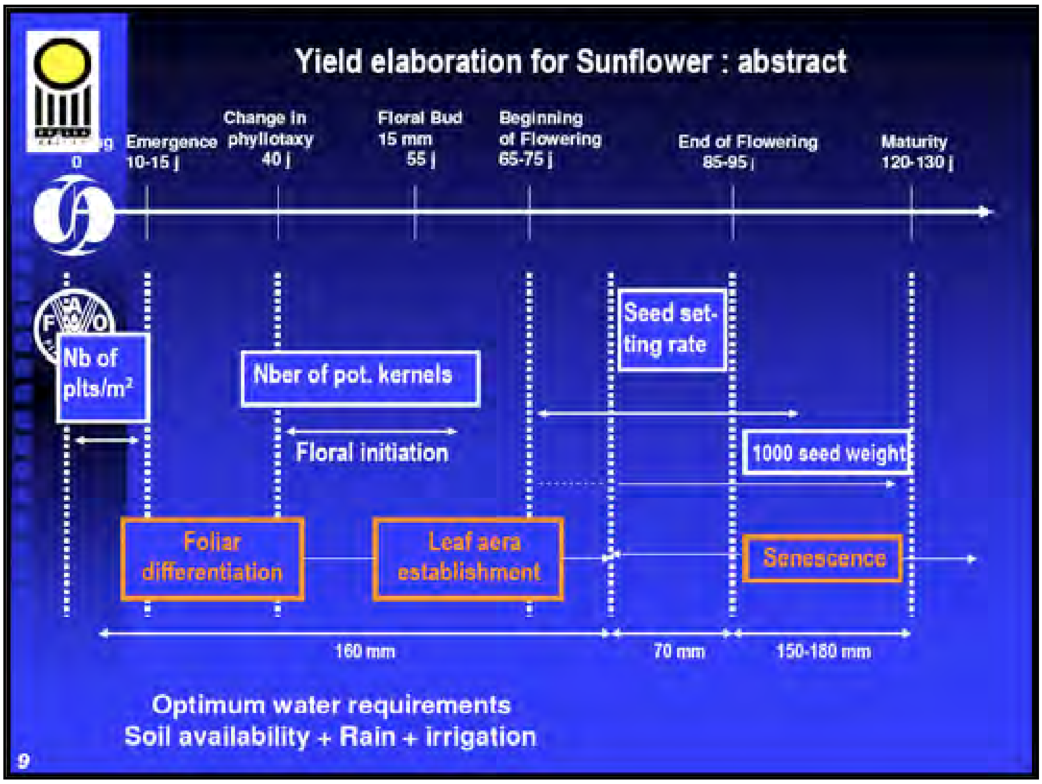

4

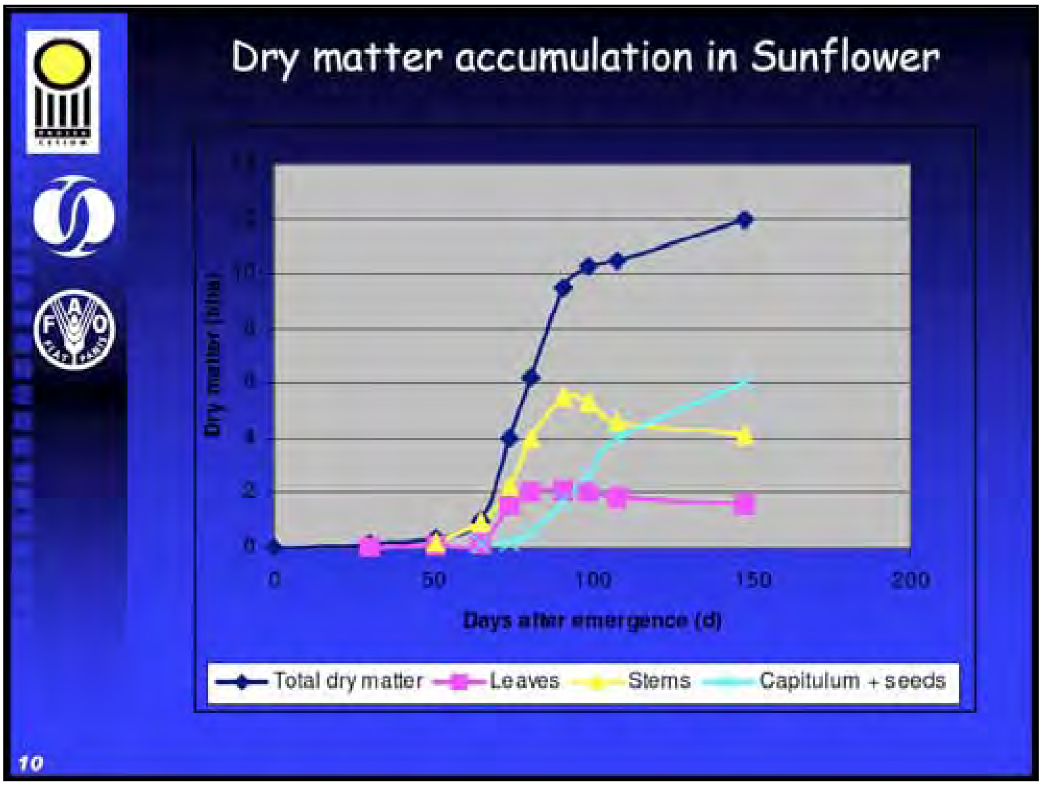

5- Seed filling period (F4–M3)
- Redistribution of assimilates : 65 % of the proteins contained in the seed at harvest come from the leaves and stem redistribution
- Oil biosynthesis (mainly from late assimilation) consequences = leaf area duration will maintain C flux to the seed for oil synthesis (high level of Energy required)
- Total Dry Matter (DM) produced : 10-15 t/ha (on the basis of 30 q/ha of yield)
5


Plant stages (1)
Sowing- 10-20 days
Emergence and cotyledons growth
30 days
5 pairs of leaves
40 days
Beginning of floral initiation
50 days
Star bud stage
60 days
End of floral initiation
Bud appears among the leaves (diameter 5 to 8 cm)
6

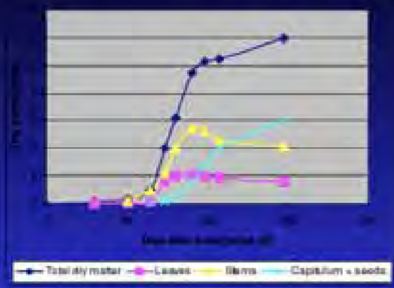

Plant stages (2)
70-80 days
Beginning of flowering
The head starts to bend
Ligule flowers appear
90-100 days
End of flowering
Ligule flowers fall
Back of the head still green
140-150 days
The head back turns to brown color
Physiological maturity
7


Biomass production
and « captors »
Root & Leaf area
8


Yield elaboration for Sunflower : abstract
Emergence 10-15 j
Change in phyllotaxy 40 j
Floral Bud 15 mm 55 j
Beginning of Flowering 65-75 j
End of Flowering 85-95 j
Maturity 120-130 j
Nb of plts/m²
Nber of pot. kernels
Floral initiation
Seed setting rate
1000 seed weight
Foliar differentiation
Leaf aera establishment
Senescence
160 mm
70 mm
150-180 mm
Optimum water requirements
Soil availability + Rain + irrigation
9


Dry matter accumulation in Sunflower
Dry matter (t/ha)
0
2
4
6
8
10
12
0
50
100
150
200
Days after emergence (d)
Total dry matter
Leaves
Stems
Capitulum + seeds
10

Dry matter accumulation in Sunflower



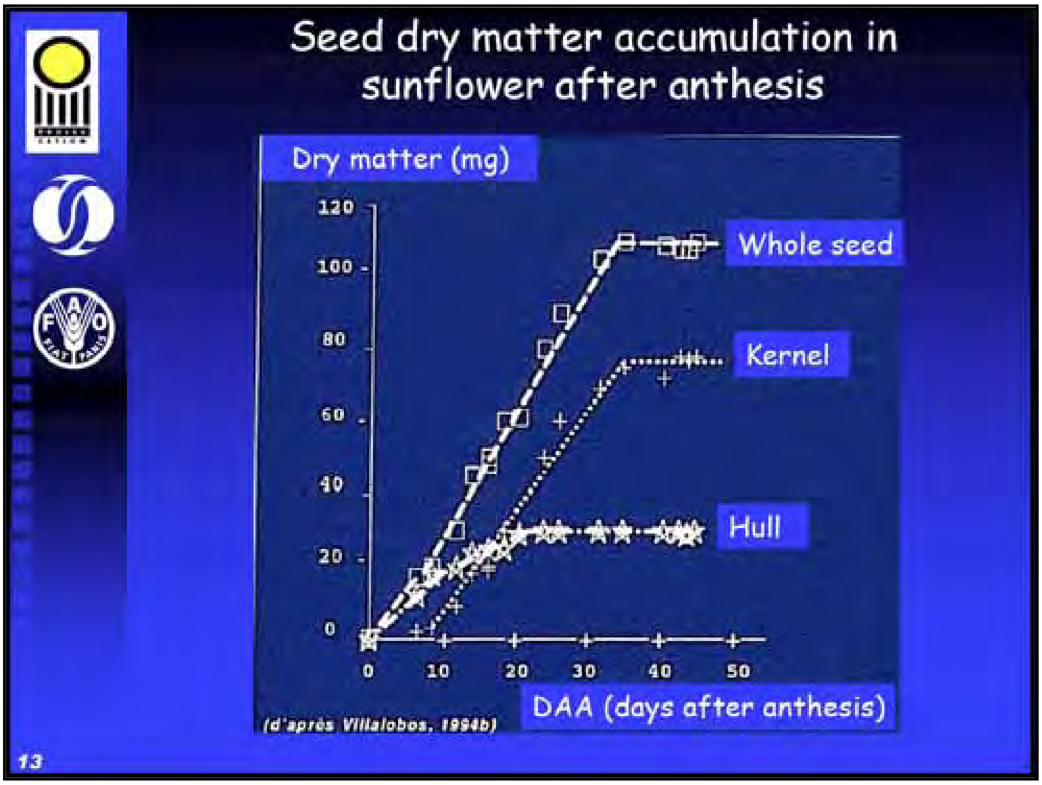
	Emergence B8	E2	F1 Flowering	F4	Maturity M3
Number of days	30	20 to 25	25 to 30	15 to 20	50
Rate for biomass accumulation (kg/ha/day)	10	10 to 15	200	100 to 150	30 to 40
Main events	Root growth Leaf initiation	Floral initiation	Establish-ment of the leaf area Active photosyn-thetic activity	Flowering And Seed setting	Translo - cations oil synthesis

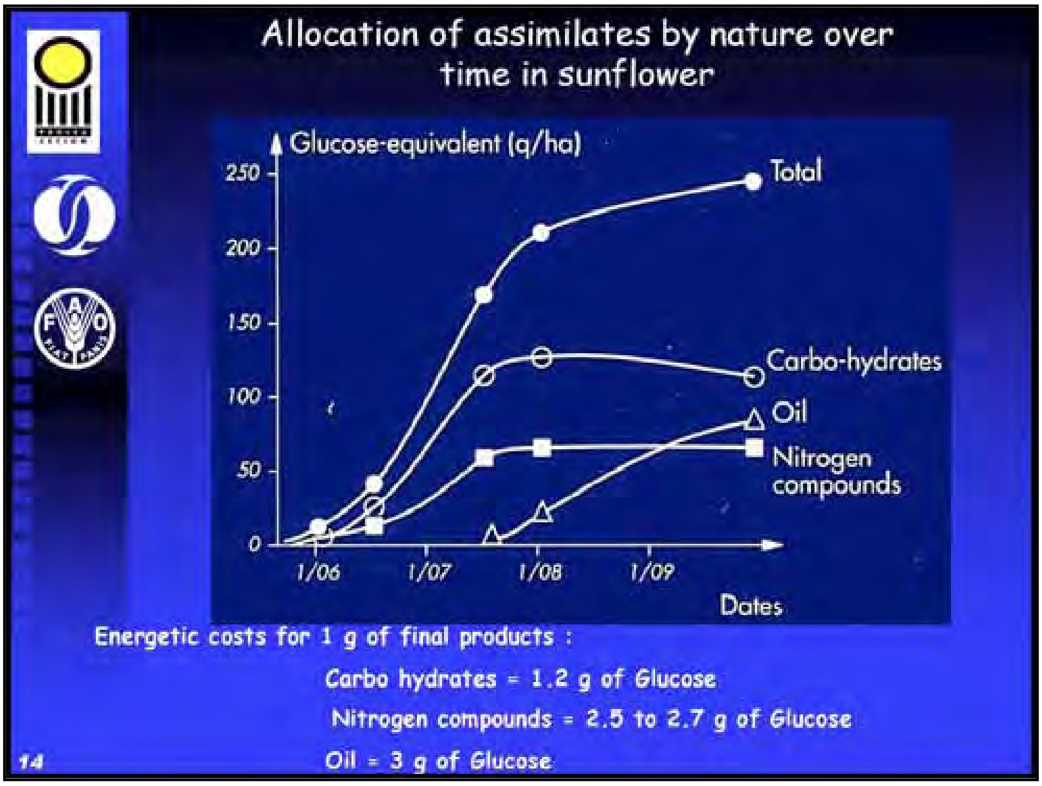
11

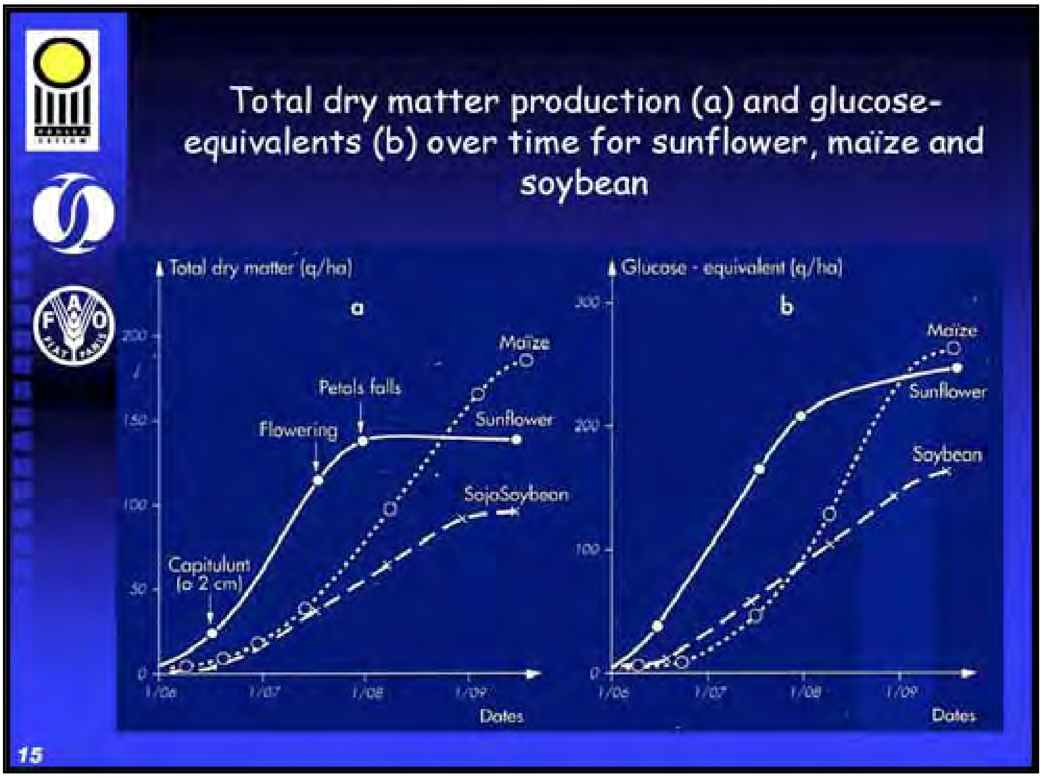
Dry matter accumulation in Sunflower

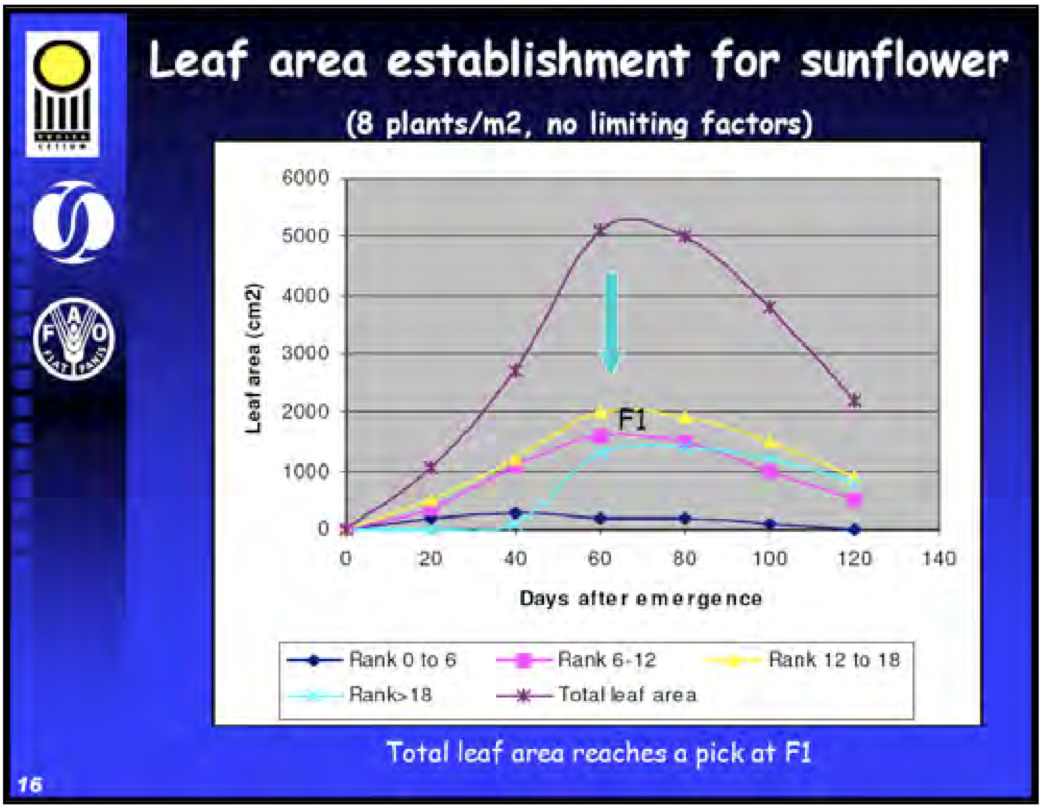
	Emergence B8	E2	F1 Flowering	F4	Maturity M3
Number of days	30	20 to 25	25 to 30	15 to 20	50
Rate for biomass accumulation (kg/ha/day)	10	10 to 15	200	100 to 150	30 to 40
Main events	Root growth Leaf initiation	Floral initiation	Establish-ment of the leaf area Active photosyn-thetic activity	Flowering And Seed setting	Translo - cations oil synthesis

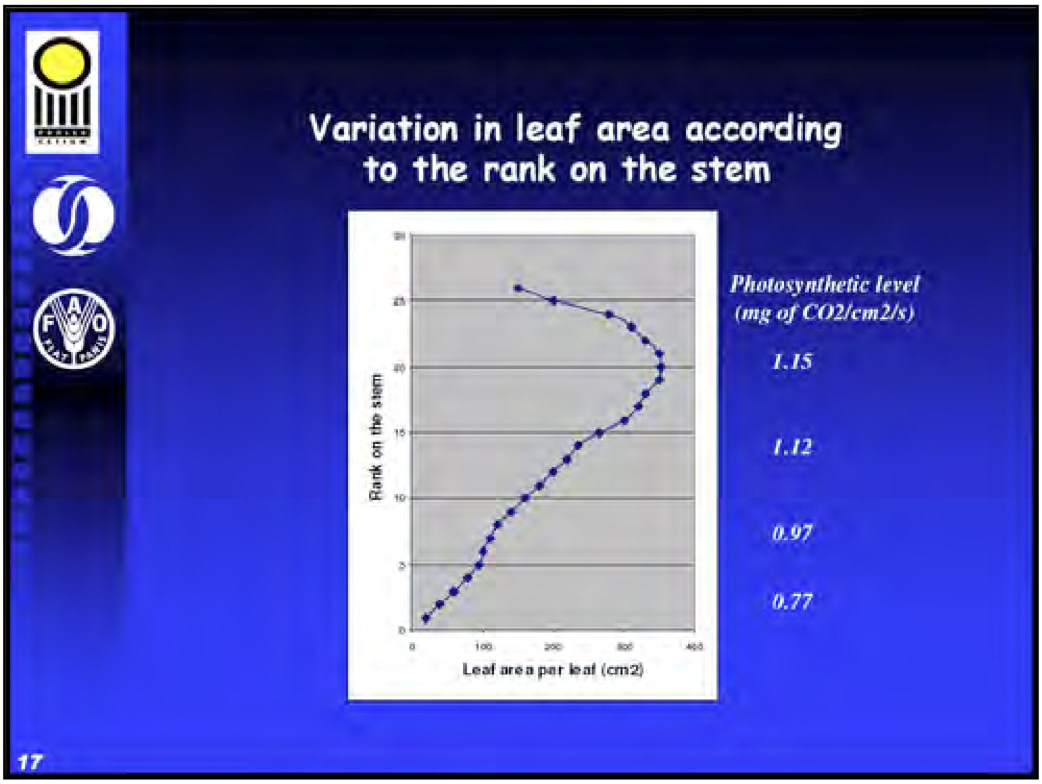
12


Seed dry matter accumulation in sunflower after anthesis
Dry matter (mg)
120
100
80
60
40
20
0
0
10
20
30
40
50
Whole seed
Kernel
Hull
DAA (days after anthesis)
(d'après Villalobos, 1994b)
13


Allocation of assimilates by nature over time in sunflower
Glucose-equivalent (q/ha)
250
200
150
100
50
0
1/06
1/07
1/08
1/09
Dates
Total
Carbo-hydrates
Oil
Nitrogen compounds
Energetic costs for 1 g of final products :
Carbo hydrates = 1.2 g of Glucose
Nitrogen compounds = 2.5 to 2.7 g of Glucose
Oil = 3 g of Glucose
14


Total dry matter production (a) and glucose-equivalents (b) over time for sunflower, maïze and soybean
Total dry matter (q/ha)
a
Maïze
Petals falls
Flowering
Sunflower
SojaSoybean
Capitulum (ø 2 cm)
Dates
Glucose - equivalent (q/ha)
b
Maïze
Sunflower
Soybean
Dates
15


Leaf area establishment for sunflower
(8 plants/m2, no limiting factors)
Leaf area (cm2)
Days after emergence
F1
Rank 0 to 6
Rank 6-12
Rank 12 to 18
Rank>18
Total leaf area
Total leaf area reaches a pick at F1
16

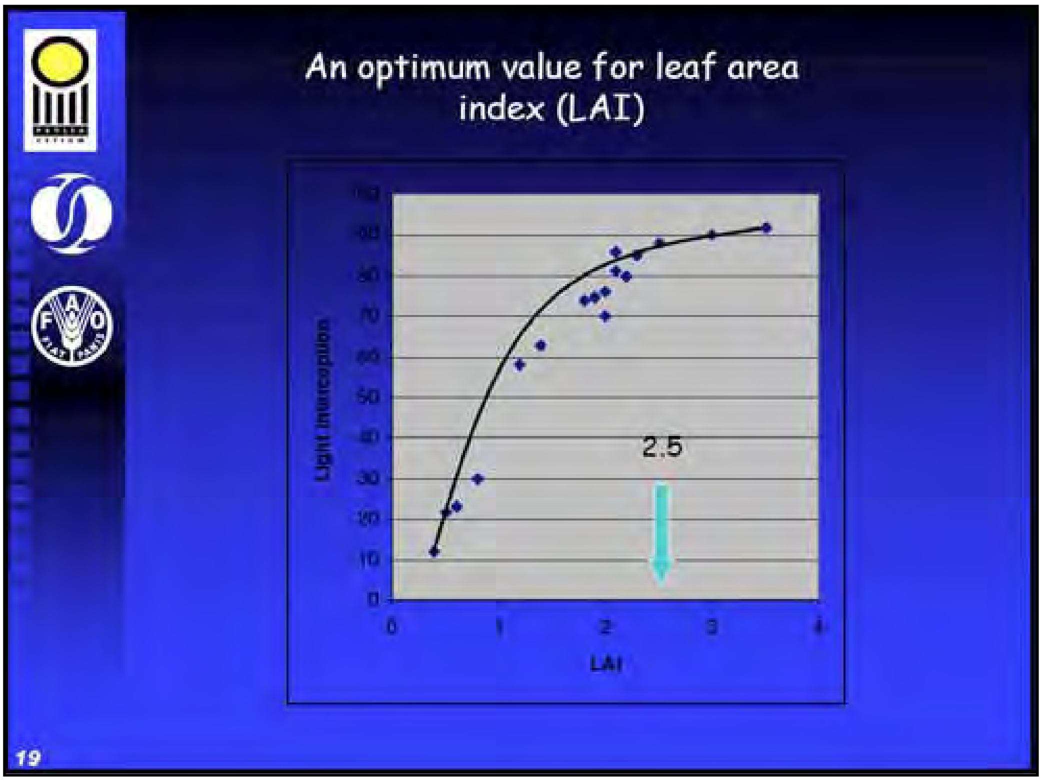


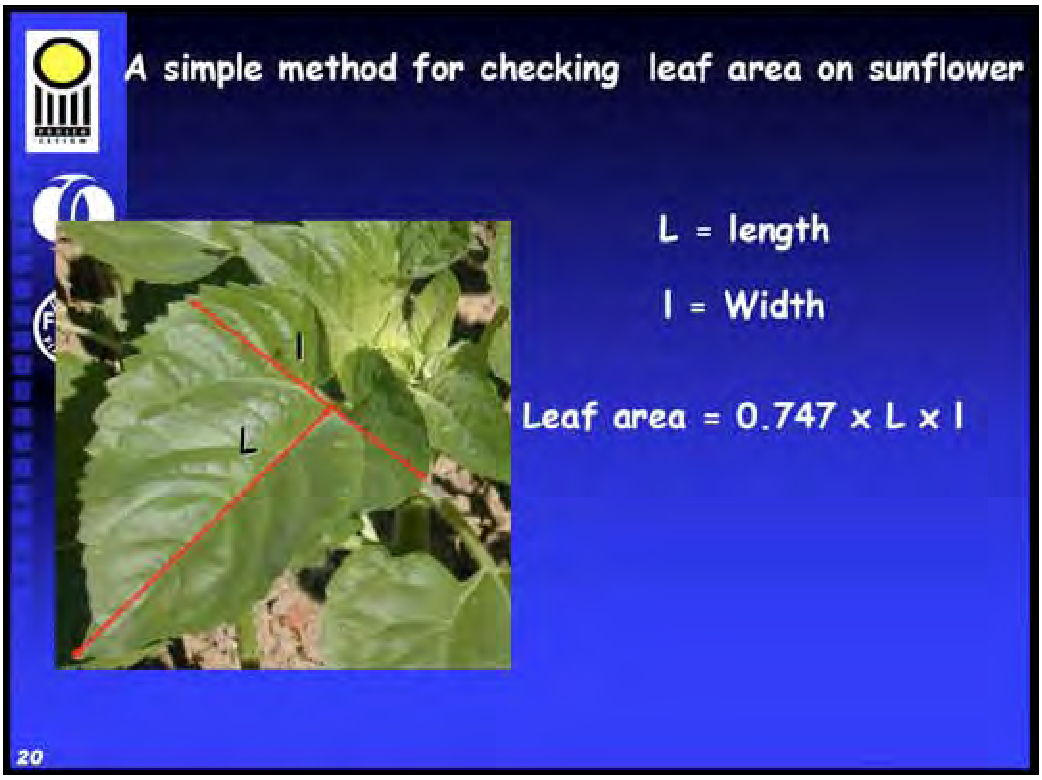
Relative importance of leaf area according to the canopy level

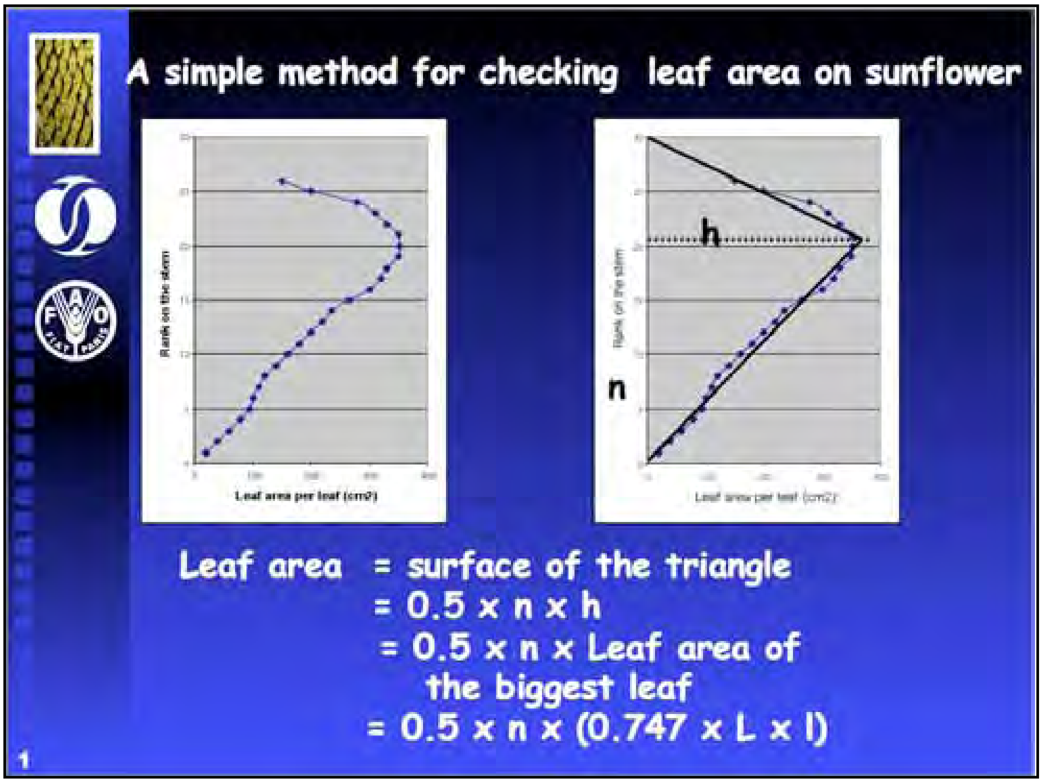
Leaves maintained (numbered from bottom to top)	% of leaf area maintained	Weight of seeds harvest (%)
All leaves (1 to 25)	100	100
Leaves 1 to 18	88 (-22 %)	55 (-45 %)
Leaves 1 to 13	59 (-41 %)	25 (-75 %)
Leaves 1 to 8	23 (-77 %)	2 (-93 %)

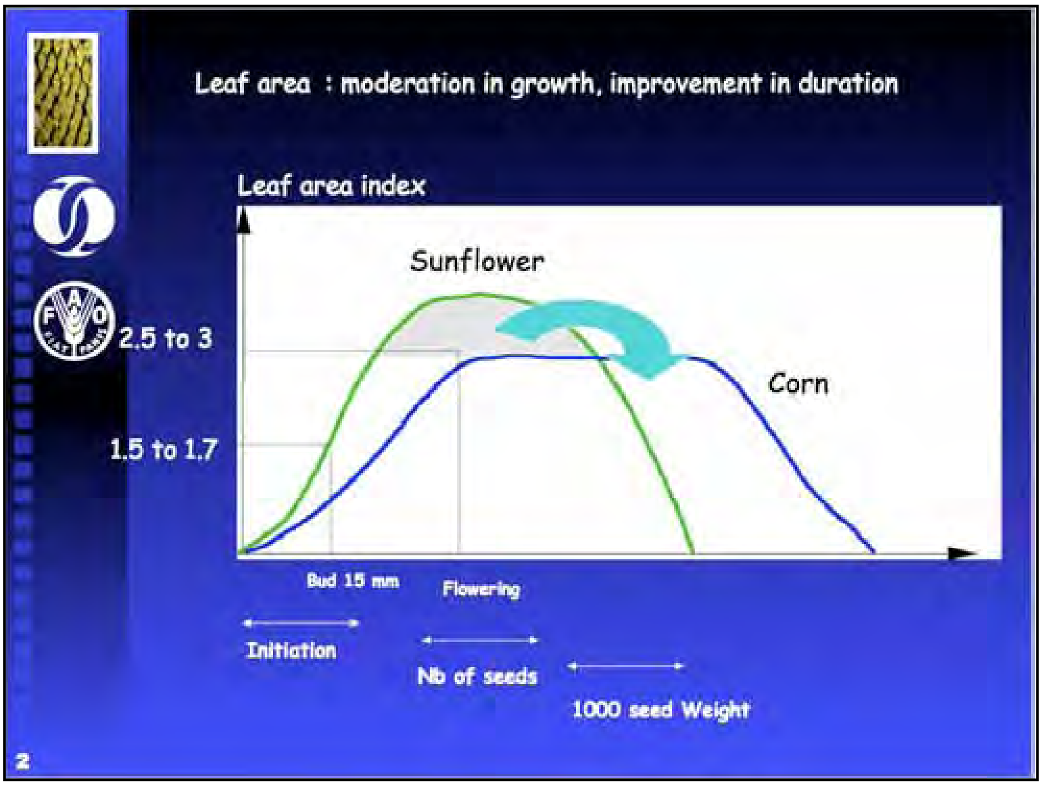
Leaves ablation occurs at flowering

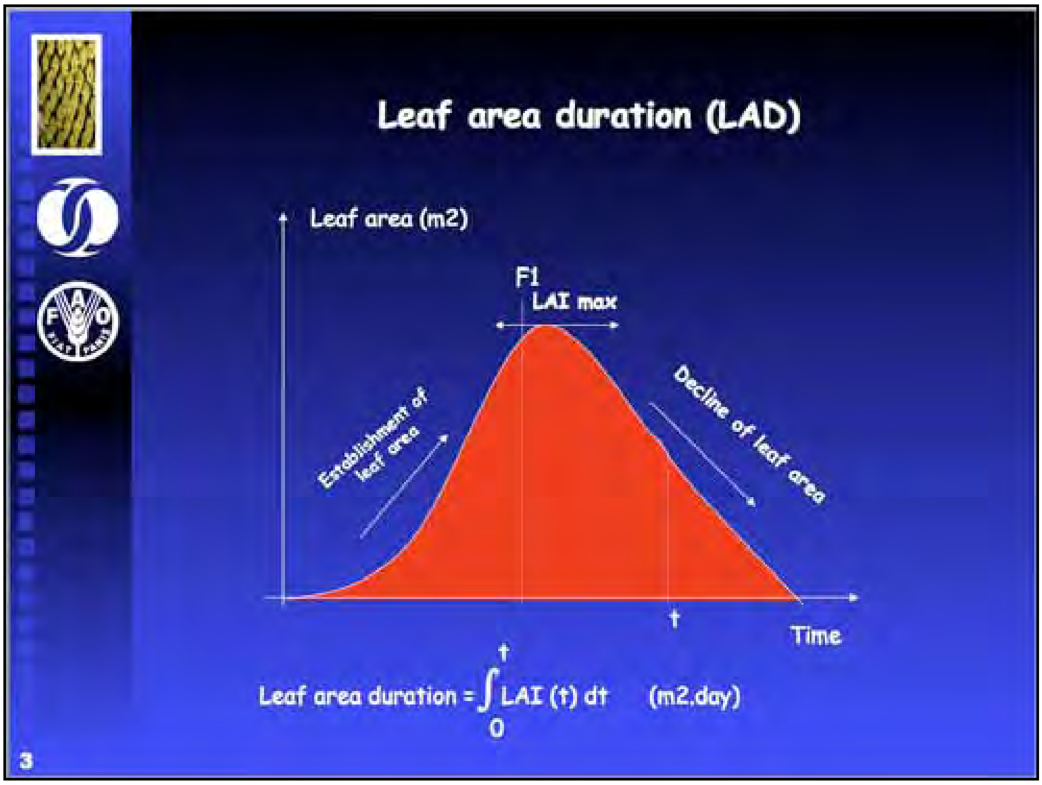
18


An optimum value for leaf area index (LAI)
Light interception
90
80
70
60
50
40
30
20
10
0
2.5
0
1
2
3
4
LAI
19

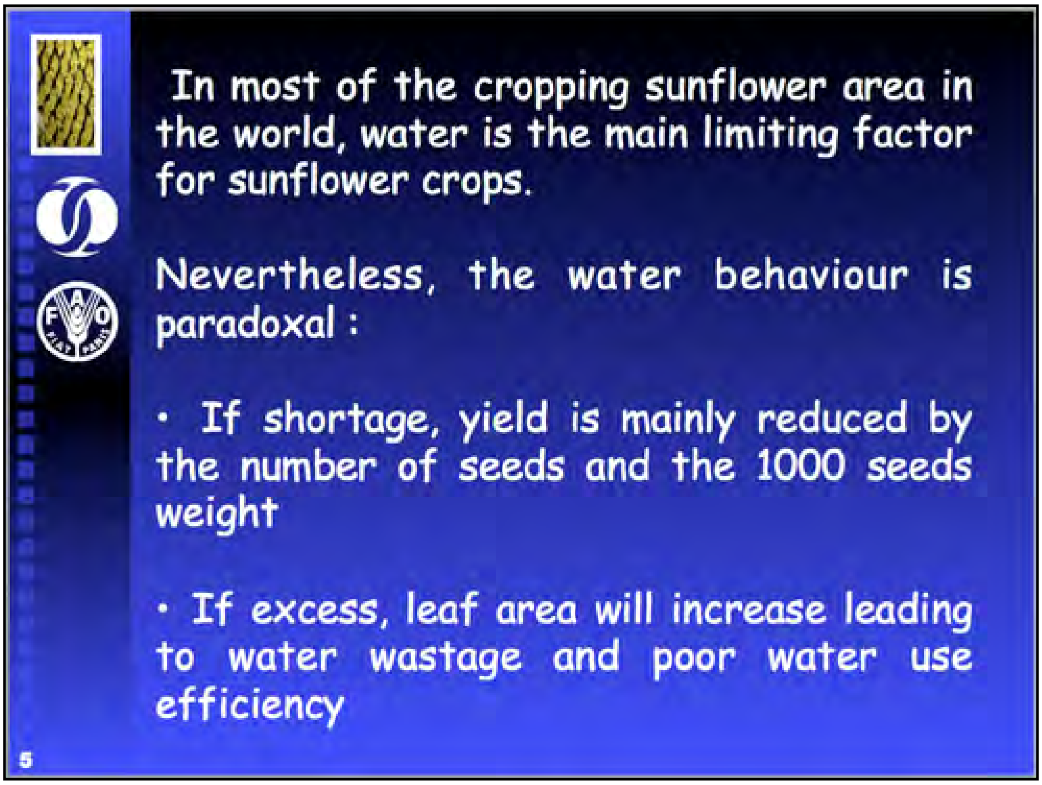

A simple method for checking leaf area on sunflower
l
L
L = length
l = Width
Leaf area = 0.747 x L x l
20

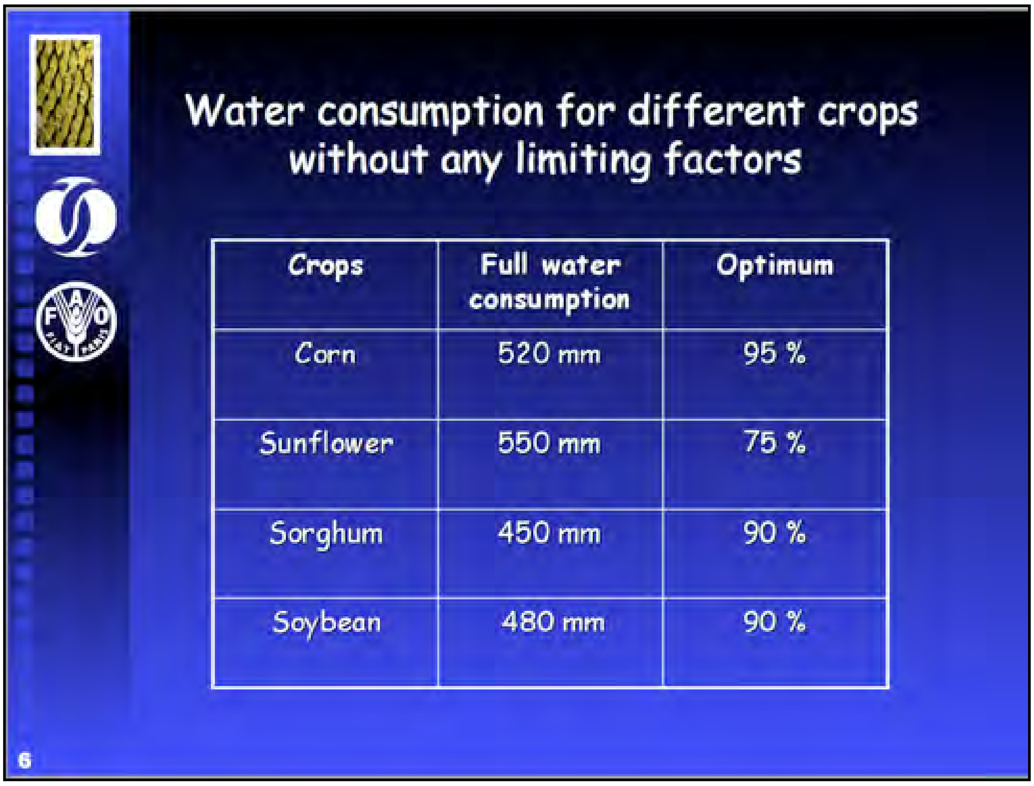

A simple method for checking leaf area on sunflower
Rank on the stem
Leaf area per leaf (cm2)
h
n
Rank on the stem
Leaf area per leaf (cm2)
Leaf area = surface of the triangle
= 0.5 x n x h
= 0.5 x n x Leaf area of the biggest leaf
= 0.5 x n x (0.747 x L x l)
1


Leaf area : moderation in growth, improvement in duration
Leaf area index
Sunflower
2.5 to 3
Corn
1.5 to 1.7
Bud 15 mm
Flowering
Initiation
Nb of seeds
1000 seed Weight
2


Leaf area duration (LAD)
Leaf area (m2)
F1
LAI max
Establishment of leaf area
Decline of leaf area
t
Time
Leaf area duration = $\int_0^t$ LAI (t) dt (m2.day)
3

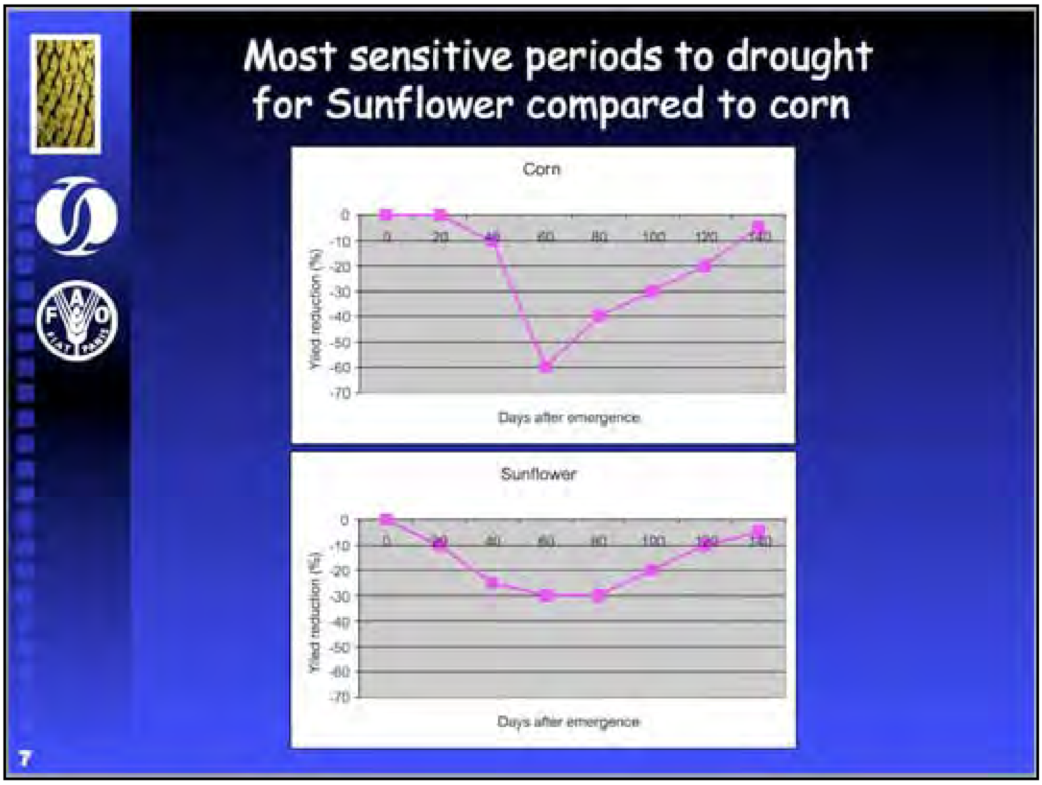

Sunflower and water relationships
4

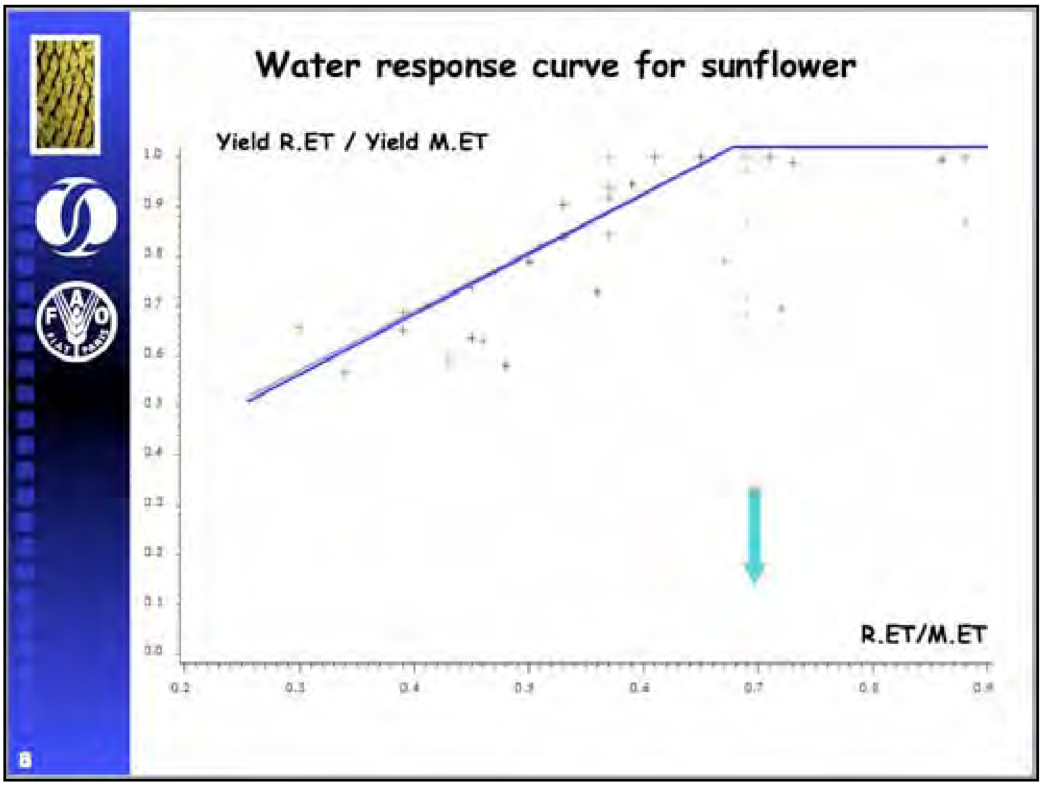


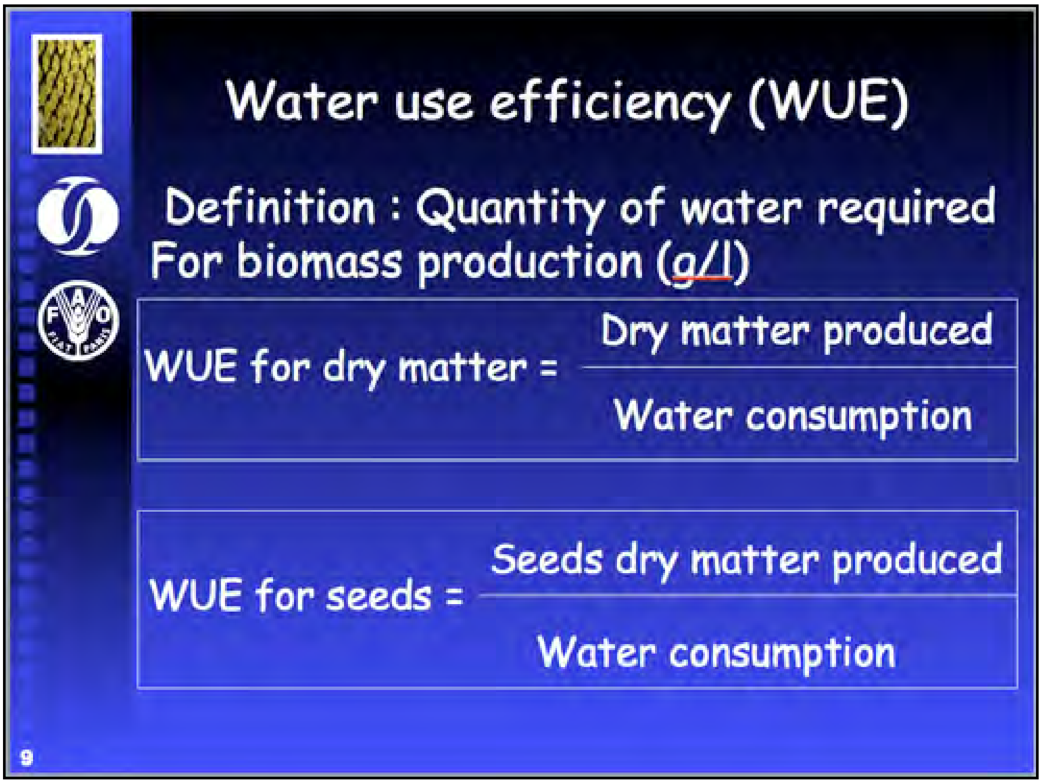

Water consumption for different crops without any limiting factors

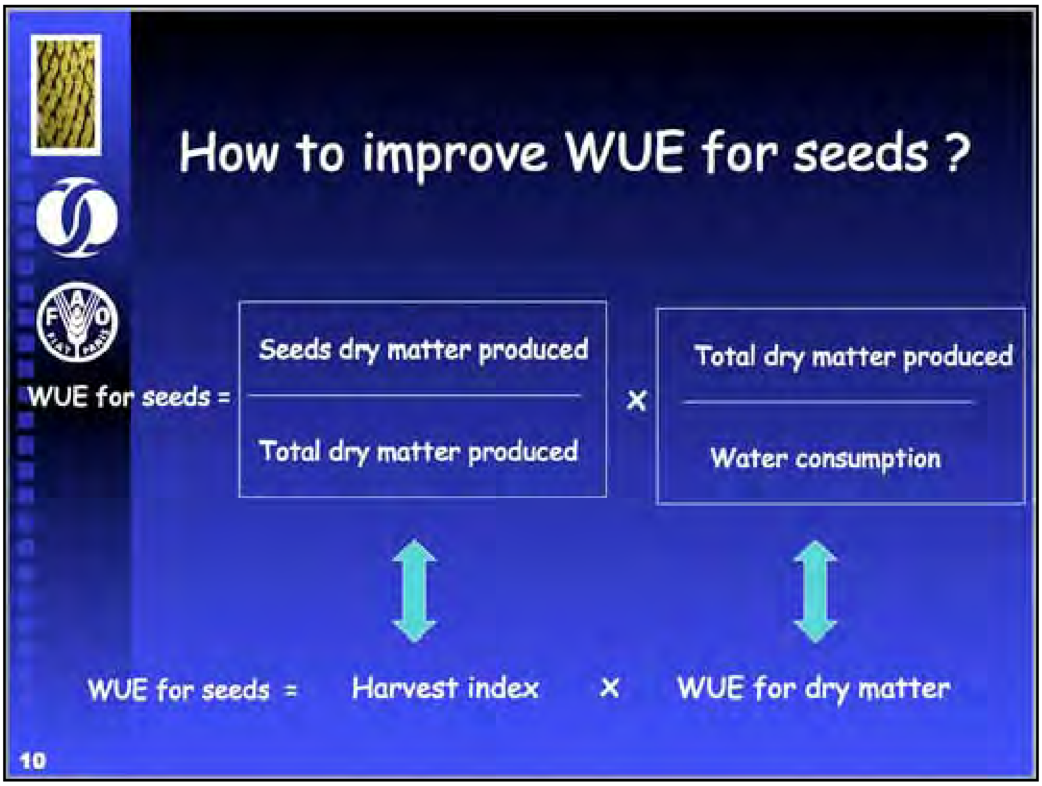
Crops	Full water consumption	Optimum
Corn	520 mm	95 %
Sunflower	550 mm	75 %
Sorghum	450 mm	90 %
Soybean	480 mm	90 %

