3rd International Oat Conference

Lund, Sweden, July 4 - 8 1988

PROGRAMME
ABSTRACTS

Vernon Burrows

3rd International Oat Conference

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PROGRAMME

MONDAY July 4th

8.30-8.45	Opening of the Conference.
Session I.	Oat history and germplasm. Chairman: T. Morikawa, Japan.
8.45-9.10	The domestication and history of oats. G. Ladizinsky, Israel.
9.10-9.30	Oat germplasm collections. R.A. Forsberg, USA.
9.30-9.50	New oat species. H. Thomas, UK
9.50-10.20	COFFEE
10.20-10.40	Breeding oats for Mediterranean-type environments. A. Barr, Australia.
10.40-10.55	The development of oat germplasm at Svalöf. B. Mattsson, Sweden.
10.55-11.10	Grain yield and others agronomic traits evolution of oat in South Brazil. F.I.F. de Carvalho, L.C. Federizzi, Brazil.
11.10-11.25	Oat screening for the Tropics, Thailand. N. Ratanadilok, Thailand.
11.25-11-40	New genes for dwarfness transferred from wild oats (Avena fatua) into cultivated oat. T. Morikawa, Japan.
11.40-12.00	The history of oat milling. S. Weaver, USA.
12.00-12.30	Discussion
12.30-2.00	LUNCH

Session II	Future breeding, new germplasm. Chairman: L.A.J. Slootmaker, The Netherlands.
2.00-2.20	Breeding oats for future use. V. Burrows, Canada.
2.20-2.35	Avena maroccana - a genetic resource used in oat improvement. P. Hagberg, Swèden.
2.35-2.50	Inter- and intra-specific hybrids involving A. agadriana. M. Leggett, UK.
2.50-3.05	Exploiting new germplasm in winter oat breeding at Aberystwyth. J. Valentine, UK.
3.05-3.20	Biological species and wild genetic resources in Avena. G. Ladizinsky, Israel.
3.20-4.00	Discussion
4.00-4.30	COFFEE
4.30-5.30	Poster papers.
8.00-8.30	Film. A Century of Skilled Plant Breeding, Svalöf A[illegible] 100 yeras.

TUESDAY July 5th

Session III	Breeding and uses of oats. Chairman: H. Küüts, USSR
8.30-8.50	Population improvement in oat gene pools -- Grain yield. D. Stuthman, USA.
8.50-9.10	Recurrent selection for protein and oil content of oats. K. Frey, USA
9.10-9.30	Biotechnology applications in oat breeding in the U.S. H. Rines, USA.
9.30-9.45	Genetic engineering of oats: Regulation of protein synthesis in endosperm during embryogenesis. I. Altosaar, Canada.
9.45-10.00	A male-sterile hexaploid oat, and three-lobed stigmas in oats. M.E. McDaniel, USA.
10.00-10.30	COFFEE
10.30-10-45	Comparison of two breeding strategies for the development of oat high yielding varieties. L.C. Federizzi, Brazil.
10.45-11.00	Recurrent selection in oat breeding. M. Vanselow, BRD.
11.00-11.15	The valuable donors for quality improvement in oat breeding. V.D. Kobylyanskii, N.A. Rodionova and H.D. Küüts, USSR.
11.15-11.30	Breeding high quality milling and feed oats in the high mountain valleys of Chuhuahua. P. Dyck, Mexico.
11.30-11.45	Protein and lipid quantity and quality in Swedish oats. H. Johansson, Sweden.
11.45-12.00	The quality of different oat varieties and indistrial oats (1984-87) in Wets-Germany. W. Ganssmann, Germany.
12.00-12.30	Discussion
12.30-2.00	LUNCH

Session IV	Animal feeding and human food. Chairman: J. Lea, UK.
2.00-2.20	Oats as animal feed. S. Thomke, Sweden.
2.20-2.40	Oats for dairy cattle. S. Sanne, Sweden.
2.40-3.00	Oat for forage/grazing. S. Mishra, India.
3.00-3.20	Oats for silage. M.A. Brinkman, USA.
3.20-3.50	COFFEE
3.50-4.10	Oats for human food: Protein and oil. P. Murphy, USA.
4.10-4.30	Chemistry & physiology of oat beta-glucans. D. Hurt, USA.
4.30-4.45	Oat fibres - composition and nutritional significance. P. Åman and E. Westerlund, Sweden.
4.45-5.00	Oat Breeding for human food in Hungary. A. Palagyi, Hungary.
5.00-5.30	Discussion
8.00-	Meeting: North American Breeders.

WEDNESDAY July 6th

Session V	Miscellaneous topics on oat research. Chairman: J. McEwan, New Zealand.
8.15-9.15	Equipment
8.15-8.30	Laboratory equipment - D. Peterson, USA
8.30-8.45	Field machinery in crop research - P. Portmann, Australia. Presentation: A. Barr, Australia.
8.45-9.00	The Hege equipment for research work. H.U. Hege, Germany
9.00-9.15	Seed cleaning and processing, KamasWestrup. T. Edholm, Sweden.
9.15-9.55	Use of computers and computer programs.
9.15-9.35	The use of microcomputers in plant breeding. R. Freed, USA.
9.35-9.55	Use of computers and computer programs for germplasm collections. S. Blixt, Sweden.
9.55-10.30	COFFEE
10.30-10.45	Comparison of the pedigree plant selection method and the gravimetric bulk selection method in producing high quality oats. P. Dyck, Mexico.
10.45-11.00	Evaluation of combining abilities of oat varieties. F. Machan, Czechoslovakia.
11.00-11.15	Discussion
11.15-11.45	Business meeting
11.45-12.45	LUNCH
Session VI	Visit to SVALÖF AB Departure from Sparta 1.00
1.00-5.30	Experimental plots and laboratories. Demonstration of equipments.
5.30-6.30	Social hour at hotel.
6.30-11.00	Banquet Departure from Grand and Sparta Hotel 6.30

THURSDAY July 7th

Session VII	Resistance of oats to biotic and abiotic stresses and oat physiology. Chairman: C. Qualset, USA.
8.30-8.55	Resistance of oats to rust diseases. J. Sebesta, Czechoslovakia.
8.55-9.20	Resistance and tolerance of oats to barley yellow dwarf. A. Comeau, Canada.
9.20-9.45	Frit fly resistance in oats. T. Jonasson, Sweden.
9.45-10.15	COFFEE
10.15-10.40	Tolerance of oats to herbicides. D. Reeves, USA.
10.40-10.55	Resistance of the new oat varieties to crown rust. E. Lyzlov, E. Luchning, P. Magurov, A. Dmitriev, H. Küüts, USSR.
10.55-11.10	Factors conditioning dominance of race 276 of Puccinia coronata avenae on Avena sterilis populations in Israel. U. Brodny, Israel.
11.10-11.25	Tolerance of common oats to the wild oat herbicide, Hoegrass. P.D. Brown, R.I.H. McKenzie, Canada.
11.25-11.40	Control of wild oats in cultivated oats. W.G. Richardson, UK.
11.40-12.30	Discussion
12.30-2.00	LUNCH

Session VIII	Crop growth and physiologi. Chairman: H. Klinck, Canada.
2.00-2.20	Tolerance of oats to drought. S. Larsson, Sweden.
2.20-2.40	Translocation and grain development in oats. D. Peterson, USA.
2.40-3.00	Growth rates of oats. K. Frey, USA.
3.00-3.30	COFFEE
3.30-3.45	Shoot: Root interrelations in oats. J. Mac Key, Sweden.
3.45-4.00	Relationships among single culm yield components and groat percentage in spring oat crosses. R.A. Bunch and R.A. Forsberg, USA.
4.00-4.15	Developmental stability in oats. (Avena sativa L.) M. Gullord, Norway.
4.15-4.30	Homogeneity of oat cultivars with respect to out-crossing. U. Bickelmann and N. Leist, BRD.
4.30-4.45	International trade in oats. N. Baker, Australia.
4.45-5.30	Discussion
6.00	Departure to Weibulls AB.

<u>FRIDAY July 8th</u>

8.30-3.00	Excursion to study Swedish agriculture.
8.20	Departure from Grand Hotel
8.30	Departure from Sparta Hotel

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The domestication and history of oats

Gideon Ladizinsky

Hebrew University, Faculty of Agriculture, Rehovot, Israel

The genus Avena includes diploid, tetraploid and hexaploid species. At each ploidy level domesticated types have been selected. The cultivated hexaploid oats, having the greatest economic importance, originated as a secondary crop from the weedy form A.fatua during the late Bronze Age and the Iron Age in central and western Europe. From there it migrated to southern Europe and the Middle East and reached China before 500 a.d., where the large naked oat was selected. Cultivated hexaploid oats found their way to the western hemisphere in the 16th century: the Spaniards introduced them into California and the southern parts of USA and English settlers into the eastern parts.

The time and place of domestication of the diploid oat A.strigosa overlap with those of the hexaploid oats. A.strigosa originated from the wild form A.hirtula probably in the Iberian peninsula. Since A.hirtula shows little weedy tendency, it is likely that man grew this wild oat for fodder before the domesticated form had evolved.

At the tetraploid level a semi-domesticated form A.abyssinica evolved from the wild species A.barbata in the Ethiopian highlands. It is sown as a contaminant in barley seeds and either weeded out or harvested according to the success of the barley crop.

nude → China.

- domesticated after wheat + oats -

- genetical & physiological change to make better adapted to culture by man.