6


Most sensitive periods to drought
for Sunflower compared to corn
Corn
0
-10
-20
-30
-40
-50
-60
-70
0
20
40
60
80
100
120
140
Yield reduction (%)
Days after emergence
Sunflower
0
-10
-20
-30
-40
-50
-60
-70
0
20
40
60
80
100
120
140
Yield reduction (%)
Days after emergence
7


Water response curve for sunflower
Yield R.ET / Yield M.ET
R.ET/M.ET
8

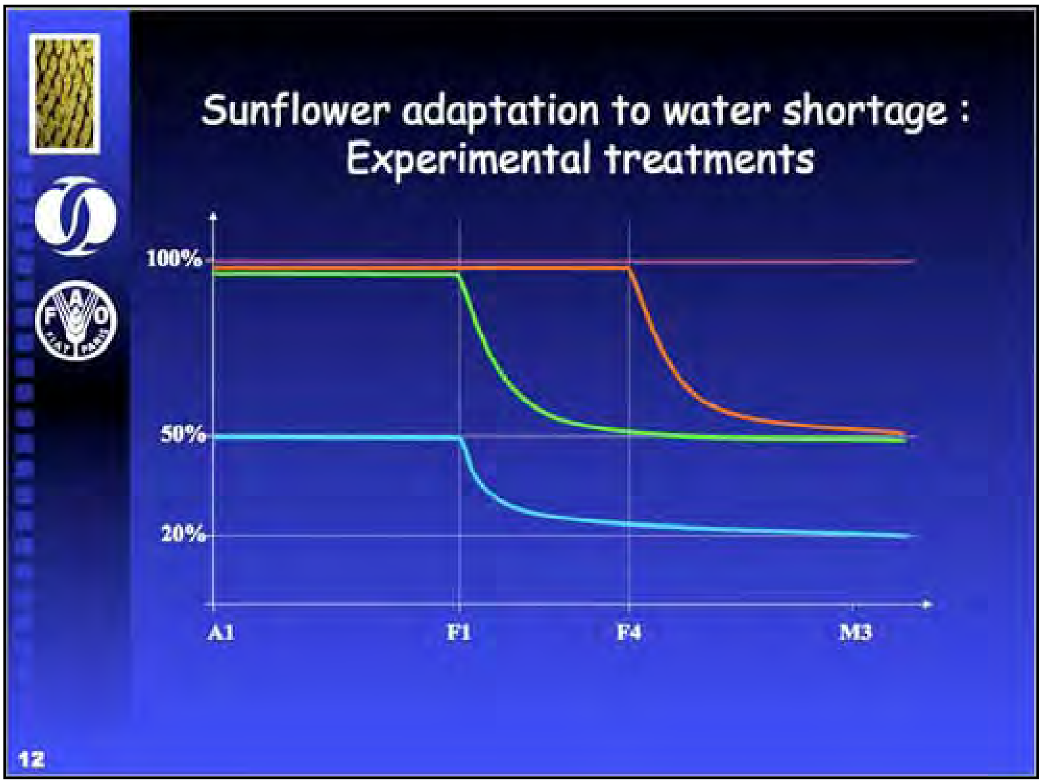

Water use efficiency (WUE)
Definition : Quantity of water required
For biomass production (g/l)
WUE for dry matter =
Dry matter produced
Water consumption
WUE for seeds =
Seeds dry matter produced
Water consumption
9


How to improve WUE for seeds ?
WUE for seeds =
Seeds dry matter produced
Total dry matter produced
x
Total dry matter produced
Water consumption
WUE for seeds =
Harvest index
x
WUE for dry matter
10

Gas exchanges according to different water treatments

Water treatment :	Max .ET	0,5 MET then Progressive adaptation	Max ET Stress during flowering
Water consumption (mm)	405	225	290
Total dry matter (g/plant)	111	120	96
Leaf area (dm^2/plant)	55,0	36,6	21,9
Water potential (Mpa) :			
▪ soil	-0,3	-1,0	-0,3
▪ leaves	- 0,7	- 1,1	- 1,1
Relative water content (% max)	93,1	85,4	88,0
Stomatal resistance (s/cm) :			
▪ upper face	0,50	0,42	0,43
▪ lower face	1,15	0,72	0,82
Transpiration ($g/dm^2/h$)	12,5 b	14,6 b	16,2 b
Net photosynthesis ($mg\ CO_2/dm^2/h$)	24,0 bc	45,1 a	30,3 b
Photosynthesis/transpiration ($x10^3$)	1,9	3,1	1,9

11



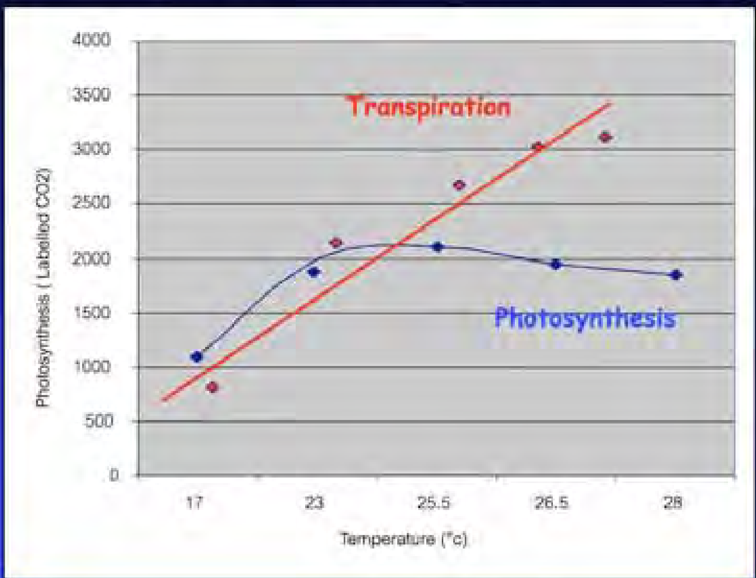
Sunflower adaptation to water shortage

Water treatment	Water consumption (l/plt)	Dry matter produce (g/plt)	Seed dry matter (g/plt)	Effic. for DM (g/l)	Effic. for seed (g/l)	Seed harvest index
Full requirements	75.8	161	56.8	2.1	0.7	0.35
Full requirts until F1 then progressive stress	32.5	104.2	33.8	3.2	1	0.32
50 % of the full requirts until F1 then 30%	16.1	67.4	23.3	4.2	1.4	0.35

Efficiency = quantity of matter (seed or total) produced per litre of water used
Harvest Index = Seed dry matter / total dry matter produced

13

Improvement in Efficiency can be explained by the Ratio Photosynthesis /transpiration



14

Kinetics of photosynthesis and transpiration over time, according to different water supplies

15

Foliar structures of different species (1)

Species	Stomas nb. upper face	Stomas nb. Lower face	Average size (L x l) (micron)	Average distance on the epiderm between 2 stomas (micron)
Sunflower	85	156	38 X 7	91
Corn	53	168	19 X 5	137
Wheat	33	14	18 X 7	302
Soybean	7	17	16 X 4	250

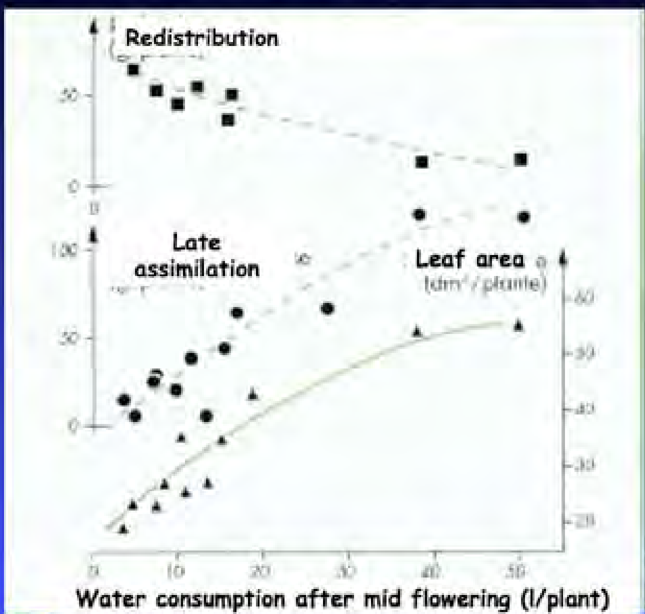
16

Foliar structures of different species (2)

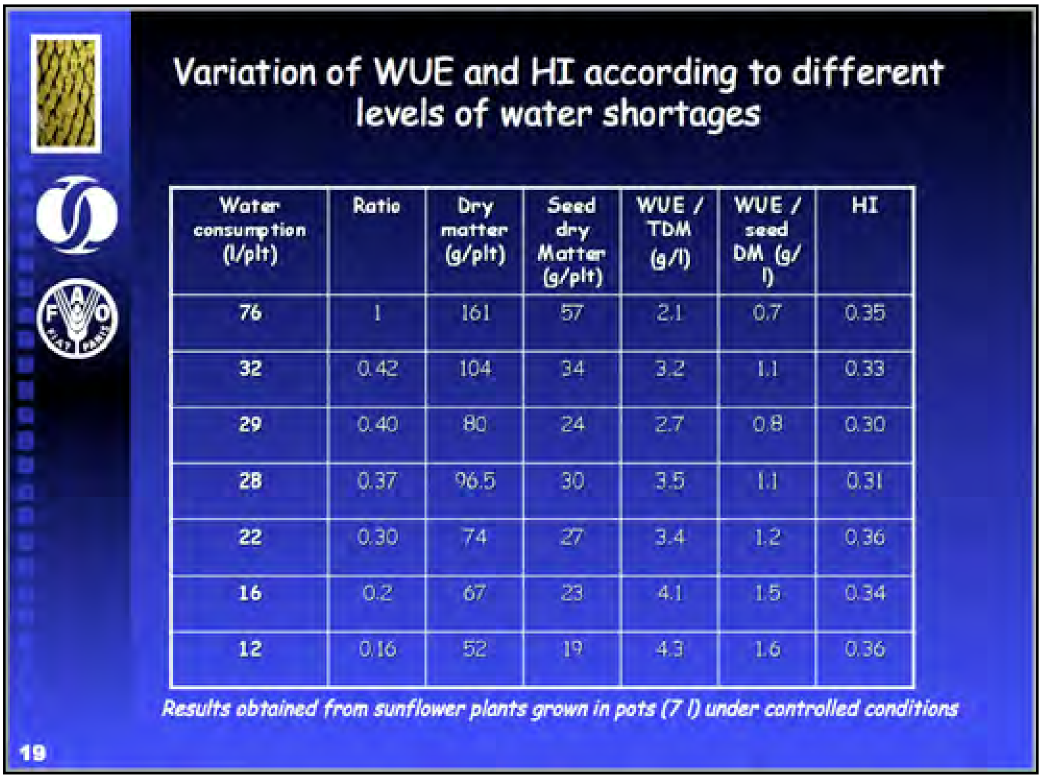
Species	Stomatal resistance (s/m)	Transpi-ration (l/d/dm2)	Leaf water potential (bars)	WUE for Dry matter (g/l)
Sunflower	60 - 100	4	- 8	2.5
Corn	200 - 300	3	- 3	-
Wheat	200	3	- 4	-
Soybean	80 - 120	3.8	- 4	4

17

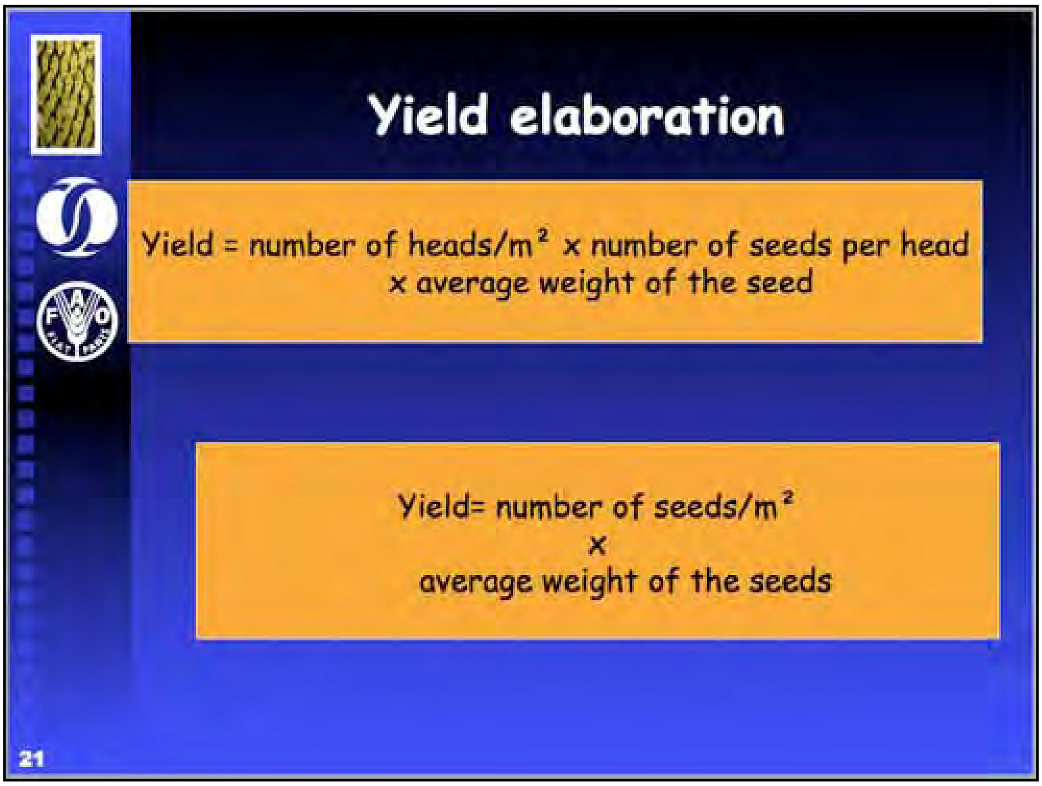
Sunflower adaptation to water shortage

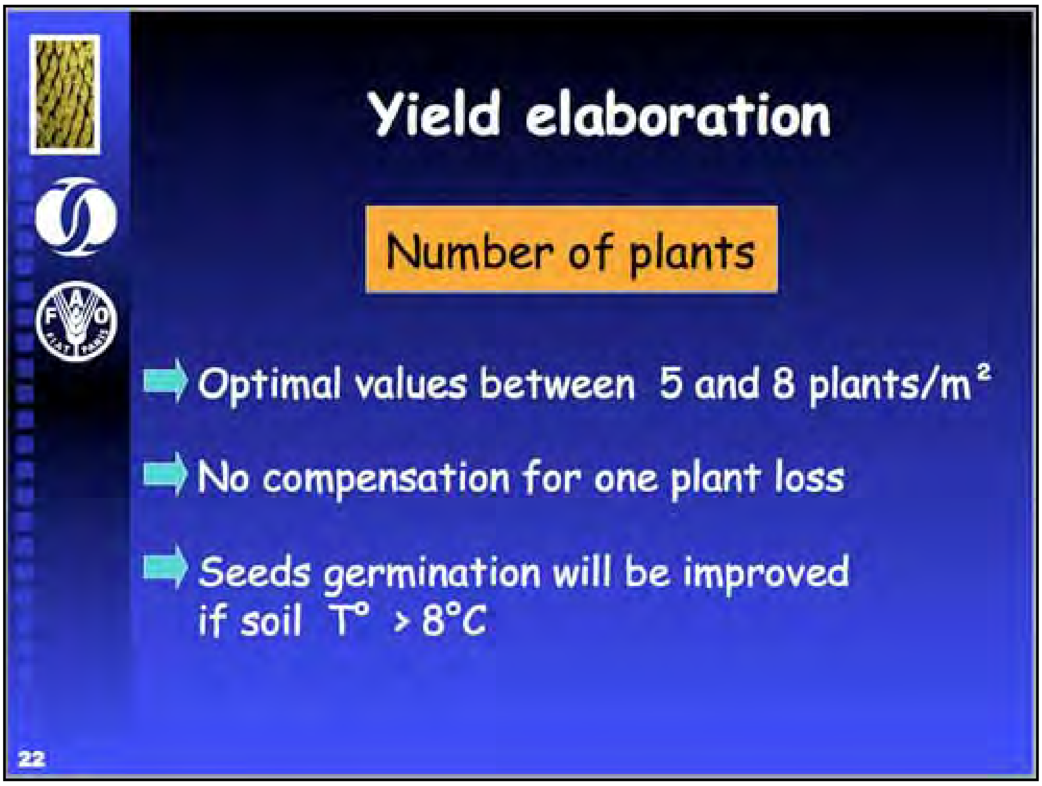


18



Water consumption (l/plt)	Ratio	Dry matter (g/plt)	Seed dry Matter (g/plt)	WUE / TDM (g/l)	WUE / seed DM (g/l)	HI
76	1	161	57	2.1	0.7	0.35
32	0.42	104	34	3.2	1.1	0.33
29	0.40	80	24	2.7	0.8	0.30
28	0.37	96.5	30	3.5	1.1	0.31
22	0.30	74	27	3.4	1.2	0.36
16	0.2	67	23	4.1	1.5	0.34
12	0.16	52	19	4.3	1.6	0.36


Yield elaboration
Yield = number of heads/m² x number of seeds per head x average weight of the seed
Yield= number of seeds/m² x average weight of the seeds
21


Yield elaboration
Number of plants
Optimal values between 5 and 8 plants/m²
No compensation for one plant loss
Seeds germination will be improved if soil T° > 8°C
22

Effect of Plant density on characteristics of the capitulum

Plant density (plant/ sqm)	Head diameter (cm)	Stem diameter (cm)	Number of parastics
2 to 3	> 30	-	144
4 to 7	21 to 27	2.5 to 3.5	89
7 to 10	11 to 21	1.8 to 2.5	55
10 to 12	6 to 11	1.1 to 1.8	34

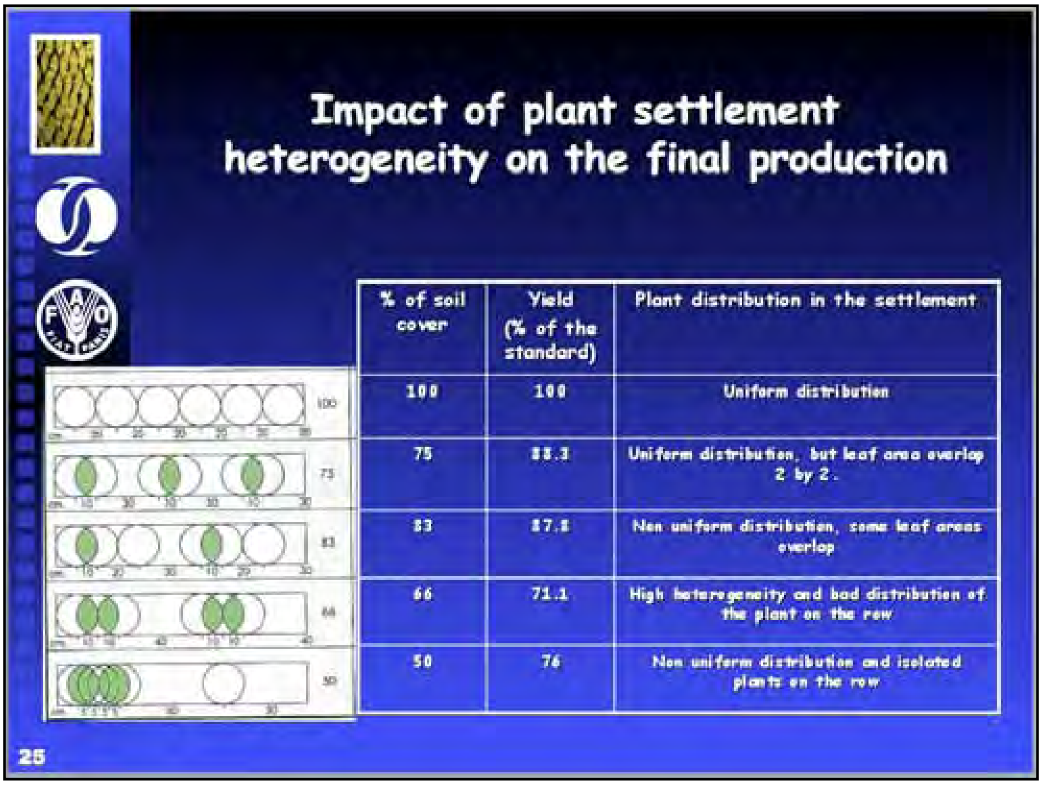
Un = Un-1 + Un-2

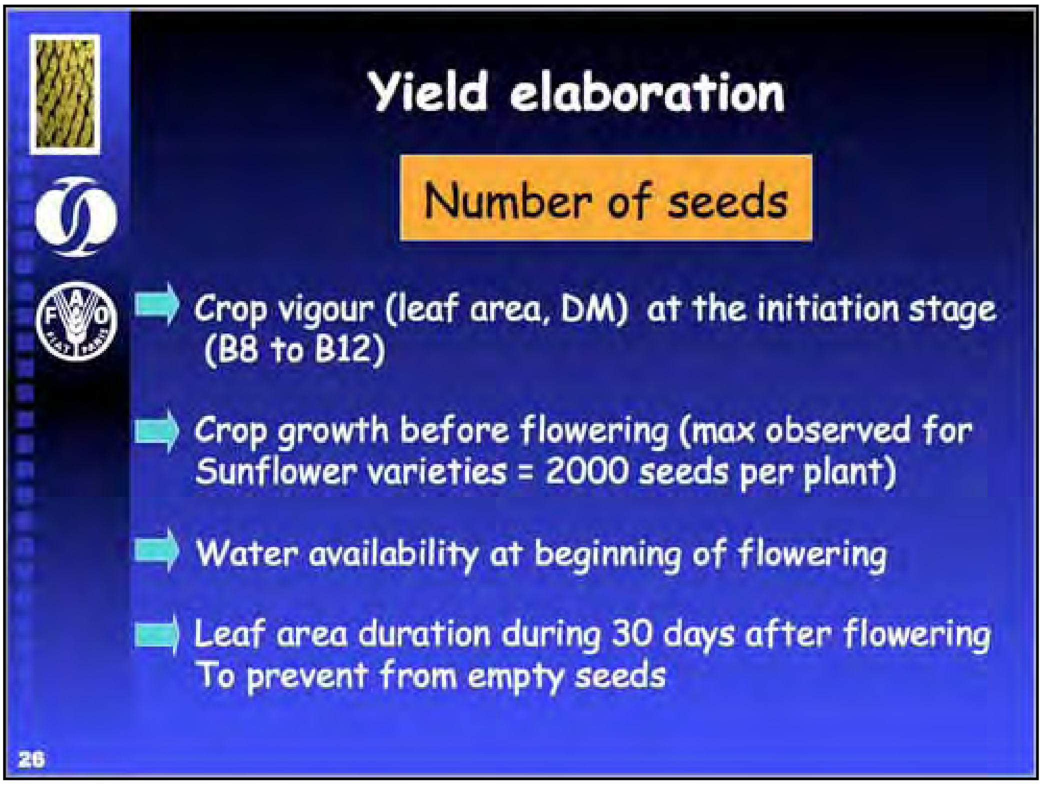
23

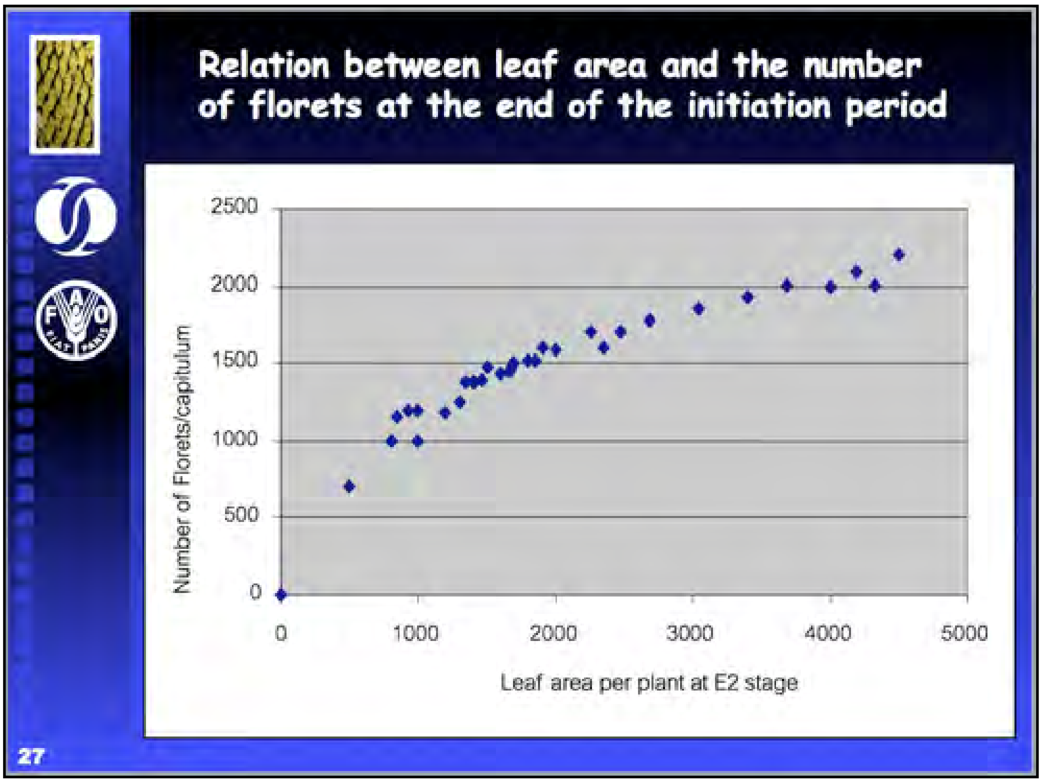
Effect of the sowing speed on yield: Effect of plant distribution heterogeneity

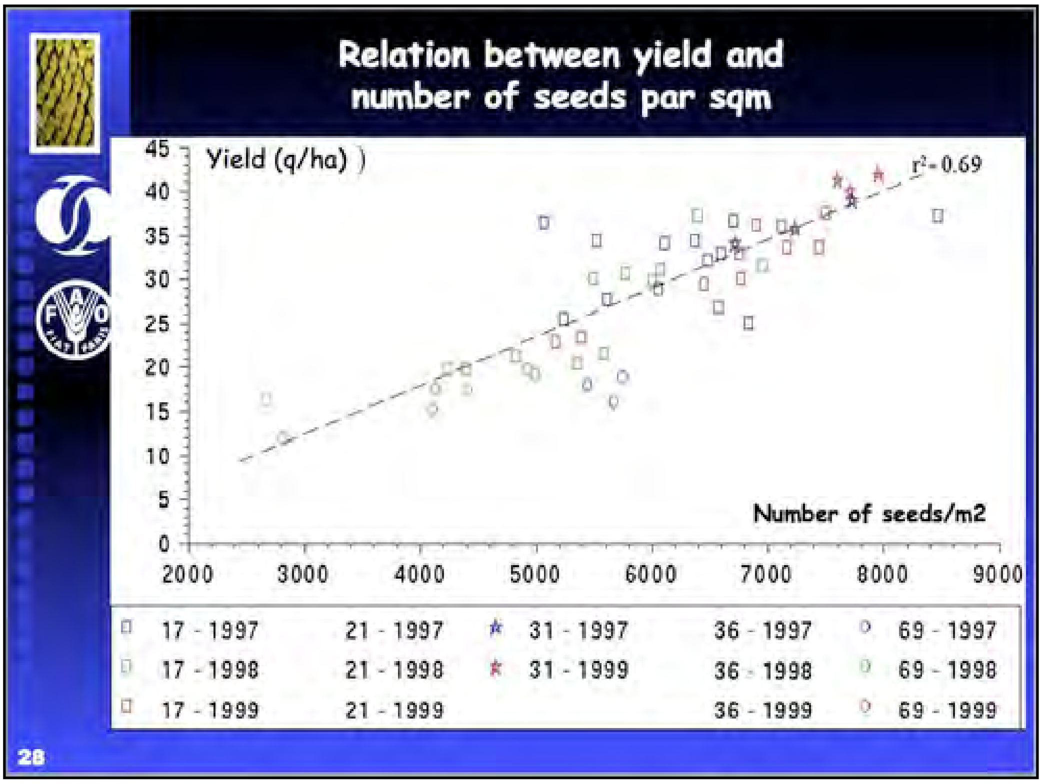
Speed of the driller (km/h)	Yield (q/ha)
2	28
4	26
6	24
8	22

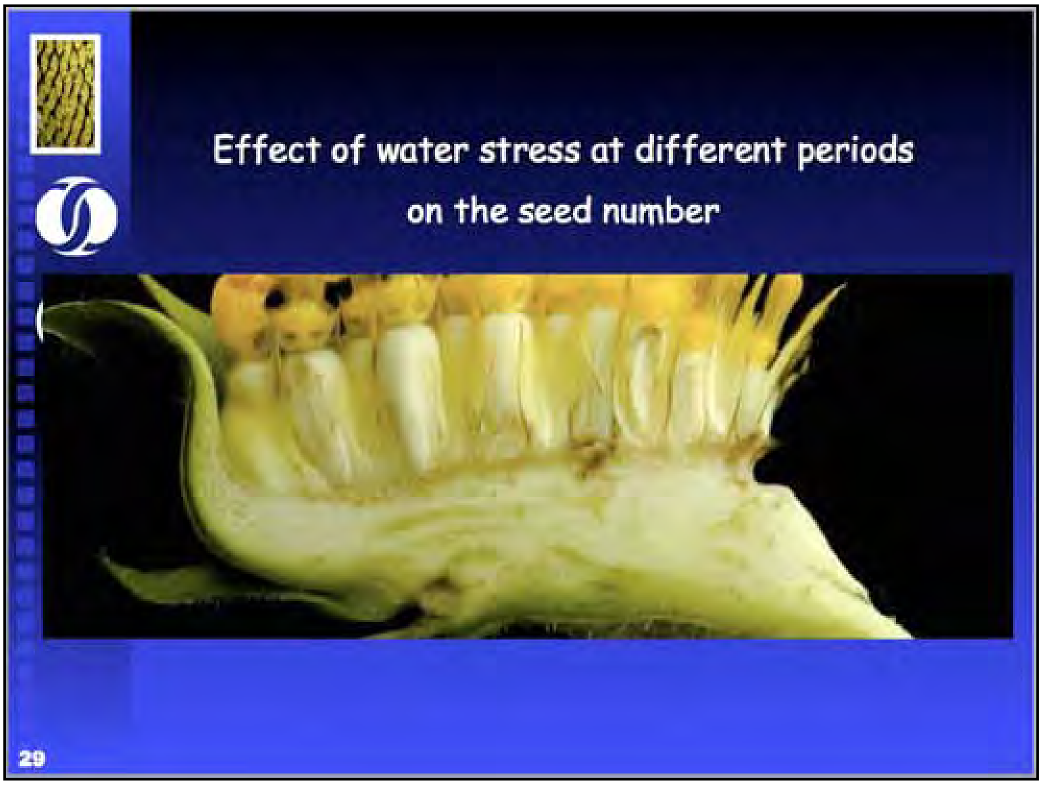
24

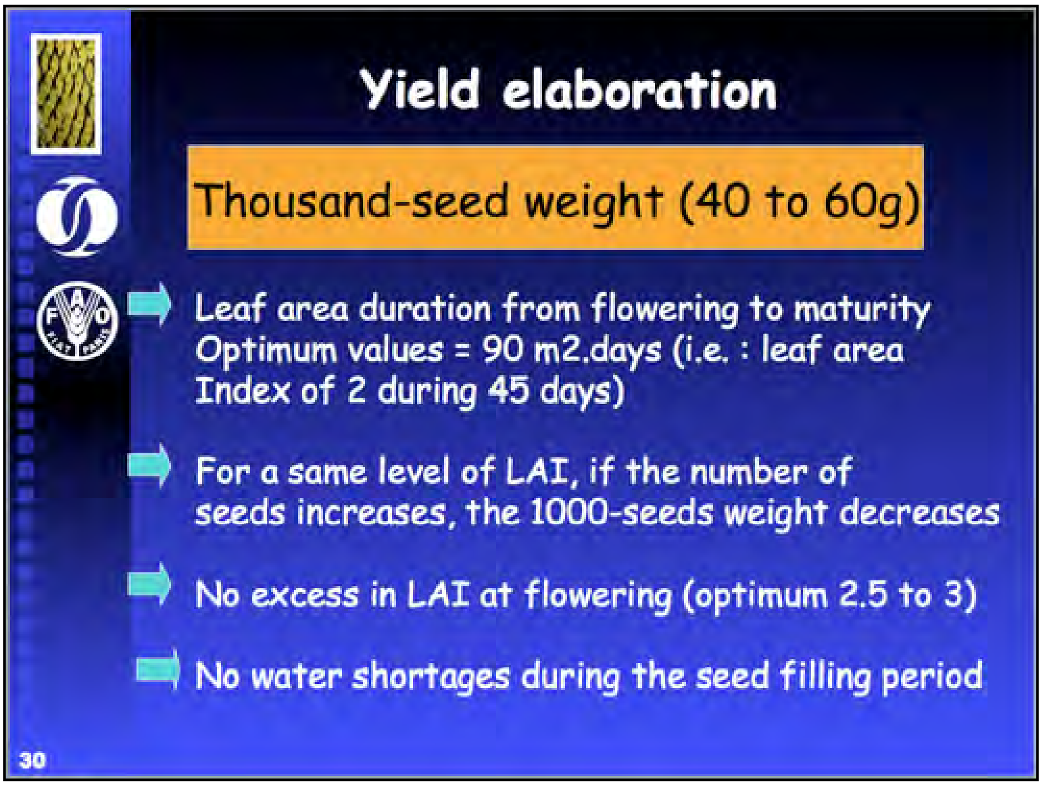

Impact of plant settlement heterogeneity on the final production
% of soil cover
Yield (% of the standard)
Plant distribution in the settlement
100
100
Uniform distribution
75
88.3
Uniform distribution, but leaf area overlap 2 by 2.
83
87.8
Non uniform distribution, some leaf areas overlap
66
71.1
High heterogeneity and bad distribution of the plant on the row
50
76
Non uniform distribution and isolated plants on the row
25

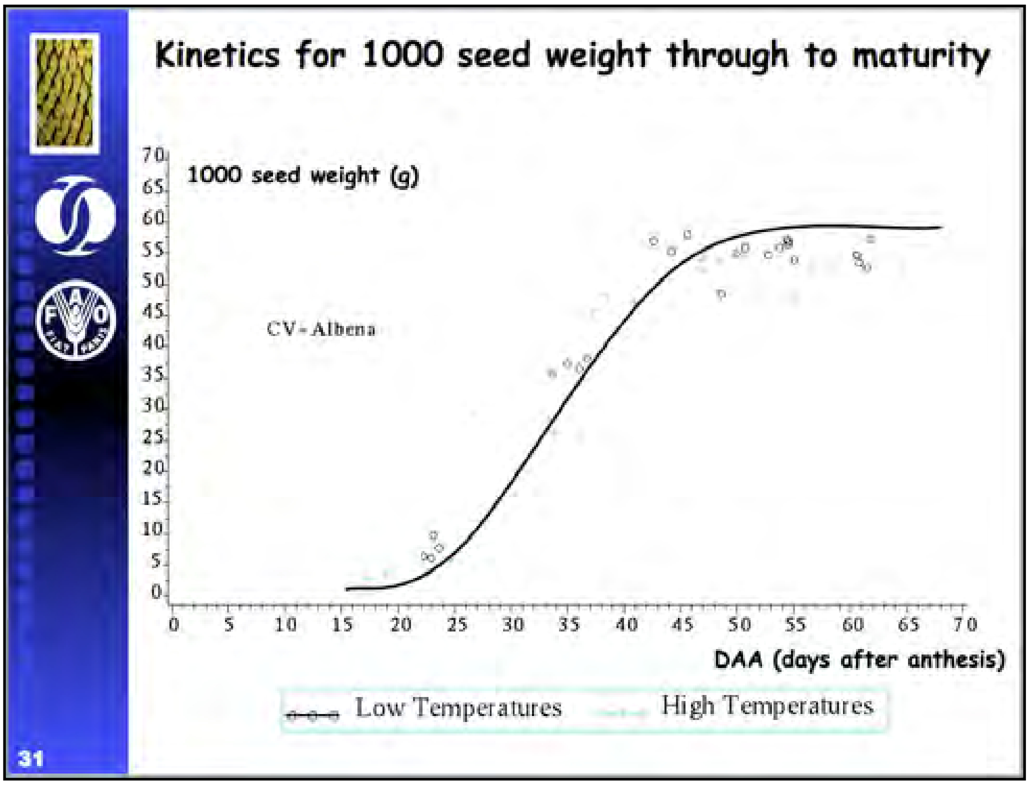

Yield elaboration
Number of seeds
Crop vigour (leaf area, DM) at the initiation stage (B8 to B12)
Crop growth before flowering (max observed for Sunflower varieties = 2000 seeds per plant)
Water availability at beginning of flowering
Leaf area duration during 30 days after flowering
To prevent from empty seeds
26


Relation between leaf area and the number of florets at the end of the initiation period
2500
2000
1500
1000
500
0
Number of Florets/capitulum
0
1000
2000
3000
4000
5000
Leaf area per plant at E2 stage
27


Relation between yield and number of seeds par sqm
Yield (q/ha)
r² = 0.69
45
40
35
30
25
20
15
10
5
0
2000
3000
4000
5000
6000
7000
8000
9000
Number of seeds/m2
17 - 1997
17 - 1998
17 - 1999
21 - 1997
21 - 1998
21 - 1999
31 - 1997
31 - 1999
36 - 1997
36 - 1998
36 - 1999
69 - 1997
69 - 1998
69 - 1999
28


Effect of water stress at different periods
on the seed number
29

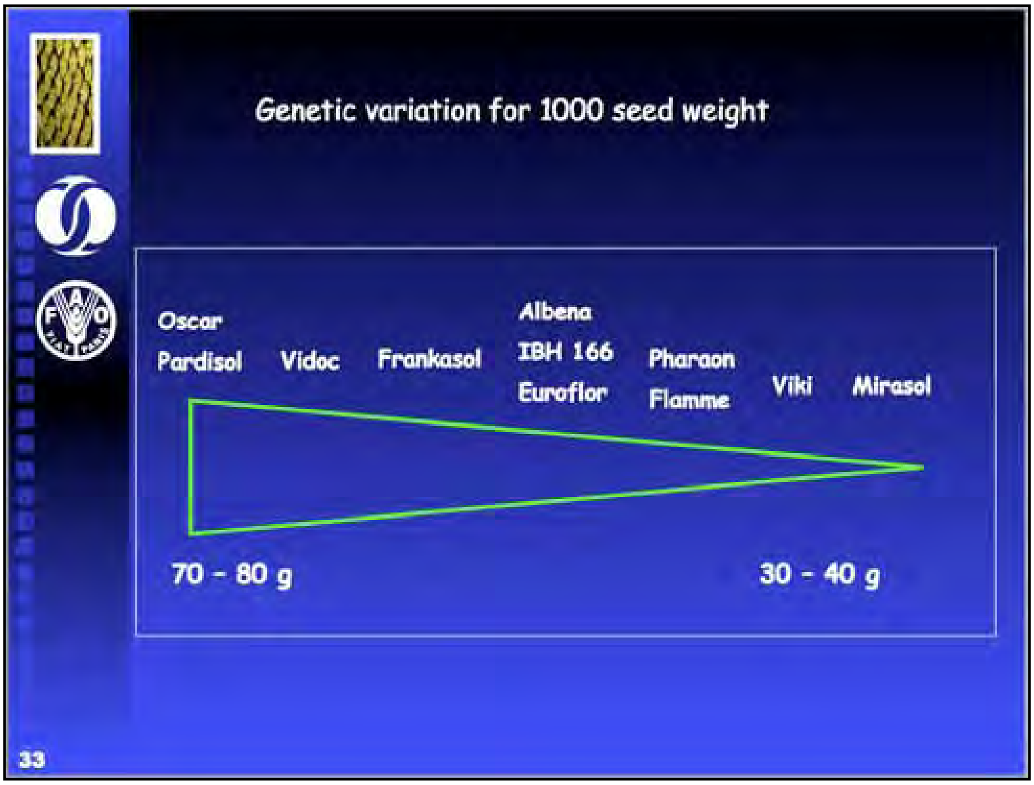

Yield elaboration
Thousand-seed weight (40 to 60g)
Leaf area duration from flowering to maturity
Optimum values = 90 m2.days (i.e. : leaf area
Index of 2 during 45 days)
For a same level of LAI, if the number of
seeds increases, the 1000-seeds weight decreases
No excess in LAI at flowering (optimum 2.5 to 3)
No water shortages during the seed filling period
30



1000 seed Weight according to location of the seeds on the capitulum (in g)

Rank on the parastic / Varieties	1 (Outside)	3	5	7	9	12 (Inside)
Albena	67	63	56	48	55	54
Euroflor	49	53	51	50	49	48
Viki	50	46	44	45	45	41

32

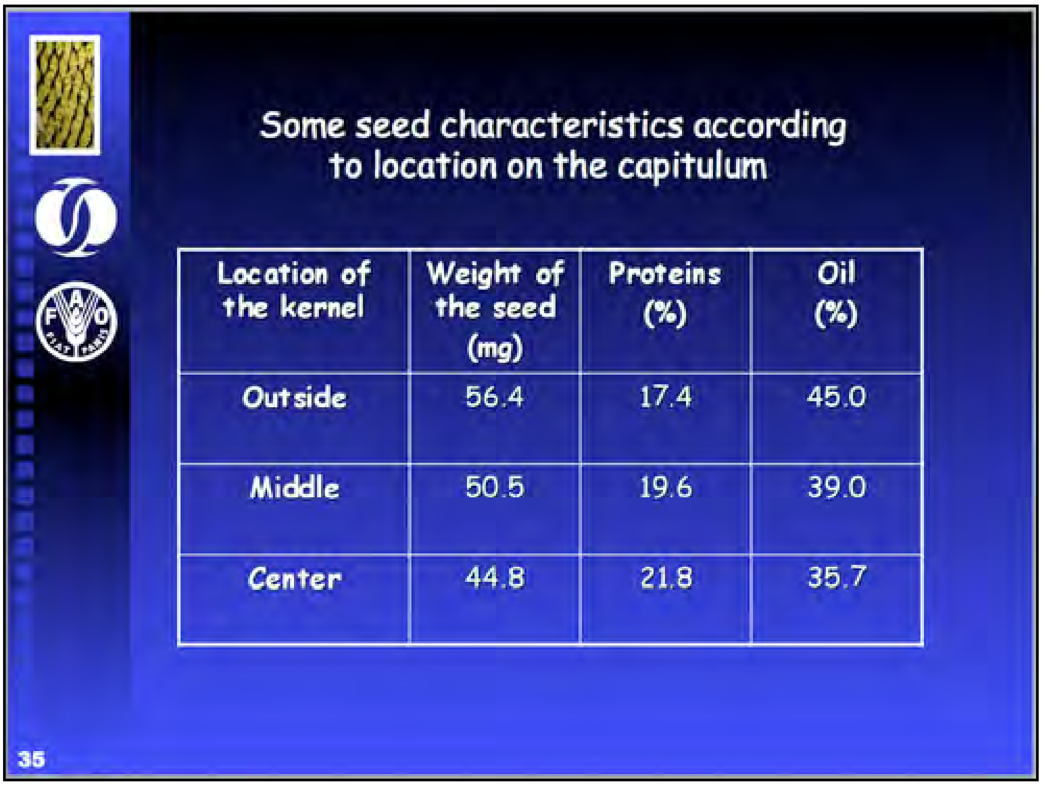


Effect of different levels of water deficit applied at different stages on the 1000 seed weight

RET/MET ratio	0,3	0,4	0,5	0,6	0,7	0,8
Phase 1 (< F1)	nc	nc	- 20%	- 10%	-	-
Phase 2 (F1-F4)	nc	- 22%	- 22%	- 15%	5%	-
Phase 3 (> F4)	- 50%	- 46%	- 28%	- 20%	- 10%	- 5%

NC = no data MET = Full requirements RET = relative requirements

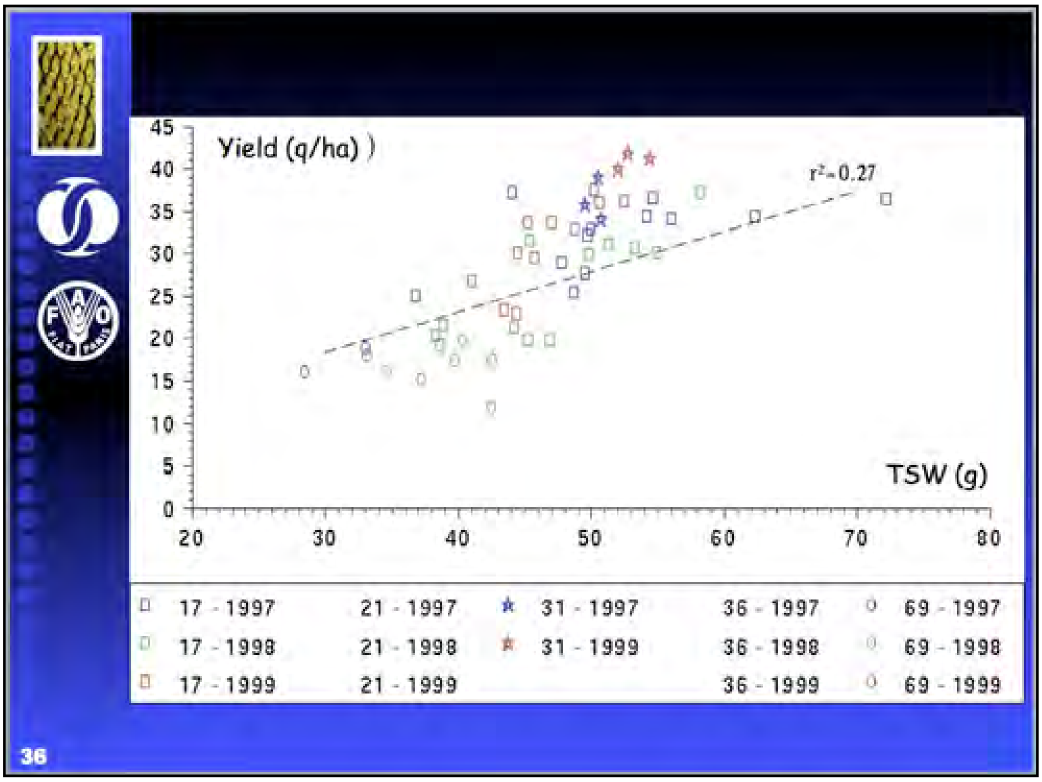
34



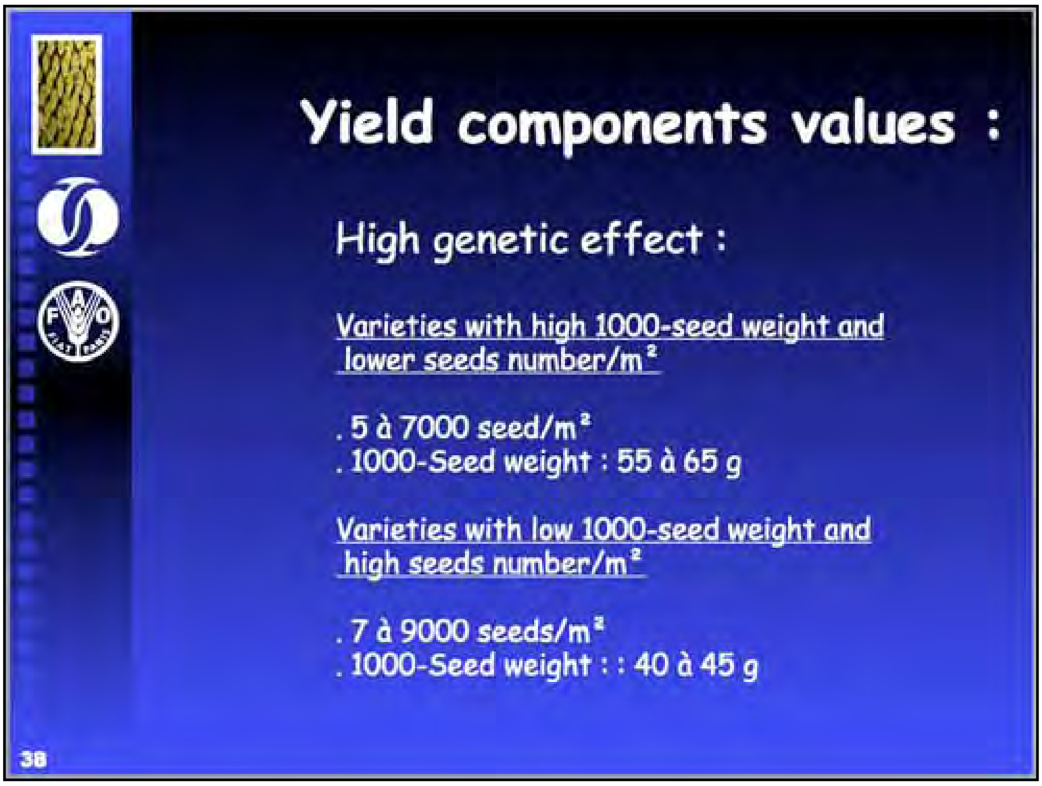
Some seed characteristics according to location on the capitulum

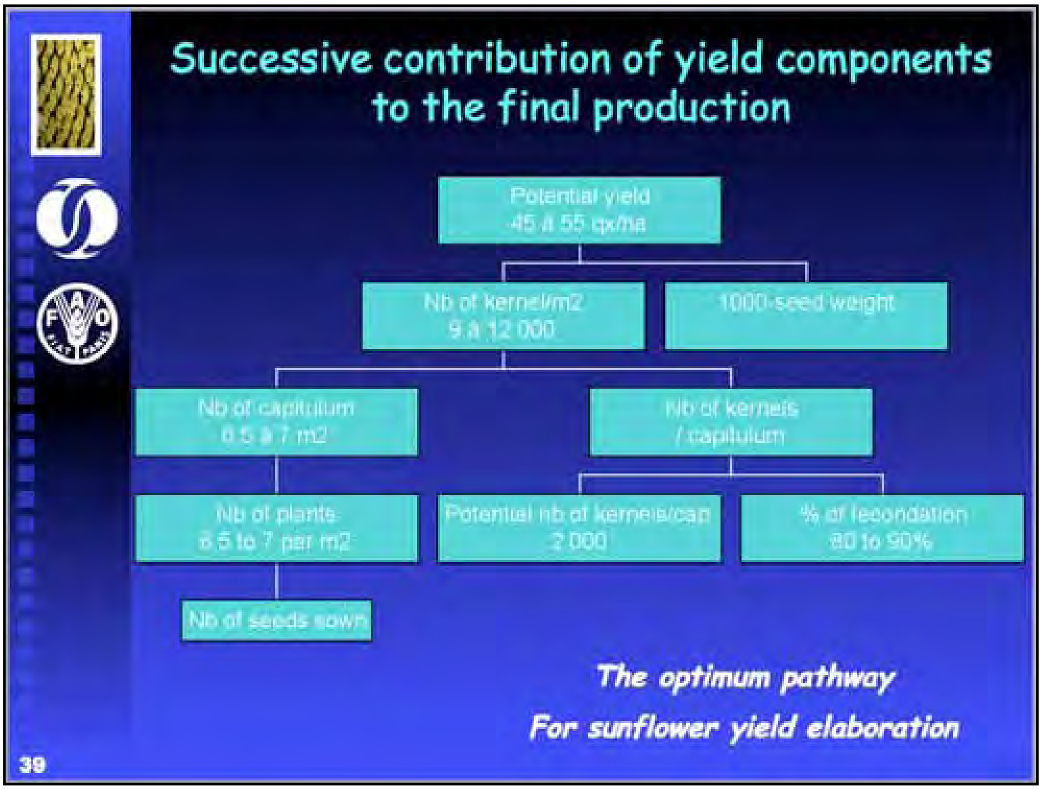
Location of the kernel	Weight of the seed (mg)	Proteins (%)	Oil (%)
Outside	56.4	17.4	45.0
Middle	50.5	19.6	39.0
Center	44.8	21.8	35.7

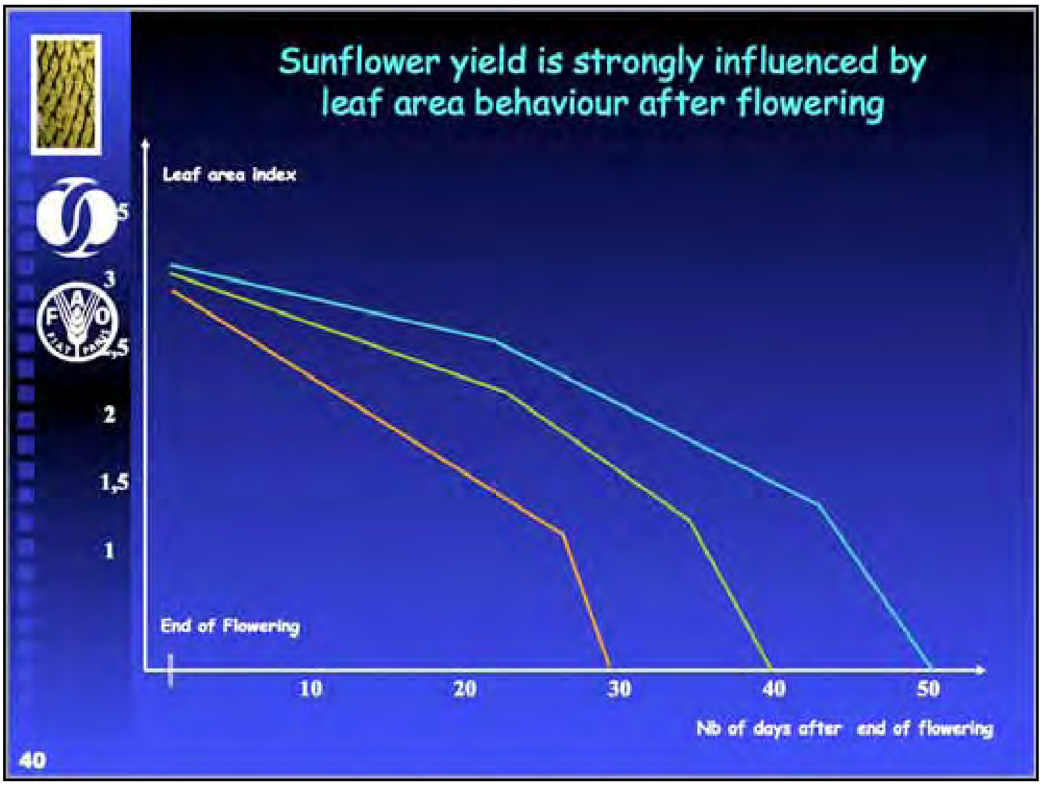
35

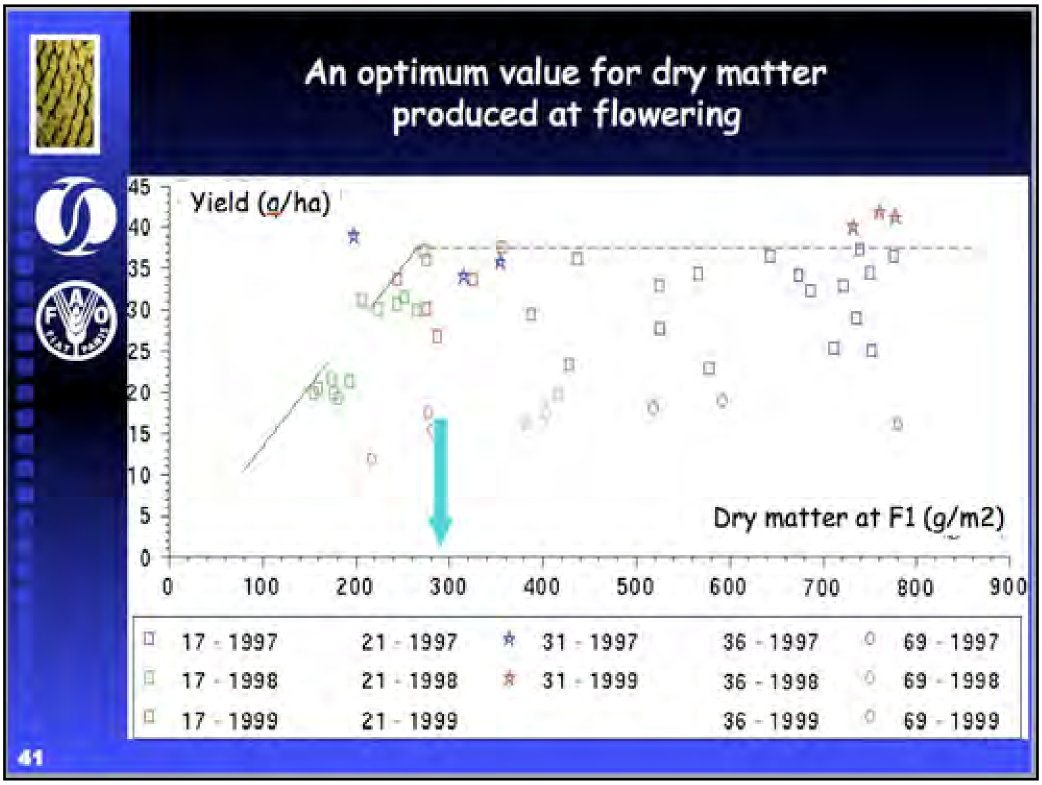


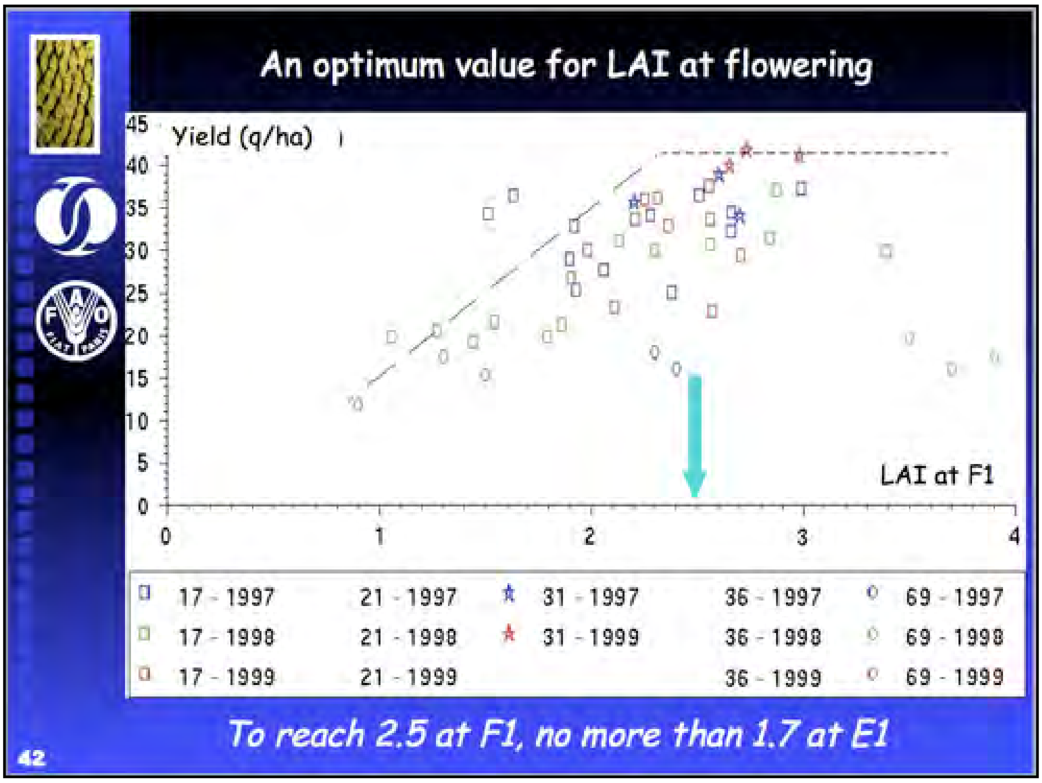
Albéna	Euroflor	Flamme	Frankasol	IBH 166	Viki
23.5	24.2	25.9	28.9	27.6	24.5

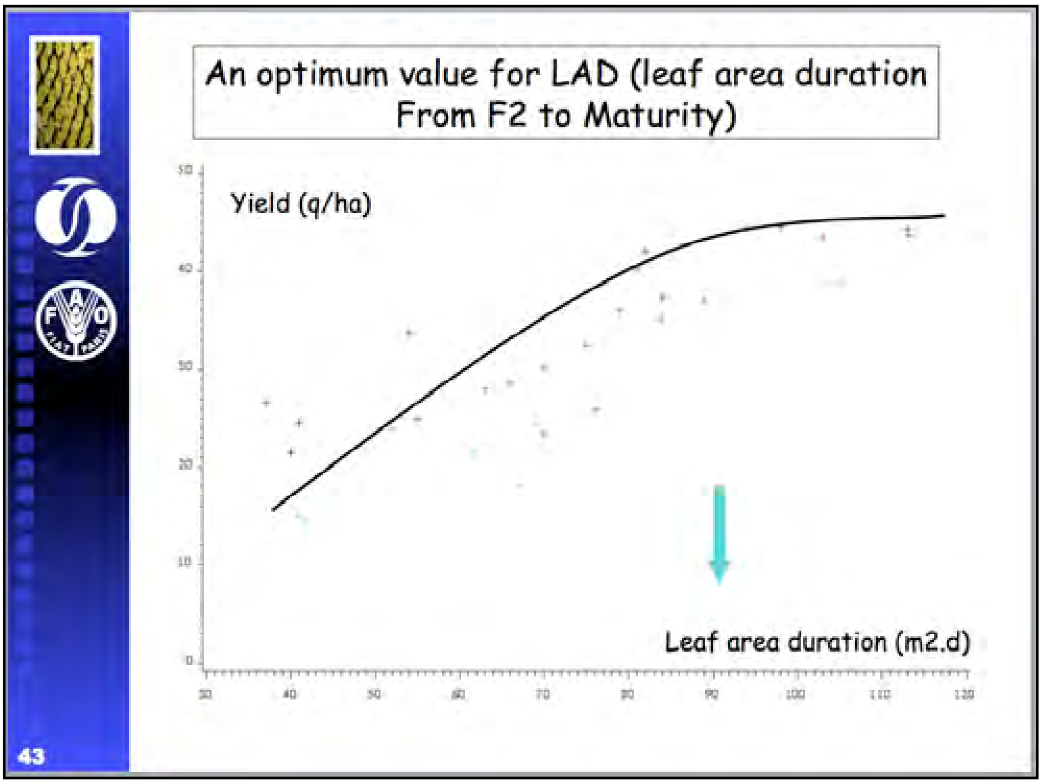


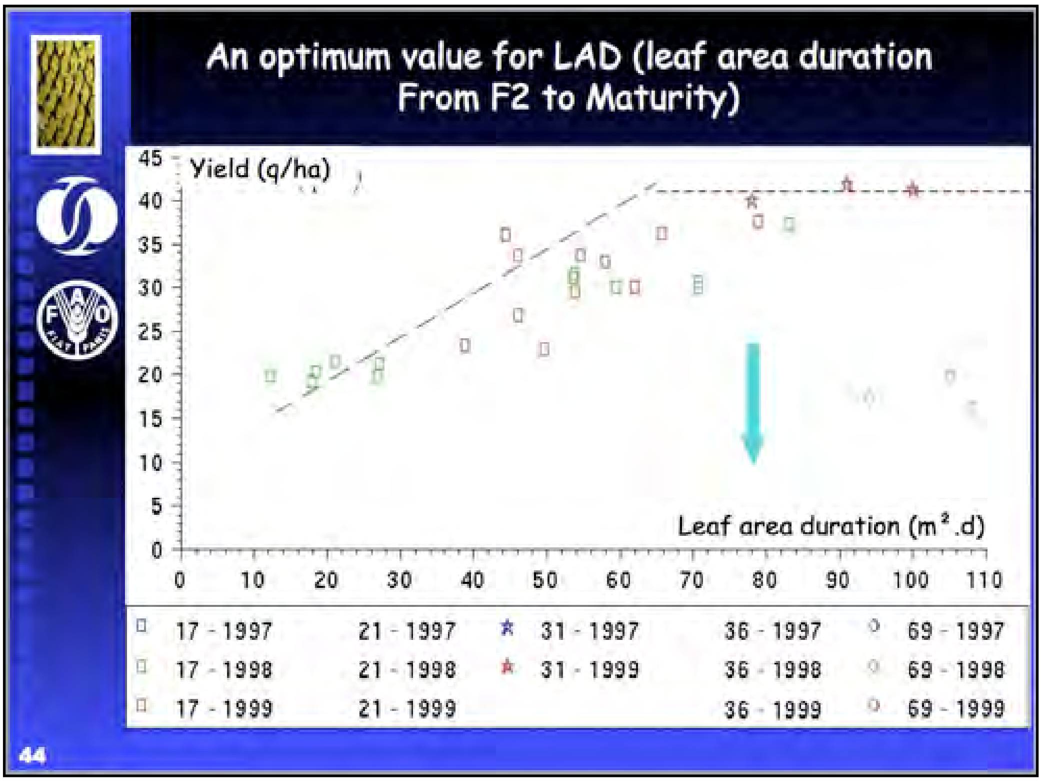

Successive contribution of yield components to the final production
Potential yield
45 à 55 qx/ha
Nb of kernel/m2
9 à 12 000
1000-seed weight
Nb of capitulum
6.5 à 7 m2
Nb of kernels
/ capitulum
Nb of plants
6.5 to 7 per m2
Potential nb of kernels/cap
2 000
% of fecondation
80 to 90%
Nb of seeds sown
The optimum pathway
For sunflower yield elaboration
39

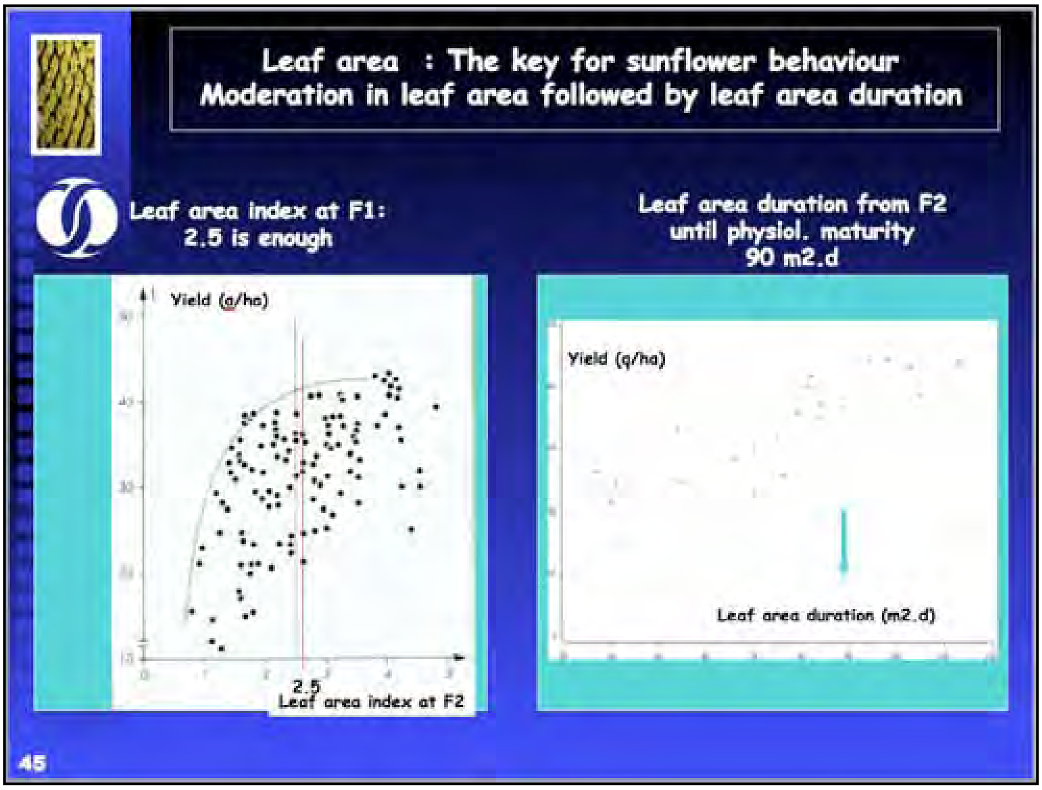

Sunflower yield is strongly influenced by leaf area behaviour after flowering
Leaf area index
3
2
1,5
1
End of Flowering
10
20
30
40
50
Nb of days after end of flowering
40

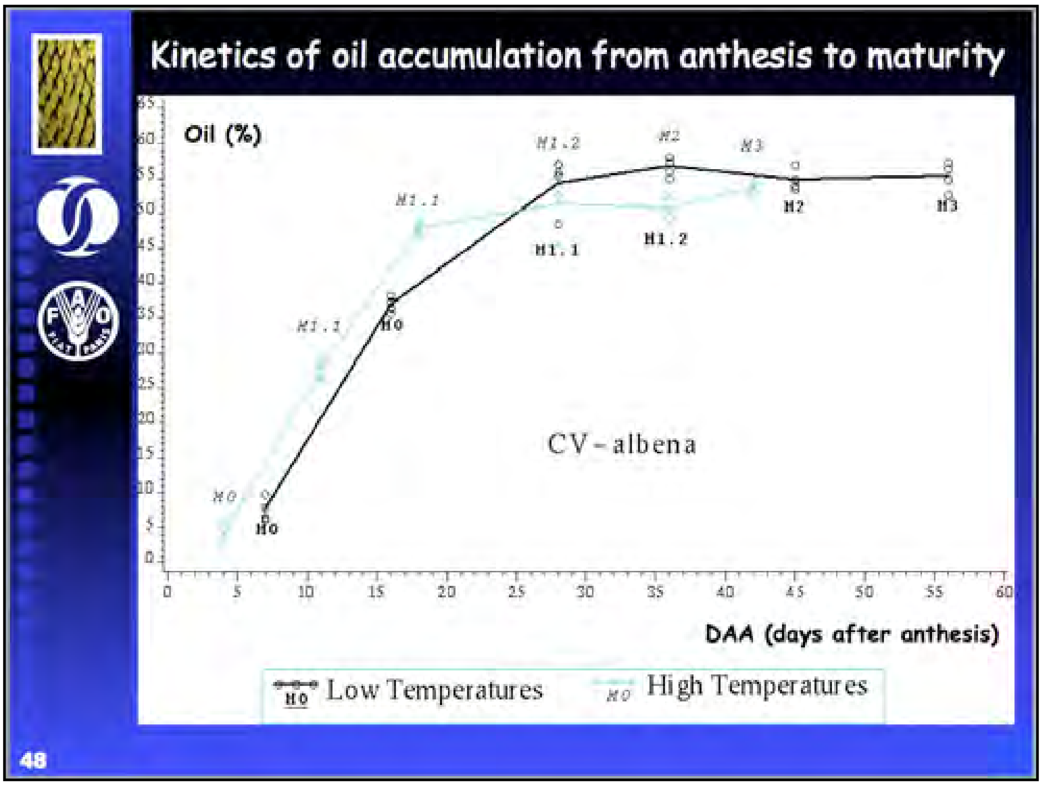

An optimum value for dry matter produced at flowering
Yield (q/ha)
Dry matter at F1 (g/m2)
0
5
10
15
20
25
30
35
40
45
0
100
200
300
400
500
600
700
800
900
17 - 1997
17 - 1998
17 - 1999
21 - 1997
21 - 1998
21 - 1999
31 - 1997
31 - 1999
36 - 1997
36 - 1998
36 - 1999
69 - 1997
69 - 1998
69 - 1999
41

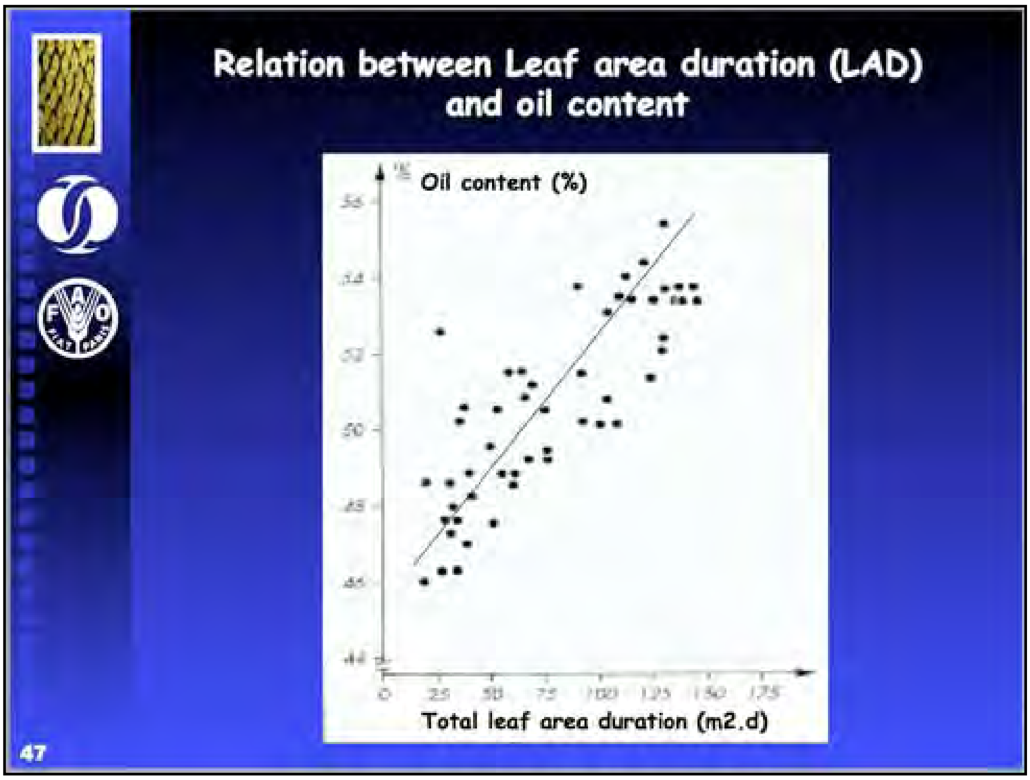

An optimum value for LAI at flowering
Yield (q/ha)
LAI at F1
0
5
10
15
20
25
30
35
40
45
0
1
2
3
4
17 - 1997
17 - 1998
17 - 1999
21 - 1997
21 - 1998
21 - 1999
31 - 1997
31 - 1999
36 - 1997
36 - 1998
36 - 1999
69 - 1997
69 - 1998
69 - 1999
To reach 2.5 at F1, no more than 1.7 at E1
42


An optimum value for LAD (leaf area duration
From F2 to Maturity)
Yield (q/ha)
Leaf area duration (m2.d)
43

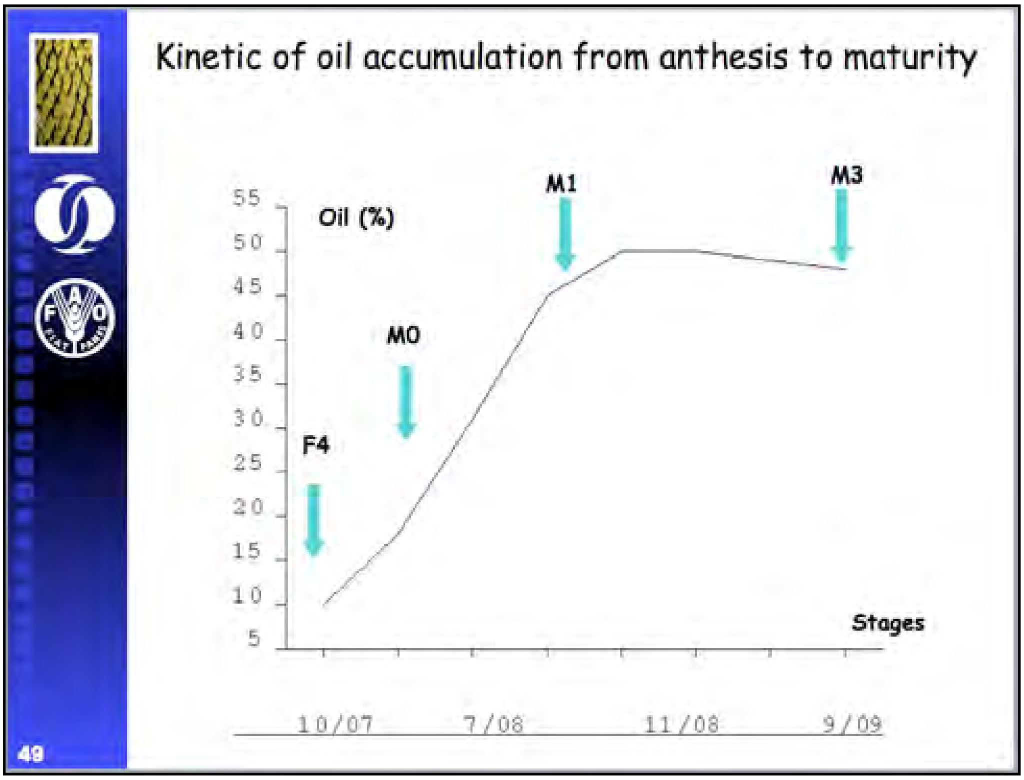

An optimum value for LAD (leaf area duration
From F2 to Maturity)
Yield (q/ha)
Leaf area duration (m².d)
17 - 1997
17 - 1998
17 - 1999
21 - 1997
21 - 1998
21 - 1999
31 - 1997
31 - 1999
36 - 1997
36 - 1998
36 - 1999
69 - 1997
69 - 1998
69 - 1999
44


Leaf area : The key for sunflower behaviour
Moderation in leaf area followed by leaf area duration
Leaf area index at F1:
2.5 is enough
Leaf area duration from F2
until physiol. maturity
90 m2.d
Yield (q/ha)
2.5
Leaf area index at F2
Yield (q/ha)
Leaf area duration (m2.d)
45


Kinetics of oil accumulation from anthesis to maturity
Oil (%)
CV - albena
DAA (days after anthesis)
Low Temperatures
High Temperatures
48


Relation between Leaf area duration (LAD)
and oil content
Oil content (%)
Total leaf area duration (m2.d)
47


Relationship between leaf area duration after flowering and yield
LAI : Leaf Area Index ; LAD : Leaf Area Duration
46

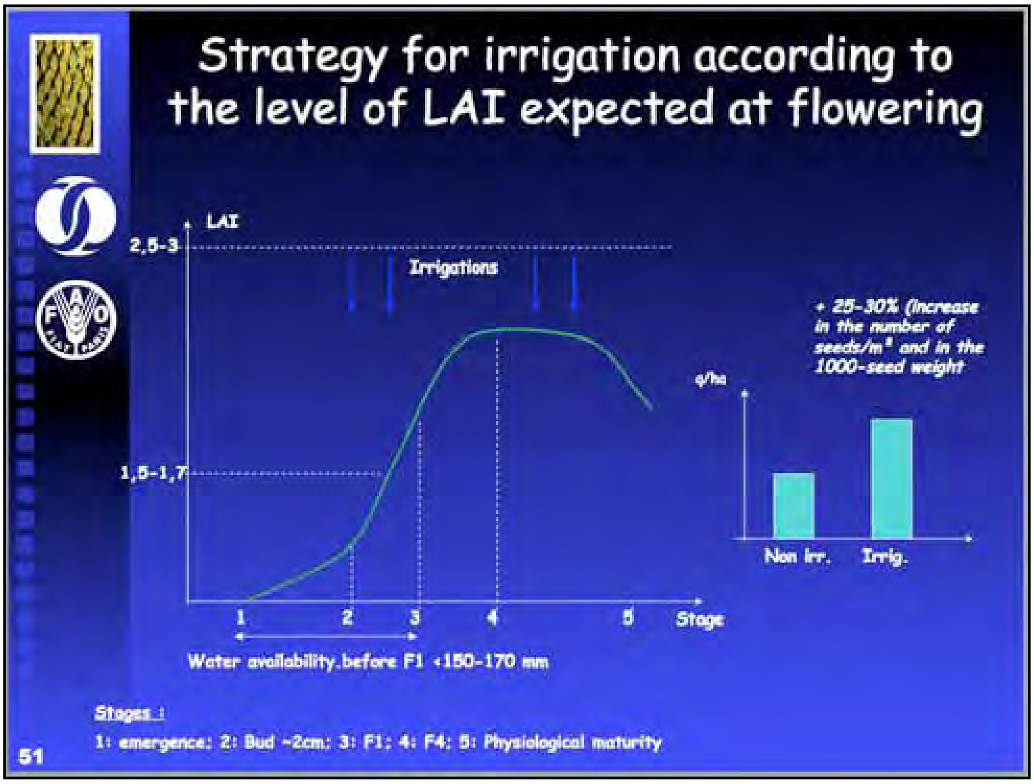


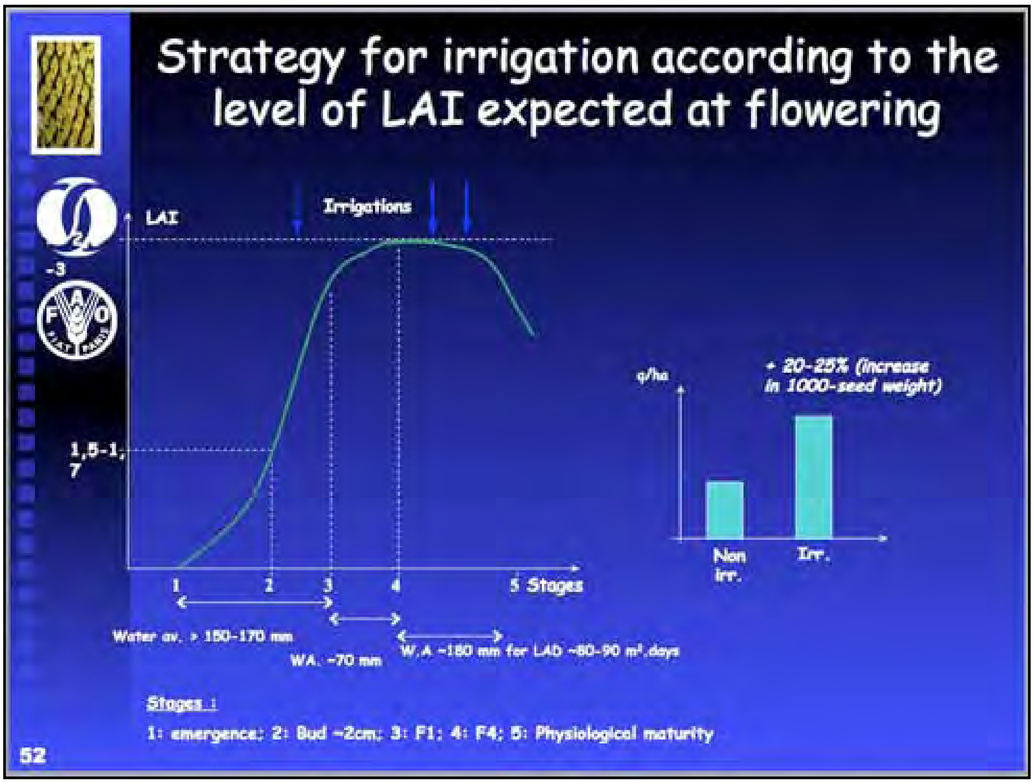
Effect of irrigation on the oil content at harvest

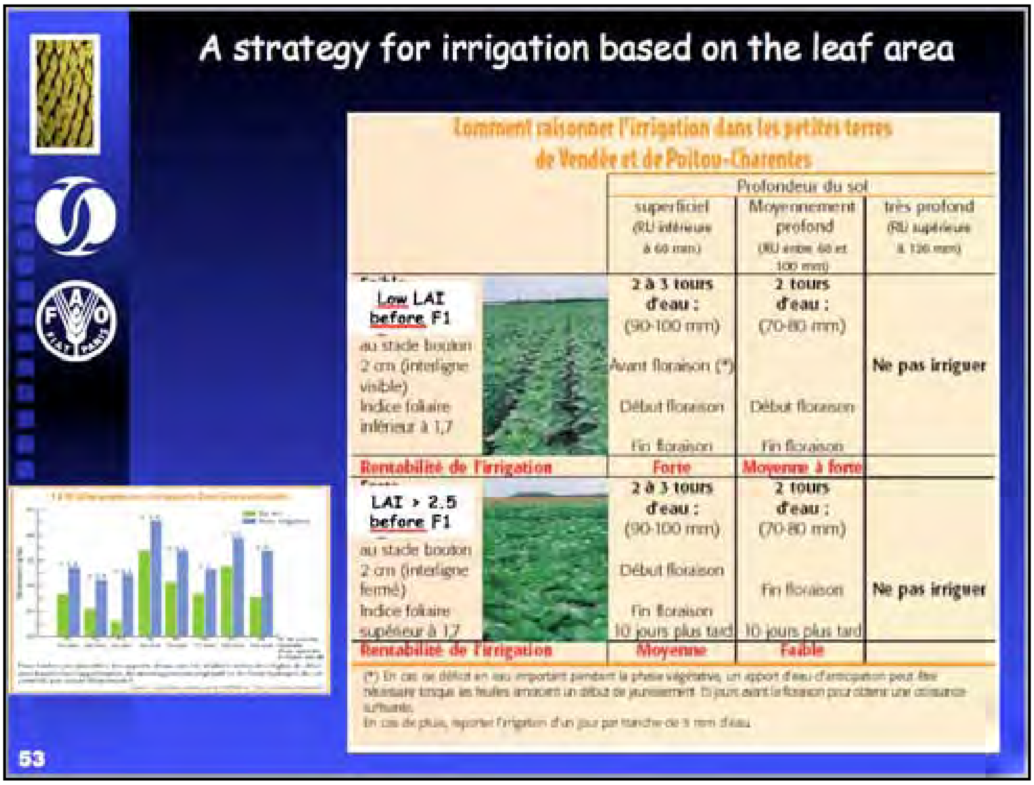
Treatment	Oil (%)		Stage for watering
Not irrigated	45,5	bc	
1 irrigation	42,5	c	4.1 (Anthesis)
2 irrigations	53,1	a	4.1 + 5.0
3 irrigations	47,4	b	3.3 + 4.1 + 5.0
Optimum Irrigation	52,6	a	3.3 + 4.1 + 4.4 + 5.0 + 5.1 + 5.2

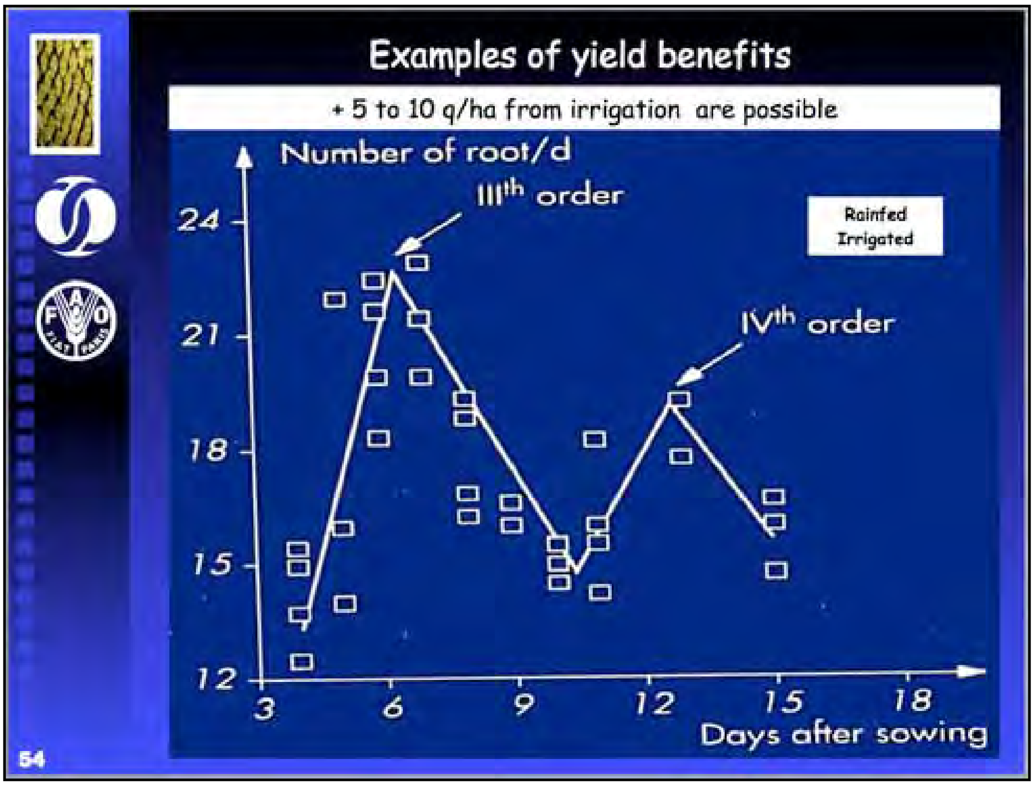
a.b.c. : Test NK at 5%

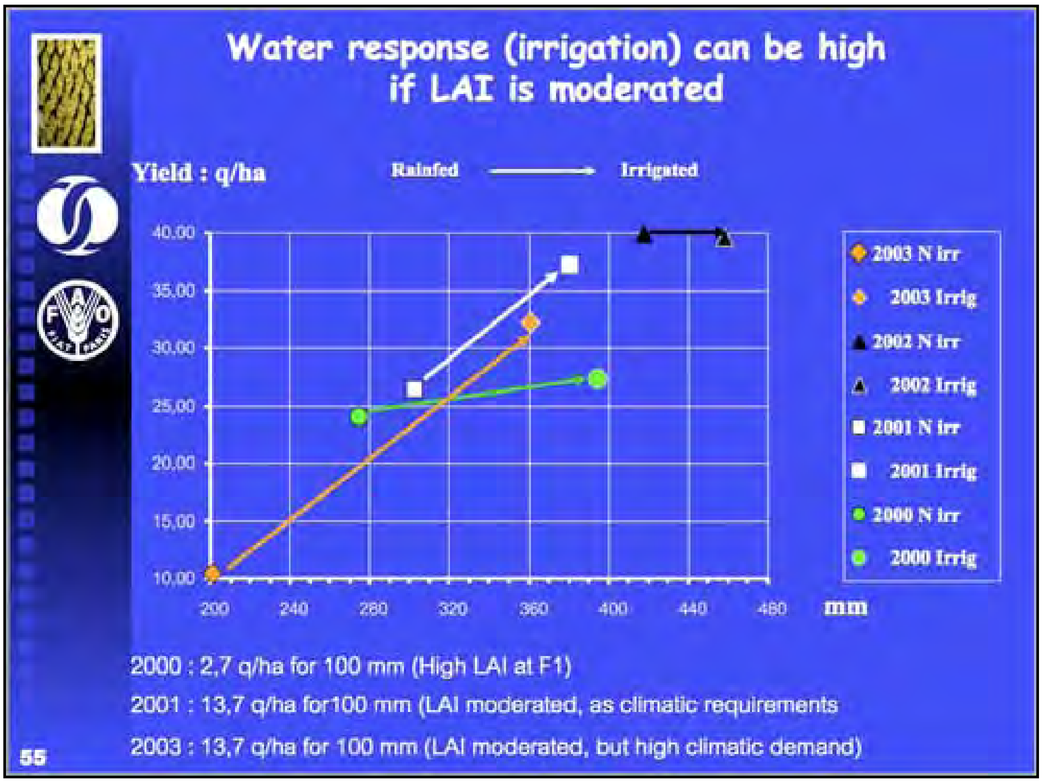
50

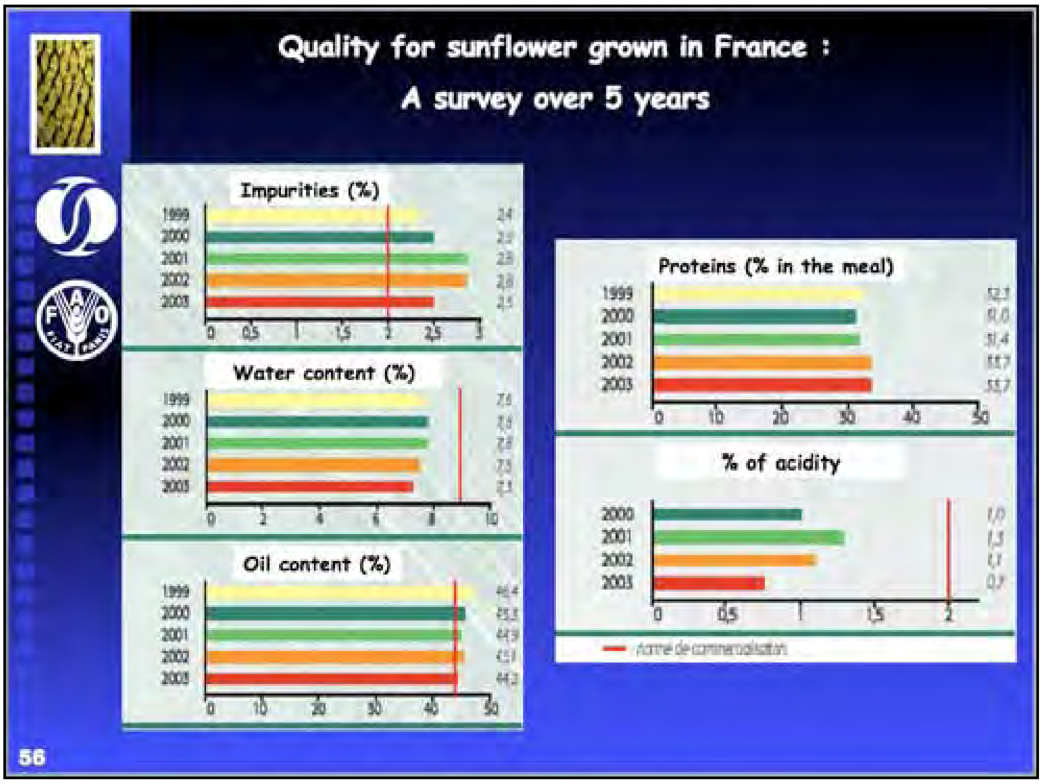

Strategy for irrigation according to the level of LAI expected at flowering
LAI
2,5-3
Irrigations
1,5-1,7
1
2
3
4
5
Stage
Water availability before F1 <150-170 mm
+ 25-30% (increase in the number of seeds/m² and in the 1000-seed weight
q/ha
Non irr.
Irrig.
Stages :
1: emergence; 2: Bud ~2cm; 3: F1; 4: F4; 5: Physiological maturity
51


Strategy for irrigation according to the level of LAI expected at flowering
LAI
-3
Irrigations
1,5-1,7
1
2
3
4
5 Stages
Water av. > 150-170 mm
WA. ~70 mm
W.A ~180 mm for LAD ~80-90 m².days
+ 20-25% (increase in 1000-seed weight)
q/ha
Non irr.
Irr.
Stages :
1: emergence; 2: Bud ~2cm; 3: F1; 4: F4; 5: Physiological maturity
52