-

	cult	wild
2x	strigosa brevis [illegible]	hirtula
4x	abyssinica	barbata
6x	A. sativa byzantina	fatua ← restricted to man made environment sterilis } insignificant difference in articulation.

A. fatua gave rise to A. sativa in western N. Europe

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2x cult: strigosa, brevis, wiestii — wild: hirtula

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A.fatua gave rise to A.sativa in western N. Europe

OAT GERMPLASM COLLECTIONS

R. A. Forsberg
University of Wisconsin-Madison, USA

There are three main types of oat germplasm collections: (1) working collections within breeding/research programs of individual oat workers, (2) National collections held by a governmental agency within individual countries, and (3) new collections resulting from plant exploration and not yet integrated into individual or national collections. This presentation will focus attention on this third category, including the rationale for plant exploration and the potential usefulness of materials collected.

The search for new species, the search for useful genes, and germplasm preservation are worthy goals of plant exploration. These goals, coupled with geographical access, determine geographical priorities and exploration feasibility.

Northern and interior regions of Turkey, from Zonguldak (northwest) to Kars (east), were searched during the 1986 Turkey-United States Oat Collection Expedition. One or more of four oat species were collected from 176 sites along a route covering nearly 7,000 kilometers: *Avena barbata*, *A. sterilis*, *A. fatua*, and *A. sativa*. Open grazing, wherever it occurs, prevents the growth and perpetuation of isolated species clusters. Consequently most collections were made within fields of wheat or barley, along field edges, and along roadways. Utilization of this germplasm awaits assay for useful agronomic, disease reaction, and biochemical traits.

Abstract

New Oat Species

Hugh Thomas

AFRC Institute for Grassland and Animal Production,
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A number of plant collecting expeditions have been undertaken in the past 20 years in areas assumed to be the centres of diversity for *Avena*. As a result of such collections a number of wild species have been described and used extensively in cytogenetic studies of genetic relationships between species of *Avena*. The availability of these newly described species has increased our understanding of the evolution of the genus but has only marginally contributed to the identity of the diploid progenitors of the cultivated oat.

Although some of these species have been shown to have desirable attributes that would be worthwhile transferring into *A.sativa* for use in oat improvement, this source of variation is not always readily available to oat breeders due to the isolation of the wild species from the cultivated oat.

From the results of cytogenetic studies it is possible to classify the species according to the ease with which genes can be transferred to the cultivated oat. The role of these newly described species in the evolution of the genus and their value as a source of variation for breeding will be discussed in the presentation.

BREEDING OATS FOR MEDITERRANEAN-TYPE ENVIRONMENTS

Andrew R. Barr
South Australian Department of Agriculture

The centre of diversity of the *Avena* genus lies in the Mediterranean region. From there, several species have spread to become serious weeds over a wide range of climatic and geographic zones. The major cultivated species, *A. sativa* is thought to have evolved in central Europe and at present is most important as a crop in the higher latitudes. One exception is Australia where cultivated oats are an important multipurpose forage, hay and grain crop. The majority of the crop in Australia is grown between latitudes 23^{o} and 40^{o}-a range similar to that of the *Avena* genus in its original habitat. The establishment of cultivated and wild *Avena* species in the agricultural systems of southern Australia is examined in this paper as an example of plant adaptation to mediterranean climates. It is proposed that wild species from the mediterranean region and the naturalised *Avena* of Australia may provide valuable germplasm for the improvement of the crop in mediterranean-type environments.

THE DEVELOPMENT OF OAT GERMPLASM AT SVALÖF.

Bengt Mattsson
Svalöf AB, 268 00 Svalöv, Sweden

The origin of the Svalöf oats could be traced back to old land varieties, or mixed local populations. Selections within old cultivars gave at the beginning of the 20th century rapid progress like Seger (Victory) and Guldregn. Planned crosses gave further improvement like Guldregn II from Seger x Guldregn. A lot of the oats in West Europe are selections or crosses among lines originating from the Probsteier-types. Introductions from foreign countries have improved different characters. Thus crosses with the Dutch Condor gave offspring with considerably better straw stiffness (Sang).

Crosses between related or distant cultivars are still giving new combinations. However, mutation breeding might give new, interesting genes which then are occuring in a balansed chromosome-set. Thus genes for resistance, earliness and short straw have been induced and used in the breeding work.

Different sources for resistance have been found all over the world and are spred to breeders. At Svalöf most attention has been paid to resistance against nematodes and rust. For instance, nematode resistant cultivars have been released with resistance from A. sterilis found by Sigurd Andersen, Denmark. Wild species are still giving valuable genes to the germplasm. Thus the tetraploid A. Magna seems to combine very well with Swedish oats and promising lines are on the way.

Special effort has been given to keep and improve the good quality of Swedish oats. Low husk content and a big kernel are desired and in addition we select for high protein- and fat content. In those programmes lines from breeders in the U.S. have extented the variation a lot.

GRAIN YIELD AND OTHERS AGRONOMIC TRAITS EVOLUTION OF OAT IN SOUTH BRAZIL

Fernando I.F. de Carvalho,
Luiz Carlos Federizzi,
University of Rio Grande do Sul, Porto Alegre, Brazil

For a long period, oat crop in the south of Brazil has maintained a stable cultivated area and an extremely low grain yield. This has been atributted to the lack of interest in the product for both human and animal nutrition as well as to the not favorable existing climate conditions.

The solution seemed to be the search for oat genotypes more adjusted to the prevailing environment. Genetics and plant breeding in the last 24 years in the south of Brazil has contributed to establish 4 distinct periods in the progress of the species. The introduction of oat-gens from Garland, Dodge, Burnett and others opened the possibility to obtain genotypes with large genetic potencial and stable productivity.

Grain yield plateau was removed mainly due to a reduction in plant stature, in flowering date and in flower sterility. Besides that, some features such as the relation grain/straw, grain weight and tolerance to the main diseases have allowed the identification of ideotypes which contributed to the increase of oat consumption as well as to the increase of cultivated area by farms in the south of Brazil.

Oat Screening for the Tropics

Thailand

Ngamchuen Ratanadilok
Agronomy Kasetsart Univ.
Bangkok 10900
Thailand

Several Oat varieties from Sweden were observed in Thailand for 2 years under tropical environments in comparison to the local variety. Some of them failed to flower and good for forage some of them were able to give satisfied seed seting. However the yield test was conducted at the high elevation station in the second year for yield components studies. The results of this study were discussed in comparison to the local chick. Oat could have a future if it can stand poor soil problems as forage, feed, food and braverages in this country.

New genes for dwarfness transferred from wild oats (*Avena fatua*) into cultivated oat

T.Morikawa

College of Agriculture, University of Osaka Prefecture, Japan

Twelve dwarf ecotypes were isolated from the accessions of *Avena fatua* from East Asia. Genetic analysis was carried out to decide how many and what genes govern the dwarfness. The genes were transferred from the dwarf wild oats into the cultivated oat. *A.byzantina* cv. Kanota by means of successive backcrosses. B4 hybrids have already been obtained in the eight genotypes. There were no segregations except for dwarfness. Out of twelve dwarf genotypes. six were single dominant, three were single recessive, two were dihybrids and one was polygenic. The genotypes with dominant genes showed extreme dwarfism of their progeny. However, the genotypes with recessive genes showed semi-dwarfism. Allelism among them is not known.

THE HISTORY OF OAT MILLING

Samuel H. Weaver
The Quaker Oats Company, USA

The process of milling oats is accomplished by simply removing the hull from the groat followed by the cutting, rolling or grinding of the groat into various finished products. Prebiblical attempts at this process were probably accomplished by the use of stones in a mortar and pestle type apparatus followed by the separation of the hull fragments from the groats by a winnowing process. The groats were subsequently used whole or ground into meal or flour and consumed as porridge or bread-like oat cakes.

Prior to the rise of the Roman Empire, progress in milling technology was greatly advanced with the introduction of querns made of two flat round stones, the lower of which remains stationary while the upper stone is rotated. With this advancement, it was determined that hulling was accomplished more easily by the use of kiln dried grain. The querns were so successful that their use continued in the milling industry until the 19th century. The winnowing process evolved to keep pace with the output of the querns by the use of supplemental wind through barns strategically positioned on windy hilltops and the subsequent development of mechanical fans.

Procedurally, the process of oat milling has remained very simple to this day. However, technological advances such as the development of the impact dehuller, steel cutting of the groats, enzyme deactivation, flaking and grinding of the groats and high speed grading and separating equipment have greatly improved oat milling efficiencies and finished product yields and quality.

Breeding Oats For Future Use - V.D. Burrows, Plant Research Centre, Agriculture Canada, Ottawa, Ontario, Canada, K1A 0C6

Oats have a promising future both for feed and food purposes. Success in breeding productive naked oat varieties has made available nutritious oat groats that have proven useful in the formulation of pig and poultry diets. The true value of naked oats for cool season climates is their ability to supply energy equal to corn combined, in the one grain, with good quality protein that is approximately equal to soybean meal. Some lysine may have to be added to diets to obtain maximum weight gains, but this amino acid can be added with the mineral and vitamin supplements. If the β-glucan content can be reduced, and the protein content of groats raised, such feed would be even more useful to feed young pigs and broilers. Interest is also growing in the use of naked oats for food processing although covered-seeded milling varieties remain the accepted standard. The medical benefits of oat dietary fiber is contributing to the increased popularity of oats for food and breeding varieties high in β-glucan gum is being pursued. For naked varieties the incomplete expression of hull-less genes is normal leading to the presence of covered-seeds in the harvested sample. This is not a problem for feeds but represents a constraint for foods because the covered seeds must first be removed by sorting. Full expression of hull-lessness has been achieved by crossing L. Avena fatua or to certain fatuoids. The problem of groat hairiness has been at least partially solved by the isolation of "bald" parents from the international oat collection. A wet milling technique has been patented to produce oat flour and oat bran as part of our program to increase the usefulness and value of oats and oat products. Conventional uses of oats must still be pursued to but the breeding of highly productive naked oats should help halt the downward trend in area allocated to oat production.