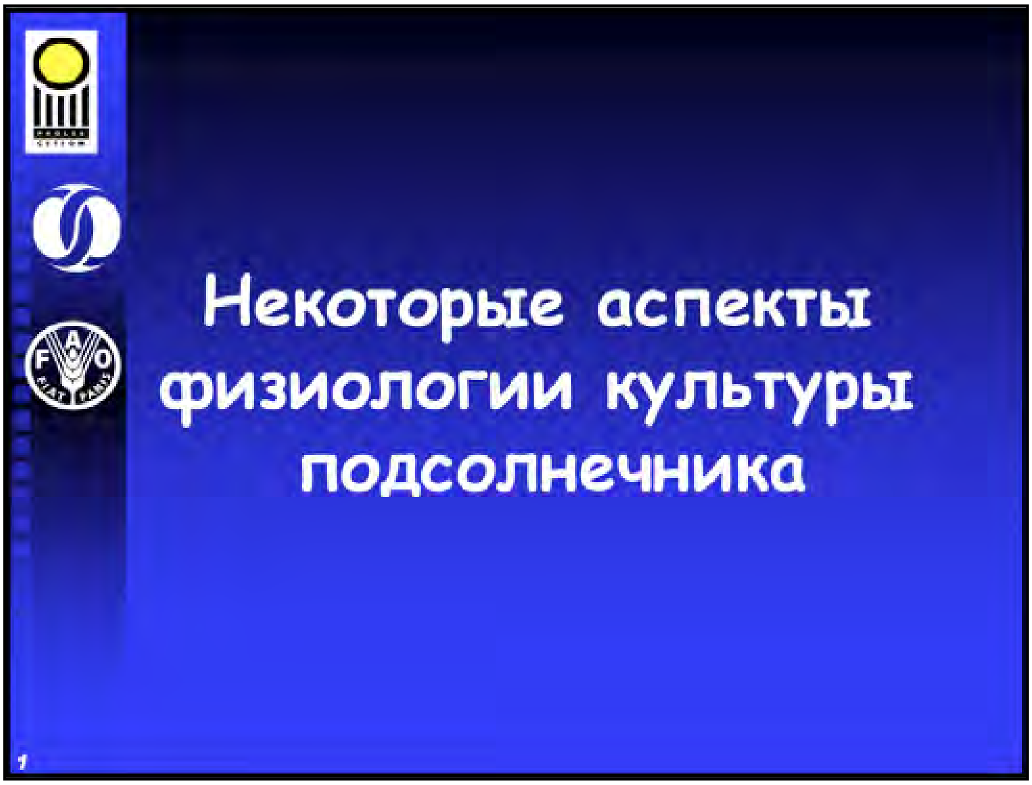

A strategy for irrigation based on the leaf area
Comment raisonner l'irrigation dans les petites terres de Vendée et de Poitou-Charentes
Profondeur du sol
superficiel (RU inférieure à 60 mm)
Moyennement profond (RU entre 60 et 100 mm)
très profond (RU supérieure à 120 mm)
Low LAI before F1
au stade bouton 2 cm (interligne visible)
Indice foliaire inférieur à 1,7
2 à 3 tours d'eau : (90-100 mm)
Avant floraison (*)
Début floraison
Fin floraison
2 tours d'eau : (70-80 mm)
Début floraison
Fin floraison
Ne pas irriguer
Rentabilité de l'irrigation
Forte
Moyenne à forte
LAI > 2.5 before F1
au stade bouton 2 cm (interligne fermé)
Indice foliaire supérieur à 1,7
2 à 3 tours d'eau : (90-100 mm)
Début floraison
Fin floraison 10 jours plus tard
2 tours d'eau : (70-80 mm)
Fin floraison 10 jours plus tard
Ne pas irriguer
Rentabilité de l'irrigation
Moyenne
Faible
53

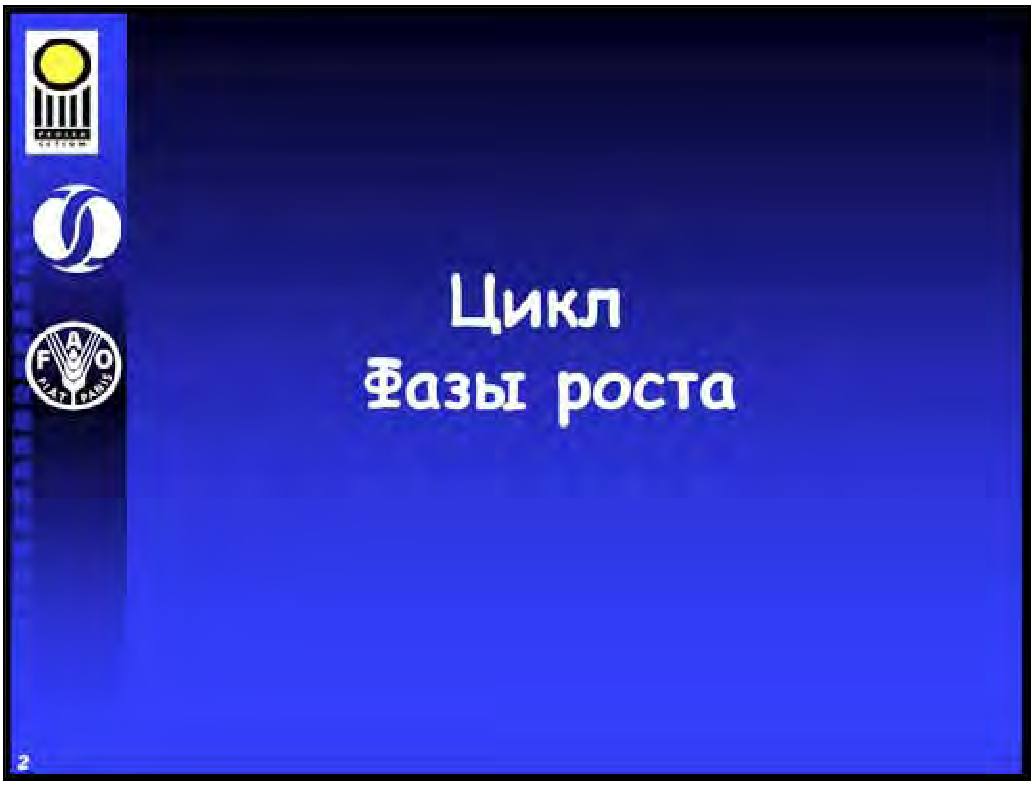

Examples of yield benefits
+ 5 to 10 q/ha from irrigation are possible
Number of root/d
III[th] order
IV[th] order
Rainfed
Irrigated
24
21
18
15
12
3
6
9
12
15
18
Days after sowing
54


Water response (irrigation) can be high
if LAI is moderated
Yield : q/ha
Rainfed
Irrigated
40,00
35,00
30,00
25,00
20,00
15,00
10,00
200
240
280
320
360
400
440
480
mm
2003 N irr
2003 Irrig
2002 N irr
2002 Irrig
2001 N irr
2001 Irrig
2000 N irr
2000 Irrig
2000 : 2,7 q/ha for 100 mm (High LAI at F1)
2001 : 13,7 q/ha for100 mm (LAI moderated, as climatic requirements
2003 : 13,7 q/ha for 100 mm (LAI moderated, but high climatic demand)
55


Quality for sunflower grown in France :
A survey over 5 years
Impurities (%)
Water content (%)
Oil content (%)
Proteins (% in the meal)
% of acidity
1999
2000
2001
2002
2003
56

Aspects of sunflower crop physiology (Russian)





Растение

Цикл: 120-150 дней в зависимости от скороспелости

Температурные требования: 1570-1700 °C (база 6)
В зависимости от скороспелости культуры
(3 классификации во Франции)

Цветение начинается на 65-70 день после появления всходов
Цикл: 5 ключевых периодов:
1- С посева до появления всходов
2- С появления всходов до стадии 5 листьев
3- Со стадии 5 листьев до начала цветения.
4- Цветение
5- Период наполнения семян

3

Градация требований к ГДР подсолнечника

Стадия / Группа скороспелости	Посев - появление всходов	Начало цветения	Завершение цветения	Зрелость
Ранняя	90	790	990	1570
Средне-ранняя	90	840	1040	1640
Средне-поздняя	90	900	1100	1700

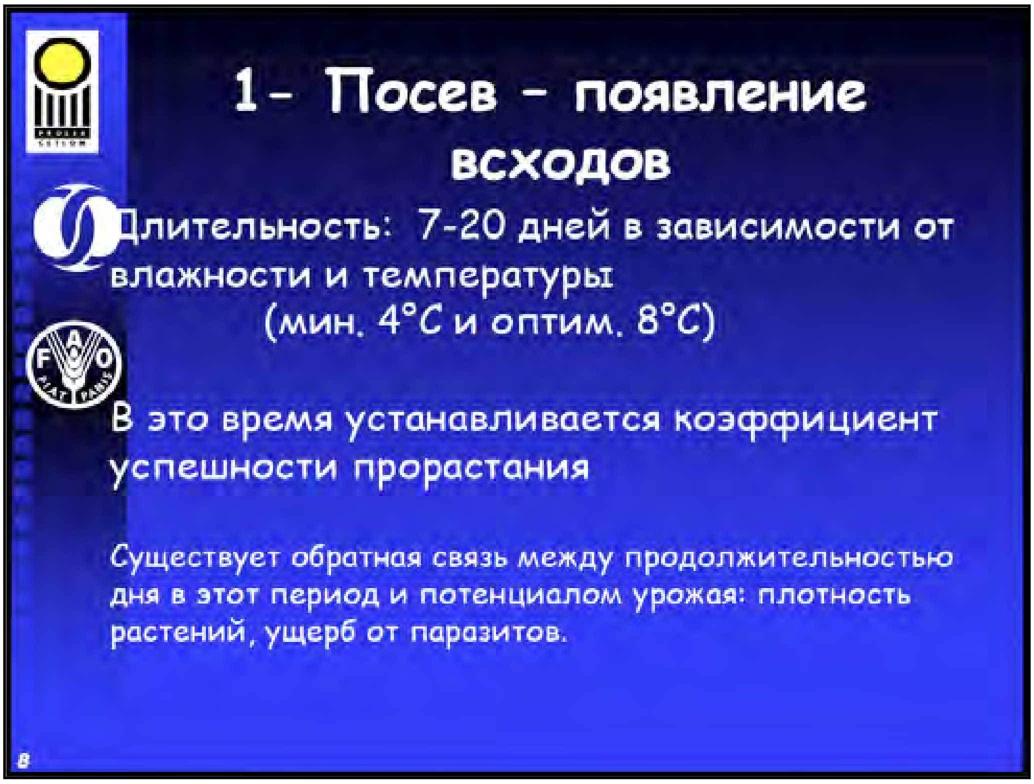
ГДР: Градусо-дни роста в °C (база 6)
Кумулятивные значения для достижения следующей стадии

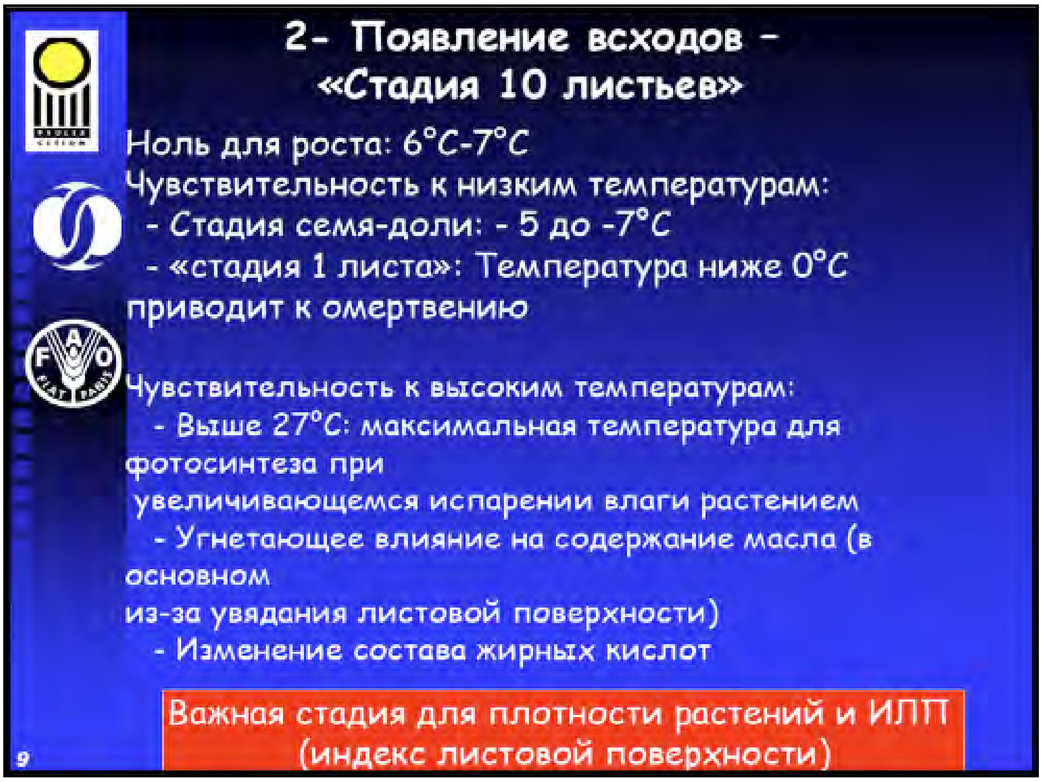
4

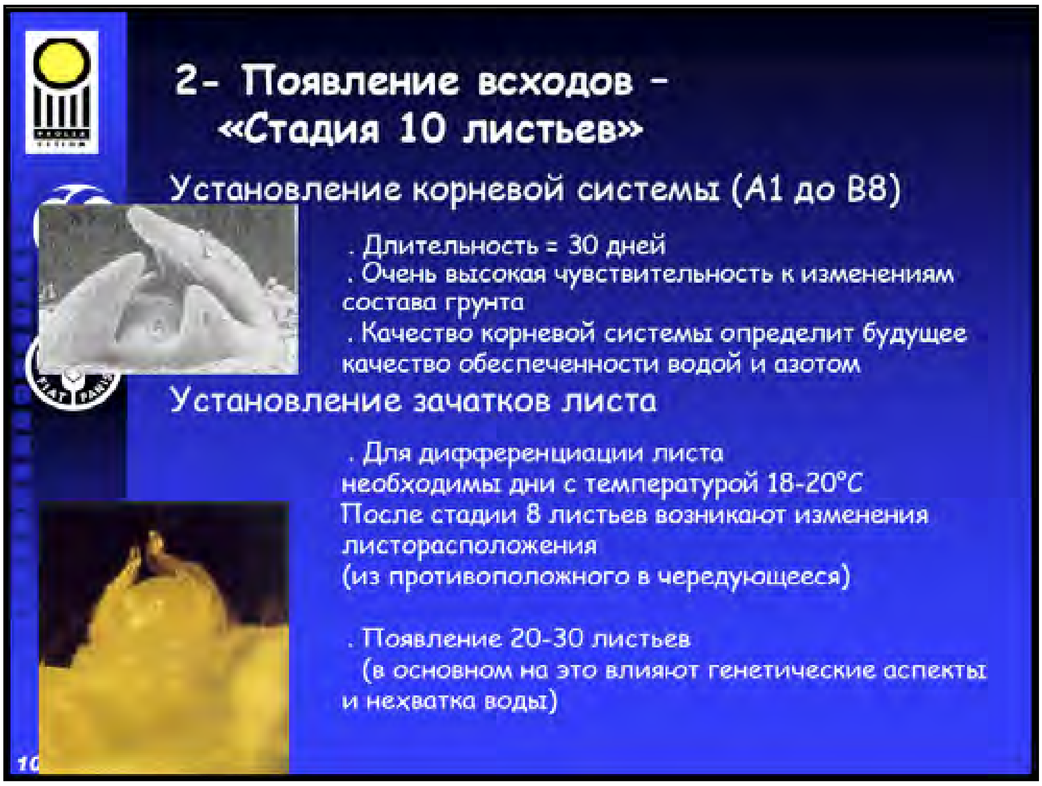

Описание основных стадий роста для подсолнечника (CETIOM)
Проращивание – появление всходов
Вегетативная стадия
Стадия бутонизации
Stade A1 (1.0)
Apparition des hypocotyles en crosse.
Stade A2 (1.1)
Emergence des cotylédons et premières feuilles visibles.
Stade B3-B4 (2.3-2.4)
La seconde paire de feuilles opposées apparaît et mesure environ 4 cm de long ; les pétioles sont visibles du dessus.
Stade E1 (3.1)
Apparition du bouton floral étroitement inséré au milieu des jeunes feuilles : stade bouton étoilé.
5

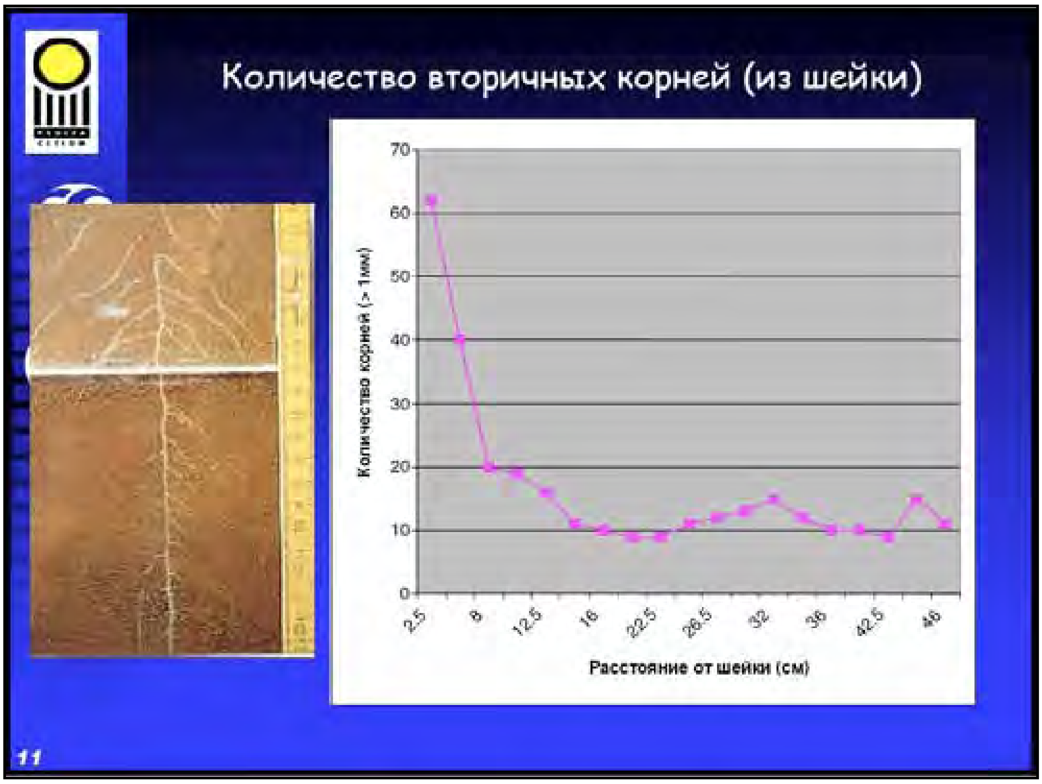

Описание основных стадий роста для подсолнечника (CETIOM)
Стадия бутонизации
Цветение
Stade E2 (3.2)
Le bouton se détache de la couronne foliaire. Son diamètre varie de 0,5 à 2 cm.
Les bractées sont nettement distinguables des feuilles.
Stade E4 (3.4)
Le bouton est nettement dégagé des feuilles à l'horizontal. Son diamètre varie de 5 à 8 cm.
Une partie des bractées se déploie.
Stade F1 (4.1)
Le bouton floral s'incline ; les fleurs ligulées sont perpendiculaires au plateau.
Stade F3.2 (4.3)
Les trois cercles de fleurons les plus externes ont leurs anthères visibles et dégagées et leurs stigmates déployés. Les trois cercles suivants ont leurs anthères visibles et dégagées.
6

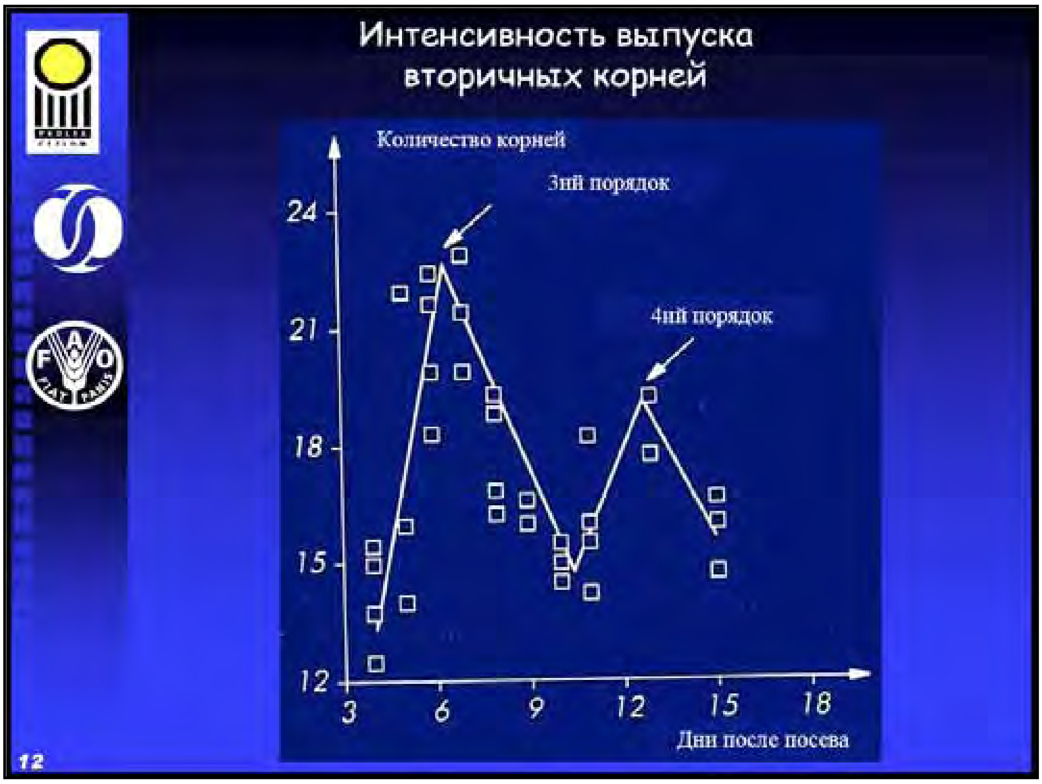

Описание основных стадий роста для подсолнечника (CETIOM))
Зрелость
Stade M0 (5.0)
Chute des fleurs ligulées. Le dos du capitule est encore vert.
Stade M2 (5.2)
Le dos du capitule est jaune. Les bractées sont aux 3/4 brunes. L'humidité de la graine avoisine 20-25 %.
Stade M3 (5.3)
Le dos du capitule est marbré de brun. Les bractées sont brunes. La tige se dessèche. L'humidité de la graine avoisine 15 %.
Stade M4 (5.4)
Tous les organes de la plante sont bruns foncés. L'humidité de la graine avoisine 10 %.
7

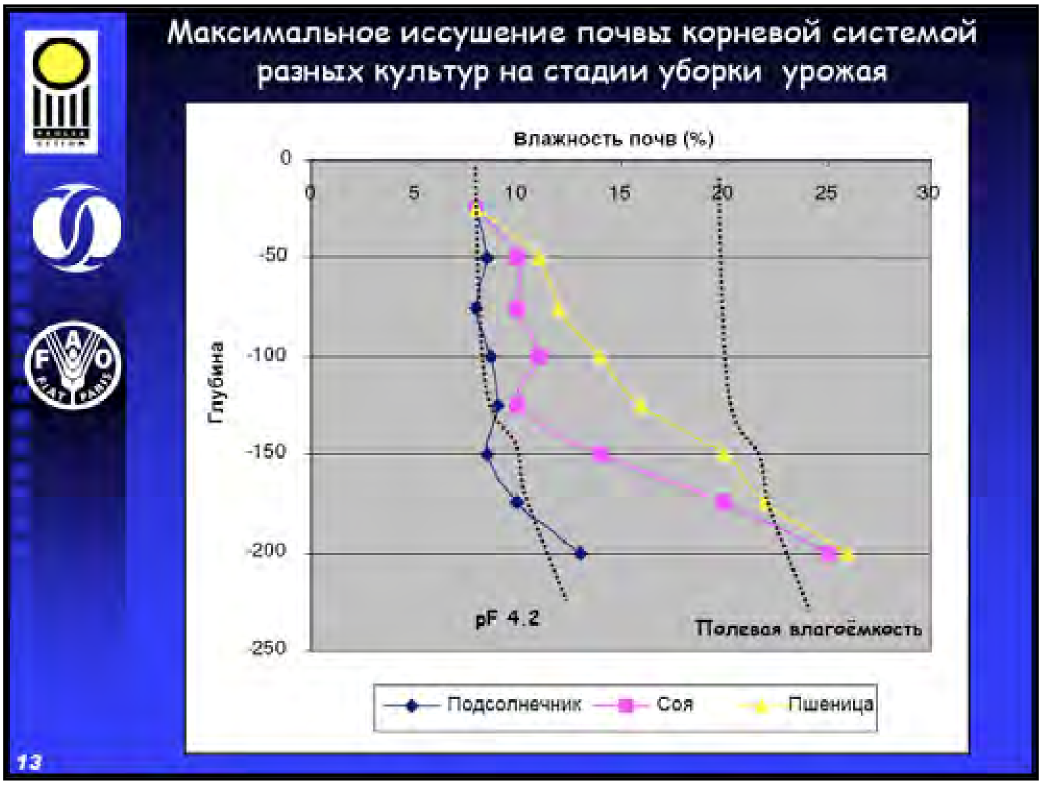

1- Посев - появление всходов
Длительность: 7-20 дней в зависимости от влажности и температуры
(мин. 4°C и оптим. 8°C)
В это время устанавливается коэффициент успешности прорастания
Существует обратная связь между продолжительностью дня в этот период и потенциалом урожая: плотность растений, ущерб от паразитов.
8


2- Появление всходов –
«Стадия 10 листьев»
Ноль для роста: 6°C-7°C
Чувствительность к низким температурам:
- Стадия семя-доли: - 5 до -7°C
- «стадия 1 листа»: Температура ниже 0°C
приводит к омертвению
Чувствительность к высоким температурам:
- Выше 27°C: максимальная температура для
фотосинтеза при
увеличивающемся испарении влаги растением
- Угнетающее влияние на содержание масла (в
основном
из-за увядания листовой поверхности)
- Изменение состава жирных кислот
Важная стадия для плотности растений и ИЛП
(индекс листовой поверхности)
9


2- Появление всходов –
«Стадия 10 листьев»
Установление корневой системы (A1 до B8)
. Длительность = 30 дней
. Очень высокая чувствительность к изменениям
состава грунта
. Качество корневой системы определит будущее
качество обеспеченности водой и азотом
Установление зачатков листа
. Для дифференциации листа
необходимы дни с температурой 18-20°C
После стадии 8 листьев возникают изменения
листорасположения
(из противоположного в чередующееся)
. Появление 20-30 листьев
(в основном на это влияют генетические аспекты
и нехватка воды)

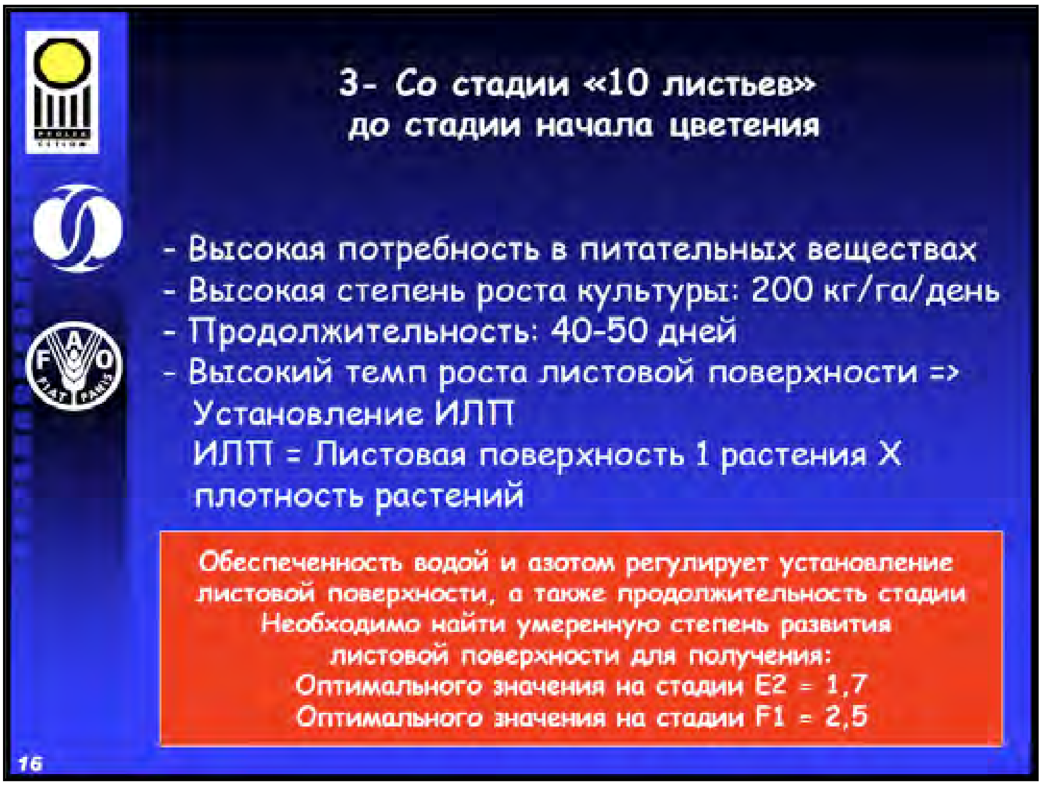

Количество вторичных корней (из шейки)
70
60
50
40
30
20
10
0
Количество корней (> 1мм)
2.5
8
12.5
16
22.5
26.5
32
36
42.5
46
Расстояние от шейки (см)
11


Интенсивность выпуска
вторичных корней
Количество корней
3ий порядок
4ий порядок
24
21
18
15
12
3
6
9
12
15
18
Дни после посева
12


Максимальное иссушение почвы корневой системой разных культур на стадии уборки урожая
Влажность почв (%)
0
5
10
15
20
25
30
0
-50
-100
-150
-200
-250
Глубина
pF 4.2
Полевая влагоёмкость
Подсолнечник
Соя
Пшеница
13

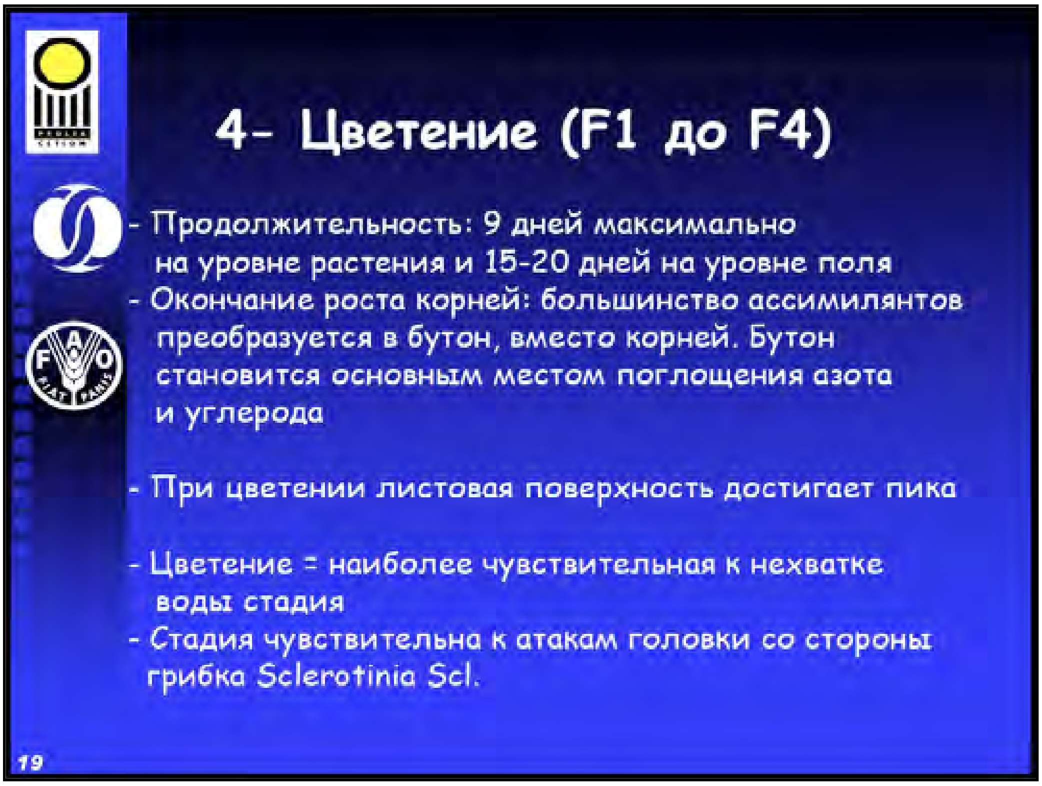

2- Появление всходов -
«Стадия 10 листьев»
От «8 листьев до 10» (B8 до B10)
. Продолжительность от 20 до 25 дней
(→ пока не наступит стадия бутонизациии, E2 = 15 мм в диам.)
. Влияние низких температур = в основном на качество начальных стадий
IB
Ключевая стадия:
вегетативный бутон, переходящий на репродуктивную стадию:
Инициация соцветья
14

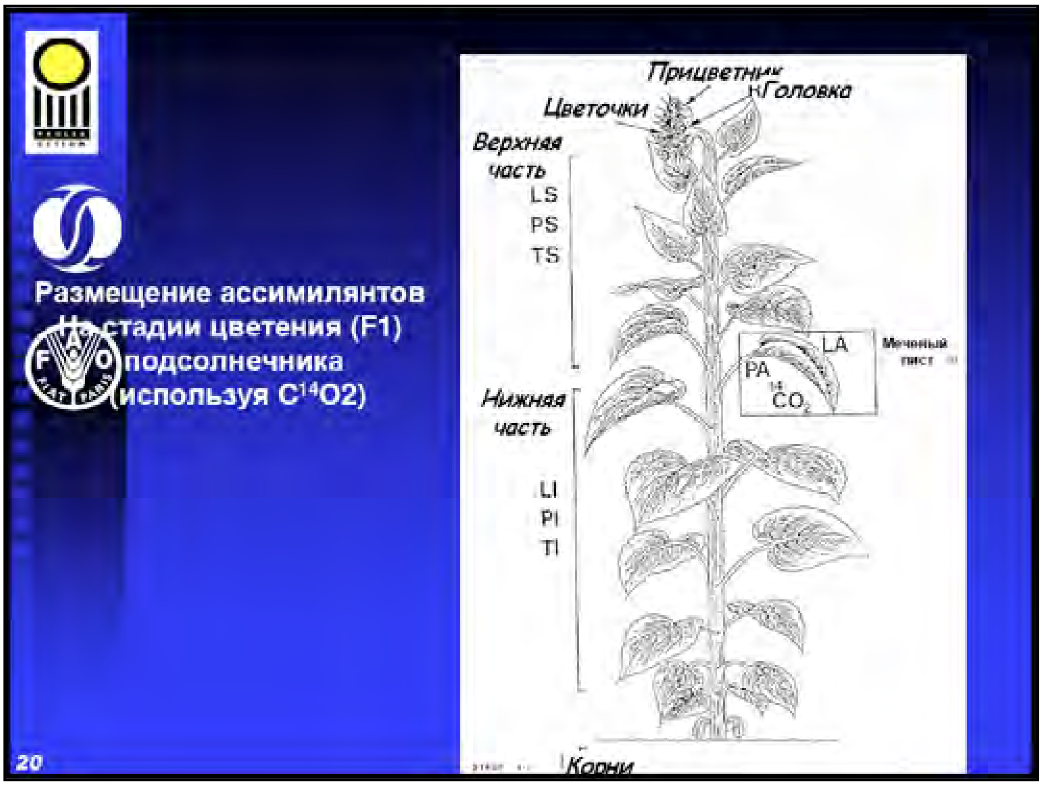

Звездообразная стадия: цветочный бутон достигает 15мм в окружности


3- Со стадии «10 листьев» до стадии начала цветения
- Высокая потребность в питательных веществах
- Высокая степень роста культуры: 200 кг/га/день
- Продолжительность: 40-50 дней
- Высокий темп роста листовой поверхности => Установление ИЛП
ИЛП = Листовая поверхность 1 растения X плотность растений
Обеспеченность водой и азотом регулирует установление листовой поверхности, а также продолжительность стадии
Необходимо найти умеренную степень развития листовой поверхности для получения:
Оптимального значения на стадии E2 = 1,7
Оптимального значения на стадии F1 = 2,5
16


Размещение ассимилянтов по циклам (используя C14O2)
Стадия бутонизации
% переданной радиоактивности
80
70
60
50
40
30
20
10
0
1
2
3
4
5
6
7
Время (недель)
Меченый черешок листа
Верхняя вегетативная часть
Нижняя вегетативная часть
17


Бутон достигает 5-10см «стадия артишок»
Появляются желтые прицветники (лепестки) : F 1
Желтые прицветники (лепестки) полностью раскрываются: F2
Цветочки являются самцами на 3 внешних кольцах: F2

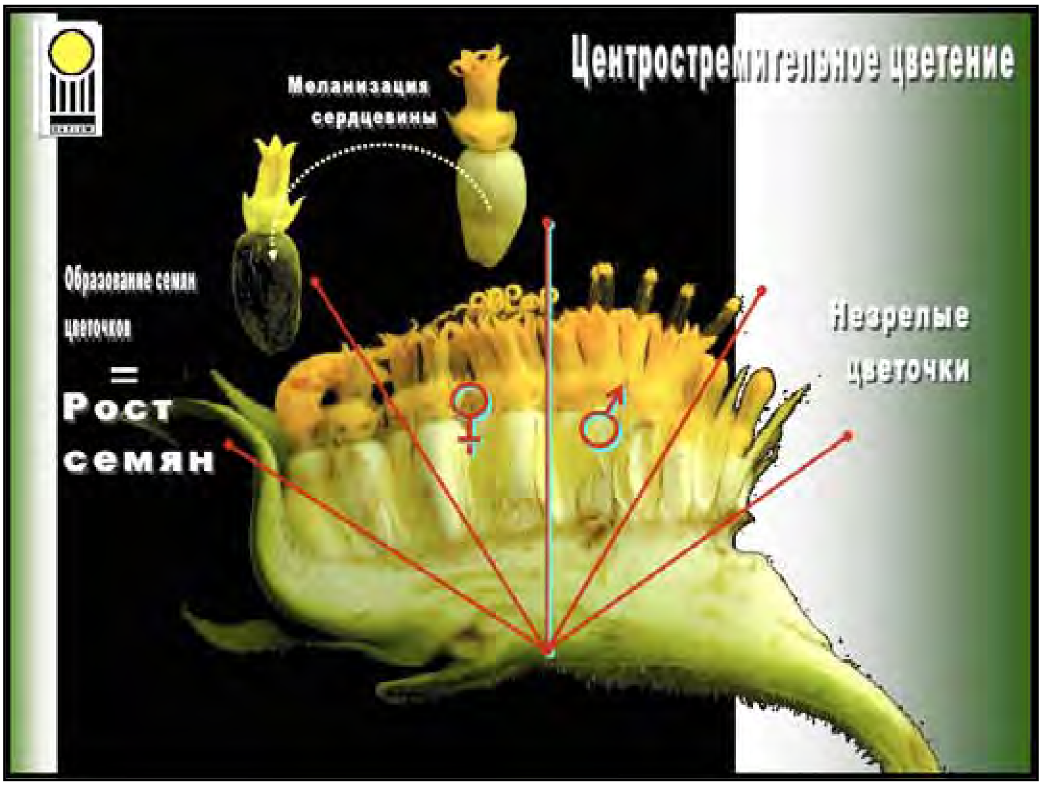

4- Цветение (F1 до F4)
- Продолжительность: 9 дней максимально на уровне растения и 15-20 дней на уровне поля
- Окончание роста корней: большинство ассимилянтов преобразуется в бутон, вместо корней. Бутон становится основным местом поглощения азота и углерода
- При цветении листовая поверхность достигает пика
- Цветение = наиболее чувствительная к нехватке воды стадия
- Стадия чувствительна к атакам головки со стороны грибка Sclerotinia Scl.
19


Размещение ассимилянтов на стадии цветения (F1) подсолнечника (используя C14O2)
Прицветник
Головка
Цветочки
Верхняя часть
LS
PS
TS
LA
PA
$^{14}CO_2$
Меченый лист
Нижняя часть
LI
PI
TI
Корни
20

Распределение отмеченного углекислого газа (CO_2) на стадии цветения в зависимости от времени

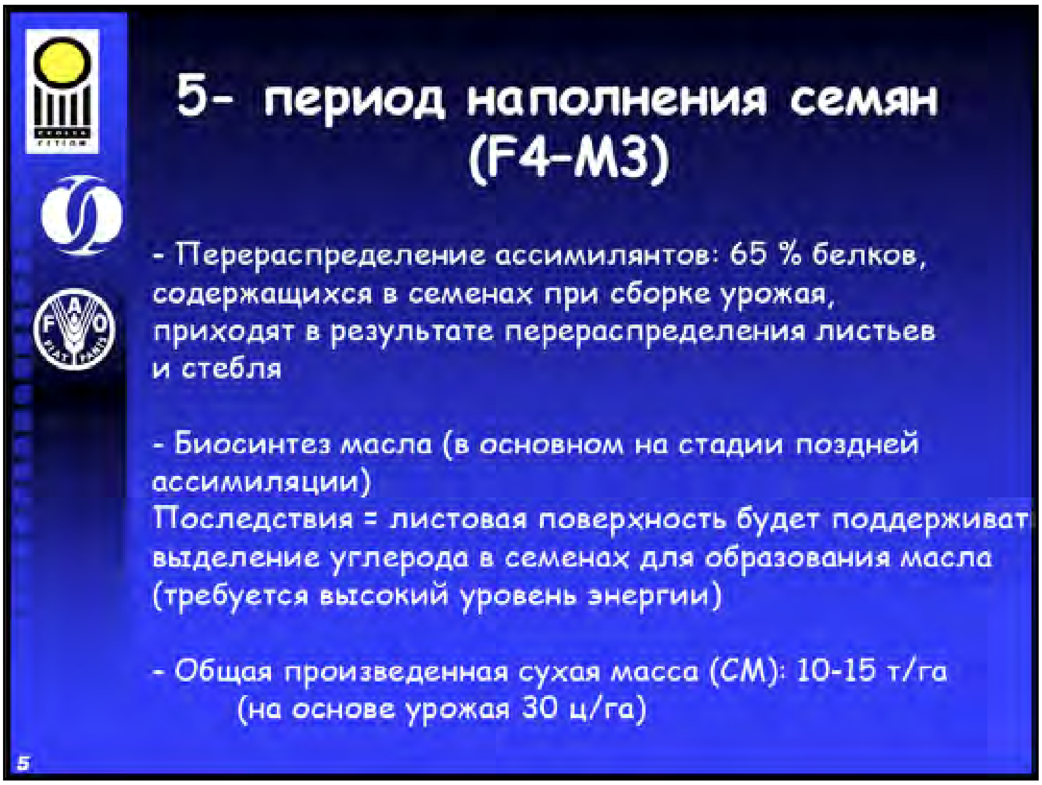
Орган / Время (ч)	Меченый орган: La	Меченый орган: Pa	Нижняя часть: LI	Нижняя часть: PI	Нижняя часть: TI	Верхняя часть: LS	Верхняя часть: PS	Верхняя часть: TS	Br.	Cap	Flor
0	92	6	T	T	0.4	T	T	0.3	T	0.7	0.1
1	73	5	0.4	T	2.4	1.8	T	13	T	1.4	2.3
3	54	3	T	T	2.4	T	T	16	T	10	13
6	37	3	0.4	T	4.6	0.4	T	14	1	0.5	41
12	30	5	T	T	3.6	0.3	T	15	T	4	41

1

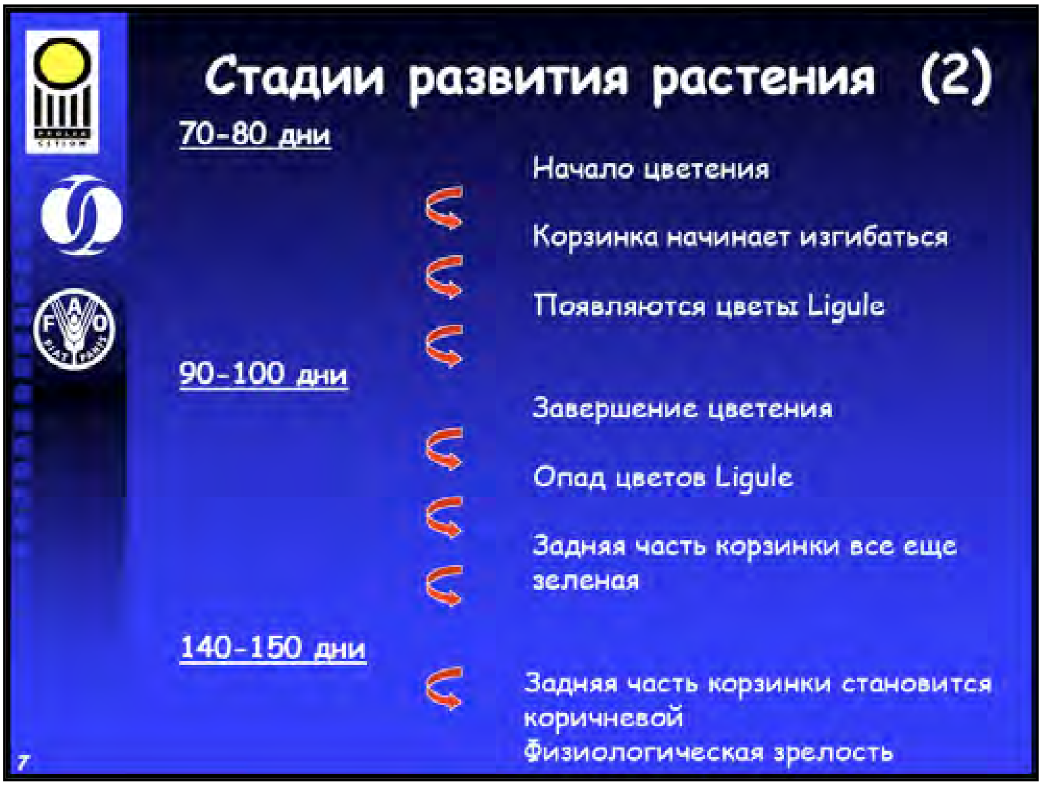



Вначале цветки являются «самцами»,
а затем становятся «самками»
До настоящего времени самоопыление
свежих гибридов достигало 80%
3


4


5- период наполнения семян (F4-M3)
- Перераспределение ассимилянтов: 65 % белков, содержащихся в семенах при сборке урожая, приходят в результате перераспределения листьев и стебля
- Биосинтез масла (в основном на стадии поздней ассимиляции)
Последствия = листовая поверхность будет поддерживат
выделение углерода в семенах для образования масла (требуется высокий уровень энергии)
- Общая произведенная сухая масса (СМ): 10-15 т/га
(на основе урожая 30 ц/га)
5

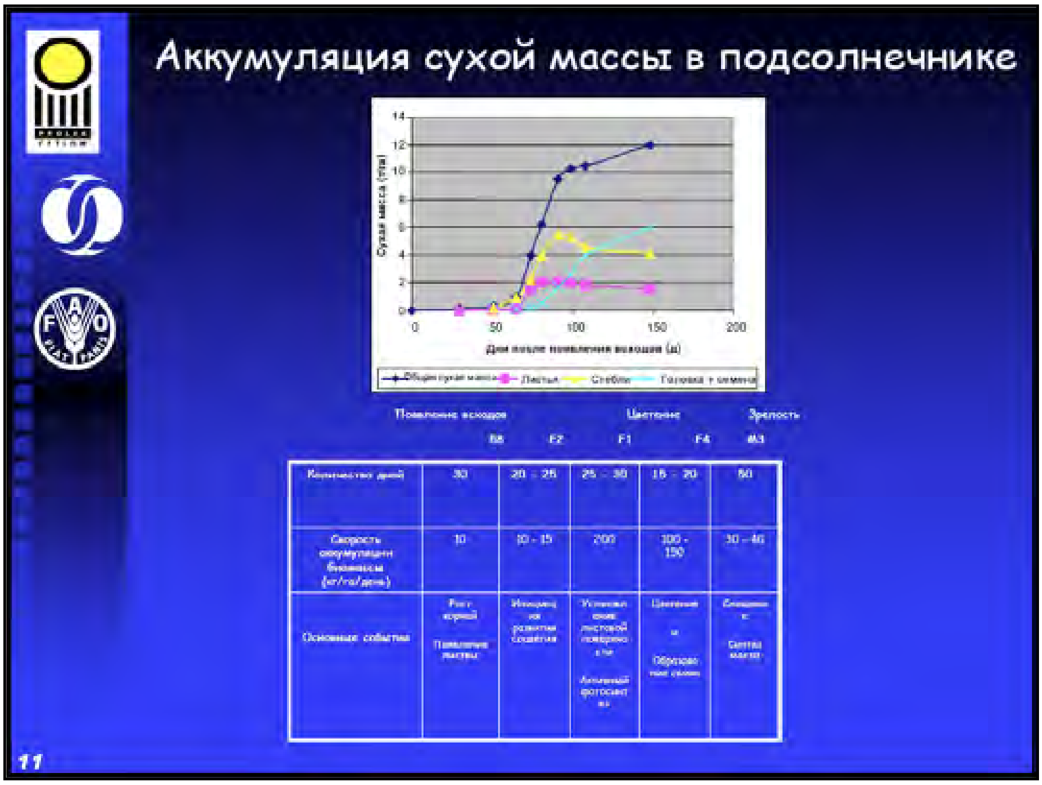

Стадии развития растения (1)
Посев- 10-20 дни
Появление всходов и рост семя-долей
30 дни
5 пар листьев
40 дни
Начало инициации развития соцветия
50 дни
Стадия «звездообразных» бутонов
60 дни
Завершение инициации развития соцветия
Среди листьев появляются бутоны (диаметр 5 - 8см)
6