AVENA MAROCCANA - A GENETIC RESOURCE USED IN OAT IMPROVEMENT

Per Hagberg
Svalöf

Interspecific hybridization experiments started at Svalöv in 1980 and were soon concentrated on the use of Avena maroccana. Prospects of increasing grain quality factors of oat were promising considering the large seed and high protein content of the wild species. Additionally, good straw characters were more easily selected from maroccana crosses than from other wild species combinations. The hybridization method was according to the one published by Ladizinsky. Pentaploid hybrids were backcrossed to A. sativa and selected for fertility and cultivated spikelet type. The progeny was then subject to a regular plant breeding selection procedure with emphasis on straw characters and grain quality. Lines extracted were improved in several different traits; earliness, grain protein and oil content, yield, straw, and crown rust resistance.

In 1985 Svalöv took part in an IBPGR wild oat germplasm collecting expedition to Spain and Morocco. 11 A. maroccana populations were collected in the area south east of Rabat. About 500 genotypes were increased at Svalöv. Vegetative characters, nematode resistance, and variation in groat protein content was evaluated. Selected superior genotypes will be used as parents in further oat improvement programmes.

Inter- and Intra- Specific Hybrids Involving *A.agadriana*.

J.M. Leggett,
Welsh Plant Breeding Station,
Aberystwyth, Dyfed, U.K.

The most recently described tetraploid species of oat A.agadriana Baum et Fedak sp.nov., is very similar in its gross morphology to the diploid species A.canariensis, and a chromosome count is required to positively identify the species.

The bidentate lemma tip of A.canariensis which is a characteristic feature of the A.maroccana/A.murphyi tetraploid groups and the hexaploids, together with the seed dispersal mechanism i.e. only the primary floret disarticulating at maturity, led to the proposal that A.canariensis might have been involved in the evolutioin of these tetraploids and the hexaploids.

The morphological similarity of A.agadriana and A.canariensis similarly indicates that the former species may have been involved in the evolution of hexaploid Avena.

Morphological differences within and between some populations of A.agadriana together with the irregular meiotic behaviour observed in some intraspecific crosses poses a problem as to whether the different morphological types are indeed taxa of the same species.

From the limited data available relating to interspecific hybrids, the two different morphological types of A.agadriana behave similarly indicating that they are certainly very closely related if they are indeed different species.

Further to this, the high univalent frequency observed in the hybrids A.agadriana x A.maroccana and A.agadriana x A.sativa indicate that it is unlikely that this tetraploid was involved in the evolutionary sequence which led to the formation of the hexaploids.

EXPLOITING NEW GERMPLASM IN WINTER OAT BREEDING AT ABERYSTWYTH

J Valentine
WPBS, UK

Considerable scope exists in winter oats for improving its adaptation to man's needs. Important goals include higher levels of realisable yield, winter-hardiness and disease resistance.

Lustre, containing Cimarron in its parentage, is now commercialised in the UK. Apart from large grains conferred by a single recessive gene, it is resistant to BYDV and SBOMV. The use of Lustre in further breeding will be illustrated.

Increasing emphasis is placed on capitalising on the unique nutritional advantages of oats. Relatively little difficulty has been experienced in producing naked oats with groat yield, straw stiffness and winter hardiness similar to, or better than, controls. Further progress in improving the yield of oil and protein, and resistance to mildew, is being sought from diverse sources.

- high yield, oil,
- Lustre - res. to BYDV.

BIOLOGICAL SPECIES AND WILD GENETIC RESOURCES IN *AVENA*

G. Ladizinsky

Hebrew University, Faculty of Agriculture, Rehovot, Israel

Classical taxonomy in *Avena* has produced a number of fully interfertile species with morphological discontinuity which is simply inherted. The large amount of cytogenetic data accumulated in the last 20 years allow to introduce the biological species concept to *Avena* and hence a more natural classification of the genus. The nomenclature of the biological species follows the same rules as for taxonomical species. Infra-specific classification is restricted to the main morphological types which are treated as sub species. Altogether 14 biological species are recognized and a key for their identification is presented.

The wild genetic resources of oats are derived from the biological species concept. All the hexaploid oats are members of the same species, form one gene pool and the wild forms can be exploited by conventional breeding techniques. The diploid and tetraploid species are members of the secondary gene pool of the common oat. This gene pool possesses genetic diversity which is absent in the primary gene pool. Gene transfer from the secondary gene pool requires special techniques such as embryo culture, doubling of chromosome number, various methods to promote chromosome pairing, and extra back-crosses to restore fertility.

POPULATION IMPROVEMENT IN OAT GENE POOLS--GRAIN YIELD

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University of Minnesota, St. Paul, MN

For the past two decades, we have utilized recurrent selection for grain yield in our oat improvement efforts. Our goal was to produce germplasm with increased grain yield potential. The program was initiated by crossing in diallel fashion 12 genotypes (5 cultivars and 7 breeding lines) which were selected for yielding ability and diversity in pedigree and heading date. The F_6 lines derived from each cross using Single Seed Descent were evaluated for yield in replicated hill plots in one environment. The best line from each of the 1/3 highest yielding crosses was chosen as parents for the next cycle. These 21 cycle 1 parents were intercrossed (each parent crossed to 6 others) to produce 63 C_1 crosses. F_6 lines were derived and evaluated as in the original cycle. In subsequent cycles, crossing, line development, evaluation, and selection were identical to that in cycle 1.

In recent years we have made comparisons between C_o parents and parents from the most advanced cycle available. These two groups of genotypes provide excellent material to assess changes, both direct and indirect, which have resulted from the selection for yield. Using cycle 3 parents, we measured growth rates and other physiological traits and a number of morphological traits. From two independent studies, we measured an average grain yield increase of 12.5%, or more than 1% per year. Increases in grain growth rate, partitioning coefficient, heading date, plant height, total dry matter, and the size of every plant part measured were observed. Harvest index, vegetative growth rate, and grain growth duration did not change.

When C_4 parents were compared with the original parents, yield increases averaged 22% when measured in several locations and with both rows and hills. Small changes occurred in several other agronomic characters.

Our latest effort is to compare the yield of lines derived from C_4 parents crossed to new cultivars outside the system with yields of lines from crosses within the system. Preliminary results were encouraging for crosses with both Ogle and Starter, two currently popular cultivars.

RECURRENT SELECTION FOR PROTEIN YIELD AND OIL CONTENT OF OATS

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Iowa State University
Ames, IA USA

A recurrent selection procedure for spring-sown cereals has been formulated which permits the completion of one cycle in one year. The intercrossing generation is grown in the greenhouse during September-November, and F_1 plants from matings among selected parents are grown during December-March. Manipulation of temperature and daylength assures the synchronous development of 3 to 4 panicles per plant that produce 120-200 seeds. The F_1-derived lines in F_2 are evaluated in replicated field tests of microplots at 2 or 3 locations during April-July. August is used for data collection and summary and selection of plants for another cycle.

The recurrent selection procedure has been used for three cycles to increase protein yield of oats in each of 3 lines of descent: (a) HGP = selection for protein yield per se; (b) HG = selection for protein yield with emphasis on grain yield; and (c) HP = selection for protein yield with emphasis on protein content. Gains per cycle (and per year) were 21 (4.3%), 21 (4.7%), and 27 (5.5%) kg ha^{-1}, respectively. Grain yield was increased significantly in all 3 lines of descent, whereas protein content was increased significantly in HP but unchanged in HG and HGP.

Over three cycles of phenotypic recurrent selection in an oat population derived from interspecific matings of *Avena sativa*^{3} x *A. sterilis*, groat-oil content was increased ca. 1.0% per cycle. The C3 mean is ca. 12.5% and extreme lines have 14.5% oil. Selection for oil content caused no associated changes in other traits.

BIOTECHNOLOGY APPLICATIONS IN OAT BREEDING IN THE U.S.

H.W. Rines*, R.L. Phillips, W.P. Bullock and E.N. Jellen
USDA-ARS* and University of Minnesota, St. Paul, MN

Cellular and molecular analyses and manipulations represent biotechnology tools now becoming available to plant breeding programs. Two studies, one involving tissue culture and one molecular biology, will be described and several listed to illustrate ways these tools are being applied to programs for oat improvement in the U.S.

Frequent chromosome breakage in oat tissue cultures, as demonstrated in earlier work, had been suggested as a means to facilitate introgression of alien genetic information. To evaluate this approach, a monosomic alien substitution line (2n=40+1+1') that contained a gene for crown rust resistance carried on a substituted *Avena strigosa* chromosome was placed into culture. The aim was to produce a translocation which would give stabilized male transmission of the resistance gene. Tests of progeny populations from 510 regenerated plants revealed improved transmission of rust resistance in one population and loss of resistance in six others, possibly reflecting tissue-culture-induced interspecific recombination or chromosome loss. Other oat improvement studies involving tissue culture approaches include *in vitro* selection for resistance to *Helminthosporium victoriae* toxin, evaluation of tissue-culture-induced variation in agronomic and biochemical traits, development of improved cultures for microinjection of foreign DNA, and production of haploids from anther culture and by rescue of embryos following pollination of oat florets with maize pollen.

Molecular biology techniques are being used to characterize specific genes and to identify DNA restriction fragment length polymorphisms (RFLP's) as molecular markers for chromosome identification and mapping. Using a 17S/26S 9.1 kilobase repeated sequence from maize as a probe, the ribosomal DNA sequences of hexaploid oats were shown to occur as three groups with slight base sequence divergences among them as evidenced by differences in their *Sac* 1, *Eco* R1, and *Bam* H1 restriction sites. Restriction fragment pattern differences were found in the rDNA sequences among the four hexaploid species — *A. sativa*, *A. byzantina*, *A. sterilis*, and *A. fatua* — and among five *A. sterilis* accessions, but not between the unrelated *A. sativa* cultivars 'Sun II' and 'Noble'. Length variations in spacer fragments were demonstrated to be the basis for the RFLP's. Other oat DNA sequences being characterized in the U.S. include genes for tubulins, phytochrome, storage proteins, and random genomic DNA clones.

GENETIC ENGINEERING OF OATS: REGULATION OF PROTEIN SYNTHESIS IN ENDOSPERM DURING EMBRYOGENESIS

M. Giband, A.E. Hansen, L.S. Robert, S. Fabijanski, S. Dukiandjiev[1], P.K. Gupta[2] and I. Altosaar*.
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Since the prolamin:globulin proportions are reversed in wheat and oat, these genes are being used as a model system to find the regulatory DNA sequences which are responsible for this differential gene expression in cereals. In oats, 75-88% of the grain protein is composed of salt-soluble globulin while the synthesis of the alcohol-soluble prolamins is stopped at 10-15%. This is in sharp contrast to the Triticeae, where prolamins form 60-70% of grain protein. The amino acid sequences of both oat globulin and prolamins (avenins) are now available from several laboratories, determined directly at the protein level, and predicted from complete cDNA sequences. Oat globulin is about 70% homologous with rice seed storage globulin (glutelin) and 30-40% homologous with storage globulins of legumes. Oat prolamins have been isolated by HPLC and the NH_2-terminal amino acid sequences of the more abundant 22,000-37,000 molecular weight polypeptides exhibit considerable homology and tandem heptapeptide repeats. The complete amino acid sequence of a 21,000 m.wt. avenin (N9) consists of 182 residues and exhibits the features common for all known prolamins. Our laboratory has sequenced a cDNA clone for a 16,000 m.wt. avenin where the predicted NH_2-terminal domain is unique and interestingly the COOH-terminal domain shows homology to globulin. Such a "chimeric" storage protein should exhibit amphipathic solubility characteristics. The available cDNA sequences for oat prolamin and globulin can be used to generate predicted secondary structures for the corresponding messenger RNA molecules to test whether steric hindrance of ribosome attachment may explain the differences in their translational efficiencies during grain development.

A MALE-STERILE HEXAPLOID OAT, AND THREE-LOBED STIGMAS IN OATS

M. E. McDaniel
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Male-sterile oat: Two spontaneous male-sterile oat plants were found among F_2 progeny of a complex cross grown in a greenhouse at College Station, Texas in 1985. The sterile plants had small "arrow-head" anthers similar to those of male-sterile wheat and barley. F_1 plants from crosses with fertile plants were fertile, while 47 of 372 F_2's grown in the greenhouse in 1987 (12.6% of the population) were male-sterile, and had the same anther morphology as the original sterile plants. Sterile plants have normal plant and spikelet morphology (other than the sterile anthers). Microspore formation appears normal through the tetrad stage, but pollen has no starch. Since it appeared that more than one gene might be involved in fertility restoration, we sib-mated fertile F_2 plants with sterile plants from the same crosses to attempt to "simplify" the sterility to a one-gene system. 34 of 78 F_1 populations (4-7 plants per cross) had at least one sterile plant; these segregating F_1 families had a total of 81 fertile plants and 75 male-steriles, which is a good fit to the 1:1 ratio expected if the male parents were heterozygous for one "restorer" gene. F_2 populations from fertile plants in these families were grown in the greenhouse in 1988. 16 of 21 families had satisfactory "fit" to the expected 3 fertile: 1 sterile ratio; overall, 488 fertile and 137 male-sterile plants were observed. It appears that male-sterility in these families was conditioned by a single, recessive gene locus.

Three-lobed stigma trait: 'H-833', a commercial cultivar of "winter" oats, was found to have a high frequency of three-lobed stigmas (22.7% of primary florets of greenhouse 'H-833' plants had the trait). The "extra" (center) stigma lobe was found to function when the normal stigma branches in emasculated florets were removed by cutting the style below the stigma; seed set was lower than that for "normal" emasculated florets (pollination by the "approach" crossing method).

COMPARISON OF TWO BREEDING STRATEGIES FOR THE DEVELOPMENT OF OAT HIGH YIELDING VARIETIES

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University of Rio Grande do Sul, Porto Alegre, Brazil

Advances in productivity of small grains can be achieved basically through two different strategies, increasing the genitical potential for yield (positive) or removing constrains that interfere with the yield potential (defensive). The success of any breeding program depends largely upon the choice of the most adequate strategy for the target environment. In Southern Brazil the low productivity of oat has been attributed mainly to the frequent occurrence of rust epifities and that argument leaded most breeding programs to select primarily for resistance to diseases (defensive).

The grain yield performance of varieties selected from the same gene pool in two different oat breeding programs provied a opportunity for the comparison of different breeding strategies. The defensive, where the main emphasis is given to the resistance to disease, and the positive, where the primary criteira is the selection of theoretical more efficient plants.

Comparisons of the varieties in several locations and years provided an unbiased estimative of the potential yield for the two set of varieties. The results obtained showed that the varieties selected for a more efficient type (UFRGS) outyielded the varieties selected for disease resistance (UPF) in all comparisons but one, even in the presence of severe rust epifities. Varieties selected for a theoretical more efficient type (UFRGS) showed reduced plant height, less numbers of days to anthesis and better harvest index than the varieties selected for disease resistance (UPF).

For this especific environment target the selection should be primarily for best agronomic type, and after this goal is reached for some tolerance to disease. Results obtained in this study may be of considerable importance for other breeding programs placed in areas with a set of environments different from those observed in the center of origin of the species being bred.

Martin Vanselow

Recurrent selection in oat breeding

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Recurrent selection is often used to improve quantitative characters in breeding cross-pollinating crops and sometimes in breeding self-pollinating crops. In oat (*Avena sativa L*), which is an obligate self-fertilizer, crosses are possible but only on a small scale. If a recurrent selection scheme in oat is planned it is necessary to use a scheme with a minimum of crosses. For the improvement of quantitative characters as grain yield (GY), 1000-kernel-weight (TKW) and plant hight (H) a recurrent selection procedure seems to be useful. Therefore we started three recurrent selection programs with crosses between two, two and four pairs of F_2-derived lines in F_5 as parents for the first cycle. For each pair about 25 crosses were made. The recurrent selection schemes are designed in that way that the number of pairs is the same at the beginning and at the end of each cycle. In 1985 the F_2-generation from the crosses of the first cycle and in 1986 the F_3-generation was tested at three locations. In 1987 the F_4-generation was tested only at two locations. 1985 only a test in 2-row-plots was possible since the amount of seed was low. In this paper the experimental results of the first cycle are presented.
In 1985 the mean correlation between replications was 0.132 for yield and 0.383 for TKW and between locations 0.113 for yield and 0.586 for TKW. In a recurrent selection program selection is done at a very early stage. Therefore it was important to check the possibility for selection in F_2 (1985) and in F_3 (1986). The corresponding correlation coefficients for yield were 0.075 between 1985 and 1986, 0.077 between 1985 and 1987 and 0.252 between 1986 and 1987. The correlations for TKW and plant hight were much higher.
From these results we draw the conclusion that the selection for yield is not effective before F_3. That means that one cycle needs at least three years.

THE VALUABLE DONORS FOR QUALITY IMPROVEMENT IN OAT BREEDING

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There is still unused resources for breeding high quality oat varieties. One reliable source will be the VIR collections of hulless oat.

The content of protein, fat, lysine and agrinin in many hulless oat varieties and strains is much higher comparing with hull oat varieties.

Low hull content and high vitamin and minerals content (vitamins B_1, B_2) will increase their importance as food and fodder. It will be valuable for developing hulless oat varieties even in case if the yield is lower comparing with usual ones.

As a result of our research work (studies) we have found among hulless oat some varieties and strains, which have high protein and fat content as K-2301 (VIR), K-1996 (VIR), "Nuprime" and "Reha" (France), K-11680 (Finland), "Nos Nact" and "Manu" (FRG), "Nany" (Chechoslovakia), "Pulavski hulless" (Poland). All they have also rather good grain yield.

As our studies showed the small grain varieties and strains which had very high protein content (20-23%) were : K- 2122 (France), K-1926 (China), K-2468 (Mongolia), K-1766, K- 1799 (USA), very high fat content (7,0...8,7%) had K-1998 (USSR) , "Nos Nact" (FGR) and "Nacota" (Canada). All this donors have been involved in oat breeding programs of our breeding centers.

A new highly productive with high protein and lysine content hulless variety "Uspeh" has been developed by crossing "Victory" (USA) and local (Perm region) hulless variety. The selection was carried out in watering conditions in drought region (Uzbek SSR). "Uspeh" has been recommended for cultivation in 1981.