Стадии развития растения (2)
70-80 дни
Начало цветения
Корзинка начинает изгибаться
Появляются цветы Ligule
90-100 дни
Завершение цветения
Опад цветов Ligule
Задняя часть корзинки все еще зеленая
140-150 дни
Задняя часть корзинки становится коричневой
Физиологическая зрелость
7


Производство биомассы
Корневая и листовая поверхность
8


Выработка урожая для подсолнечника: резюме
0
Появление всходов 10-15 j
Изменение листорас-положения 40 j
Цветковый бутон 15 мм 55 j
Начало цветения 65-75 j
Завершение цветения 85-95 j
Зрелость 120-130 j
Ко-во раст/м²
Кол-во потенц. сердцевин
Начало цветения
Скорость образования семян
Вес 1000 семян
Дифференциация листвы
Установление листовой поверхности
Увядание
160 мм
70 мм
150-180 мм
Оптимальные потребности в воде
Доступность в почве + осадки + орошение
9

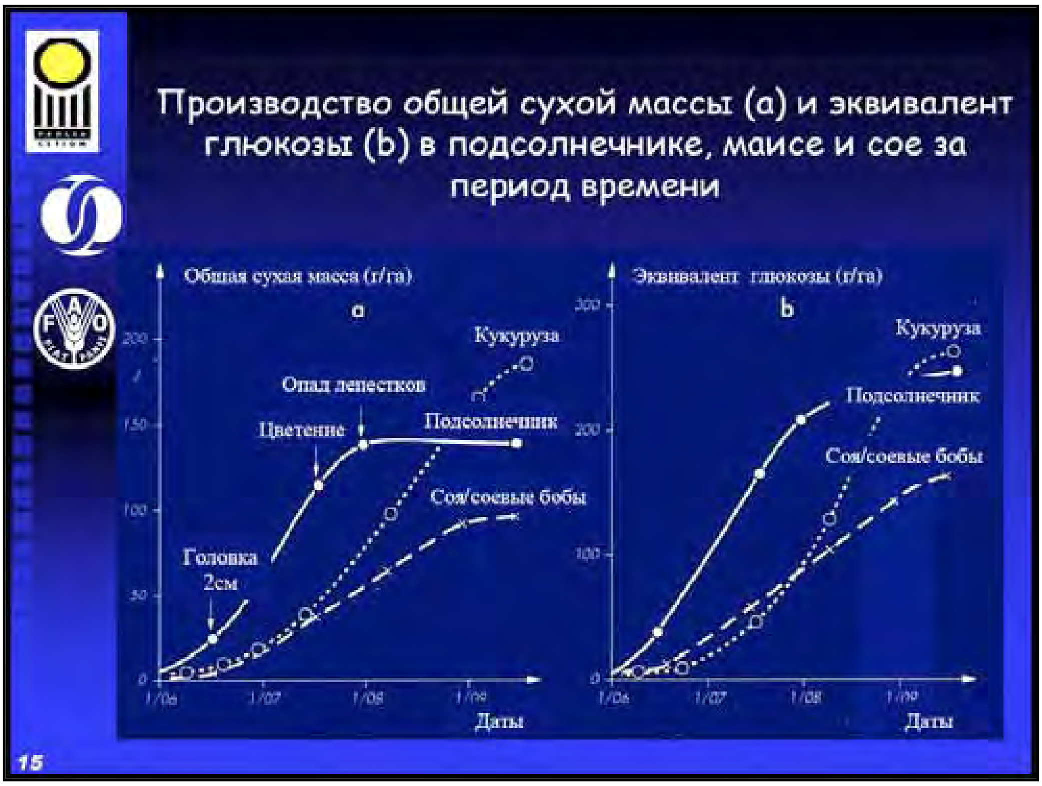

Аккумуляция сухой массы в подсолнечнике
Сухая масса (т/га)
0
2
4
6
8
10
12
14
0
50
100
150
200
Дни после появления всходов (д)
Общая сух. масса
Листья
Стебли
Головка + семена
10


Аккумуляция сухой массы в подсолнечнике
0
50
100
150
200
Появление всходов
Цветение
Зрелость
B8
E2
F1
F4
M3
30
20 - 25
25 - 30
15 - 20
50
10
10 - 15
200
100 - 150
30 - 40
11


Аккумуляция сухой массы в подсолнечнике
Появление всходов
Цветение
Зрелость
B8
E2
F1
F4
M3
Количество дней
30
20 to 25
25 to 30
15 to 20
50
Скорость аккумуляции биомассы (кг/га/день)
10
10 to 15
200
100 to 150
30 to 40
Основные события
Рост корней
Появление листьев
Инициация развития соцветия
Установление листовой поверхности
Активный фотосинтез
Цветение
и
Образование семян
Смещение
Синтез масла
12


Аккумуляция сухой массы семян в подсолнечнике после цветения
Сухая масса (мг)
120
100
80
60
40
20
0
Целое семя
Сердцевина
Шелуха
0
10
20
30
40
50
ДПЦ (дни после цветения)
(d'après Villalobos, 1994b)
13


Размещение ассимилянтов в подсолнечнике по их свойствам с течением времени
Эквивалент глюкозы
250
200
150
100
50
0
Total
Карбогидраты
Масло
Соединения азота
1/06
1/07
1/08
1/09
Даты
Энергетические затраты для получения 1г конечного продукта:
Углеводы = 1,2 г глюкозы
Соединения азота = 2,5-2,7 г глюкозы
Масло = 3 г глюкозы
14


Производство общей сухой массы (a) и эквивалент глюкозы (b) в подсолнечнике, маисе и сое за период времени
Общая сухая масса (г/га)
a
Кукуруза
Опад лепестков
Цветение
Подсолнечник
Соя/соевые бобы
Головка 2см
Даты
Эквивалент глюкозы (г/га)
b
Кукуруза
Подсолнечник
Соя/соевые бобы
Даты
15

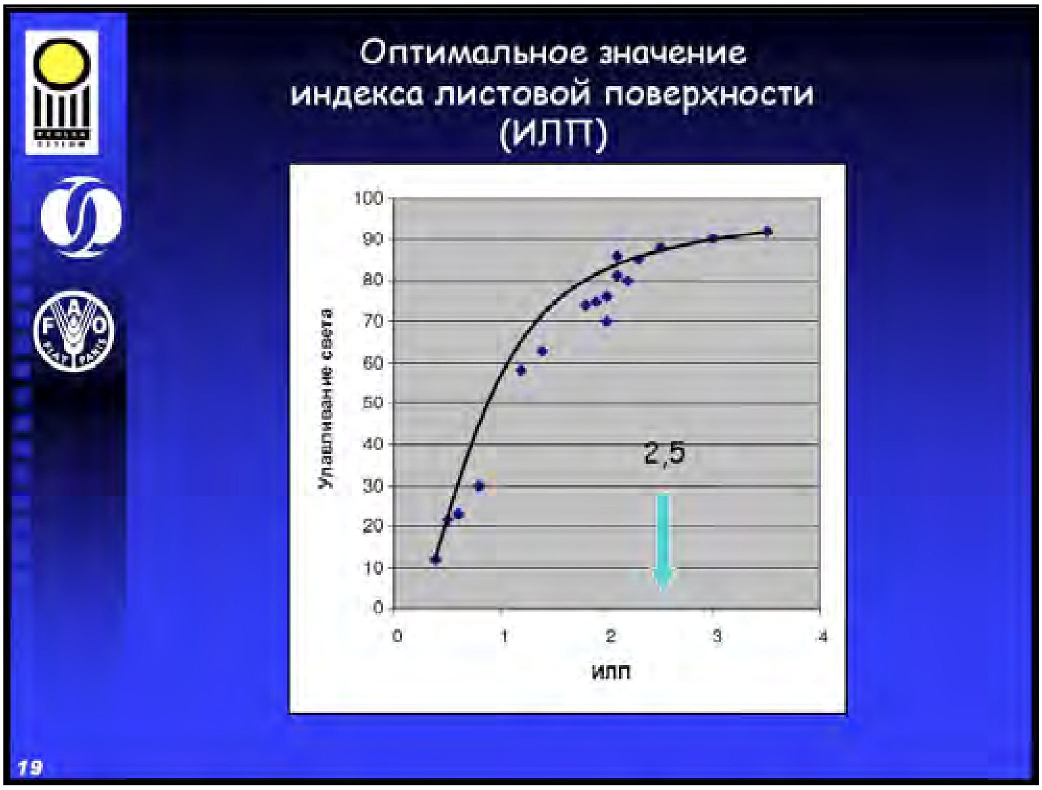

Образование листовой поверхности подсолнечника
Листовая поверхность (см2)
6000
5000
4000
3000
2000
1000
0
F1
0
20
40
60
80
100
120
140
Дни после появления всходов
Уровень 0-6
Уровень 6-12
Уровень 12-18
Уровень >18
Общая листовая поверхность
Общая листовая поверхность достигает максимума на стадии F1
16

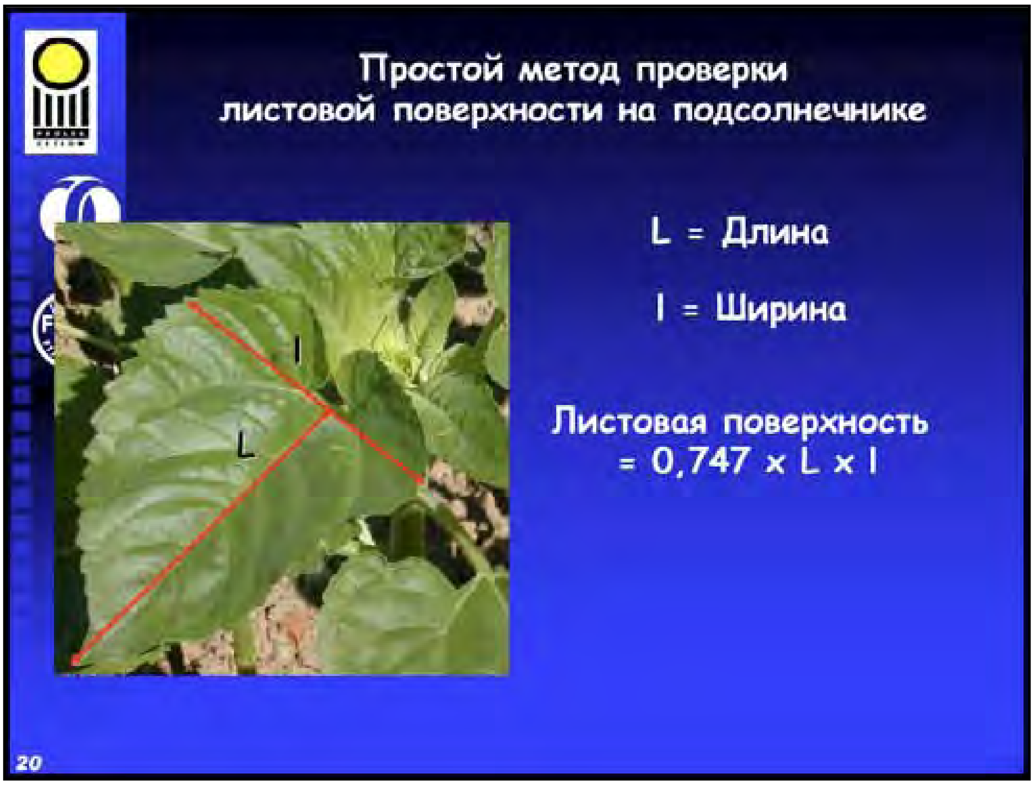
Относительная значимость листовой поверхности в зависимости от уровня растительного покрова

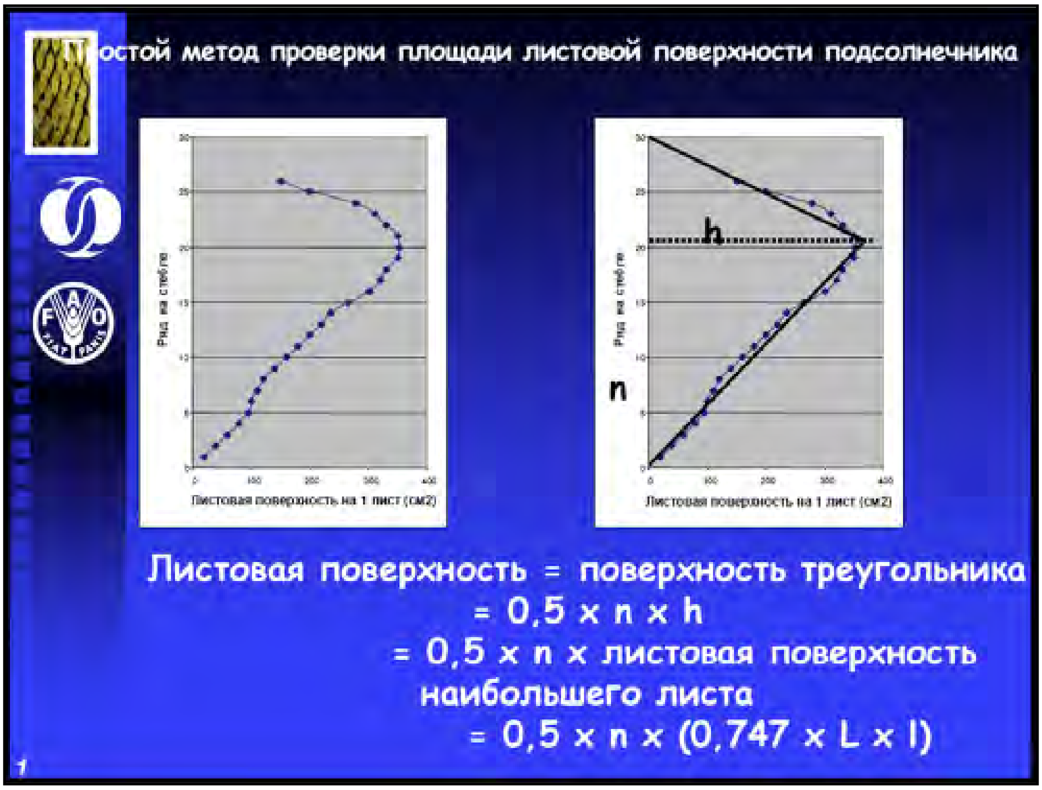
Листва (количество с основания до верхушки)	% листовой поверхности	Вес урожая семян (%)
Все листья (1-25)	100	100
Листья 1-18	88 (-22 %)	55 (-45 %)
Листья 1-13	59 (-41 %)	25 (-75 %)
Листья 1-8	23 (-77 %)	2 (-93 %)

При цветении наблюдается разрушение листвы

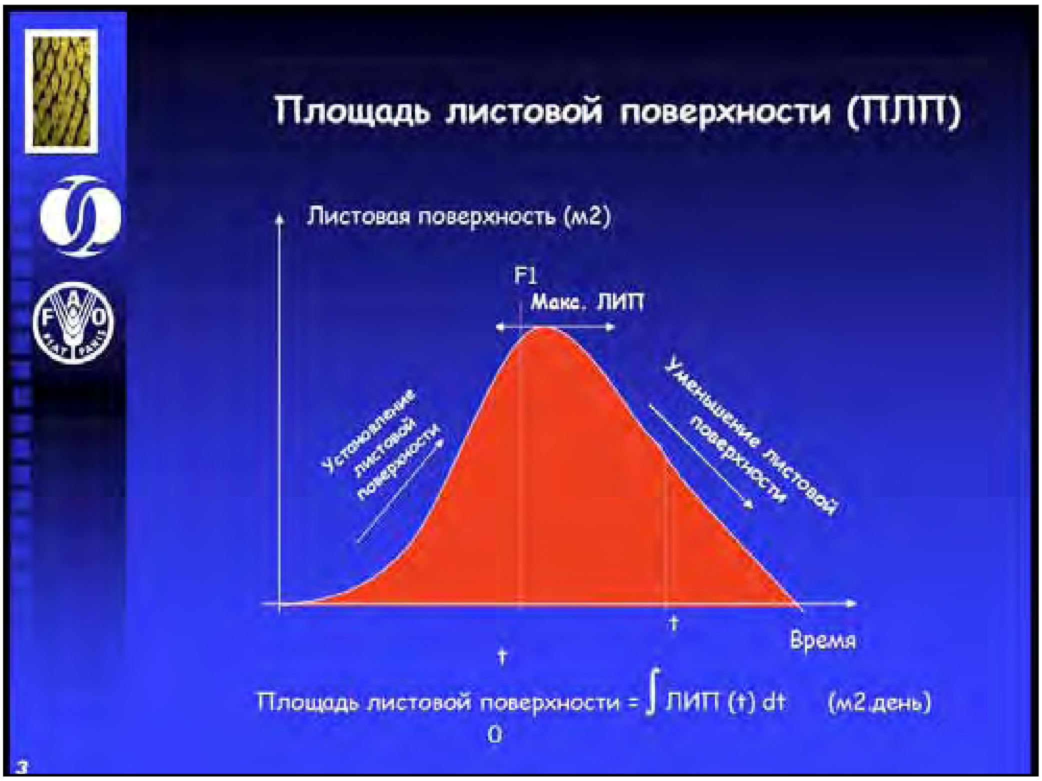
18

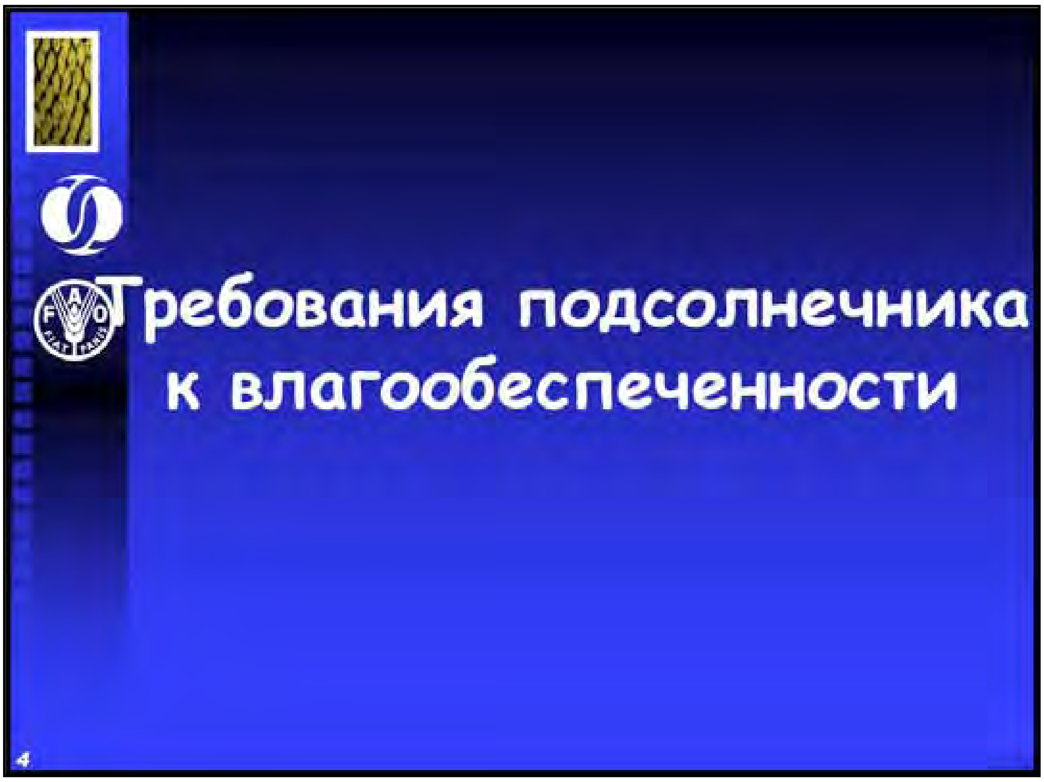

Оптимальное значение
индекса листовой поверхности
(ИЛП)
100
90
80
70
60
50
40
30
20
10
0
Улавливание света
2,5
0
1
2
3
4
ИЛП
19


Простой метод проверки
листовой поверхности на подсолнечнике
l
L
L = Длина
l = Ширина
Листовая поверхность
= 0,747 x L x l
20


Простой метод проверки площади листовой поверхности подсолнечника
Ряд на стебле
Листовая поверхность на 1 лист (см2)
h
n
Листовая поверхность = поверхность треугольника
= 0,5 x n x h
= 0,5 x n x листовая поверхность наибольшего листа
= 0,5 x n x (0,747 x L x l)
1


Листовая поверхность: регулирование роста
Улучшение вегетационного периода
индекс листовой поверхности (ЛИП)
Подсолнечник
Кукуруза
2,5 до 3
1,5 до 1,7
Бутон 15мм
Цветение
Инициация
Кол-в семян
Вес 100 семян
2


Площадь листовой поверхности (ПЛП)
Листовая поверхность (м2)
F1
Макс. ЛИП
Установление листовой поверхности
Уменьшение листовой поверхности
t
t
Время
Площадь листовой поверхности = ∫ ЛИП (t) dt (м2.день)
0
3


Требования подсолнечника к влагообеспеченности
4

Низкий уровень увлажнения почвы является основным ограничивающим фактором развития культур подсолнечника, т.к. в большинстве регионов мира, где выращивают подсолнечник наблюдаются очень засушливые погодные условия.

Тем не менее, ответ подсолнечника на влагообеспеченность парадоксален:

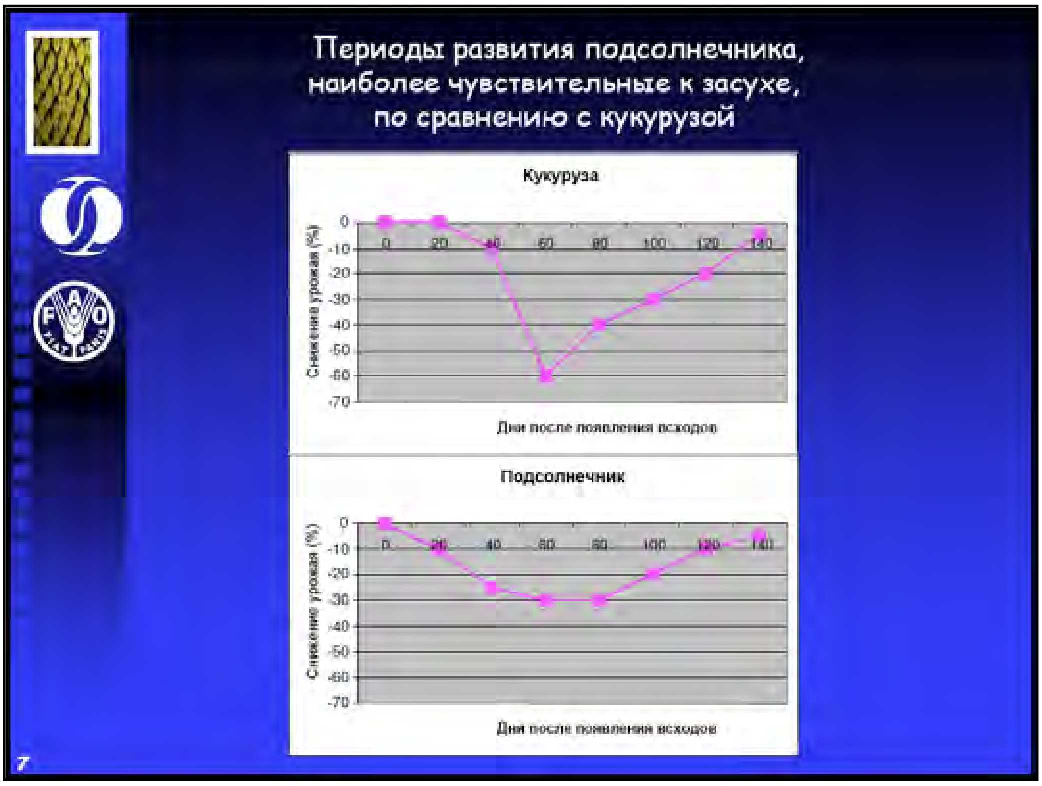
- При ее дефиците, урожай снижается в расчете на количество семян и вес 1000 семян
- При избытке листовая поверхность увеличивается, что приводит к потерям воды и низкой эффективности водопользования

5

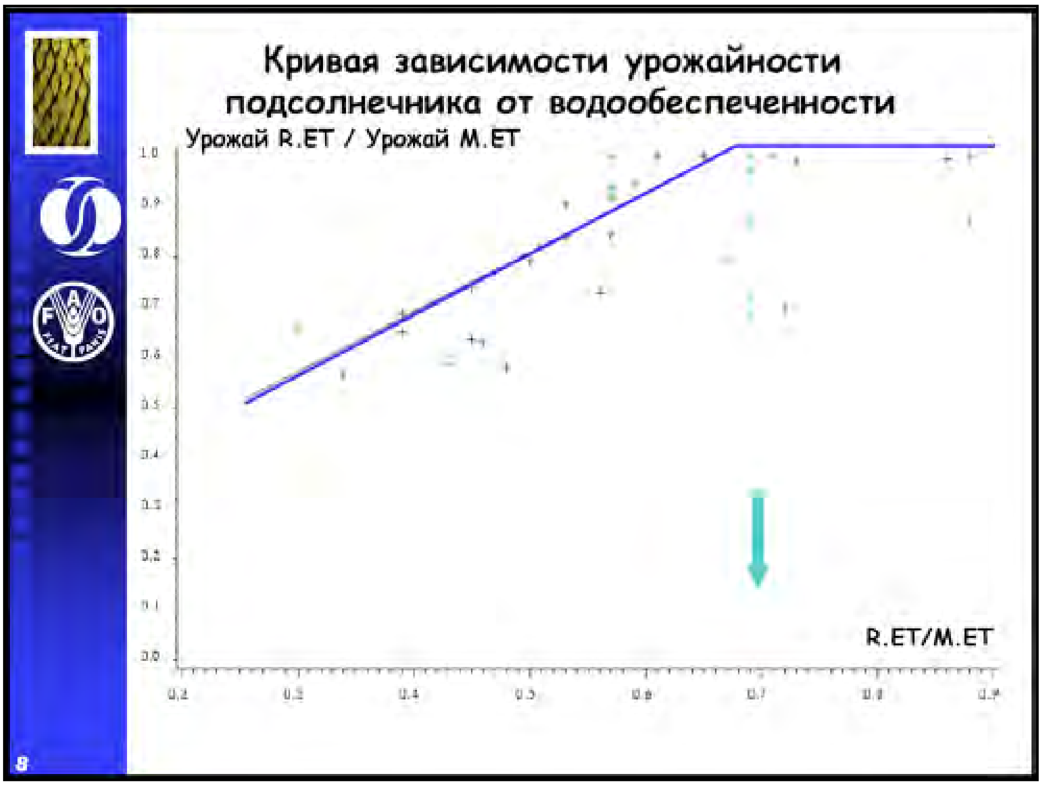
Водопотребление для различных культур без каких-либо ограничивающих факторов

Культуры	Общее водопотребле ние	Оптимальное
Кукуруза	520мм	95 %
Подсолнечник	550мм	75 %
Сорго	450мм	90 %
Соя	480мм	90 %

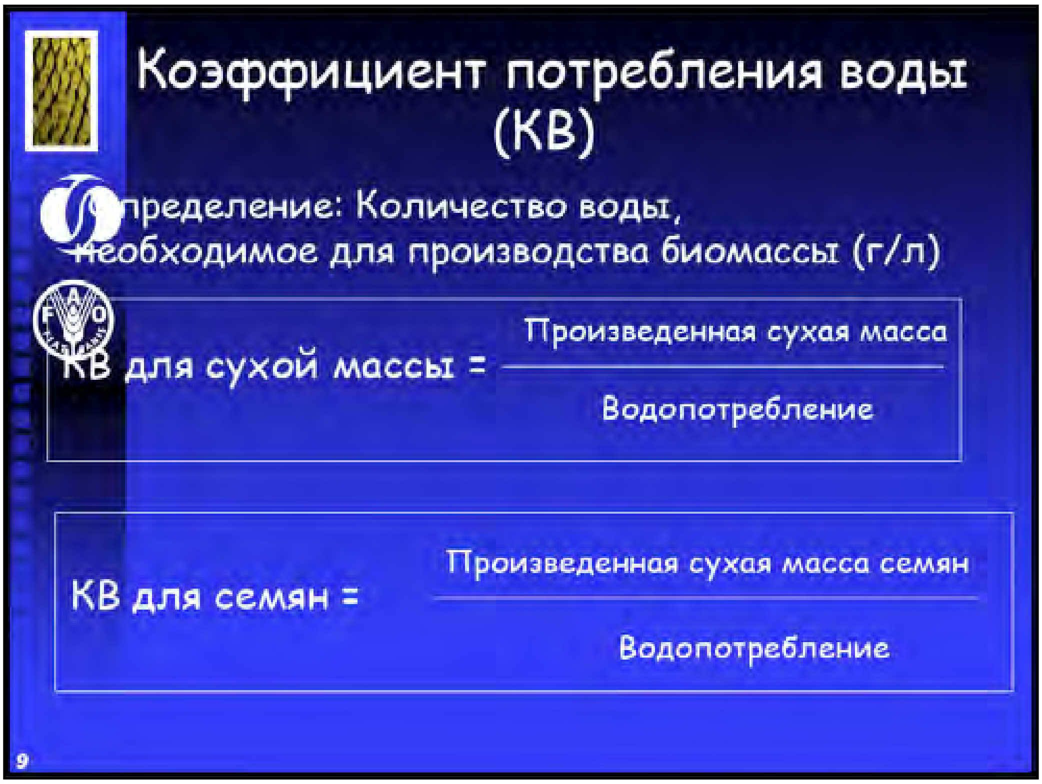
6



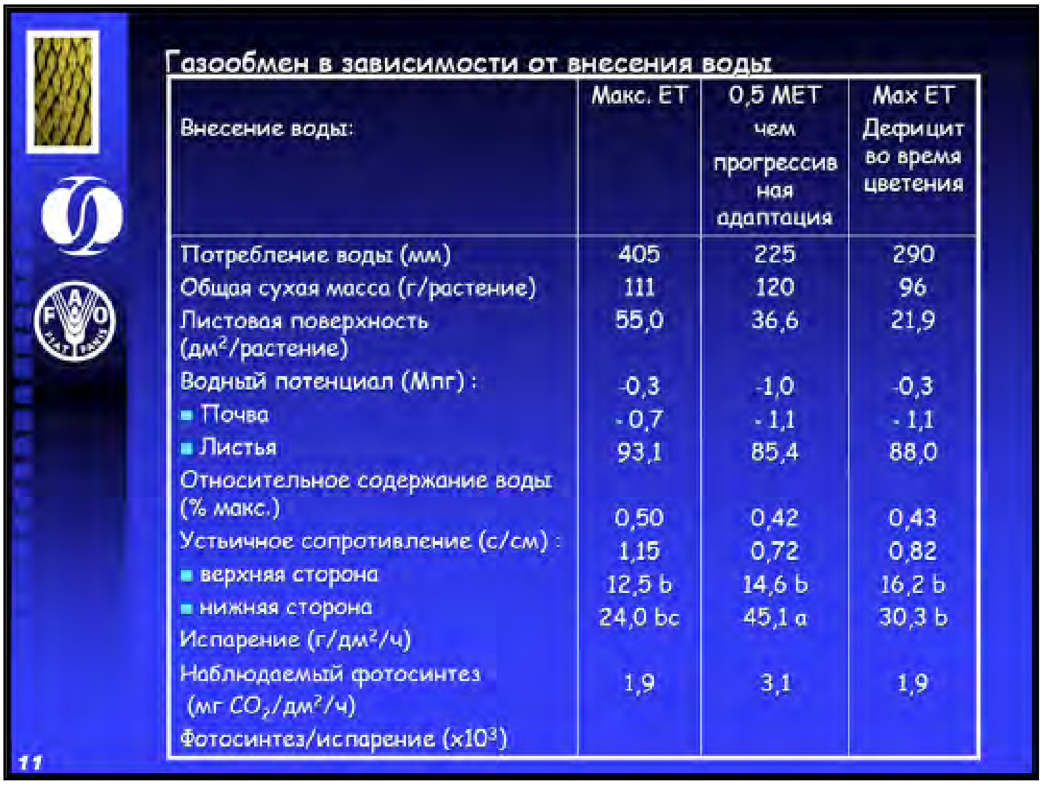
Периоды развития подсолнечника, наиболее чувствительные к засухе, по сравнению с кукурузой
Кукуруза
Снижение урожая (%)
0
-10
-20
-30
-40
-50
-60
-70
0
20
40
60
80
100
120
140
Дни после появления всходов
Подсолнечник
Снижение урожая (%)
Дни после появления всходов
7



Кривая зависимости урожайности подсолнечника от водообеспеченности
Урожай R.ET / Урожай M.ET
R.ET/M.ET
8


Коэффициент потребления воды (КВ)
пределение: Количество воды,
необходимое для производства биомассы (г/л)
КВ для сухой массы =
Произведенная сухая масса
Водопотребление
КВ для семян =
Произведенная сухая масса семян
Водопотребление
9

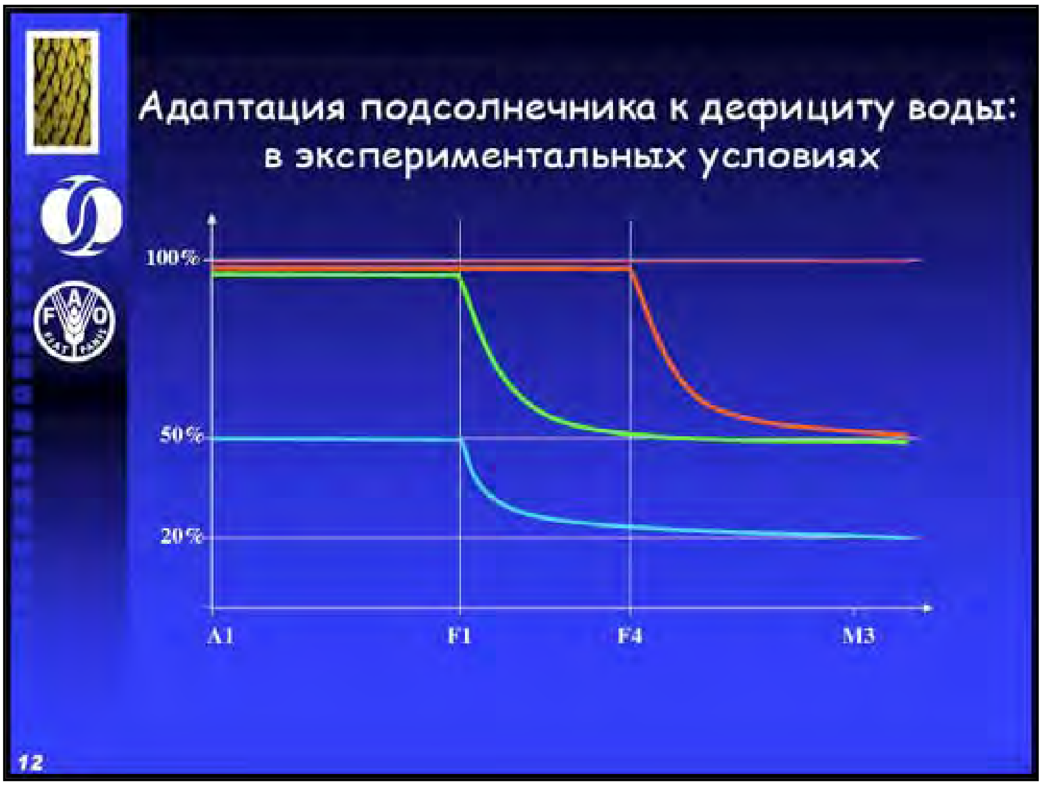

Как повысить КВ для семян ?
ля семян =
Произведенная сухая масса семян
Общая произведенная сухая масса
×
Общая произведенная сухая масс
Водопотребление
КВ для семян = Индекс урожайности (ИУ) × КВ для сухой массы
10



Газообмен в зависимости от внесения воды

Внесение воды:	Макс. ЕТ	0,5 МЕТ чем прогрессивная адаптация	Max ET Дефицит во время цветения
Потребление воды (мм)	405	225	290
Общая сухая масса (г/растение)	111	120	96
Листовая поверхность (дм²/растение)	55,0	36,6	21,9
Водный потенциал (Мпг):	-0,3	-1,0	-0,3
■ Почва	- 0,7	- 1,1	- 1,1
■ Листья	93,1	85,4	88,0
Относительное содержание воды (% макс.)	0,50	0,42	0,43
Устьичное сопротивление (с/см):	1,15	0,72	0,82
■ верхняя сторона	12,5 b	14,6 b	16,2 b
■ нижняя сторона	24,0 bc	45,1 a	30,3 b
Испарение (г/дм²/ч)			
Наблюдаемый фотосинтез (мг CO_2/дм²/ч)	1,9	3,1	1,9
Фотосинтез/испарение (x10³)			

11



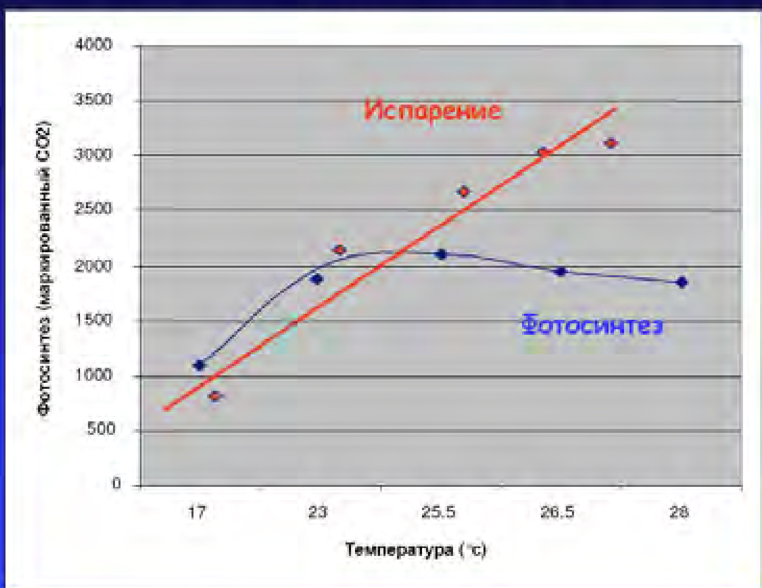
Адаптация подсолнечника к дефициту влаги

Доступность влаги	Водопотребление (л/рас)	Пр-во сухой массы (г/рас)	Сухая масса семян (г/рас)	Эфф-ть для сухой массы (г/л)	Эфф-ть для семян (г/л)	Индекс урожайности семян
Полная необходимая (оптимальная)	75,8	161	56,8	2,1	0,7	0,35
Полная до стадии F1, затем прогрессирующая нехватка	32,5	104,2	33,8	3,2	1	0,32
50 % от полной до стадии F1,а затем 30% от нее	16,1	67,4	23,3	4,2	1,4	0,35

Эффективность = количество массы (общей или семян), произведенного на литр использованной воды
Индекс урожайности = отношение массы урожая к полной массе растений

13

Повышение эффективности можно выразить через Отношение «Фотосинтез / испарение



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Лиственная структура различных культур (1)

Вид	Количество устьев на верхней стороне	Количество устьев на нижней стороне	Средний размер (L x l) (микрон)	Среднее расстояние на эпидермисе между 2 устьями (микрон)
Подсолнечник	85	156	38 X 7	91
Кукуруза	53	168	19 X 5	137
Пшеница	33	14	18 X 7	302
Соя	7	17	16 X 4	250

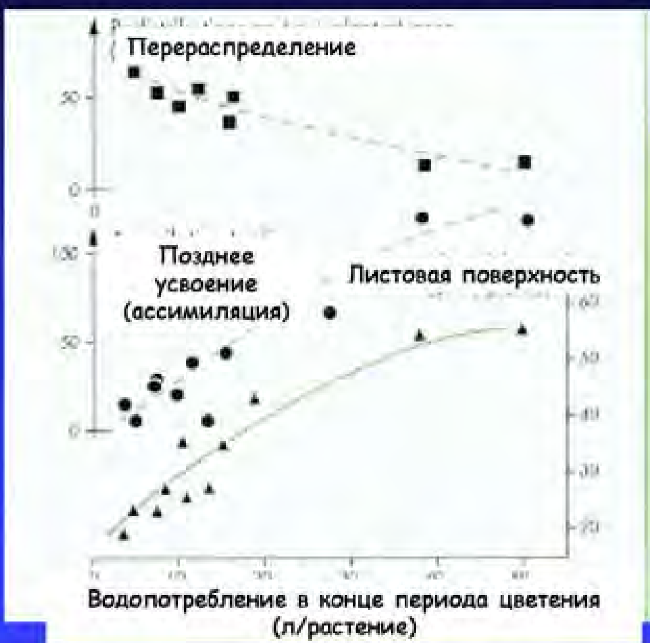
16

Лиственная структура различных культур (2)

Вид	Устьичное сопротив ление (с/м)	Испарение (л/д/дм2)	Водный потенциал листа(бар)	КВ для сухой массы (г/л)
Подсолнечник	60 - 100	4	- 8	2,5
Кукуруза	200 - 300	3	- 3	-
Пшеница	200	3	- 4	-
Соя	80 - 120	3,8	- 4	4

17

Адаптация подсолнечника к дефициту влаги

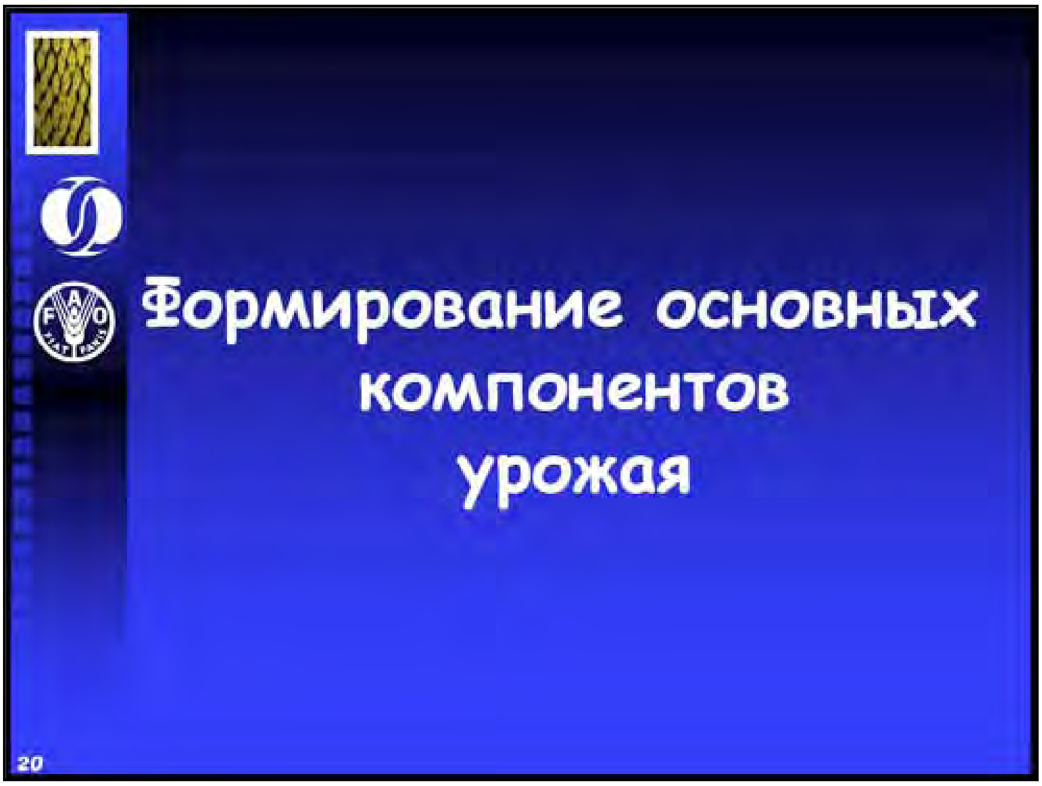


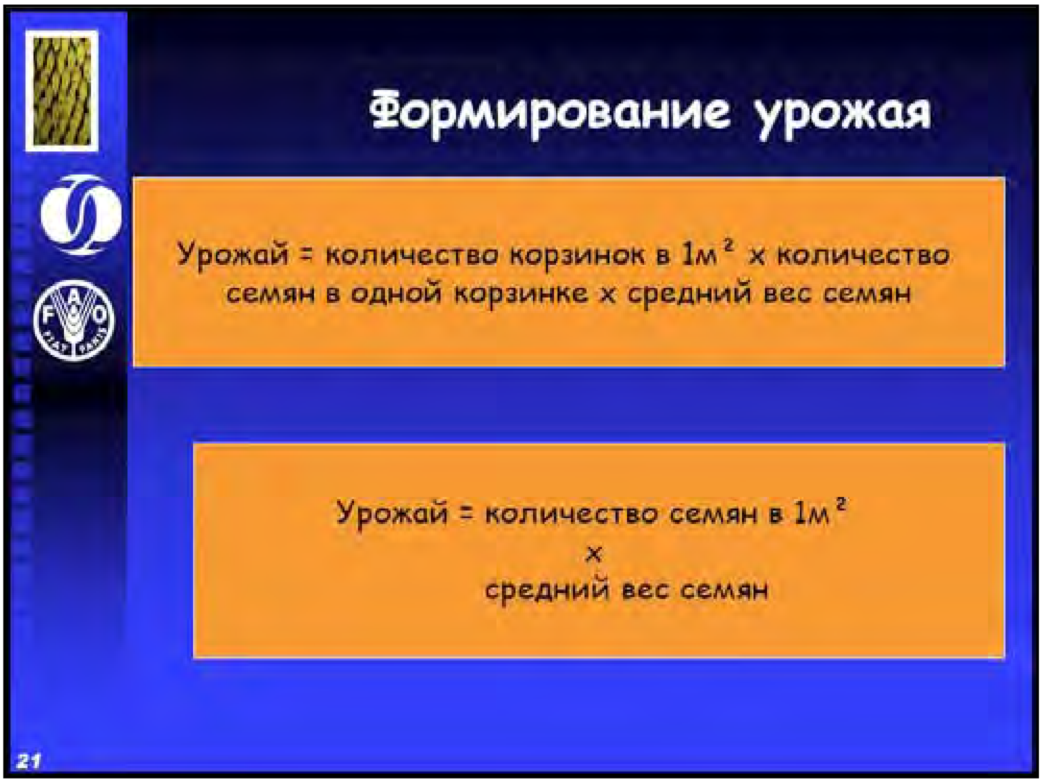
18

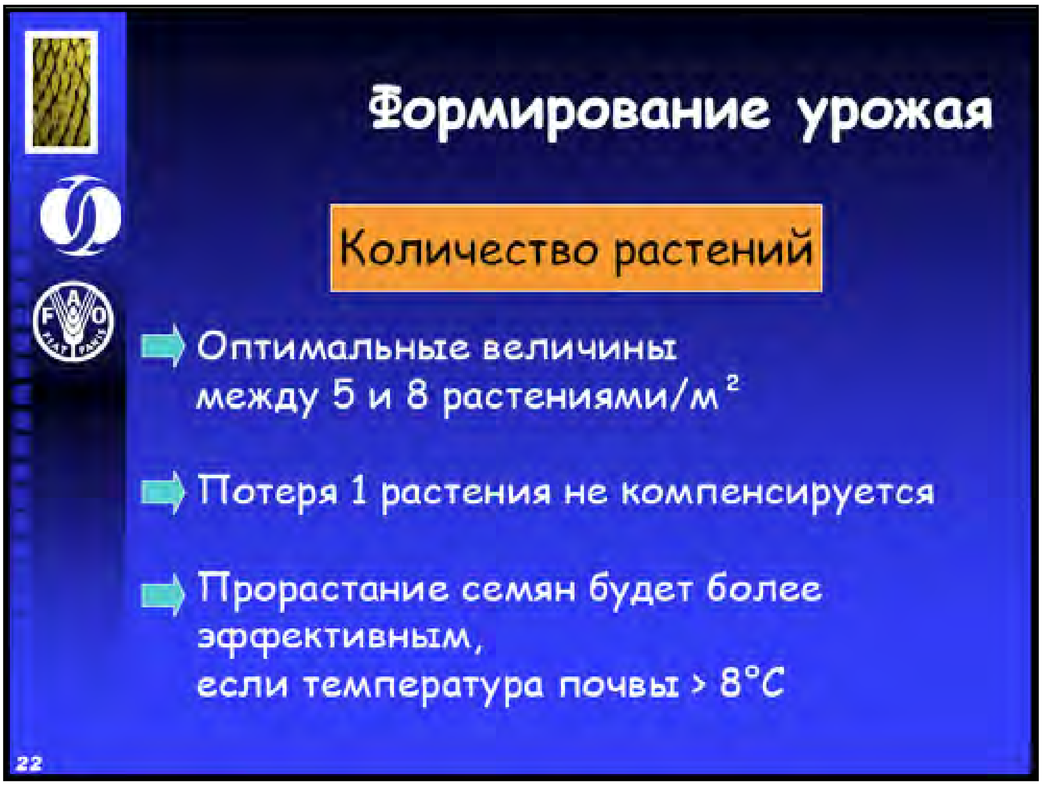

Изменение КВ и ИУ в зависимости от различных уровней дефицита влаги

Водопотребление (л/рас)	Отношение	Сухая масса (г/рас)	Сухая масса семян (г/раст)	ВК /ОСМ (г/л)	ВК /СМС (г/л)	ИУ
76	1	161	57	2,1	0,7	0,35
32	0,42	104	34	3,2	1,1	0,33
29	0,40	80	24	2,7	0,8	0,30
28	0,37	96,5	30	3,5	1,1	0,31
22	0,30	74	27	3,4	1,2	0,36
16	0,2	67	23	4,1	1,5	0,34
12	0,16	52	19	4,3	1,6	0,36