VIR has large number of varieties and strains with wide genetic variability as initial material for quality improvement breeding.

BREEDING HIGH QUALITY MILLING AND FEED OATS IN THE HIGH MOUNTAIN VALLEYS OF CHIHUAHUA.

Philip Dyck
Cd. Cuauhtémoc, Chih., México.

This region, produces 80% of the oats in Mexico. Of the grain produced 20% is used by the four local oat meal plants, the Quaker Oat meal Company. and by farmers as seed. The oat forrage is used as dairy and beef cattle feed by local farmers and ranchers.

There are several problems involved in producing high quality oats. First, the short growing season wich ocasionally is 104 days or less. Secondly the irregular rainfall. Thirdly, the high stem rust infestation in season with high humidity. Fourthly, there are general problems of shattering and lodging. Therefore early, drought tolerant, disease, shatter and lodging resistant varieties are being developed.

Oat improvement began when the local farmers replaced their late Canadian varieties with the earlier good yielding variety Burt, named Texas by the farmers. When the Quaker Oats Company opened its oat meal plant in Mexico City, it introduced the high yielding, High groat content varieties Newton and Clintland. In 1961 the National Agricultural Research Institute through its local Experimental Farms began to improve oat varieties at first by the introduction of the USA varieties AB-177 and Nodaway, and later by the release of the varieties Cuauhtémoc, Chihuahua, Guelatao, Pâramo and Tarahumara selected from Mexican crosses of which Guelatao, Pâramo and Tarahumara are the earliest maturing varieties released. Pâramo and Tarahumara are also lodging and shatter resistant. Varieties had been evaluated on yield, earliness, lodging, shatter and disease resistance, but since 1975 oat varieties have also been analysied for kernal quality. Protein and groat percent and 1000 Kernel weight. The new varieties Papigochi, Babîcora, Pampas, Raramuri and Cusi have these high Kernel characteristics besides the other characteristics but the fatty acid content of the kernal and protein content of the forage still have to made.

Protein and lipid quantity and quality in Swedish oats.

Henrik Johansson

Swedish Cereal Laboratory, Svalöv, Sweden

Individual payment for protein content in oats to farmers for each delivery was introduced in Sweden in 1987. Premium starts from 12% protein on dry matter basis with two percent per percentage point protein. The harvest last year was extraordinary. The protein content in all cereals was extremely low. The mean protein content in oats was as low as 10%. During a period of a decade ending ten years ago the quality of oats was analysed each year in an inventory survey. The mean protein content each year was then between 12 and 13%.

Lipid content and fatty acid composition in oats from a world collection grown in Svalöv in 1981-83 was investigated. The variation in 1981 in total, free and bound lipids was 5.6-10.8, 3.5-8.9 and 0.7-3.4% respectively. Several lines and cultivars contained 50% more lipids than our Swedish market varieties. The lipid content in 1982 was considerably higher than in 1981. The variation in dehulled oats in 1983 in total lipids was 8.7-13.4%.

The variation in fatty acid composition in free lipids in 1981 was for palmitic acid 10.4-17.5% for oleic acid 40.0-52.4% and for linoleic acid 32.1-43.1%. In wild oats as low content as 24.9% of linoleic acid was observed.

The quality of different oat varieties and industrial oats (1984-87) in West-Germany

W. Ganßmann,

Peter Kölln, Köllnflockenwerke, Elmshorn, Fed.Rep.of Germany

To get more information about the quality of German oat varieties for oat milling purposes the main parameters 1.000 grain weight (tgw), the amount of hulls and the protein and oil content were investigated and related to grain yield (4 years, 10-11 varieties, 9-13 locations).

Independent of the different growing conditions in the years and at the trial locations the individual varieties showed always a variety typical quality development. So certain varieties with constant high milling quality characteristics were found and could be recommended to the farmers.

A comparison of industrial oats usually handled in Europe and grown in different countries resulted in great differences in quality, i.e. hl-weight, tgw, hull content, grain size, foreign material and nutrient content in the groat (protein, oil, minerals).
In many cases the demanded quality requirements were not obtained.

German oats normally have a sufficient kernel development to give a good milling quality, but its use for human consumption products of high quality is often limited because of grey-black looking and damaged grains affected by bad conditions during harvest and storage.
In this respect Australian oats are very excellent.
High quality oats in trade are also produced in Sweden and Finland; French oats have a very low tgw and small grain size.

Generally the market in high quality milling oats worldwhile is very small.

OATS AS ANIMAL FEED

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The most important factor influencing the chemical composition and hence the nutritive value of oats is the relationship between husks and groats. However, in addition to this, other factors influence the chemical composition. The following ranges for the chemical composition of entire oats are (% of d.m.): crude protein (CP) 8-17, crude fat 4-8, crude fibre (CF) 7-15, ash 2-4 and starch 38-55. Only small amounts of free glucose, fructose and fructans are found. The content of β-glucans varies slightly ($\bar{x}$ 3.2% d.m.) whereas the content of arabinoxylans varies considerably ($\bar{x}$ 8.0, variation 4-15% d.m.). The amino acid (AA) profile of oats is influenced by the CP content but to a lesser degree than that of barley, maize and wheat. However, different essential AA are affected differently. The lysine content of oats is less firmly correlated to the CP content than e.g. threonine and methionine. From a nutritional point of view the protein quality of oats is superior to that of the other cereals mentioned above.

The content of metabolizable energy of oats varies between animal species as ruminants are capable of making use of the husks which are of very low or nil value for the monogastric animal species. The energy value of the groats is, as a result of the higher lipid content in comparison with wheat and barley, approximately that of maize. The feeding properties to broiler chickens of dehulled oats seems to depend on the content of arabinoxylans, as supplementation with multi-enzyme preparations improves the growth rate. The effect of processing oats seems to be limited compared to other cereal species. Oats is a suitable cereal crop for different animal species, but some form of quality indicator is necessary to give an estimate of its useful energy content.

OATS FOR DAIRY CATTLE

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Oats and barley make up about 70% of the total concentrates to ruminants in Sweden. Barley is the main feed grain with a production of 2.3 million tonne per year. The oat production is about 1.7 million tonne per year. Of the total harvest of feed grain in Sweden, about 30% is used by ruminants.

Oats is a widely used cereal for dairy cattle. Milk producers claim that milk production and the content of fat in milk increase when oats are used as an ingredient in the concentrate instead of barley.

Differences in chemical constituents between oats and barley may have an influence on the feeding value for dairy cattle.

Oats has a higher content of crude fat and crude fiber than barley. The amount of nitrogen-free extract is high, and this is mainly starch. The amount of starch is, on average, lower in oats than in barley. However, there is a big variation in the starch content of grains that is important when evaluating the feeding value. Even if the relations between amylose and amylopectin in starch from oats and barley do not differ, the difference in the structure of the starch granules may be of importance. The fact that fat in oats to some extent is bound in the endosperm may have an important influence on the feeding value.

The crude protein content (N x 6.25) of oats and barley may be the same. However, the contents of globulins are higher and the prolamines and glutelins lower in oats than in barley. This makes the proteins in oats more soluble. The degradability of the oat protein will be higher in the rumen, making the utilization of the proteins differ between the two grains.

The digestibility of organic matter is lower in oats than in barley, making a 5% difference in the calculated content of metabolizable energy in favour of barley.

In feeding trials with dairy cattle at Lantmännens' research farm, Viken, the milk production per cow and day was higher when feeding oats than feeding barley. The positive effect of oats on milk production seems to be related to the fat content of the ration. This difference in fat content between oats and barley may be compensated by other fats in the feed mixture.

OAT FOR FORAGE/GRAZING

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There has been a long time interest in breeding oats for feed and forage. One of the important objectives have been to find good genotypes that would include high forage yield, grazing adaptation (regrowth), high grazing yield (animal gains), followed by acceptable grain yields.

From ancient times oats have been mentioned as a forage for livestock. The utilization of oats for both grazing and grains has been common for more than 75 years. Oats produce an abundance of excellent forage at a time when other succulent, high protein feeds is scarce. Green oats when dried before heading contain 20 % or more protein. Digestibility of the oat forage dry matter averages 79.4 %. Oat pastures increase milk production and body weight without supplemental feed.

Oats can be used both as single cut and multicut for forage production. The multicut cultivars need to have fast and uniform regeneration capacity after each clipping/cutting. Genotypic differences for this and related traits exist in the oat germplasm. Cultivars suitable for grazing should have well developed root system. The major factors which affect yield and quality of forage oats are varietal choice, seeding rates and dates, diseases and insects, soil moisture, temperature and fertilization.

Sufficient genetic variability exists for forage yield and its contributing traits. In order to make oats more useful as forage emphasis is needed to produce cultivars with good herbage yield and quality. Plant traits such as growth habit, regeneration, plant height, days to heading, and tillering should be given due attention in selection and breeding for increased forage yield. It may be an added advantage to use genes from related wild species for the improvement of cultivated oats for forage/grazing.

OATS FOR SILAGE

Marshall A. Brinkman
University of Wisconsin

Harvesting oats (Avena spp.) by ensiling at some point prior to maturity has been a common practice in many oat growing areas of the world, especially where dairying is common. Although reports on forage yield, forage quality, and feeding trials are relatively common in the literature, minimal breeding effort has been directed towards improving forage yield and quality in oats.

Feeding studies are not in complete agreement on the optimum time to harvest oats for forage, in part because the precise role and importance of several forage quality traits is still being evaluated. Nevertheless, the consensus is that oats are higher in forage quality prior to heading than after heading. Because forage yield increases until physiological maturity is reached, the oat grower must decide when to harvest his oats: early for higher quality or later for higher yield. The major factor influencing the decision that the oat grower makes usually is intended use. Growers who intend to feed oatlage (oat silage) to high producing dairy cows are likely to harvest their oats in the late boot to early heading stage for high quality, while growers who intend to feed oatlage to dry cows, heifers, beef cattle or sheep may decide to wait longer for high yield. Farmers who supplement oatlage with grain as an additional source of energy may decide to delay harvest until after heading.

Another factor that affects time of harvest is the alfalfa (Medicago sativa L.) underseeding. Growers who use oats as a companion crop to establish alfalfa may emphasize early harvest of oats to facilitate growth of the alfalfa underseeding.

In recent years the Wisconsin small grains project has evaluated forage yield and quality of oats grown in pure stands and in mixtures with peas (Pisum spp.). Excellent quality forage should be high in crude protein (CP), and low in ADF (acid detergent fiber) and NDF (neutral detergent fiber). In general, short, early oats have lower forage yield and higher forage quality than tall, late oats. Planting peas with oats has not produced a consistent response in forage yield, as forage yield response is affected by genotype and environment. If the concentration of peas is sufficient (at least 4 seeds/ft^2 and preferably 6 to 10 seeds/ft^2), planting peas with oats consistently improves forage quality by increasing CP and reducing NDF.

OATS FOR HUMAN FOOD: PROTEIN AND OIL

Paul Murphy
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Oats (*Avena sativa* L.) contain the highest protein levels amongst the cereal grains. Groat protein levels in excess of 21% are frequently reported in modern cultivars grown in North America. Biological evaluations from feeding tests support the data from chemical analysis concerning the high nutritional value of oat protein. Lysine, threonine, and methionine are limiting essential amino acids. In contrast to other cereals, the low-lysine prolamin fraction constitutes a small percentage of storage protein. Increased protein in oats is correlated with elevated levels of the nutritionally balanced globulin storage fraction. While breeders have been successful in developing high protein cultivars using *A. sativa* germplasm, many recent efforts have involved research into utilization of high protein genes from *A. sterilis* (22.1 to 31.4% groat protein). Researchers are optimistic about further increases in protein percentage in *A. sativa* based upon: occurrence of transgressive segregation and significant genetic variation among progeny of interspecific crosses; preponderance of additive effects in protein expression; intermediate heritabilities (frequently >40%); complementarity between *A. sativa* and *A. sterilis* protein genes; and, in some breeding populations, low and nonsignificant negative correlations between protein percentage and grain yield.

Oat groats generally contain the highest concentration of seed oil amongst the cereal grains. Triacylglycerides of palmitic, oleic, and linoleic fatty acids form the largest fraction (95%) of oat oil. Increased oil content is positively correlated with oleic acid and negatively correlated with palmitic and linoleic acids. Increased oil content would enhance the energy value of oats as a feed, and the potential of oats being utilized as an oilseed crop. Results from both inter- and intraspecific crosses have shown that oil content is a polygenic trait, governed primarily by additive gene effects with partial dominance. Inheritance of individual fatty acids has been reported to be under both poly- and oligogenic control.

Chemistry & Physiology of Oat Beta-Glucans

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Oat beta-glucans are mixed (1-->3) and (1-->4)-B-D glucans which are distributed throughout the endosperm as the major cell wall polysaccharide. However, greatest concentrations are found in the outer layers of the groat as a result of thick sub-aleurone endosperm cell walls. Oat bran is enriched in these thick cell-walled outer layers, and as a result, may contain approximately twice the amount of beta-glucan found in whole rolled oats.

Recent clinical studies with oats, oat bran, and oat gum suggest that beta-glucans have several health related implications for man. The best studied health affect of oat consumption is its hypocholesterolemic properties which appear to be mediated via several mechanisms. Beta-glucans play a major role in lowering serum cholesterol possibly by decreasing bile acid reabsorption in the colon. The water soluble properties of beta-glucans result in increases in viscosity in the small intestine and tend to slow absorption of nutrients such as glucose. This suggests that oat beta-glucans may also have positive affects on control of blood sugar and energy utilization.

The current interest in dietary fiber on the part of the health professional and general public presents challenges to the food industry to provide quality products high in dietary fiber which are palatable and convenient. One of the questions which must be addressed relates to the effect of processing on dietary fiber. Does processed oat fiber have the same hypocholesterolemic properties as unprocessed oat fiber? How has the chemical form of beta-glucans changed during food processing involving elevated pressure and temperature. Data will be presented which suggests that processing of oat B-glucans does not compromise its hypocholesterolemic properties. However, data obtained using the Theander method for dietary fiber determination will also be discussed which indicates that the chemical form of the dietary fiber in oats does change in response to processing.

OAT FIBRES - COMPOSITION AND NUTRITIONAL SIGNIFICANCE

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An efficient utilization of cereal grain requires a greater understanding of the chemical composition and properties of the available material. Thus modern as well as rapid chemical techniques have been applied to evaluate the composition of fibres in oats. Cellulose, arabinoxylans, ß-glucans and Klason lignin were the predominant components but the amount and solubility varied considerably in different samples.

Oat hulls contained predominantly insoluble fibre constituents with arabinoxylans, cellulose and Klason lignin as main constituents. As a consequence, the amount of soluble dietary fibre and ß-glucans as well as soluble ß-glucans were enriched in the dehulled oat fraction. Also, the solubility of ß-glucans was significantly reduced by dehulling, probably due to decreased activity of endogenous ß-glucanases.

The high content of ß-glucans in oat endosperm are probably responsible for the reduced serum cholesterol and blood glucose peak observed on oat diets and also in some cases in reduced growth and health problems for monogastric animals. The nutritional significance of ß-glucans in oats will be further discussed.

OAT BREEDING FOR HUMAN FOOD IN HUNGARY

András Palágyi
Cereal Research Institute, Szeged, Hungary

As it is known, oat is a cereal of high nutritive value. Its balanced protein and fatty acid composition, fibre content, alcaloids and microelements make it apt not only for animal feeding but also for human food. It can be used as "natural medicine" by its dietician and therapeutic effect.

More than 17 % of the oat quantity produced in the world is utilized for human food, however, in Hungary less than 1 % of the growing area is utilized as "food oat" basic material. The reason is, on the one hand, the bad tradition, that is, that oat is the fodder of horses. On the other hand, our corn /milling/ industry has not had any modern processing machines, suitable technology up to now which garantee the good quality of final product.

Our objective was to reduce this problem when we started to develop naked varieties for food industry at the beginning of the 70's. Since then two of our naked oat varieties have been registered. They can also be produced under the Middle-European dry and warm climate with success. They can be processed by cca. 25-30 % less cost and energy than covered oats. At present a modern "quaker-oat" factory is being established by the cooperation of several plants. We try to produce highly enjoyable confectionary and baking industrial products by an extruder developed partly by Hungarian experts.

Selecton is carried out to develop normal oat lines with higher groat volume and medical experiments are done to develop certain natural oat medicines.

LABORATORY EQUIPMENT

David M. Peterson. Agricultural Research Service, United States Department of Agriculture, 501 N. Walnut Street, Madison, WI 53705 U.S.A. and Department of Agronomy, University of Wisconsin-Madison.

Several new techniques have been developed that are useful in oat research for evaluation of grain quality, cultivar identification and basic metabolic and structural studies. Technologies requiring expensive equipment may be available only in specialized laboratories, accessible to plant breeding projects through cooperative arrangements. Other technologies can be set up and used by individual breeding projects. Near infrared reflectance (NIR) spectroscopy has been used for about a decade to measure protein and moisture in oats and has the potential to measure oil and other constituents. Modern instruments have been considerably improved, and they range from relatively inexpensive units designed for use in grain elevators to complex scanning instruments with considerable computing power. The most common instrument for oil analysis is the nuclear magnetic resonance (NMR) spectrometer, and this technology has the advantage of being nondestructive. NMR is also useful for basic studies involving the analysis of metabolites specifically labeled with stable isotopes of carbon, phosphorus or hydrogen. For analysis of kernel size and shape and structural features such as cell wall thickness, digital image analysis has been applied. This technology can also be used to study the distribution of protein or other components within the kernel. Cultivars can be identified from seed samples by electrophoresis of seed proteins on polyacrylamide gels. Many cultivars have unique banding patterns. High performance liquid chromatography has been applied to cultivar identification in other cereals and may be useful for oats.

FIELD MACHINERY IN CROP RESEARCH

P.A. PORTMANN

Since World War 2 there have been major advances in mechanisation for agricultural research which have revolutionised the way research can be done. Probably the two most significant contributions have been the cone seeder and the self propelled experimental plot combine.

Equally significant has been the impact of computer technology. It has been an essential complement to mechanisation, enabling the handling of the sheer volume of book-keeping and data handling. Data can now be directly recorded onto electronic memory in the field, greatly improving the accuracy and speed of collecting data.

Electronics will have a major effect on research in the future. We are yet to see the real impact of 'robotics'. Many of the repetitious operations in research such as preparing seed for trials and quality screening are perfect targets for automation.

Remote sensing is only just starting to be explored for its value in measuring useful physiological characters such as leaf area index and early growth. Techniques such as these may at last make it feasible for Plant Breeders to screen for physiological characters as readily as they can now screen for yield.