Результаты получены с растений подсолнечника, выросших в горшках (7л) в регулируемых условиях
19


Формирование основных компонентов урожая
20


Формирование урожая
Урожай = количество корзинок в 1м² х количество семян в одной корзинке х средний вес семян
Урожай = количество семян в 1м²
х
средний вес семян
21


Формирование урожая
Количество растений
Оптимальные величины между 5 и 8 растениями/м²
Потеря 1 растения не компенсируется
Прорастание семян будет более эффективным, если температура почвы > 8°C
22

Влияние плотности посева на характеристики головки

Плотность посадки (растений/м2)	Диаметр корзинки (см)	Диаметр стебля (см)	Количество паразитов
2 - 3	> 30	-	144
4 - 7	21 - 27	2,5 - 3,5	89
7 - 10	11 - 21	1,8 - 2,5	55
10 - 12	6 - 11	1,1 - 1,8	34

$Un = Un\text{-}1 + Un\text{-}2$

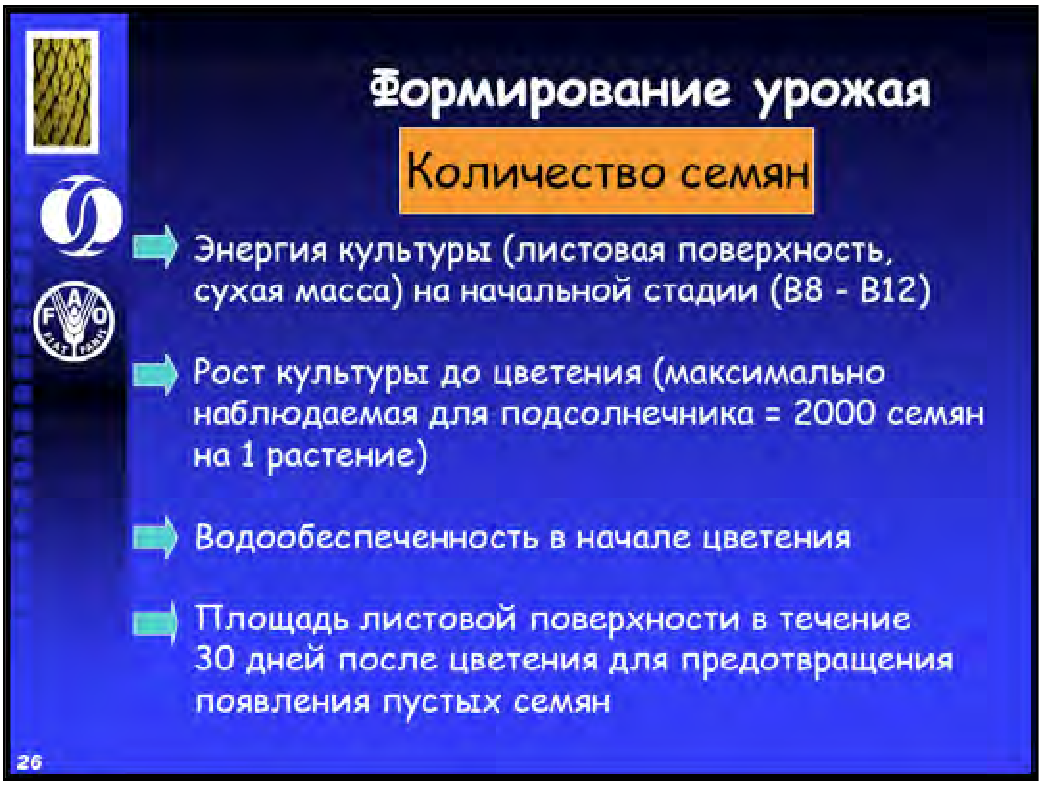
23

Влияние скорости сеялки на урожайность и неравеномерность распределения растений

Скорость сеялки (км/ч)	Урожай (ц/га)
2	28
4	26
6	24
8	22

24

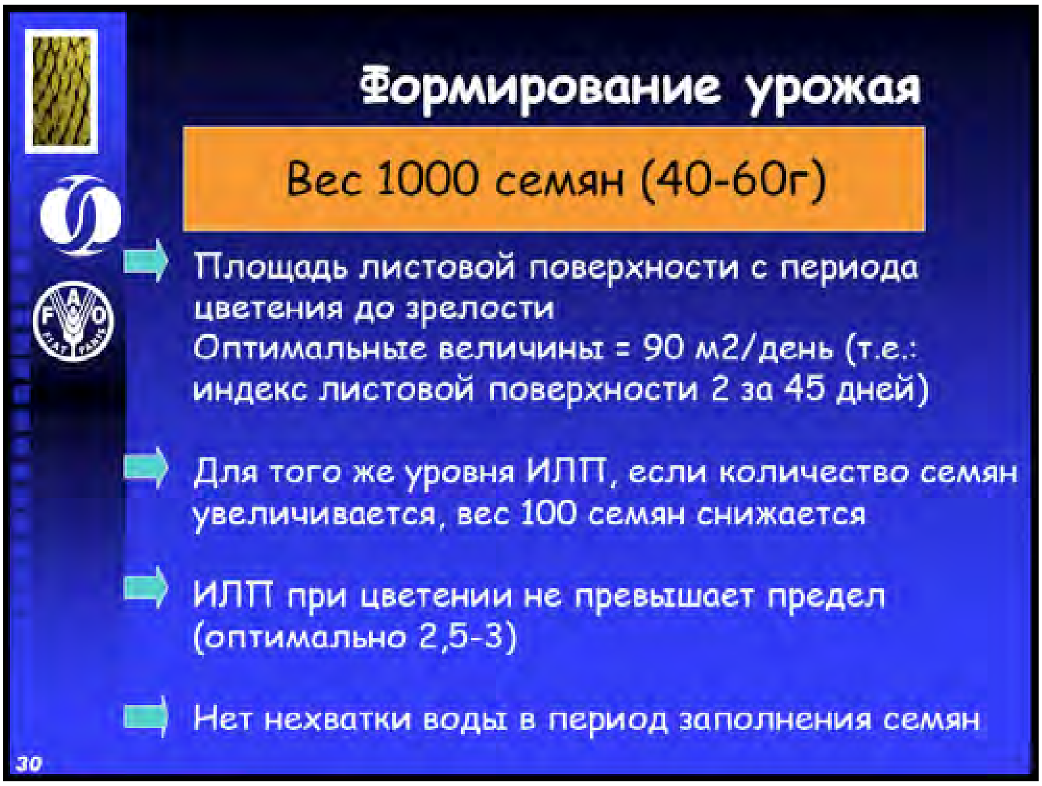
% почвенного покрова	Урожай (процент от эталона)	Распределение растений в колонии
100	100	Равномерное распределение
75	88,3	Равномерное распределение, но с перекрытием листовой поверхности 2 на 2.
83	87,8	Неравномерное распределение с некоторым перекрытием листовой поверхности
66	71,1	Высокая неоднородность и плохое распределение растений в ряду
50	76	Неравномерное распределение, в ряду изолированные растения

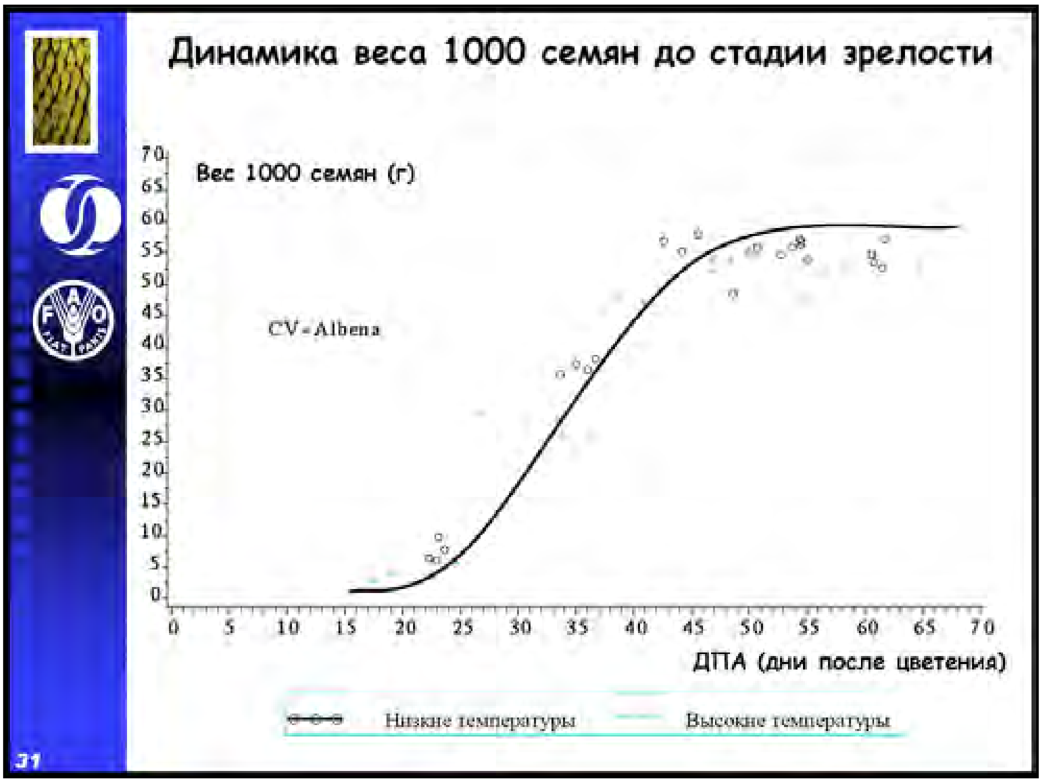



Связь между листовой поверхностью и количеством цветков
Количество цветков/корзинок
2500
2000
1500
1000
500
0
0
1000
2000
3000
4000
5000
Листовая поверхность
на 1 растение на стадии E2
27


Связь между урожаем и количеством семян на 1м2
Урожай(ц/га)
45
40
35
30
25
20
15
10
5
0
r²=0.69
Количество семян/м2
2000
3000
4000
5000
6000
7000
8000
9000
17 - 1997
21 - 1997
31 - 1997
36 - 1997
69 - 1997
17 - 1998
21 - 1998
31 - 1999
36 - 1998
69 - 1998
17 - 1999
21 - 1999
36 - 1999
69 - 1999
28


Влияние нехватки воды на количество семян в различные периоды
29

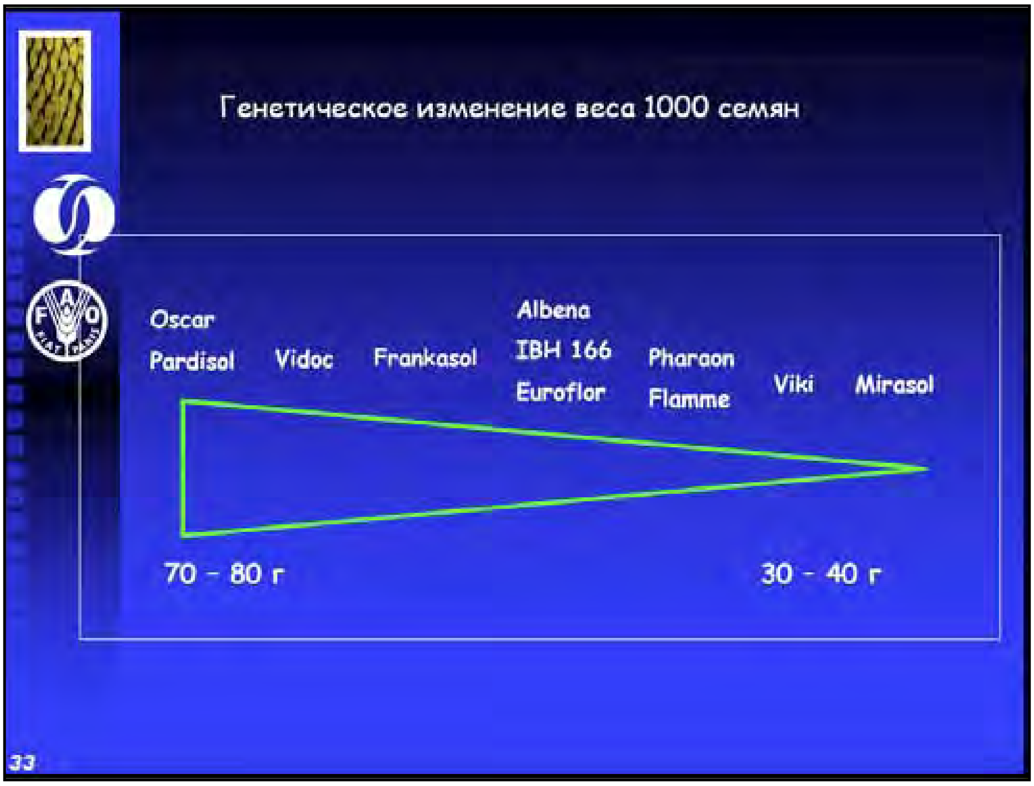

Формирование урожая
Вес 1000 семян (40-60г)
Площадь листовой поверхности с периода цветения до зрелости
Оптимальные величины = 90 м2/день (т.е.: индекс листовой поверхности 2 за 45 дней)
Для того же уровня ИЛП, если количество семян увеличивается, вес 100 семян снижается
ИЛП при цветении не превышает предел (оптимально 2,5-3)
Нет нехватки воды в период заполнения семян
30



Вес 1000 семян в зависимости от размещения семян в головке (в граммах)

Сорта	1 (Снаружи)	3	5	7	9	12 (Внутри)
Albena	67	63	56	48	55	54
Euroflor	49	53	51	50	49	48
Viki	50	46	44	45	45	41

32



Влияние различных уровней дефицита влаги на вес 1000 семян на разных стадиях

Отношение ОтП/ОП	0,3	0,4	0,5	0,6	0,7	0,8
Фаза 1 (< F1)	НД	НД	- 20%	- 10%	-	-
Фаза 2 (F1 - F4)	НД	- 22%	- 22%	- 15%	-5%	-
Фаза 3 (>F4)	- 50%	- 46%	- 28%	- 20%	- 10%	- 5%

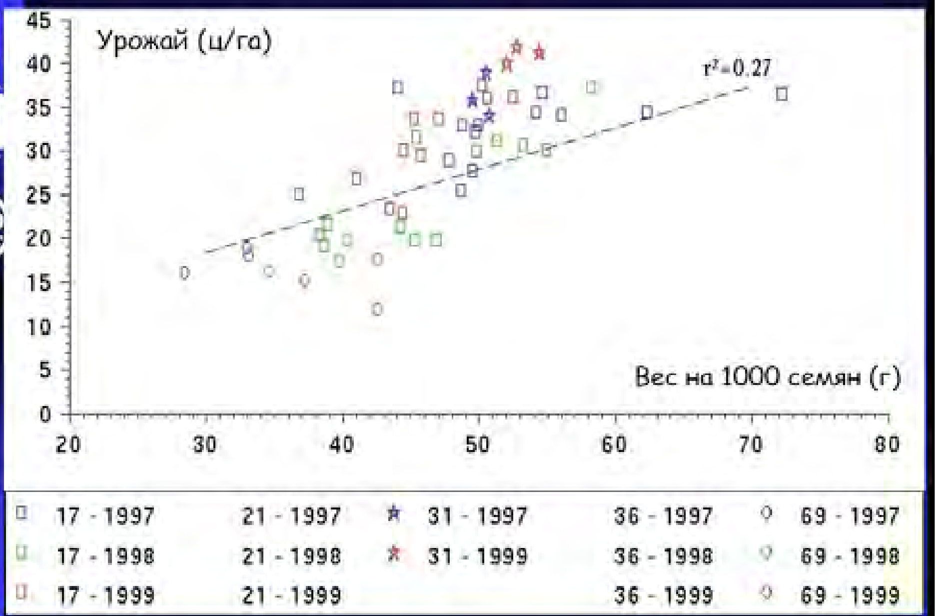
НД = нет данных ОП = Общие потребности ОтП = относительные потребности

34

Характеристики некоторых семян в зависимости от их расположения на головке

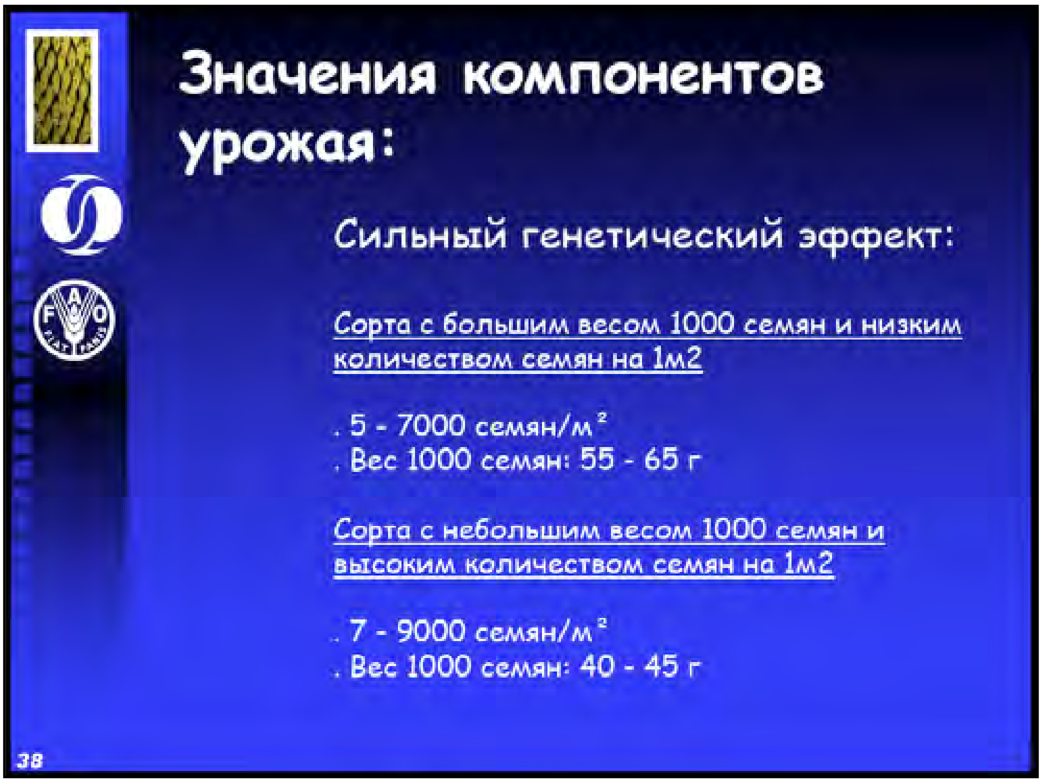
Расположение сердцевины	Вес семени (мг)	Белки (%)	Масло (%)
Снаружи	56,4	17,4	45,0
В середине	50,5	19,6	39,0
В центре	44,8	21,8	35,7

35

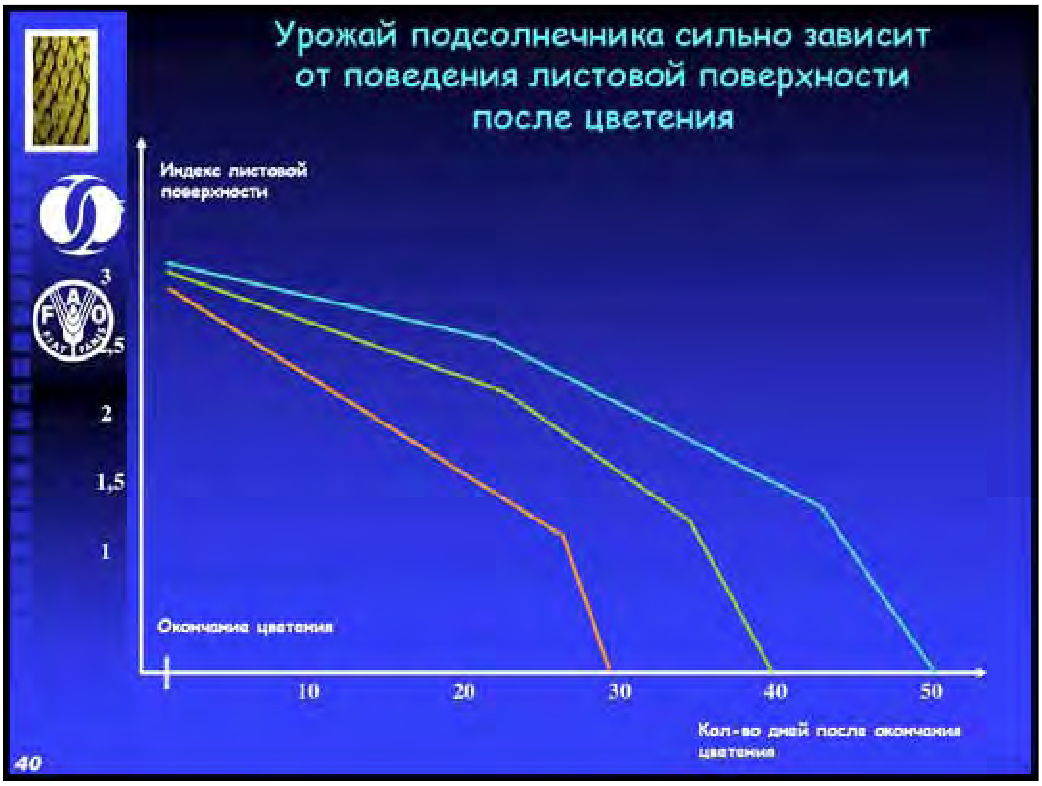


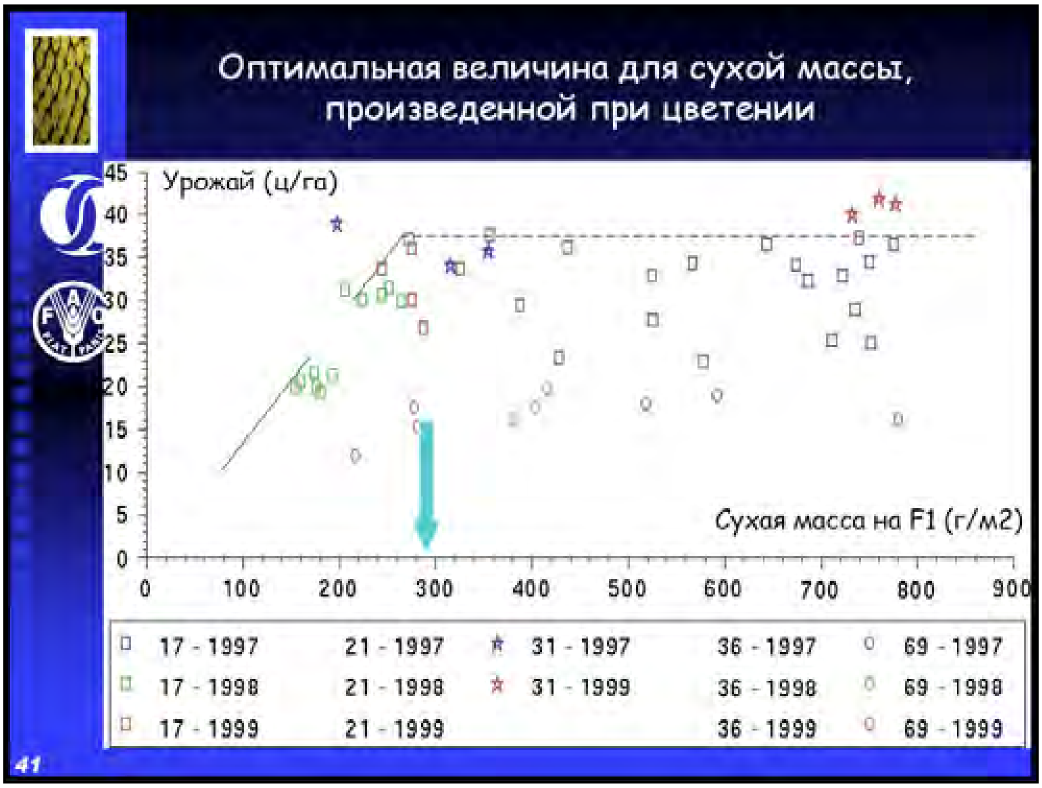
36

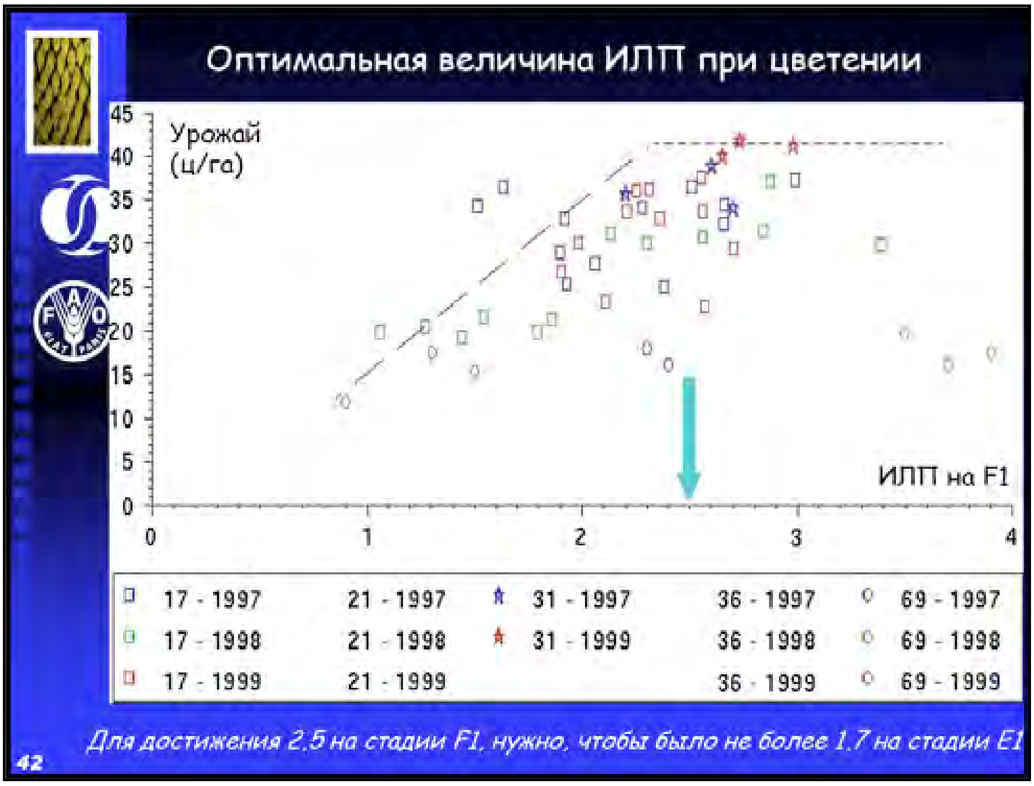

Отношение оболочки-сердцевины:
Стабильное свойство подсолнечника
Albéna
Euroflor
Flamme
Frankasol
IBH 166
Viki
23,5
24,2
25,9
28,9
27,6
24,5
37

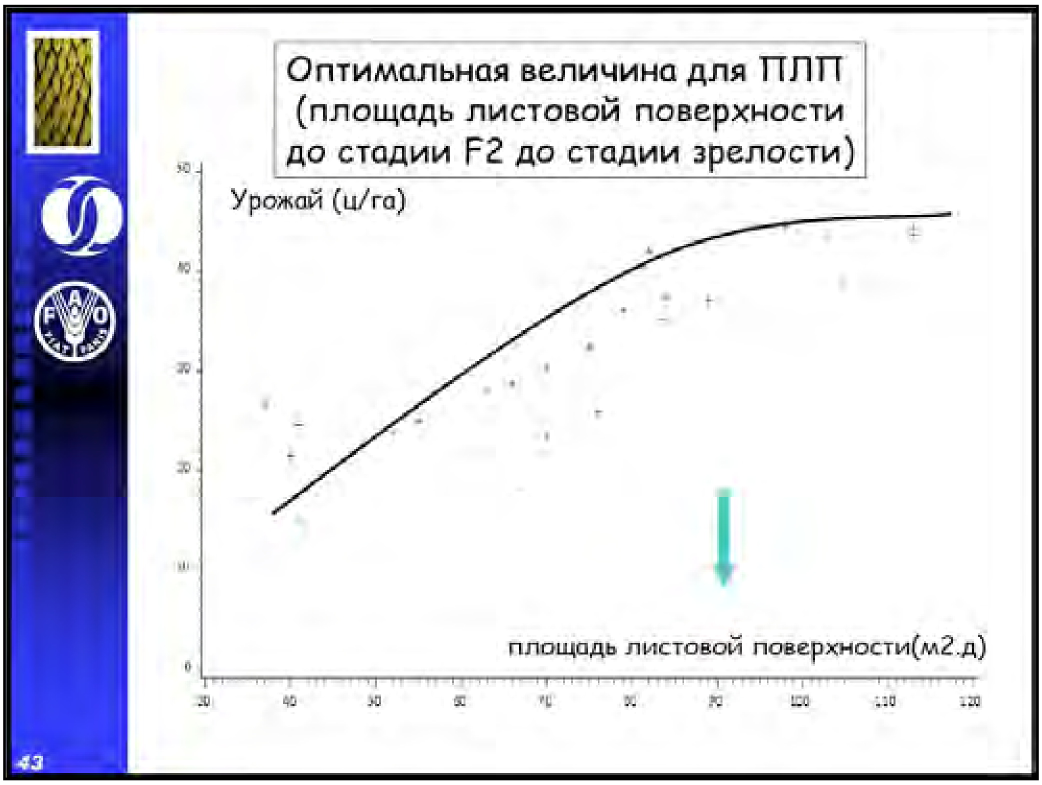

Значения компонентов урожая:
Сильный генетический эффект:
Сорта с большим весом 1000 семян и низким количеством семян на 1м2
. 5 - 7000 семян/м²
. Вес 1000 семян: 55 - 65 г
Сорта с небольшим весом 1000 семян и высоким количеством семян на 1м2
. 7 - 9000 семян/м²
. Вес 1000 семян: 40 - 45 г
38

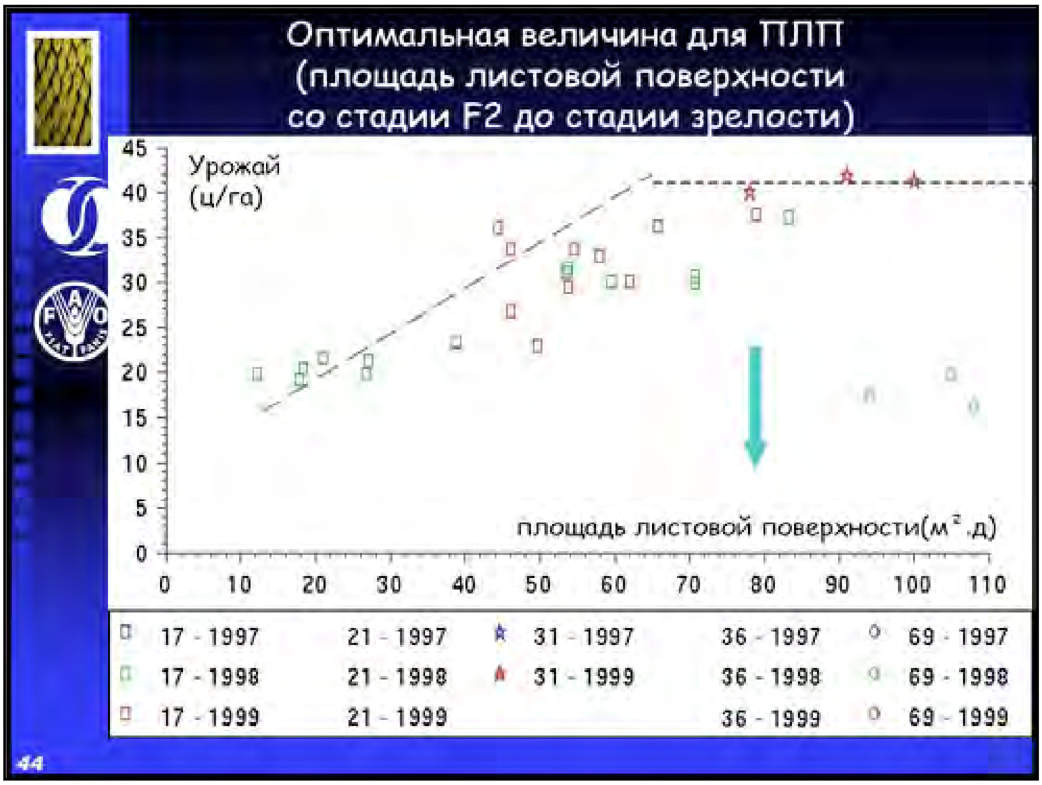

Последовательное внесение компонентов урожая в конечный продукт
Потенциальный урожай 45 - 55 ц/га
Кол-во семечек /м2 9 - 12 000
Вес 1000 семян
Кол-во головок 6,5 – 7/м2
Кол-во сердцевин в 1 головке
Кол-во растений 6,5 - 7 /м2
Потенциальное кол-во семян в головке 2 000
% фертилизации (опылени 80 - 90%
Кол-во посеянных семян
Оптимальное направление выработки урожая подсолнечника
39

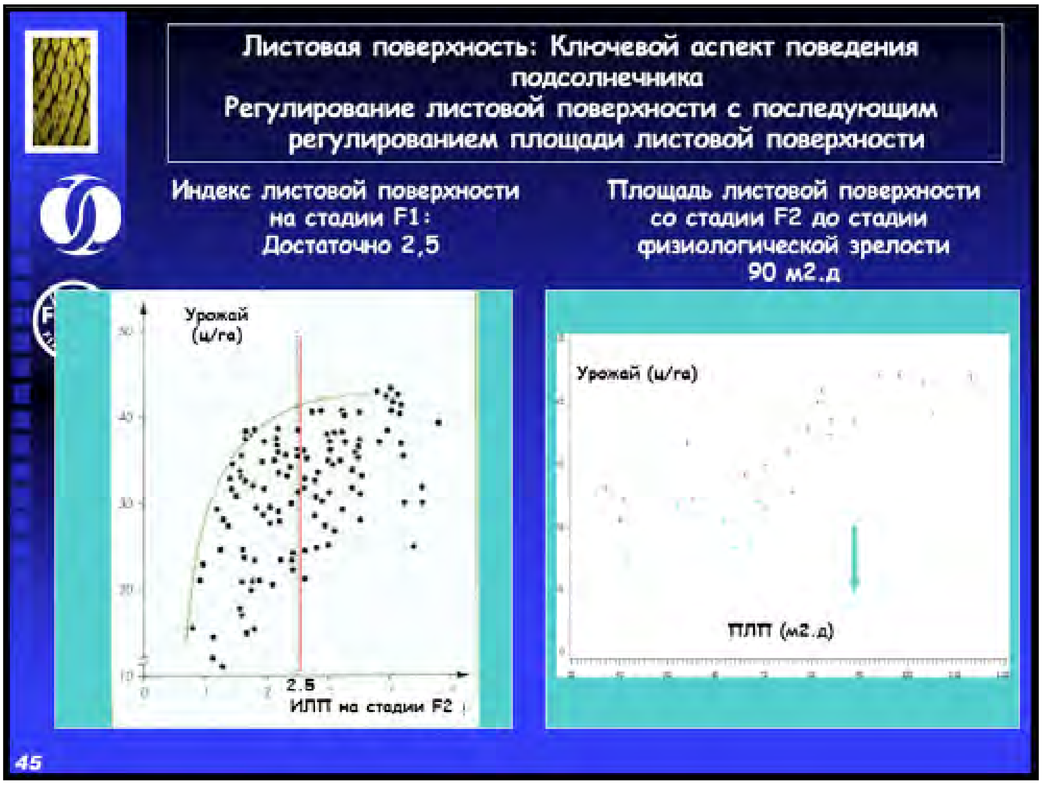

Урожай подсолнечника сильно зависит от поведения листовой поверхности после цветения
Индекс листовой поверхности
3
2,5
2
1,5
1
Окончание цветения
10
20
30
40
50
Кол-во дней после окончания цветения
40

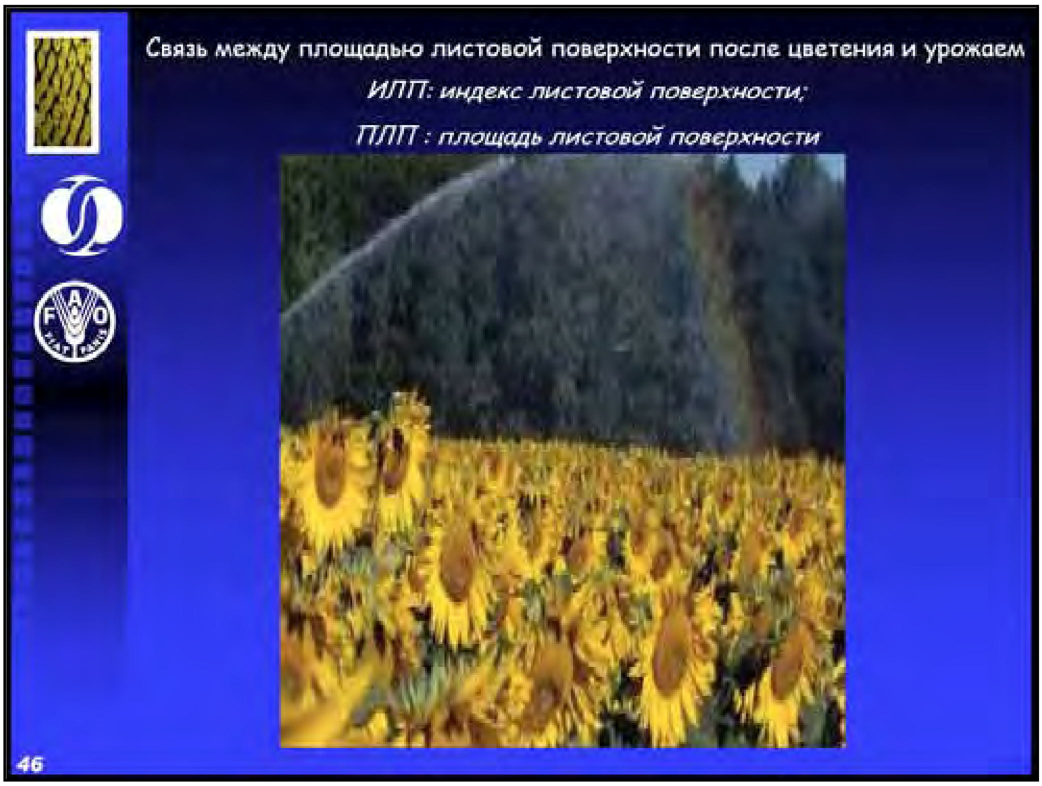

Оптимальная величина для сухой массы, произведенной при цветении
Урожай (ц/га)
Сухая масса на F1 (г/м2)
17 - 1997
17 - 1998
17 - 1999
21 - 1997
21 - 1998
21 - 1999
31 - 1997
31 - 1999
36 - 1997
36 - 1998
36 - 1999
69 - 1997
69 - 1998
69 - 1999
41


Оптимальная величина ИЛП при цветении
Урожай (ц/га)
ИЛП на F1
17 - 1997
17 - 1998
17 - 1999
21 - 1997
21 - 1998
21 - 1999
31 - 1997
31 - 1999
36 - 1997
36 - 1998
36 - 1999
69 - 1997
69 - 1998
69 - 1999
Для достижения 2,5 на стадии F1, нужно, чтобы было не более 1.7 на стадии E1
42

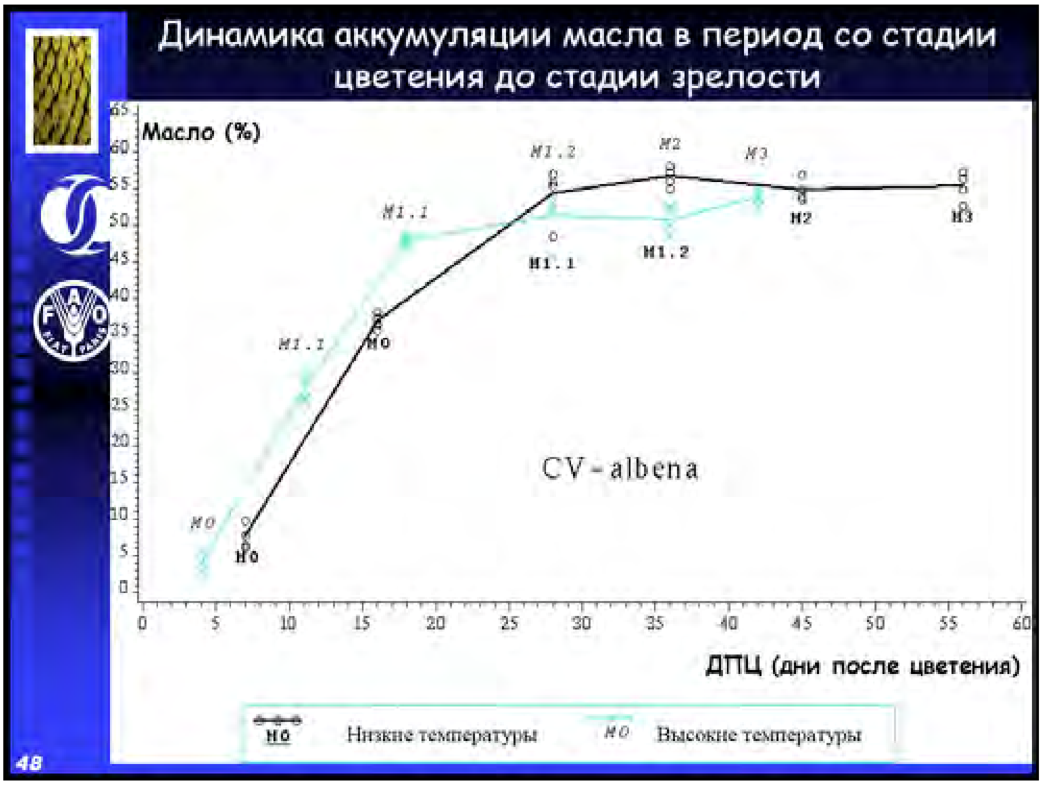

Оптимальная величина для ПЛП
(площадь листовой поверхности
до стадии F2 до стадии зрелости)
Урожай (ц/га)
площадь листовой поверхности(м2.д)
43

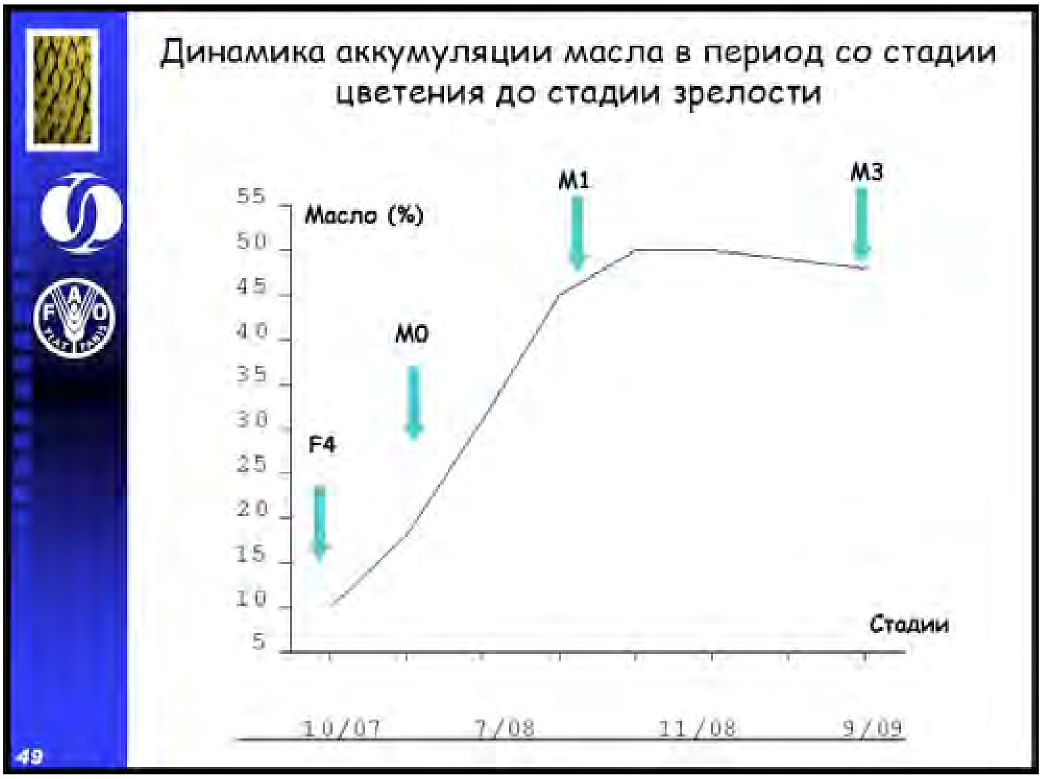

Оптимальная величина для ПЛП
(площадь листовой поверхности
со стадии F2 до стадии зрелости)
Урожай
(ц/га)
площадь листовой поверхности(м².д)
0
5
10
15
20
25
30
35
40
45
0
10
20
30
40
50
60
70
80
90
100
110
17 - 1997
17 - 1998
17 - 1999
21 - 1997
21 - 1998
21 - 1999
31 - 1997
31 - 1999
36 - 1997
36 - 1998
36 - 1999
69 - 1997
69 - 1998
69 - 1999
44

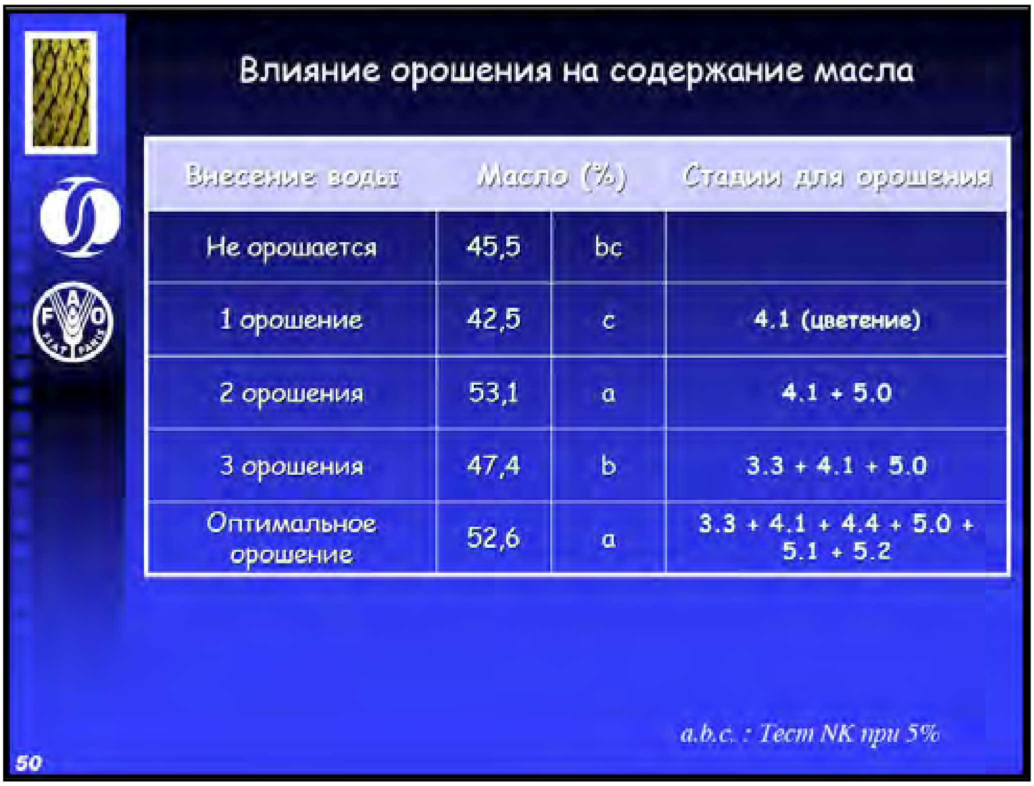

Листовая поверхность: Ключевой аспект поведения подсолнечника
Регулирование листовой поверхности с последующим регулированием площади листовой поверхности
Индекс листовой поверхности на стадии F1: Достаточно 2,5
Площадь листовой поверхности со стадии F2 до стадии физиологической зрелости 90 м2.д
Урожай (ц/га)
2.5
ИЛП на стадии F2
Урожай (ц/га)
ПЛП (м2.д)
45


Связь между площадью листовой поверхности после цветения и урожаем
ИЛП: индекс листовой поверхности;
ПЛП : площадь листовой поверхности
46


Связь между площадью листовой поверхности (ПЛП) и содержанием масла
Содержание масла (%)
Общая площадь листовой поверхности (м2.д)
47