THE HEGE EQUIPMENT FOR RESEARCH WORK

Hans Ulrich Hege
Saatzuchtmaschinen - Hohebuch
West Germany

As certainly known, I am a plant breeder with an own, private breeding station, working in cereal, legume seeds, forage crops etc. Nearly 25 years ago I started with designing a plot combine. In the meantime there is a full program developed and manufactured at our factory, where we are specialized in the equipment for agricultural research work.

The Hege Company is expert in building machines for research work. with the continous development of the machines a lot of experience was gained, which enables us to help the stations for their individual equipment, if wanted. We are specialized in such type of equipment, which means, we do the best to make them ideal in practical use. but also spare parts supply, stabil construction and low wearing-out of parts is a line of our production. all machines are high in capacity, but in spite of this also small in dimension, easy to transport and to operate.

The machines discussed are:

The Plot Combines: Hege 140 and Hege 125 C. The Forage Plot harvester Hege 212.

The Hege Seed Drills: Hege 95 B Pneumatic Space Planter, Hege 80 Belt-Cone Plot Drill, Hege 90 Single Row Drill.

The Tool Carrier Hege 75.

Laboratory equipment: Hege 11 Liquid Seed Dresser, Hege 16 Single Plant and Ear Thresher, Electronic Scales, Moisture Testers.

The Fertilizer Distribution System: Hege 33 and Hege 34.

The Handpushed Single Row Drill Hege 90/1.

Seed cleaning and processing, KamasWestrup

Thomas Edholm

KamasWestrup, consisting of a group of companies, Kamas Industri AB, Sweden, Brdr. Westrup Maskinfabrik A/S, Denmark, Kamas Machinery Ltd, England and KamasWestrup,Inc., USA, Design and manufacture machinery and construct complete plants for grain and all types of seed. The product range includes machines with capacities from 100 kg/h up to 120 t/h.

The product range also include laboratory machines with the same features as the large scale machines. These are in the following going to be described an later on demonstrated during our visit in Svalöv.

THE USE OF MICROCOMPUTERS IN PLANT BREEDING. Russell Freed, Associate Professor of International Agronomy, Department of Crop and Soil Sciences, Michigan State University, East Lansing, Michigan, USA.

ABSTRACT

Data management is an important component of a plant breeding program. Computers enable breeders to quickly and efficiently manage large data bases. Computers can also be used to design experiments; print field books, labels, and maps; and analyze the data. MSTAT, a software program started by Dr. Oivind Nissen at the Agricultural University of Norway, can be used by breeders to manage their programs. MSTAT will design experiments with one to five factors and zero to four splits. It will also design simple and triple lattice designs. It has two plant breeding programs to manage pedigrees. The BR series is a straight forward breeding program while the AC series is a complex program based on a master accession file. The AC series enables the breeder to use information gathered in earlier generations to help select superior lines. The program can be used to select parents for crossing, assign hybridization numbers, and print field books and labels. MSTAT will run on IBM compatible computers with at least 256K.

Use of computers and computer programs.

For germplasm collections.

S.Blixt, Nordic Gene Bank, Alnarp

ABSTRACT

Genetic resources information in genebanks are today almost entirely handled on computers, of different makes and using different software. The computers are mainly used for registering and for direct retrieval of registered data, i.e. the main effect of using computers is the saving of time.

The use of computers have much more potential than saving time but more efficient and sophisticated use is hampered by lack of suitable software as well as lack of high quality genetic data.

Presently the Nordic Gene Bank oat collections holds 608 accessions of Avena frrom the Nordic countries (including some duplicates) and the Central European Oats Database at FAL, Braunschweig, BRD, 16 875 accessions, including 30-40 per cent duplicates.

COMPARISON OF THE PEDIGREE PLANT SELECTION METHOD AND THE GRAVIMETRIC BULK SELECTION METHOD IN PRODUCING HIGH QUALITY OATS.

Philip Dyck
Cuauhtemoc, Chih., Mexico.

Oats is used to produce oat meal and as dairy cattle feed where the milk is used for cheeze production. For both purposes high quality oats is required.

Oat improvement involves the following problems: The short growing season, disease resistance especially stem rust high yielding, drought tolerant cultivars with kernels that have high protein and groat percent. Because 90 percent of the farmers have suffeved heavy losses because they seeded a stem rust susceptible variety Paramo. New oat lines and cultivars with hig groat content are being developed that are early, stem rust resistant and drought tolerant. Before new cultivars are released, they are tested for groat and protein percent, 1000 kernal weight and the protein content of the kernal. Groat oil percent is a very important characteristics of the oat kernel, no test are being made for this characteristic at the present time.

Until recently all the selection in oats was done by the Pedigree Plant Selection method. In past few years several lines ware developed, by the Gravimetric Bulk method three of which are among the five highest yielding lines. The grain yield of two of these Papigochi and Babicora are the highest. The pedigree plant selections, Cusihuiriachi and Raramuri mature in a similar time period as Paramo. All the lines have a similar height and all of them are moderately susceptible to stem rust where as Paramo is susceptibe. All the lines have a higher groat percent than Paramo, the highest being Babicora. The protein content of all the lines, except for the gravimetric line Papigochi, are equal to or higher than Paramo. However, all the gravimetric lines have a better 1000 kernal weight than the pedigree lines and equal or are better than Paramo. This data indicates that this gravitational bulk method can replace the pedigree plant selection method to develop new oat cultivars.

EVALUATION OF COMBINING ABILITIES OF OAT VARIETIES

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CRBI Kroměříž
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For evaluation of combining abilities in oat varieties the modified method of incomplete diallel cross, elaborated by HINKELMANN (1966), was used. Its principle consists in crosses of chosen female varieties with selected male ones. Obtained asymmetrical scheme is represented only by specific and premeditated combinations of selected parents. Analysis of results is performed only in hybrids, without evaluation of parents, and it is based on following equation:

$$Y_{ijk} = u + V_i + W_j + S_{ij} + r_k + E.$$

F1 and F2 generations from crosses of common parental varieties Pan (CS), Perona (NL) and Flämingsnova (D) with 9 non-common parental varieties of oat were evaluated in 1984 - 1985. Mean values of series of crosses, their deviations from total mean, GCA and SCA were expressed numerically and classified into groups according to degree of significance. Results were completed with variance analysis and with values of aditive genetical variance σ^2_A and variance of dominance σ^2_D.

The highest grain weight per plant was performed in combinations: Pan x Alfred, Pan x Pirol, and Pan x Petkus 8045. The highest grain weight from series of crosses appeared in series Petkus 8045, Alfred and Pirol, the lowest grain weight was achieved in series containing Flämingsnova. GCA for this trait was statistically significant in male and female parents, SCA was not significant. Petkus 8045 had the best GCA of male parents, Pan was the best variety in GCA of female parents. The highest SCA towards increasing of the trait was performed by varieties Alfred and Pan, SCA toward reduction of the trait was the highest in Flämingsnova, Borrinova and BOA 179.

This method was utilized for evaluation of 10 most significant traits in 3 combinations of crosses. It provided valuable informations for oat breeding.

RESISTANCE OF OATS TO RUST DISEASES

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Oat crown rust (*Puccinia coronata Cda.* var. *avenae Fras. et Led.*) and oat stem rust (*P. graminis Pers.* f.sp. *avenae Erikss. et Henn.*) are widespread diseases occurring in most parts of the world where oats are cultivated. The resistance of oats to these pathogens, used with success for more decades, is the most feasible and economical protection of the crop from them. It contributes to stability of grain yield and keeping its quality.

The origin and the effectiveness of crown rust (Pc) and stem rust (Pg) resistance genes and some new rust resistance sources, recently found, will be described. Up to now, more than 60 and 15 genes for crown rust and stem rust resistance were described, respectively. The majority of them was found to be dominant or partially dominant. In unrelated oats the crown rust and the stem rust resistance genes are mostly differently localized. A linkage between rust resistance genes and genes for other characteristics seems to be relatively rare. However, attention should be paid to this question in rust resistance with potential practical usefulness.

Much more investigations should be carried out in inheritance of general resistance and tolerance and mechanisms responsible for these properties. Problems of the precocity of teliospore formation as a potential component of the genetic control of rusts will be mentioned.

The adequacy of the current strategies of the genetic control of crown rust and stem rust and problems and prospectives of some other approaches will be discussed.

Resistance and tolerance of oats to barley yellow dwarf

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Many agronomists and agricultural scientists are still holding the view that barley yellow dwarf virus (BYDV) is a minor disease of oats. The pioneering work on BYDV could do little to challenge this misconception, because there was no rapid tool to prove that BYDV was present in a field, and because BYDV tolerance was available only in genotypes with poor agronomic value and low yield potential.

Breeders and pathologists have worked together to produce remarkable BYDV-tolerant oat cultivars in North America. Twenty years ago there was almost no BYDV-tolerant oats grown in USA and Canada; by 1990, BYDV-tolerant cultivars may cover half of the total crop area.

The two concepts of resistance and tolerance will be explained.

BYDV tolerance apparently improves yield potential. This challenging observation means that either BYDV levels are heavily underestimated, or else that some tolerance genes have a beneficial pleiotropic effect.

The use of the ELISA method can now generate a larger knowledge of BYDV epidemiology and prove BYDV is present more often than anyone previously imagined; however, the hypothesis of beneficial pleiotropic effect of tolerance genes has not been disproved. When BYDV tolerance or resistance is obtained from wild species such as Avena sterilis, methods related to backcross may be useful, but other methods related to recurrent selection may have more general value to pyramid tolerance or resistance genes from many species.