Динамика аккумуляции масла в период со стадии цветения до стадии зрелости
Масло (%)
CV - albena
ДПЦ (дни после цветения)
Низкие температуры
Высокие температуры
48



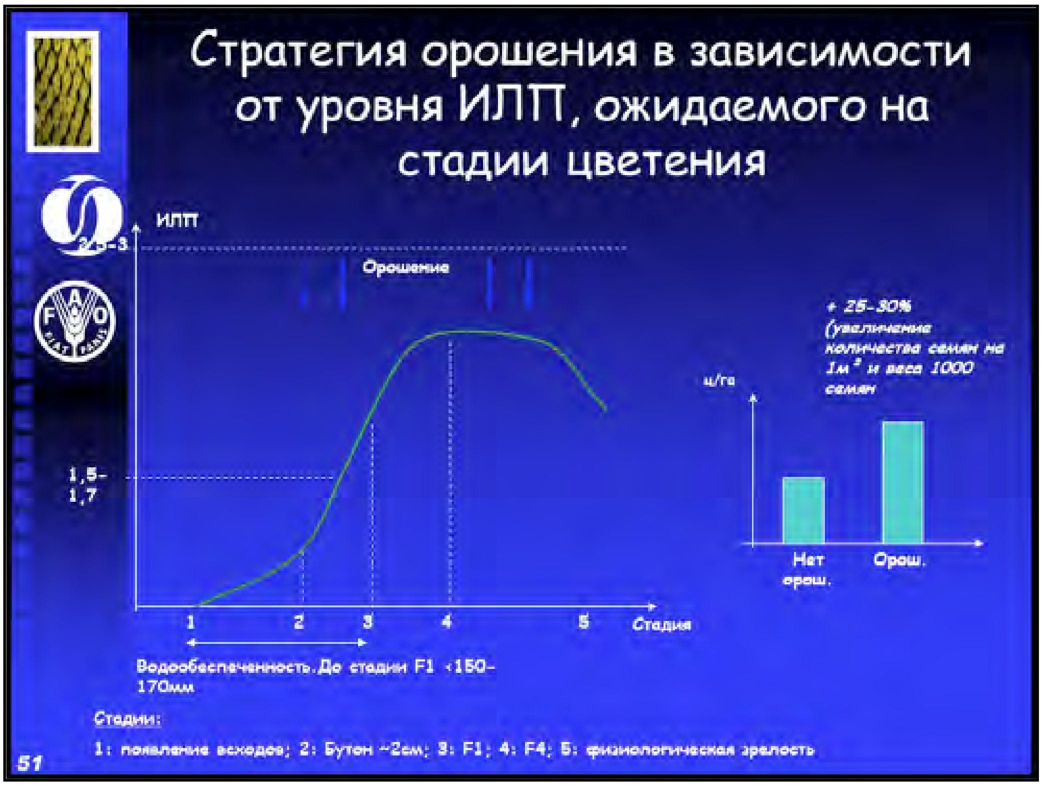


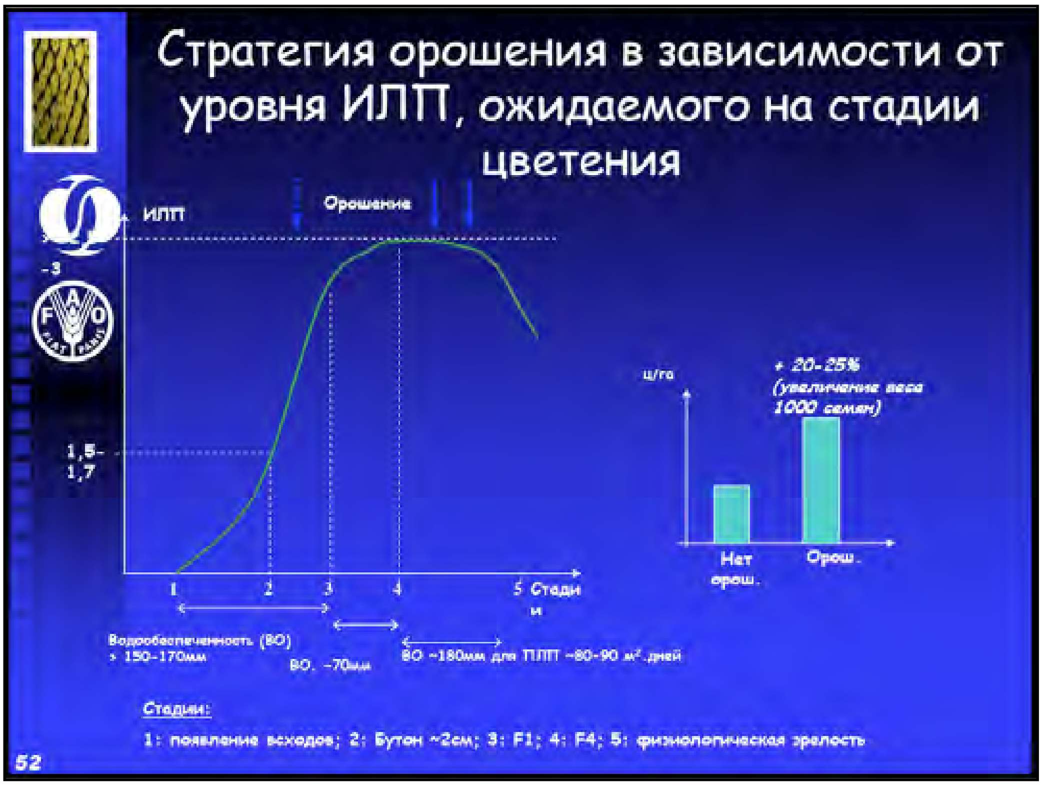
Влияние орошения на содержание масла

Внесение воды	Масло (%)		Стадии для орошения
Не орошается	45,5	bc	
1 орошение	42,5	c	4.1 (цветение)
2 орошения	53,1	a	4.1 + 5.0
3 орошения	47,4	b	3.3 + 4.1 + 5.0
Оптимальное орошение	52,6	a	3.3 + 4.1 + 4.4 + 5.0 + 5.1 + 5.2

a.b.c. : Тест NK при 5%

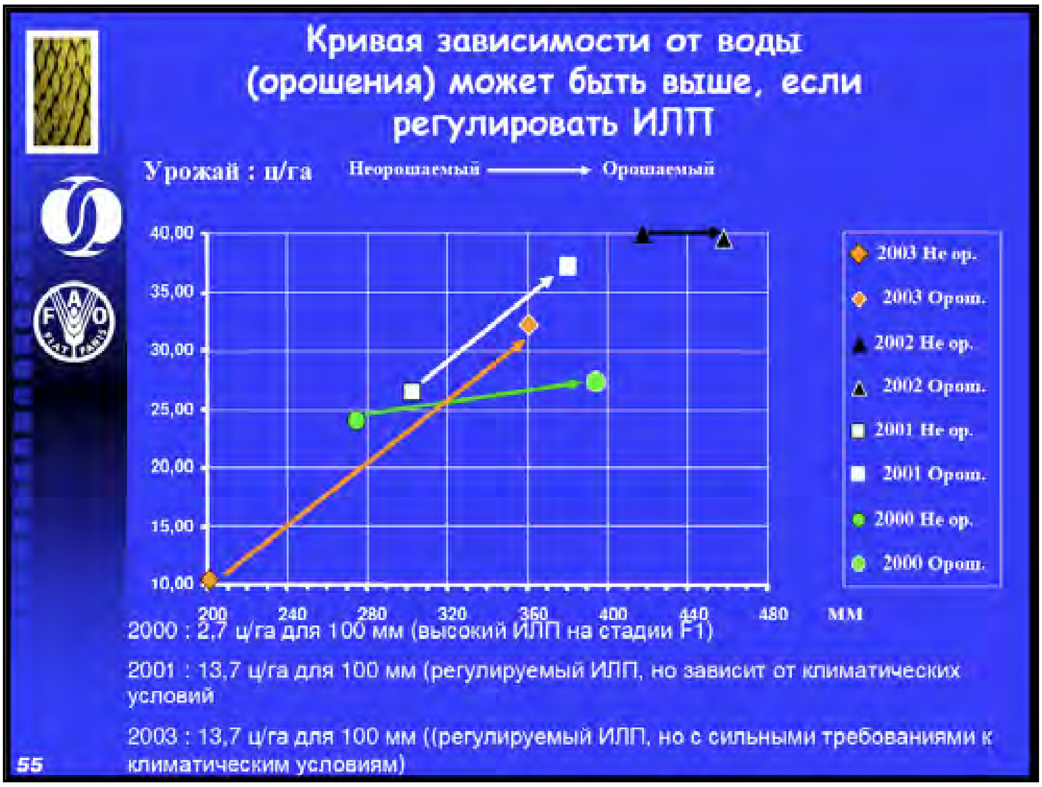
50


Стратегия орошения в зависимости от уровня ИЛП, ожидаемого на стадии цветения
ИЛП
Орошение
1,5-
1,7
1
2
3
4
5
Стадия
ц/га
+ 25-30%
(увеличение количества семян на 1м² и веса 1000 семян
Нет орош.
Орош.
Водообеспеченность.До стадии F1 <150-170мм
Стадии:
1: появление всходов; 2: Бутон ~2см; 3: F1; 4: F4; 5: физиологическая зрелость
51


Стратегия орошения в зависимости от уровня ИЛП, ожидаемого на стадии цветения
ИЛП
Орошение
-3
1,5-
1,7
1
2
3
4
5
Стадии
ц/га
+ 20-25%
(увеличение веса 1000 семян)
Нет орош.
Орош.
Водообеспеченность (ВО)
> 150-170мм
ВО. ~70мм
ВО ~180мм для ПЛП ~80-90 м².дней
Стадии:
1: появление всходов; 2: Бутон ~2см; 3: F1; 4: F4; 5: физиологическая зрелость
52

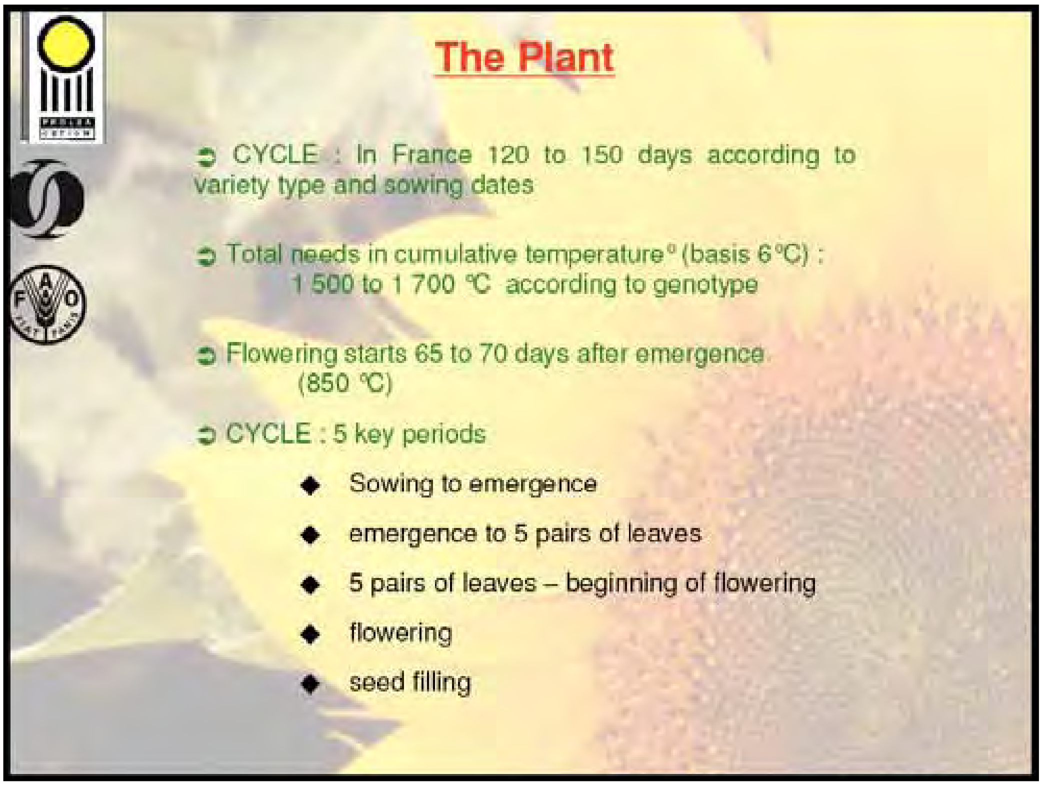

Стратегия орошения на основе лиственной поверхности
Comment raisonner l'irrigation dans les petites terres de Vendée et du Poitou-Charentes
Profondeur du sol
superficiel
Moyennement profond
très profond
Низкий ИЛП до стадии F1
au stade bouton 2 cm (interligne visible)
Indice foliaire inférieur à 1,7
2 à 3 tours d'eau : (90-100 mm)
2 tours d'eau : (70-80 mm)
Avant floraison (*)
Début floraison
Fin floraison
Ne pas irriguer
Rentabilité de l'irrigation
Forte
Moyenne à forte
ИЛП > 2,5 до стадии F1
au stade bouton 2 cm (interligne fermé)
Indice foliaire supérieur à 1,7
Début floraison
Fin floraison
10 jours plus tard
Ne pas irriguer
Rentabilité de l'irrigation
Moyenne
Faible
53

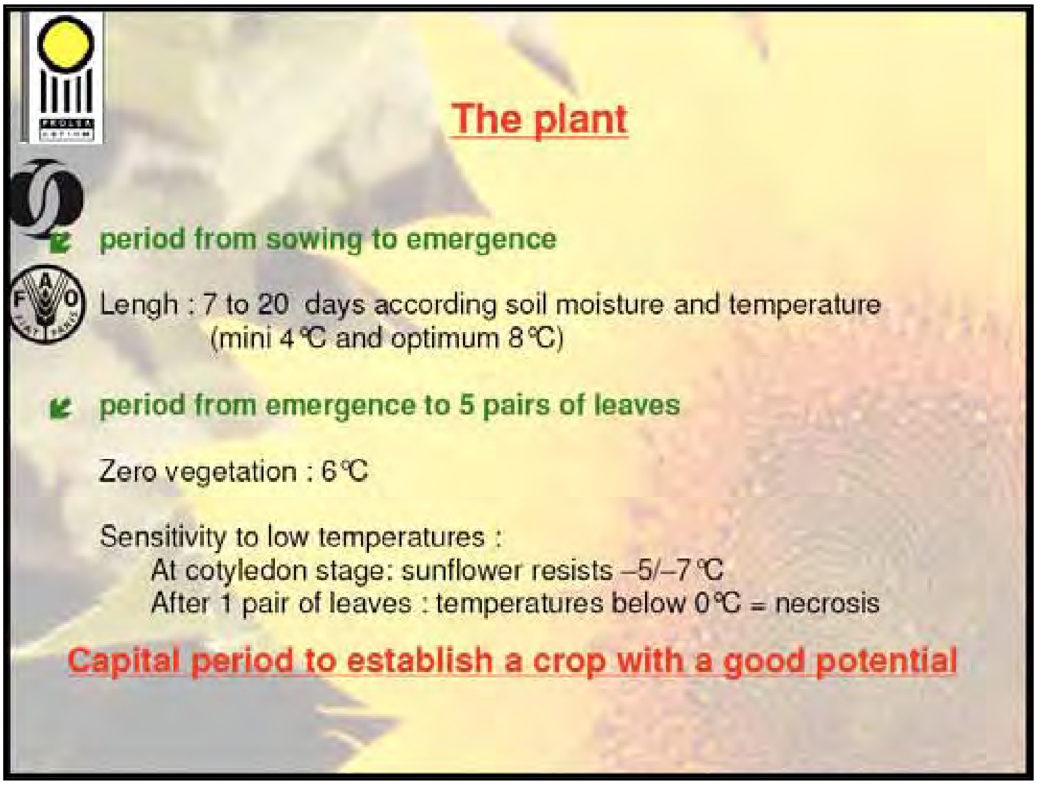

Примеры влияния на урожайность
При орошении возможно получить до + 5 - 10 ц/га
Количество корней/д
Третий порядок
Четвертый порядок
Неорошаемый
Орошаемый
24
21
18
15
12
3
6
9
12
15
18
Дни после посева
54

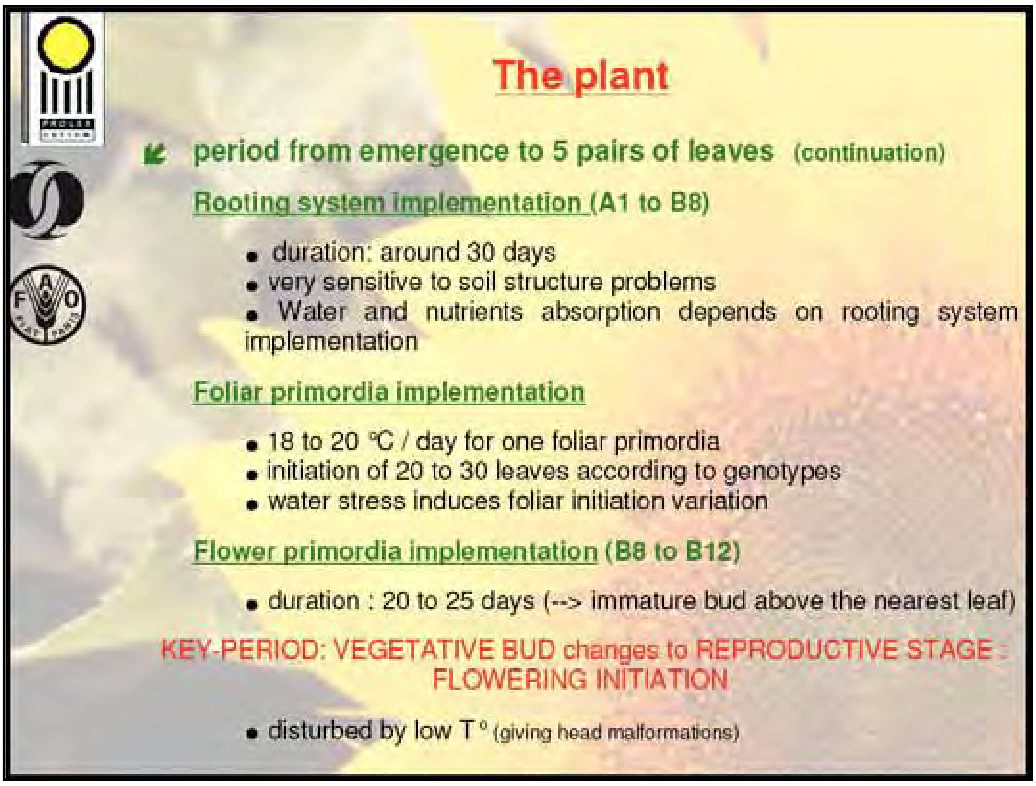

Кривая зависимости от воды (орошения) может быть выше, если регулировать ИЛП
Урожай : ц/га
Неорошаемый
Орошаемый
40,00
35,00
30,00
25,00
20,00
15,00
10,00
200
240
280
320
360
400
440
480
ММ
2003 Не ор.
2003 Орош.
2002 Не ор.
2002 Орош.
2001 Не ор.
2001 Орош.
2000 Не ор.
2000 Орош.
2000 : 2,7 ц/га для 100 мм (высокий ИЛП на стадии F1)
2001 : 13,7 ц/га для 100 мм (регулируемый ИЛП, но зависит от климатических условий
2003 : 13,7 ц/га для 100 мм ((регулируемый ИЛП, но с сильными требованиями к климатическим условиям)
55

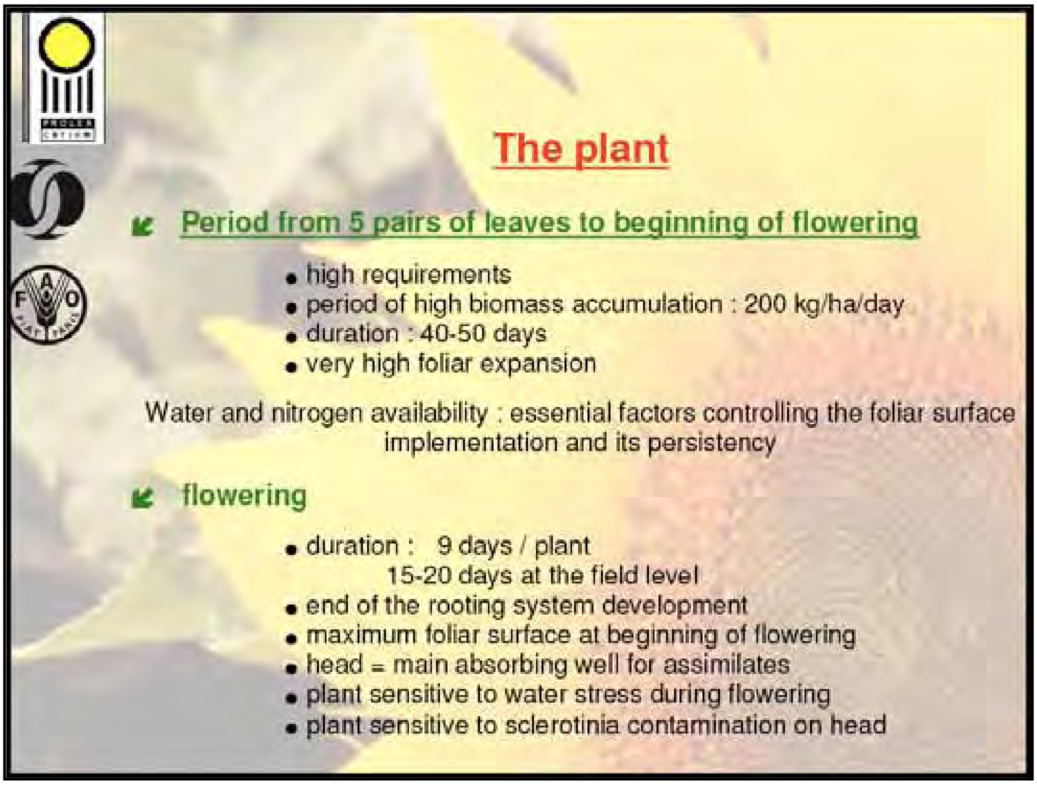

Качество роста подсолнечника во Франции:
Пятилетнее исследование
Примеси (%)
Содержание воды (%)
Содержание масла (%)
Протеин (% в муке)
% кислотности
1999
2000
2001
2002
2003
norme de commercialisation
56

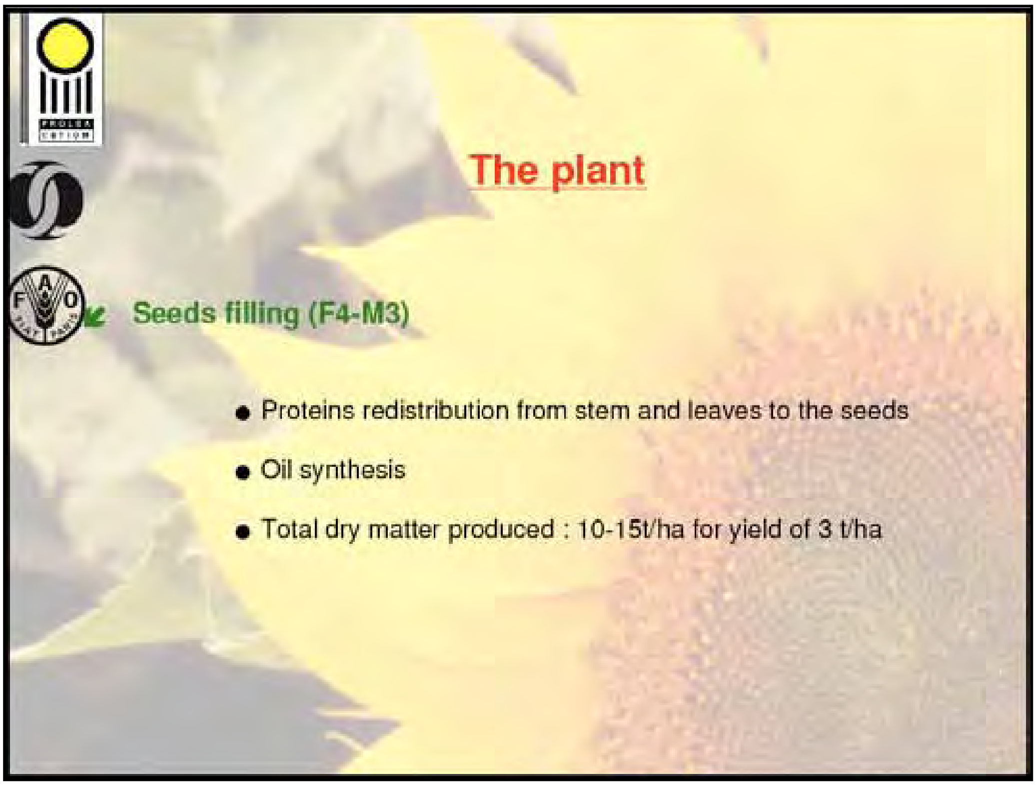
Sunflower crop (English)



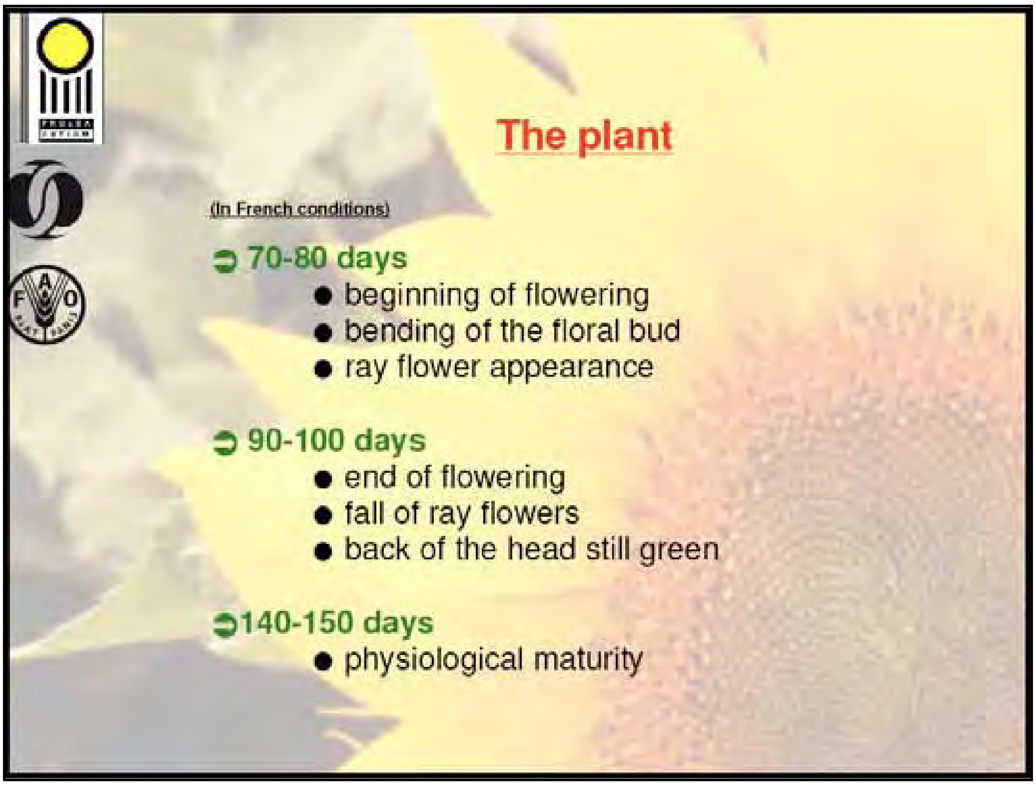

The plant
period from sowing to emergence
Lengh : 7 to 20 days according soil moisture and temperature
(mini 4 °C and optimum 8 °C)
period from emergence to 5 pairs of leaves
Zero vegetation : 6 °C
Sensitivity to low temperatures :
At cotyledon stage: sunflower resists –5/–7 °C
After 1 pair of leaves : temperatures below 0 °C = necrosis
Capital period to establish a crop with a good potential

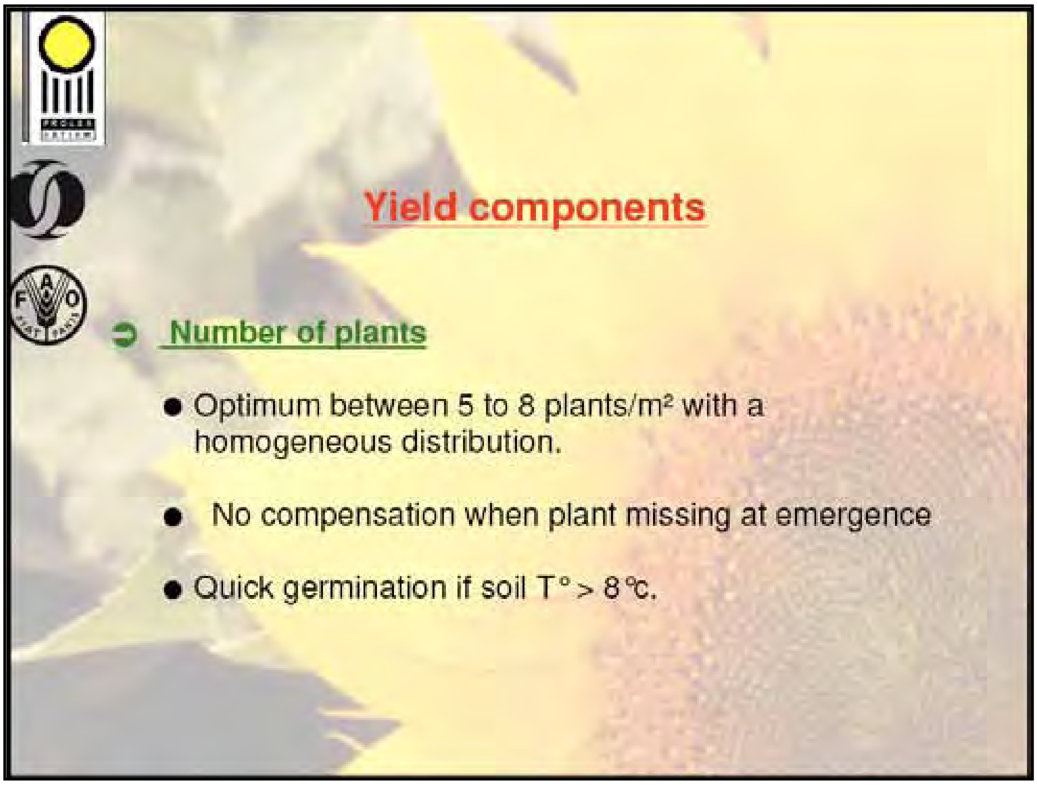

The plant
period from emergence to 5 pairs of leaves (continuation)
Rooting system implementation (A1 to B8)
• duration: around 30 days
• very sensitive to soil structure problems
• Water and nutrients absorption depends on rooting system implementation
Foliar primordia implementation
• 18 to 20 °C / day for one foliar primordia
• initiation of 20 to 30 leaves according to genotypes
• water stress induces foliar initiation variation
Flower primordia implementation (B8 to B12)
• duration : 20 to 25 days (--> immature bud above the nearest leaf)
KEY-PERIOD: VEGETATIVE BUD changes to REPRODUCTIVE STAGE : FLOWERING INITIATION
• disturbed by low T ° (giving head malformations)

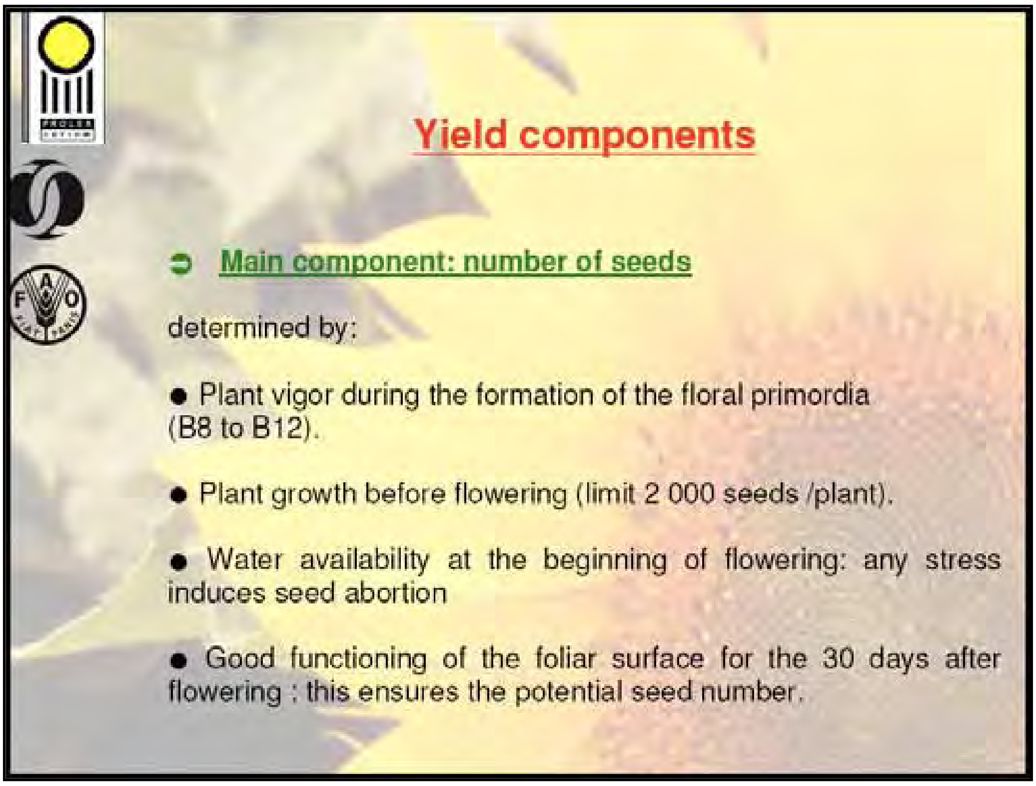

The plant
Period from 5 pairs of leaves to beginning of flowering
high requirements
period of high biomass accumulation : 200 kg/ha/day
duration : 40-50 days
very high foliar expansion
Water and nitrogen availability : essential factors controlling the foliar surface implementation and its persistency
flowering
duration : 9 days / plant
15-20 days at the field level
end of the rooting system development
maximum foliar surface at beginning of flowering
head = main absorbing well for assimilates
plant sensitive to water stress during flowering
plant sensitive to sclerotinia contamination on head

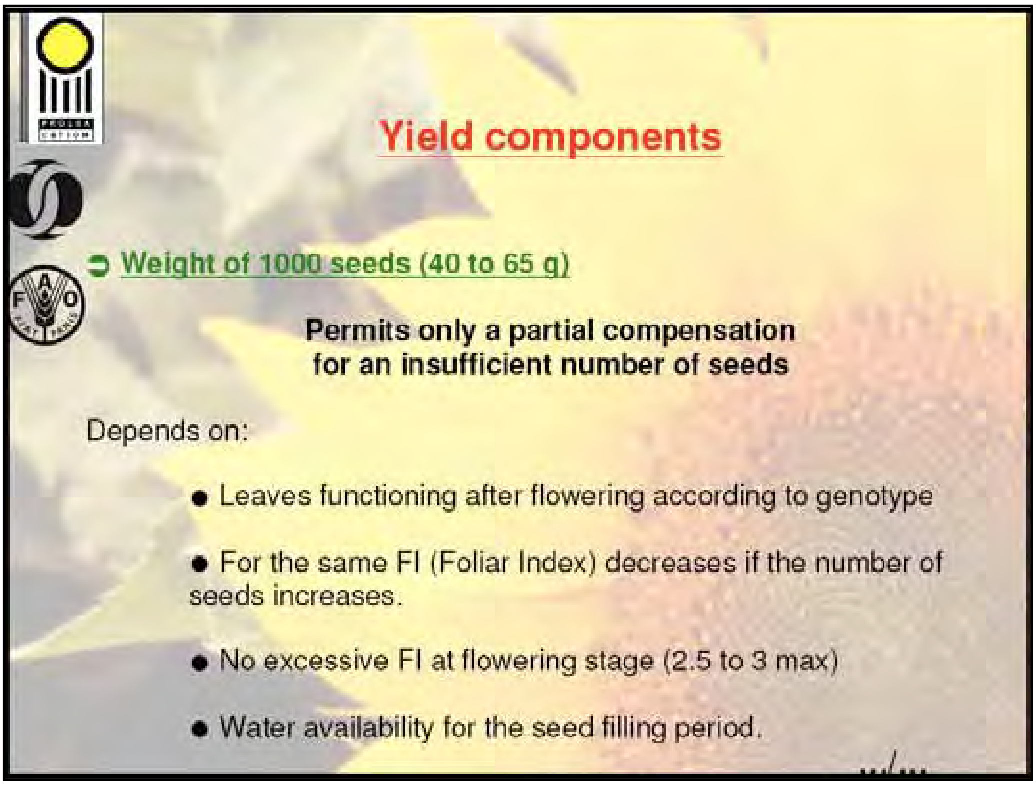

The plant
Seeds filling (F4-M3)
Proteins redistribution from stem and leaves to the seeds
Oil synthesis
Total dry matter produced : 10-15t/ha for yield of 3 t/ha

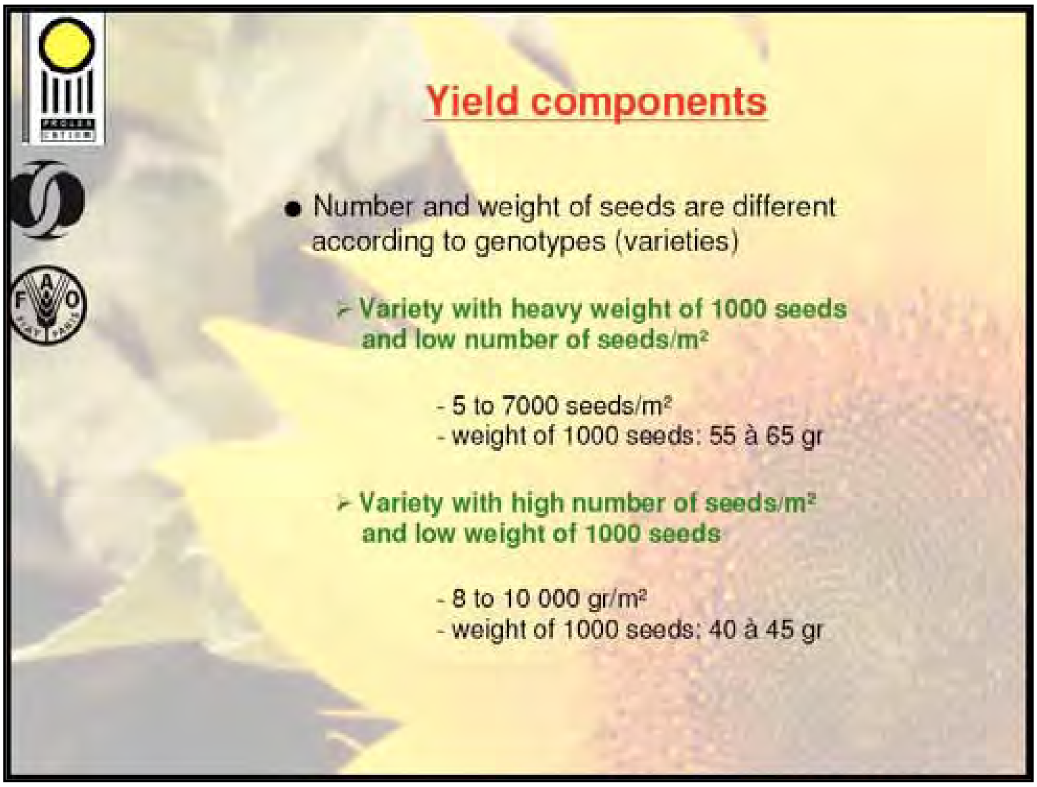

The plant
(In French conditions)
sowing - 10-20 days
emergence and cotyledons appearance
30 days
5 pairs of leaves
40 days
beginning of the floral initiation
50 days
stage "Star-like"
60 days
end of floral initiation
bud above the nearest leaf (diameter 5 to 8 cm)

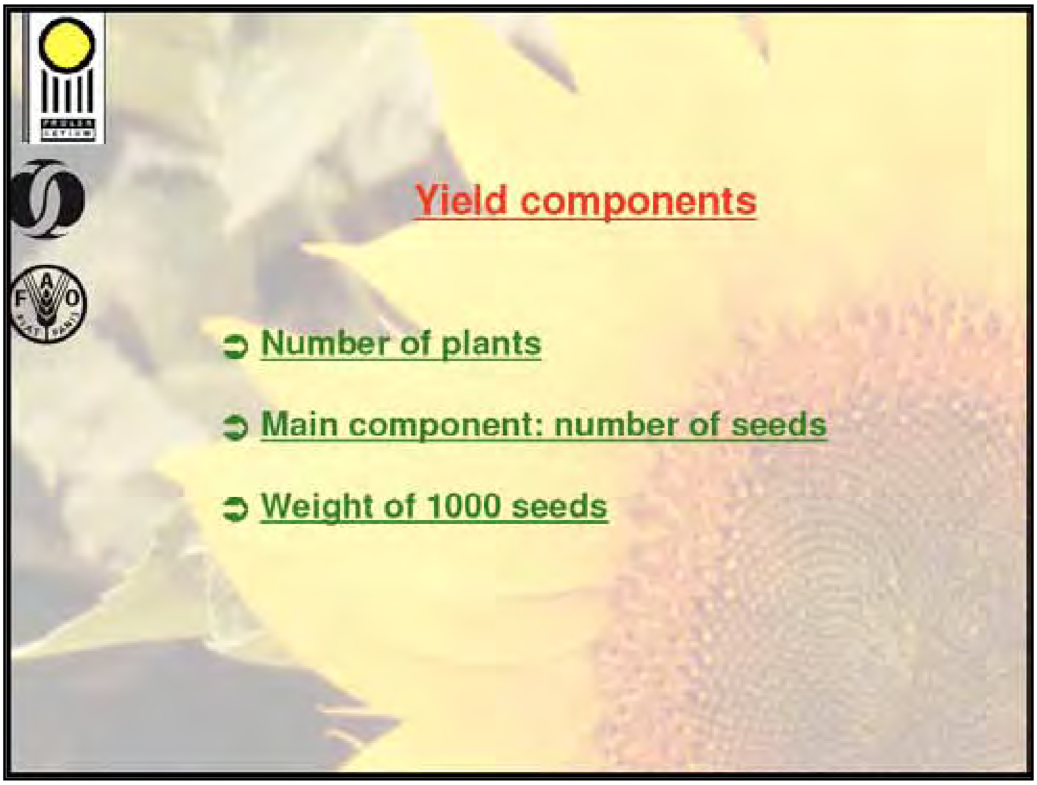

The plant
(In French conditions)
70-80 days
beginning of flowering
bending of the floral bud
ray flower appearance
90-100 days
end of flowering
fall of ray flowers
back of the head still green
140-150 days
physiological maturity

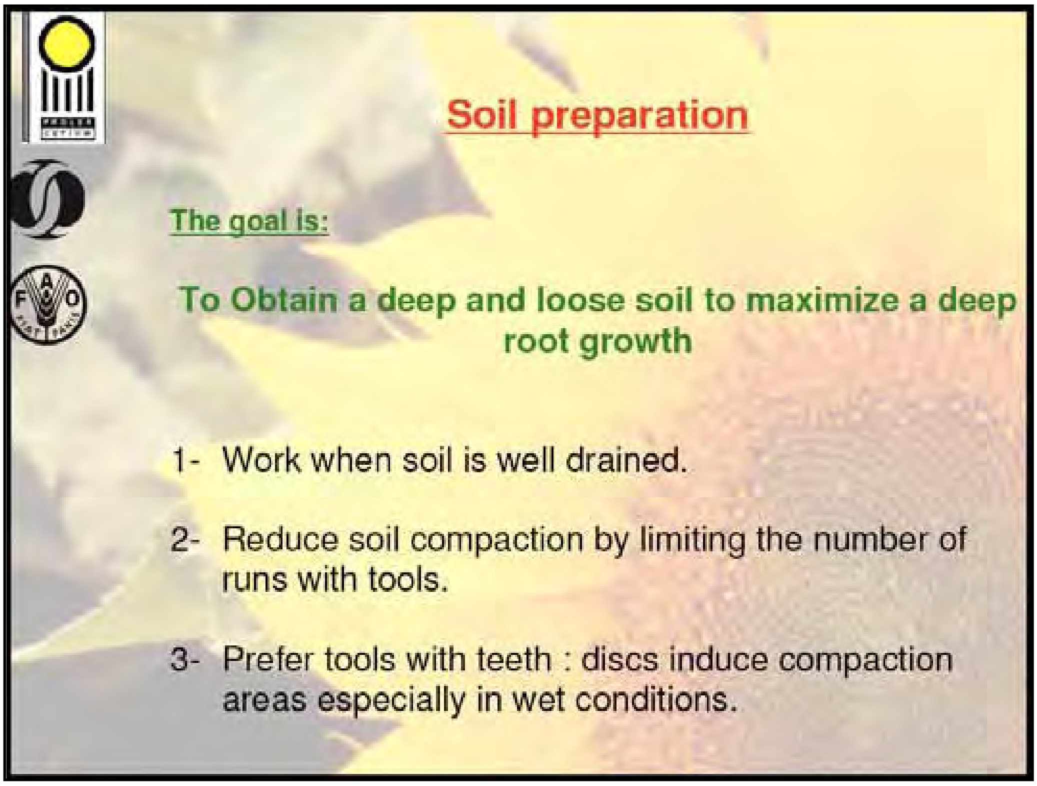

Yield components
Number of plants
Optimum between 5 to 8 plants/m² with a homogeneous distribution.
No compensation when plant missing at emergence
Quick germination if soil T° > 8°c.


Yield components
Main component: number of seeds
determined by:
Plant vigor during the formation of the floral primordia (B8 to B12).
Plant growth before flowering (limit 2 000 seeds /plant).
Water availability at the beginning of flowering: any stress induces seed abortion
Good functioning of the foliar surface for the 30 days after flowering : this ensures the potential seed number.


Yield components
Weight of 1000 seeds (40 to 65 g)
Permits only a partial compensation
for an insufficient number of seeds
Depends on:
Leaves functioning after flowering according to genotype
For the same FI (Foliar Index) decreases if the number of seeds increases.
No excessive FI at flowering stage (2.5 to 3 max)
Water availability for the seed filling period.
.../...


Yield components
Number and weight of seeds are different according to genotypes (varieties)
Variety with heavy weight of 1000 seeds and low number of seeds/m²
- 5 to 7000 seeds/m²
- weight of 1000 seeds: 55 à 65 gr
Variety with high number of seeds/m² and low weight of 1000 seeds
- 8 to 10 000 gr/m²
- weight of 1000 seeds: 40 à 45 gr


Yield components
Number of plants
Main component: number of seeds
Weight of 1000 seeds

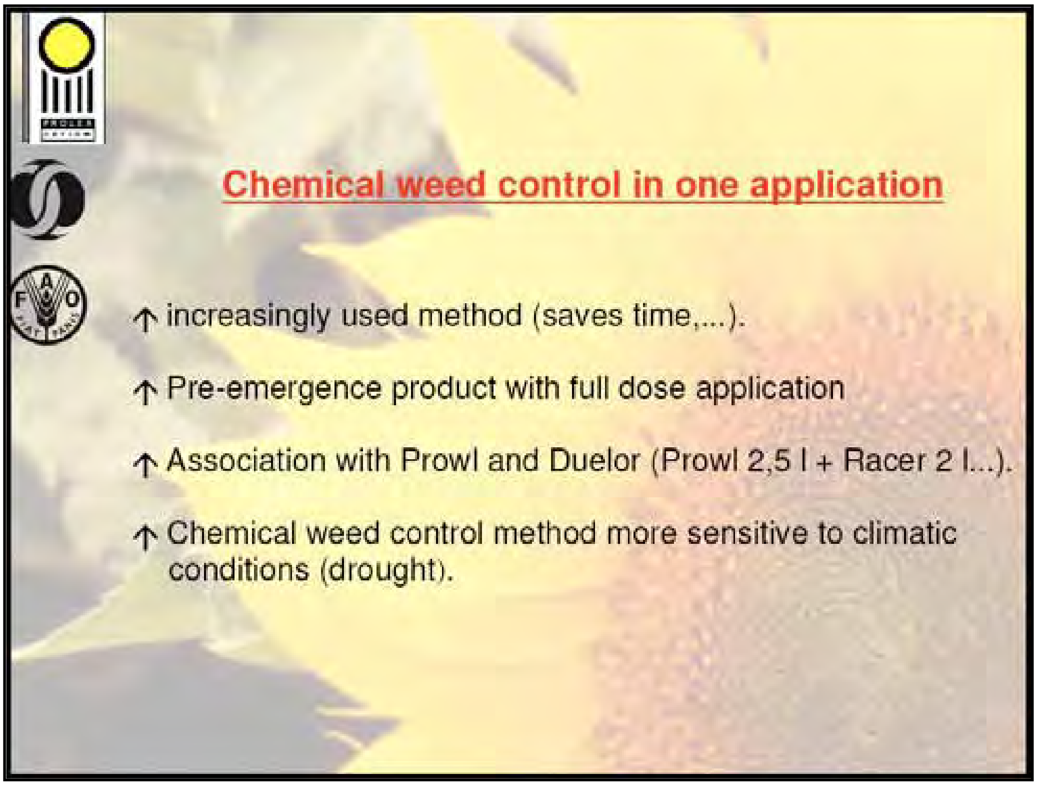

Soil preparation
The goal is:
To Obtain a deep and loose soil to maximize a deep root growth
1- Work when soil is well drained.
2- Reduce soil compaction by limiting the number of runs with tools.
3- Prefer tools with teeth : discs induce compaction areas especially in wet conditions.

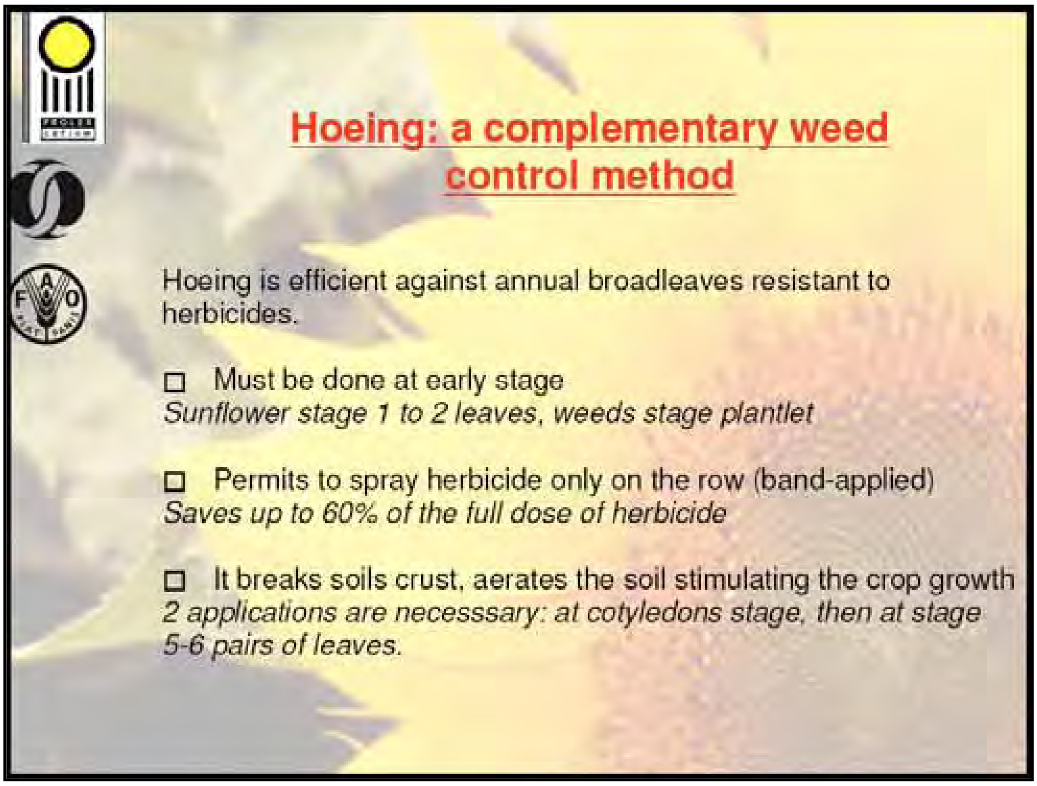

Conventional tillage or minimum tillage ?
1- Conventional tillage (Plowing)
Loose soil or beating soil,
plow just before sowing.
Heavy soil, clay soil,
plow during summer or automn.
Plowing = Good mixing of the organic matter
Incorporated herbicides easy to use,
Needs high power tractors and working time
2- Minimum tillage
Possible in soils without compaction (In these situations, yields equivalent to conventional tillage method of cultivation).
More attention is requested (slugs, weeds).
Difficulties of incorporation of pre-sowing herbicides due to surface residues.

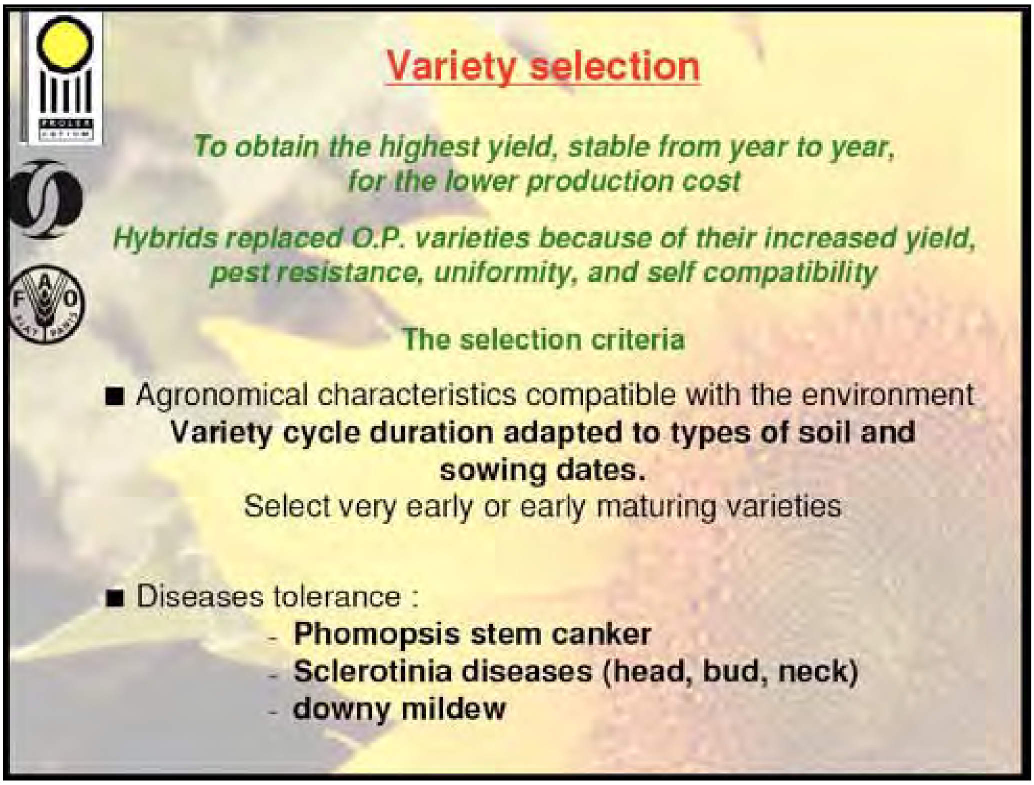

Weed control
Pre-emergence products are necessary
Association of a incorporated pre-sowing product (Triflurin) followed by a pre-emergence product remains the basis of the chemical weed control.

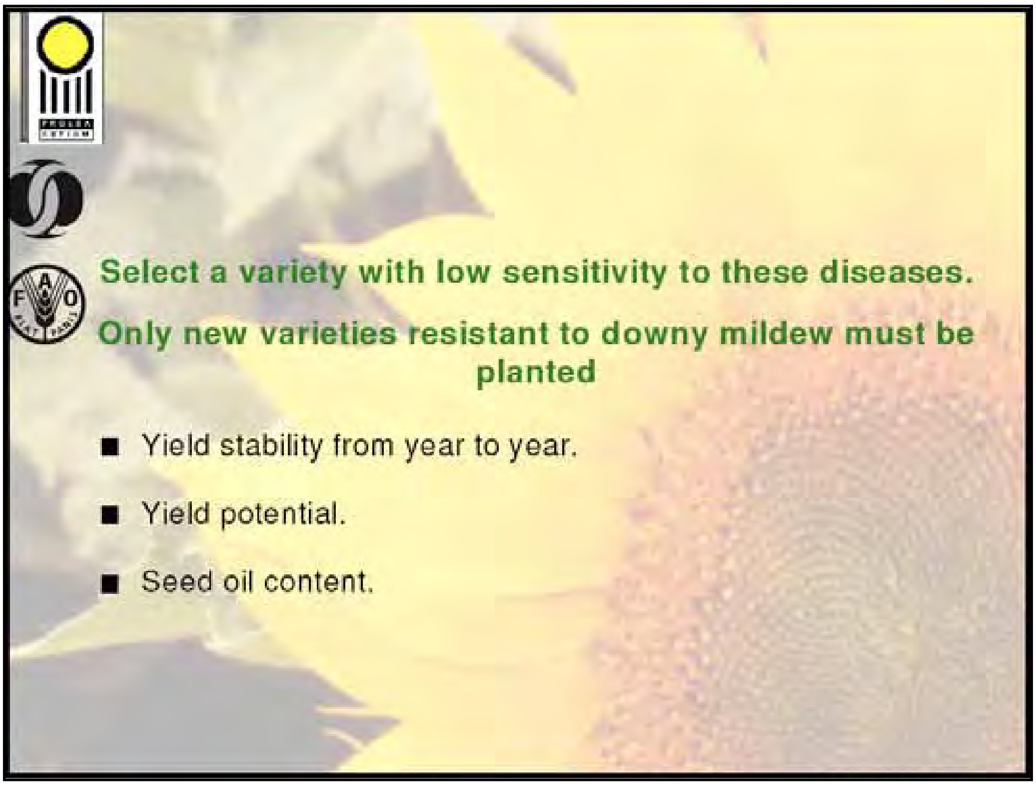

Weed control: Select the good product and the right application method
❑ Weed control starts before sowing:
➡ During the rotation (Thistle, horsetail...)
➡ During the soil preparation against weed regrowths after plowing using a non-selective herbicide (sowing without new soil preparation): False-sowing
❑ Pre-emergence products are necessary
❑ No solution against broadleaves after emergence, except with Challenge 600 (Aclonifen)
Narrow-leaves: Several efficient products are available


❑ Which weed control programme?
Sort in decreasing order the 4 to 5 main weeds and select the right herbicide against them
➢ Incorporated Treflan (Trifluralin) then pre-emergence herbicide such as:
- Afalon (Linuron)
- Other products: Racer (Fluochloridone)
Challenge 600 (Aclonifen)
Phare (Aclonifen + Oxadiazon)
Nickeyl (Aclonifen + Flurtamone)


Chemical weed control in one application
increasingly used method (saves time,...).
Pre-emergence product with full dose application
Association with Prowl and Duelor (Prowl 2,5 l + Racer 2 l...).
Chemical weed control method more sensitive to climatic conditions (drought).

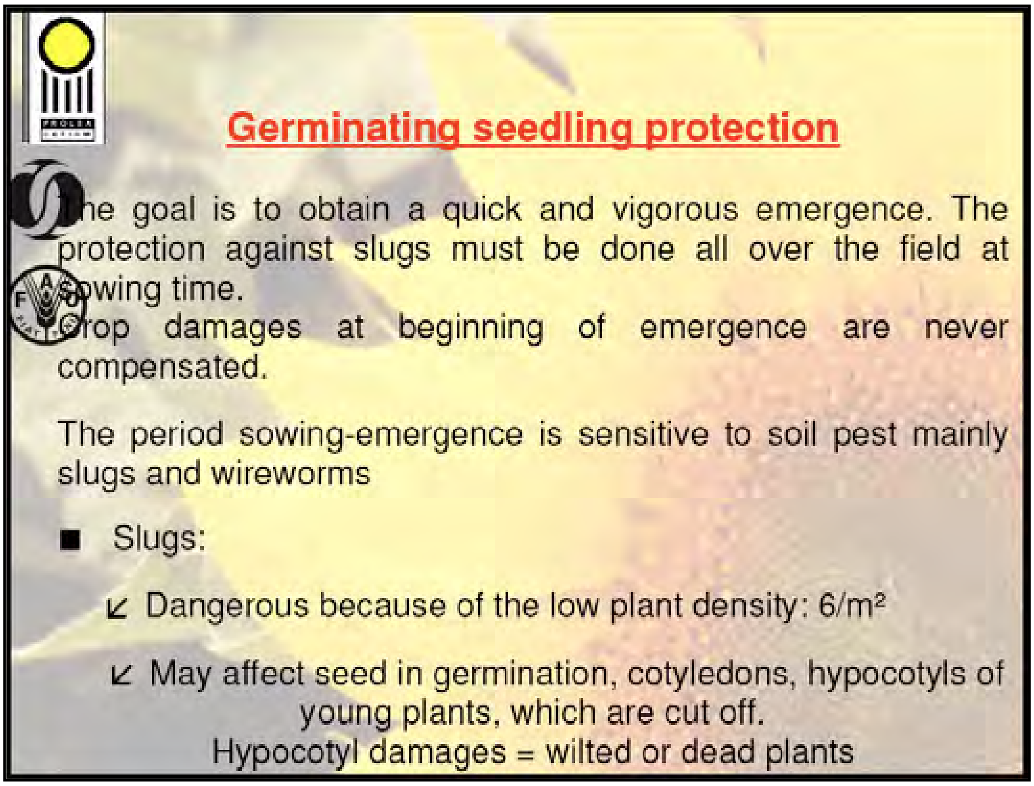

Hoeing: a complementary weed control method
Hoeing is efficient against annual broadleaves resistant to herbicides.
Must be done at early stage
Sunflower stage 1 to 2 leaves, weeds stage plantlet
Permits to spray herbicide only on the row (band-applied)
Saves up to 60% of the full dose of herbicide
It breaks soils crust, aerates the soil stimulating the crop growth
2 applications are necesssary: at cotyledons stage, then at stage 5-6 pairs of leaves.

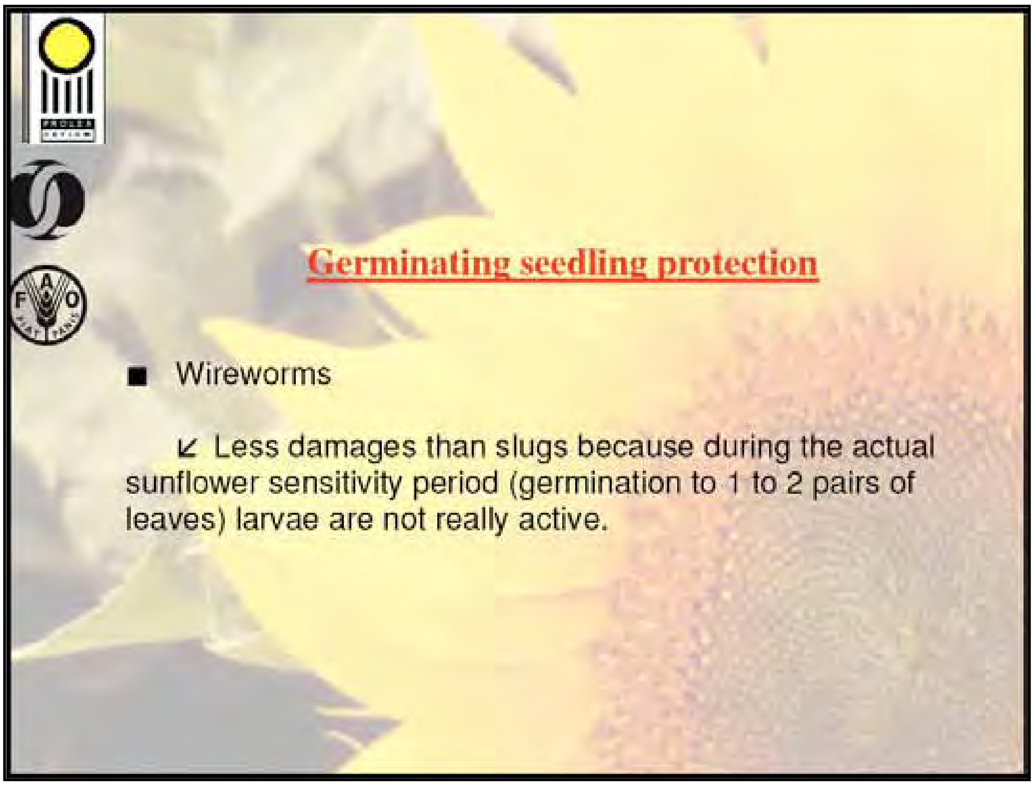

Variety selection
To obtain the highest yield, stable from year to year,
for the lower production cost
Hybrids replaced O.P. varieties because of their increased yield,
pest resistance, uniformity, and self compatibility
The selection criteria
■ Agronomical characteristics compatible with the environment
Variety cycle duration adapted to types of soil and
sowing dates.
Select very early or early maturing varieties
■ Diseases tolerance :
- Phomopsis stem canker
- Sclerotinia diseases (head, bud, neck)
- downy mildew


Select a variety with low sensitivity to these diseases.
Only new varieties resistant to downy mildew must be
planted
■ Yield stability from year to year.
■ Yield potential.
■ Seed oil content.

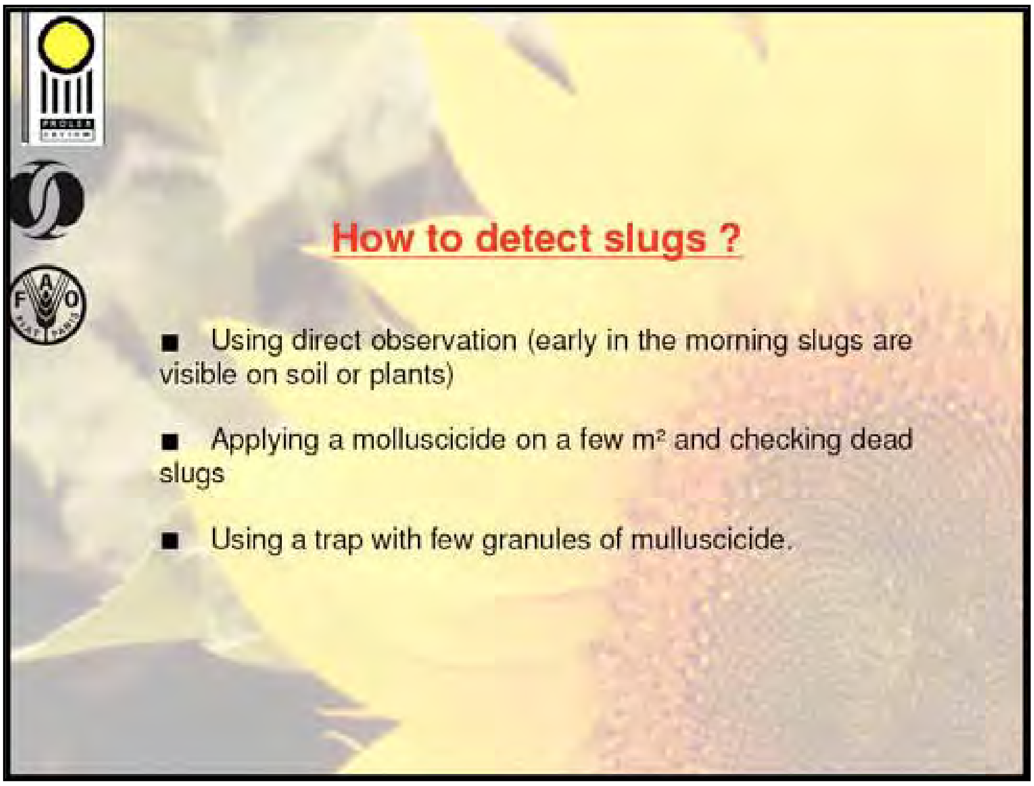
Planting

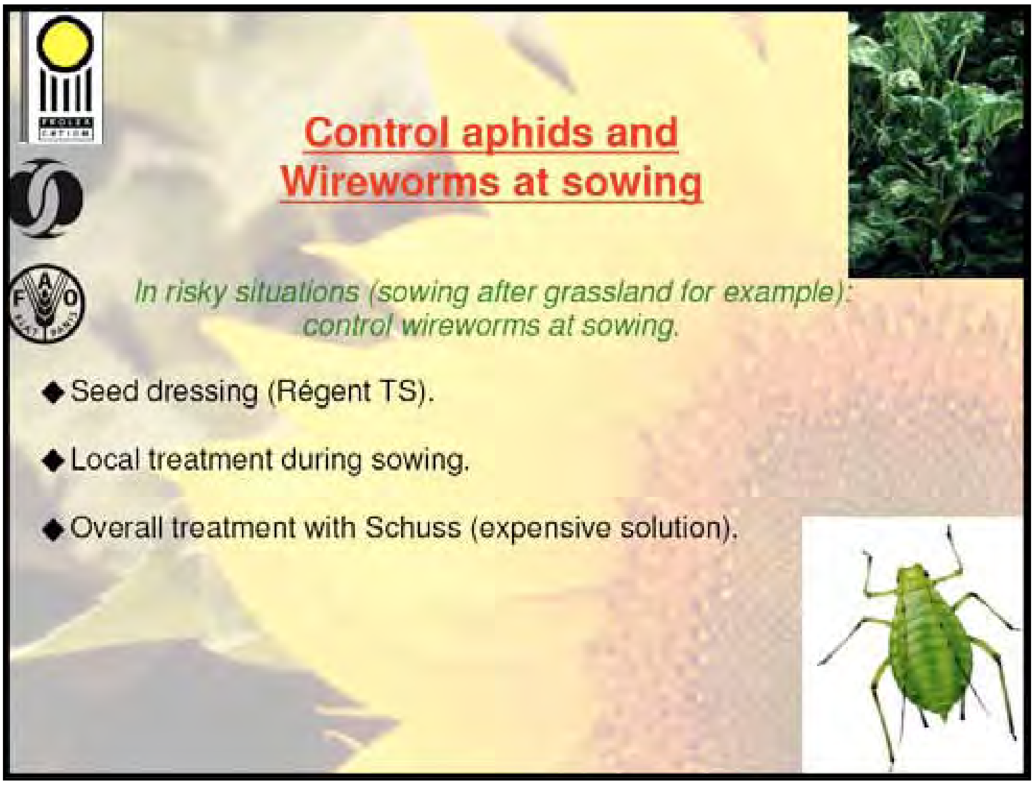
- Sow when the soil temperature reaches 8 to 10°C
  (In France from End of March to mid May according to region and type of soil)
- Planting depth: Between 2 and 3 cm.
  Must be adapted to type of soil: 4 to 5 cm in sandy soil.
- Reduce speed during sowing to ensure a good seed positioning.
- Plant population: plant a maximum of 75000 plants / ha.
  The goal is to obtain 55 to 60000 emerged plants well distributed.
- Row spacing: 50 to 60 cm.
- Protect against slugs immediatly after sowing.
- Protect seedlings against soil insects (wireworm, Tipula, blanulia, scutigerella) and diseases (downy mildew and botrytis).


Germinating seedling protection
The goal is to obtain a quick and vigorous emergence. The protection against slugs must be done all over the field at sowing time.
Crop damages at beginning of emergence are never compensated.
The period sowing-emergence is sensitive to soil pest mainly slugs and wireworms
Slugs:
Dangerous because of the low plant density: 6/m²
May affect seed in germination, cotyledons, hypocotyls of young plants, which are cut off.
Hypocotyl damages = wilted or dead plants

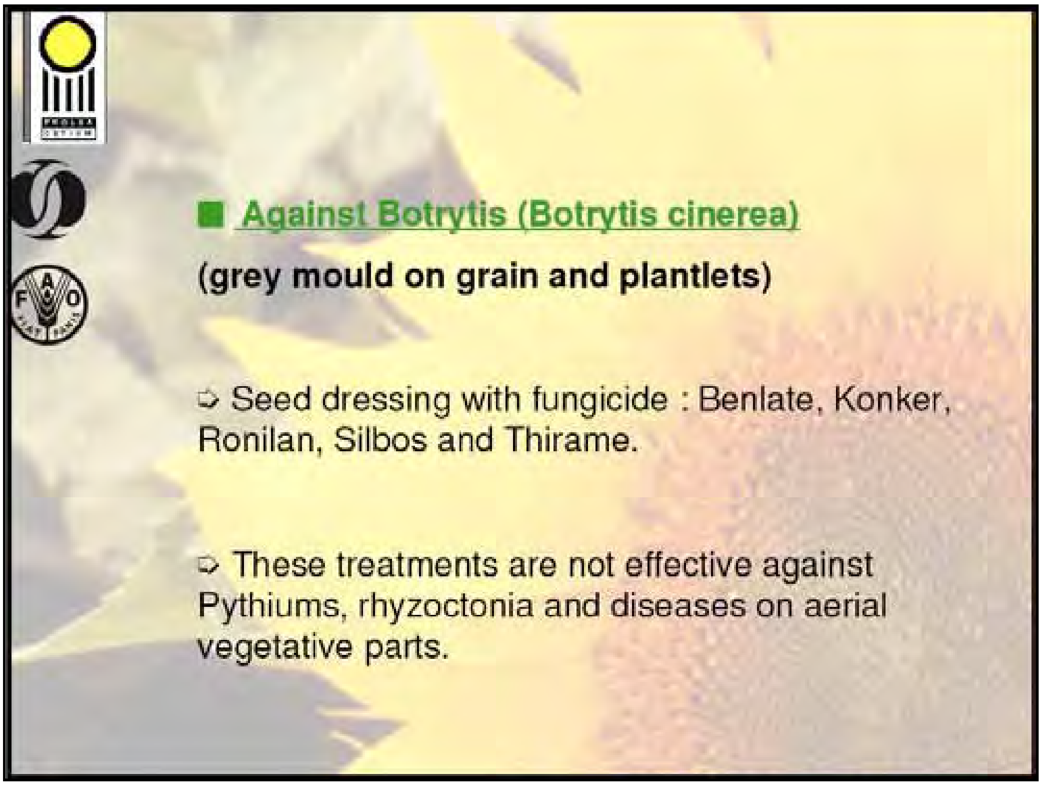

Germinating seedling protection
Wireworms
Less damages than slugs because during the actual sunflower sensitivity period (germination to 1 to 2 pairs of leaves) larvae are not really active.

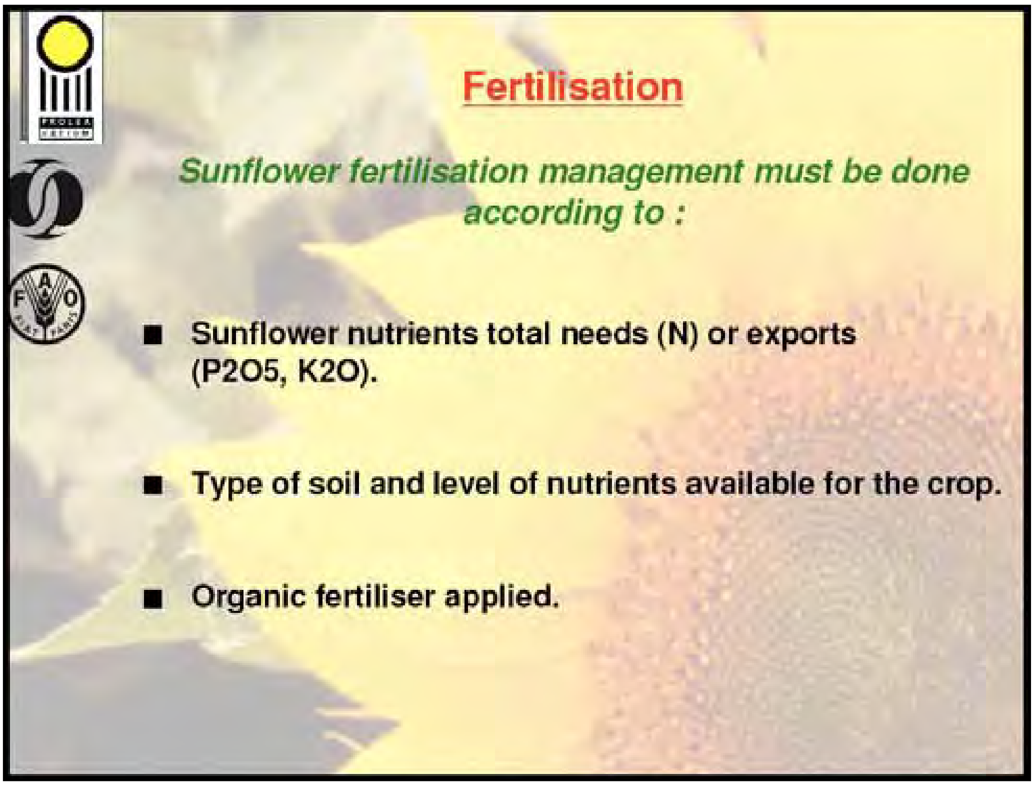

Control the slugs infestation before sowing
■ Avoid soil insufficiently compacted, cloddy, seedbed with high content of surface crop residue.
■ If a severe attack is expected: Apply molluscicide on the soil at sowing or immediately after, before rain and always before emergence.
■ Keep watch on all fields during emergence especially if the soil is wet.
■ Do not use pesticides if not necessary because some molluscicides have nocive effects on the soil fauna (night crawlers, ground beetles,...).

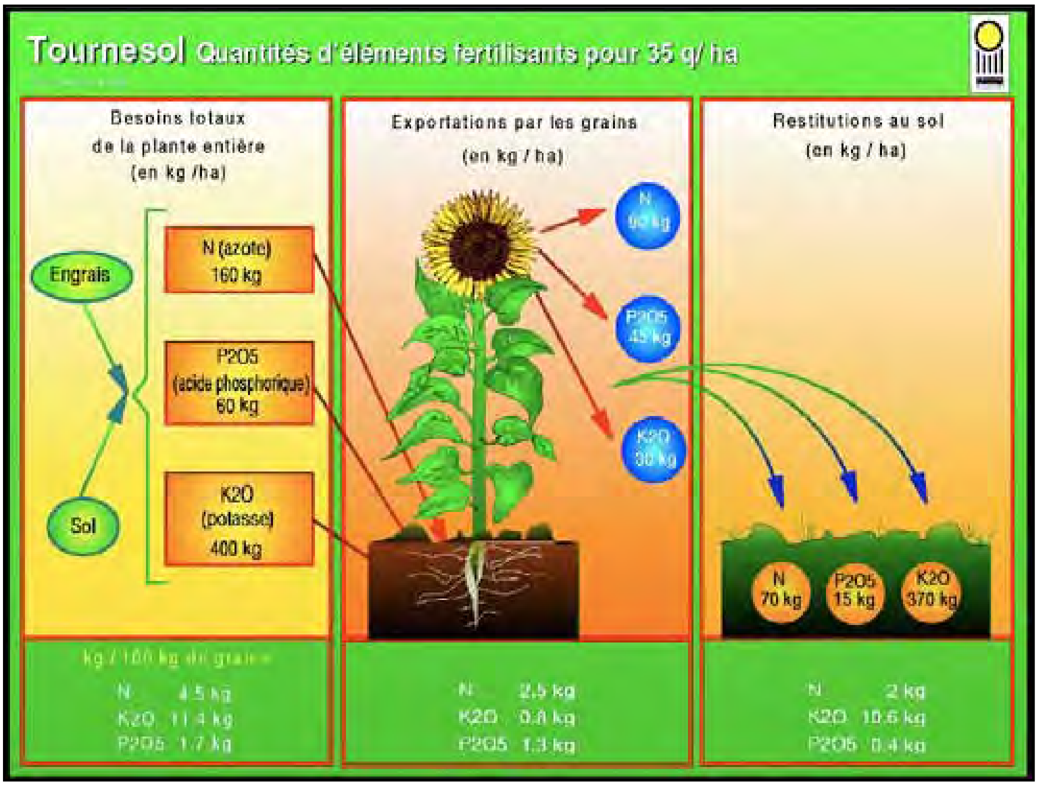

How to detect slugs ?
■ Using direct observation (early in the morning slugs are visible on soil or plants)
■ Applying a molluscicide on a few m² and checking dead slugs
■ Using a trap with few granules of mulluscicide.

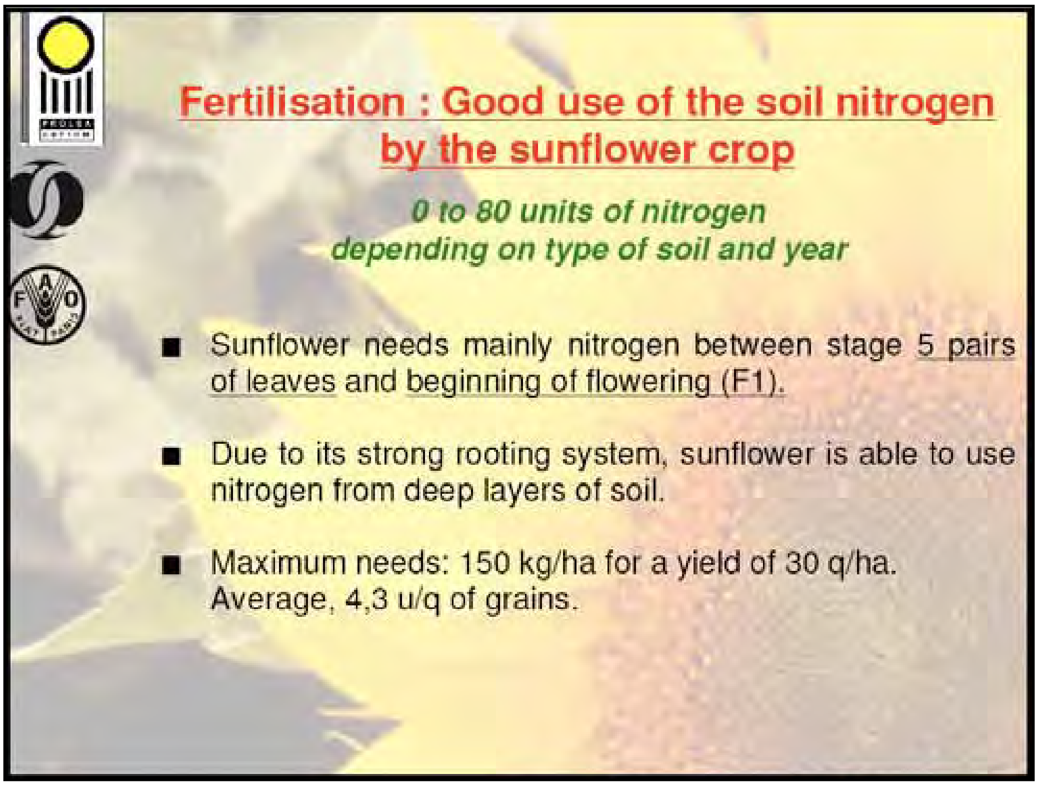

Control aphids and
Wireworms at sowing
In risky situations (sowing after grassland for example):
control wireworms at sowing.
◆ Seed dressing (Régent TS).
◆ Local treatment during sowing.
◆ Overall treatment with Schuss (expensive solution).


Diseases control
Against downy mildew (Plasmopara halstedii):
If the variety is not genetically resistant to present Mildew races, seeds must be potected by a fungicide (Apron = Metalaxyl).
Fungicide treatment is efficient.but the active period could be too short
Volonteers must be destroyed in all other crops to avoid secondary contaminations.
Variety genetically resistant to new Mildew races don't need to be protected by a fungicide.

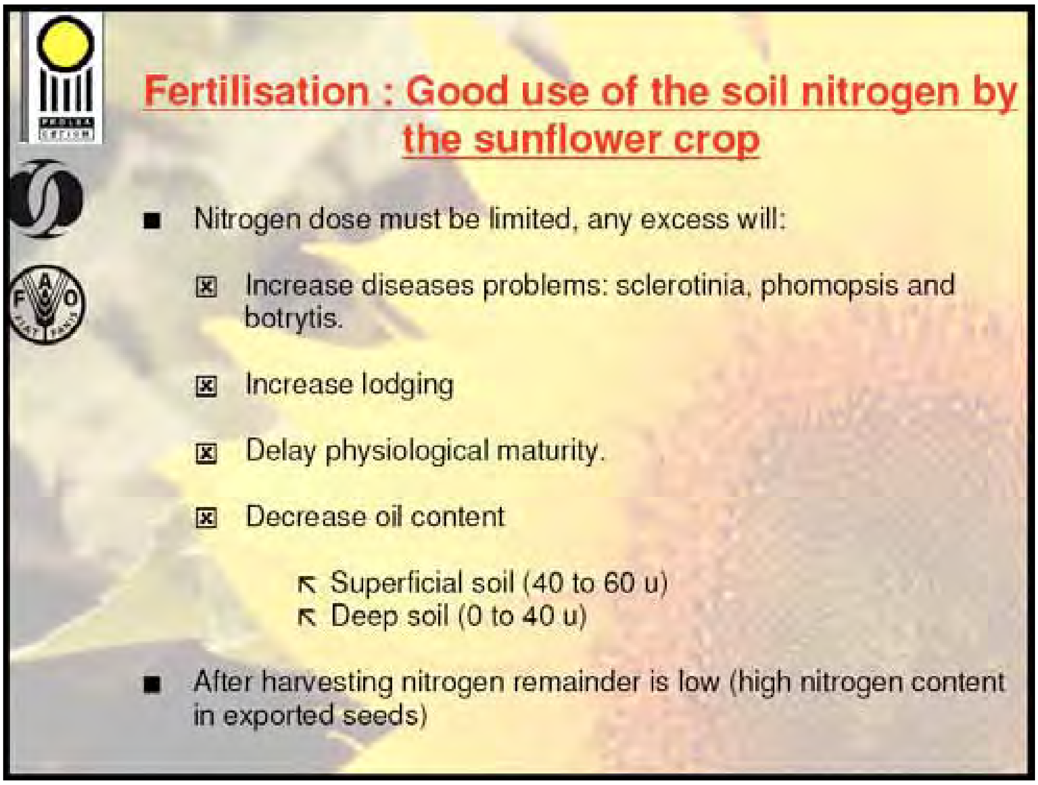

■ Against Botrytis (Botrytis cinerea)
(grey mould on grain and plantlets)
➩ Seed dressing with fungicide : Benlate, Konker, Ronilan, Silbos and Thirame.
➩ These treatments are not effective against Pythiums, rhyzoctonia and diseases on aerial vegetative parts.

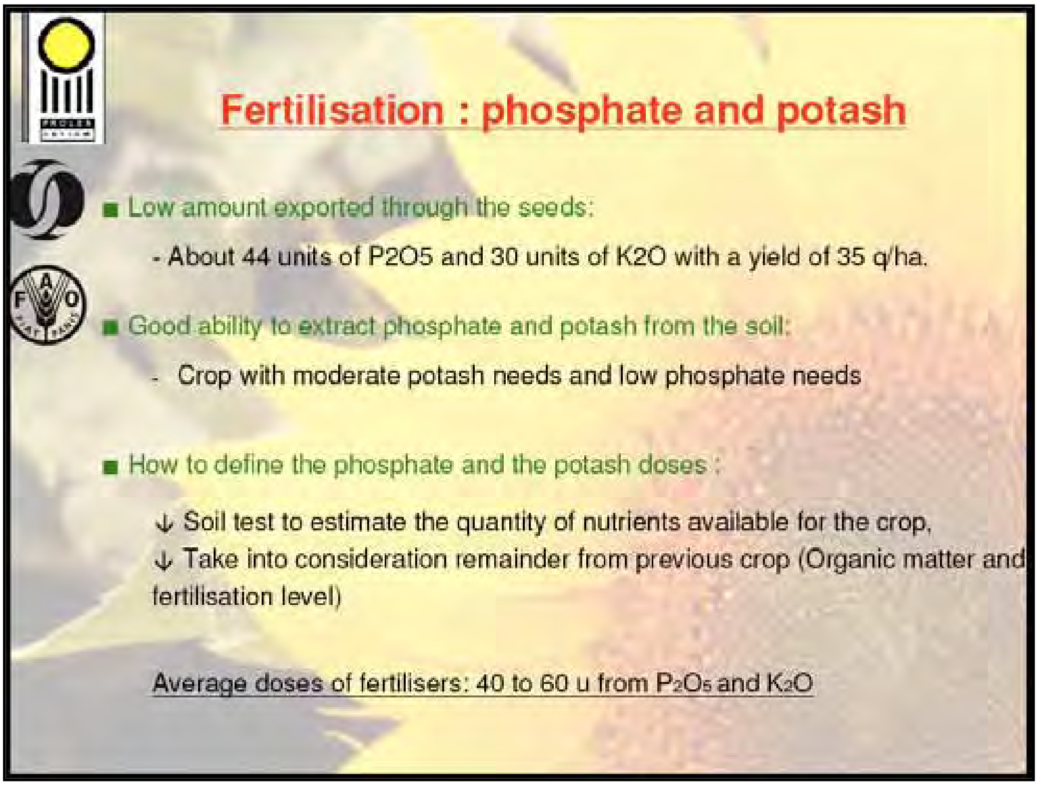

Fertilisation
Sunflower fertilisation management must be done according to :
■ Sunflower nutrients total needs (N) or exports (P2O5, K2O).
■ Type of soil and level of nutrients available for the crop.
■ Organic fertiliser applied.

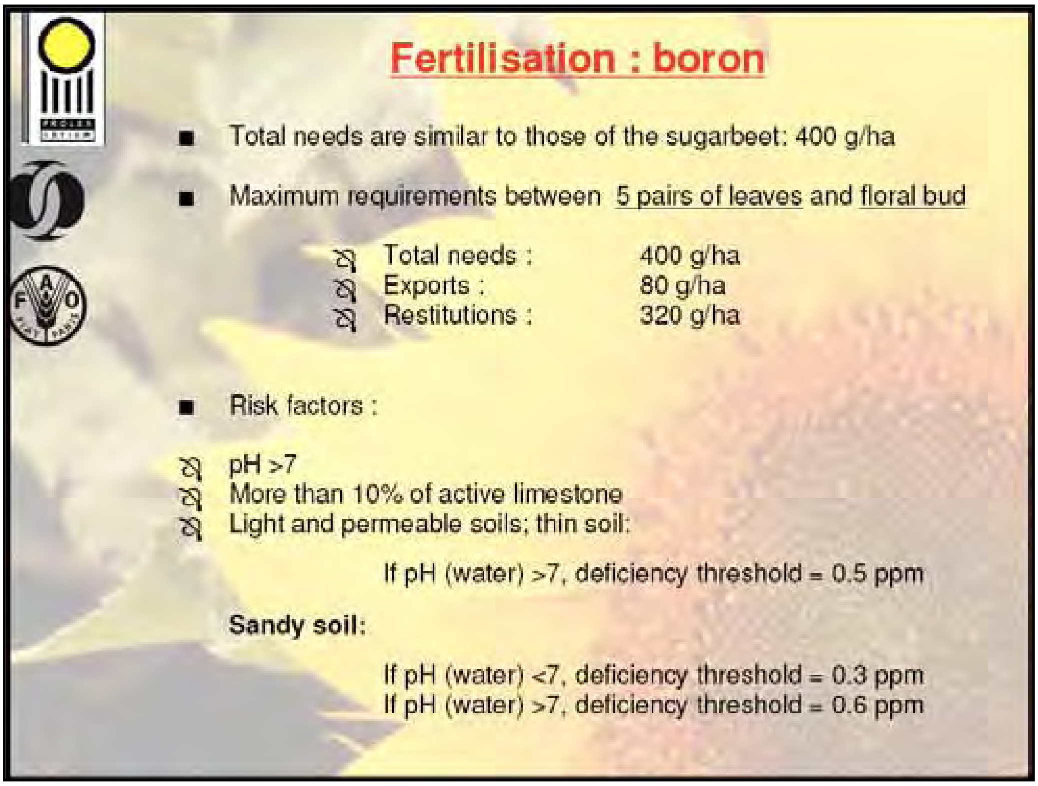

Tournesol Quantités d'éléments fertilisants pour 35 q/ ha
Besoins totaux
de la plante entière
(en kg /ha)
Engrais
Sol
N (azote)
160 kg
P2O5
(acide phosphorique)
60 kg
K2O
(potasse)
400 kg
Exportations par les grains
(en kg / ha)
N
90 kg
P2O5
45 kg
K2O
30 kg
Restitutions au sol
(en kg / ha)
N
70 kg
P2O5
15 kg
K2O
370 kg
kg / 100 kg de grains
N 4.5 kg
K2O 11.4 kg
P2O5 1.7 kg
N 2,5 kg
K2O 0.8 kg
P2O5 1.3 kg
N 2 kg
K2O 10.6 kg
P2O5 0.4 kg

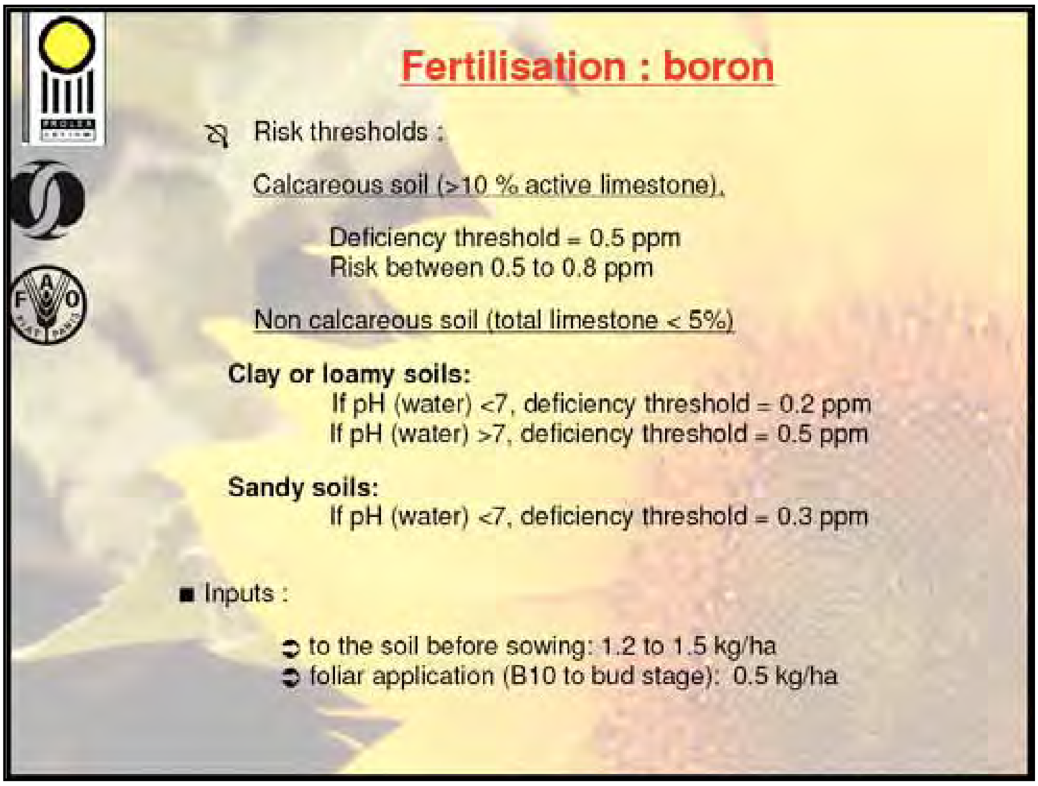

Fertilisation : Good use of the soil nitrogen
by the sunflower crop
0 to 80 units of nitrogen
depending on type of soil and year
■ Sunflower needs mainly nitrogen between stage 5 pairs of leaves and beginning of flowering (F1).
■ Due to its strong rooting system, sunflower is able to use nitrogen from deep layers of soil.
■ Maximum needs: 150 kg/ha for a yield of 30 q/ha.
Average, 4,3 u/q of grains.


Fertilisation : Good use of the soil nitrogen by the sunflower crop
The dose of nitrogen fertilisation must be the complement to the Nitrogen available in the soil
How to define the nitrogen dose:
Superficial soil and rainy winter:
Low nitrogen remains in the soil → Apply a higher dose.
Winter with low rainfall:
Higher remains in the soil → Reduce the dose.


Fertilisation : Good use of the soil nitrogen by the sunflower crop
Nitrogen dose must be limited, any excess will:
Increase diseases problems: sclerotinia, phomopsis and botrytis.
Increase lodging
Delay physiological maturity.
Decrease oil content
Superficial soil (40 to 60 u)
Deep soil (0 to 40 u)
After harvesting nitrogen remainder is low (high nitrogen content in exported seeds)


Fertilisation : phosphate and potash
Low amount exported through the seeds:
- About 44 units of P2O5 and 30 units of K2O with a yield of 35 q/ha.
Good ability to extract phosphate and potash from the soil:
- Crop with moderate potash needs and low phosphate needs
How to define the phosphate and the potash doses :
Soil test to estimate the quantity of nutrients available for the crop,
Take into consideration remainder from previous crop (Organic matter and fertilisation level)
Average doses of fertilisers: 40 to 60 u from P2O5 and K2O


Fertilisation : boron
Total needs are similar to those of the sugarbeet: 400 g/ha
Maximum requirements between 5 pairs of leaves and floral bud
Total needs : 400 g/ha
Exports : 80 g/ha
Restitutions : 320 g/ha
Risk factors :
pH >7
More than 10% of active limestone
Light and permeable soils; thin soil:
If pH (water) >7, deficiency threshold = 0.5 ppm
Sandy soil:
If pH (water) <7, deficiency threshold = 0.3 ppm
If pH (water) >7, deficiency threshold = 0.6 ppm


Fertilisation : boron
Risk thresholds :
Calcareous soil (>10 % active limestone).
Deficiency threshold = 0.5 ppm
Risk between 0.5 to 0.8 ppm
Non calcareous soil (total limestone < 5%)
Clay or loamy soils:
If pH (water) <7, deficiency threshold = 0.2 ppm
If pH (water) >7, deficiency threshold = 0.5 ppm
Sandy soils:
If pH (water) <7, deficiency threshold = 0.3 ppm
Inputs :
to the soil before sowing: 1.2 to 1.5 kg/ha
foliar application (B10 to bud stage): 0.5 kg/ha


Fertilisation: boron
Deficiency symptoms description:
Deformed head or multi-flowering
These symptoms may be also due to low temperature during floral primordia period (stage 10 – 12 leaves)
Yellowing and / or drying of leaves
Head fall
Below the head, cuts on stem, which can enlarge into open cracks.
Bad seed setting
Smaller size of head or abnormal stand – Black (normal) and white (empty) seeds.
Lodging and growth decreasing
Weak stem, reduction of the neck diameter.