Artificial BYDV inoculation methodology will be discussed briefly. The preliminary correlations and conclusions of the FIRST INTERNATIONAL OAT BYDV NURSERY, grown in four countries, will show how international collaboration could accelerate progress in breeding tolerant cultivars.

FRIT FLY RESISTANCE IN OATS

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Oat seedlings are maximally susceptible to frit fly attack around the two leaf stage. Younger seedlings are resistant because they do not offer suitable egg-laying sites to the frit fly females. The gradually increasing resistance of older seedlings, on the other hand, is caused by a reduced ability of the larvae to penetrate the shoot. The utilization of a direct resistance to larval penetration seems to be the most promising way of improving the resistance to frit fly attack in oats. An early development of resistance to larval penetration is associated with a rapid build-up of additional vascular bundles in the leaf sheath of the first leaf. This anatomical character can easily be observed in individual plants and hence be selected for in a segregating breeding population. Experimental studies indicate that the level of frit fly resistance can be increased in this way. Total resistance, however, is probably impossible to achieve by this method. Nevertheless, a breeding strategy aiming at a reduced period of susceptibility during the seedling stage would be of practical interest. If combined with an early sowing date, choice of large, high quality seed, and a possibility of predicting the risk of frit fly attacks, a partially resistant oat cultivar may contribute substantially towards a reduced need for chemical insecticides. This view is based on the conviction that partial host plant resistance can be a powerful ingredient in a system of integrated pest management.

TOLERANCE OF OATS TO HERBICIDES

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Production of field crops has become very dependent upon the use of herbicides in most countries. Farmers are quite aware of the weed control herbicides can provide. However, there can be problems.

Oats are more sensitive to herbicides than the other small grains. Therefore, improper herbicide application often causes problems. Second, the cultivar is often not considered when applying a herbicide. However, considerable evidence has accumulated which provides evidence that the different cultivars of a crop have different levels of tolerance to various herbicides. The idea of differential cultivar response was brought sharply to the public's attention when seed companies recommended certain maize hybrids <u>not</u> have specific herbicides applied due to sensitivity.

Differential varietal sensitivity has been shown in oats for herbicides such as 2,4-D, atrazine [2-chloro-4-(ethylamino)-6-(isopropylamino)-s-triazine], and HoeGrass (diclofop-methyl).

Determining cultivar response to a herbicide is made complex by the large environment interaction. In addition, the response to the herbicide is not always easy to measure. The agronomist views the issue as never ending because each new cultivar would need to be checked for its response for each herbicide. In addition, new herbicides are continuously being produced. Therefore, we appear to be dealing with a situation with no final answer.

Resistance of the new oat varieties to crown rust.

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Crown rust (Puccinia coronifera Kleb.f. avenae Erikss) is the most spread and harmful oat disease in the USSR. Yield losses due to disease severity reah an average of 20 %.

New estoblished varieties created og the NPO "PodmosKovie", Druge, ScaKun an the line 27 h 377 have high level, of horizontal (general) resistance and in conseguence of it they are affected slightly.

In laboratory, green-house and field trials effect of the pathogen on grain yield, it's structure and seed guality of resistant varieties in companison with noide spreacl sensitive Astor and Lymto were investigated. On artificial infectional background, crown rust decreased sensitive varieties yield up to 40 - 60 %, losses of resistant varieties consisted of 5 - 20 %. Yield losses and it's deterioration are resulted from reducing of 1000 grain weight and increasing of the amount of hies K.

Reaction of varieties on spraying of fungicide tilt and effectiveness of it's application was determined.

Factors Conditioning Dominance of Race 276 of *Puccinia coronata avenae* on *Avena sterilis* Populations in Israel

U.Brodny, I. Wahl and J. Rotem

ABSTRACT

Isolates of *Puccinia coronata avenae* races 276 and 263 were collected from *Avena sterilis* in different ecological locations. Components of pathogen fitness of the isolates were compared in different temperatures in the greenhouse and in the field. The results obtained may help provide an explantion for factors that contribute to the dominance of race 276 over race 263. These results were found country-wide and over many years despite the fact that race 263 had a wider host range in seedling populations of its main hosts *Avena sterilis* L., in greenhouse trials. The study revealed that isolates of race 276 showed advantages under different environmental conditions in producing higher yields of urediospores with preferential viability. Telial formation occurs later, and the period of urediospore productivity is thus prolonged.

TOLERANCE OF COMMON OATS TO THE WILD OAT HERBICIDE, HOEGRASS

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Wild oats (*Avena fatua* L.) is an economically important weed causing reductions in both yield and grade. If an oat (*A. sativa* L.) cultivar tolerant to one of the wild oat herbicides were available, a herbicide could be used to control wild oats in common oats. Due to their biological similarities, however, no herbicide has been recommended for this control.

Several sources of tolerance to wild oats have been reported. The best appears to be Savena 1, an oat cultivar developed in South Australia by Andrew Barr, which is tolerant to the wild oat herbicide diclofop-methyl (HoeGrass). Savena 1 has been used as a source of tolerance to diclofop-methyl in the Winnipeg oat breeding program.

To compare the yield potential of several diclofop-methyl tolerant, rust resistant lines, trials involving sprayed and unsprayed plots have been conducted at one station for two years. When the plants were at the 2-3 leaf stage, one of the trails was sprayed at the recommended rate of 0.7 kg/ha.

Differences between and within the unsprayed and sprayed tests were observed. In all cases the lines in the sprayed tests were shorter and lodged less than in the unsprayed control tests. Test weight was not influenced by the application of diclofop-methyl but yields were. The greatest yield reductions (approximately 40%) were observed in the herbicide sensitive parents. The experimental lines varied in their reaction. The three best lines over 2 station years showed less than a 10% yield reduction in the presence of the herbicide compared with their yield in the unsprayed tests. In the unsprayed tests these lines yielded 3-7% less than the high yielding oat variety Dumont. These same lines yielded at least 43% more than Dumont when both were sprayed with diclofop-methyl.

These results show that by backcrossing and selecting for this relatively simply inherited trait, a diclofop-methyl tolerant, high yielding oat cultivar can be developed.

TCA
Ethofumesate

TCA + Metolachlor
1.5 + 0.5 Kg ai/ha.

Epstein – polymers in drug trade.

Steep –

CONTROL OF WILD OATS IN CULTIVATED OATS

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Although several herbicides are available in the UK for controlling wild oats (Avena fatua, L.) in wheat and barley, there is none available for control in cultivated oats. This lack of chemical control of wild oats has limited the increase of oats as an alternative crop by the British cereal grower.

Experiments, primarily in pots, with safeners used in conjunction with certain wild oat herbicides, has re-opened the possibility of wild oat control in oats. About 50 pre-emergence herbicides were tested on oat seeds dressed with four commercially available safeners; 1,8-naphthalic anhydride (NA), R25788, M32988 and flurazole. NA was the most successful, working favourably with a greater number of herbicides and to a greater degree than the other safeners. Ten of the herbicides tested showed significant safening effects with one or more of the safeners.

An examination of various biotic factors, such as N, P, K and pH, failed to explain why the degree of safening with NA variance. Soil moisture appeared to to be the most important influence on safening as well as on herbicide performance. Further work on chemical and physical factors relating to adhesion of safener to seeds, demonstrated that improvements in the degree of safening were possible.

The potential of these safeners and other chemicals for protecting oats from herbicides, thereby affording control of wild oats, is discussed.

Safeners work in gramineous crops.

ABA = a safener. –

Napthalic anhydride best. 10 Kg ai/ha.

TOLERANCE OF OATS TO DROUGHT

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The supply of water is one of the most important ecological events affecting grain production of cereal plants. Grain crops are relatively often exposed to drought stress also in temperate and rather humid regions. Short periods of drought at crucial growth stages have often considerable effects on yield.

Rainfall deficiency periods fluctuate from year to year, within years and between different locations. Spring and early summer droughts, however, are an almost annually recurrent problem for the farmers in the central and eastern parts of Sweden. It is known among breeders that some old types of oats, as the central Swedish black oats, had a better ability to endure periods of early summer drought than modern white oats. Attempts have been made to use black oats in crosses to improve drought resistance in the breeding material.

Application of data on genotypic variation in oat root system to crop improvement have been documented. It may be concluded from that that use of seedling stage indices as indirect selection criteria of drought resistance appears to be a profitable tool for improvement of yielding capacity of oats.

TRANSLOCATION AND GRAIN DEVELOPMENT IN OATS

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Grain development in oats is dependent upon the translocation system to provide essential nutrients for the formation of starch, protein, lipid and other components of the endosperm and embryo. Sucrose provides the bulk of the carbohydrate that is transported through the phloem, whereas nitrogen is supplied as amino acids and amides. Some assimilates are remobilized from previously stored protein and polysaccharides, whereas current (post-anthesis) assimilation of N and photosynthesis provides the remainder. Several pertinent questions regarding the relationship of grain development to translocation can be addressed: Is assimilate supply limiting the rate or duration of grain filling under normal (non-stressed) growing conditions? What is the relative importance of pre- versus post-anthesis assimilates for grain filling? To what extent can the supply of assimilates affect grain composition? These questions will be discussed using data from oats or other cereals where oat data are lacking.

GROWTH RATES OF OATS

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Grain yield of oats can be conceptualized according to the following formula:

Grain yield = Growth rate x Growth duration x Harvest index

The product of growth rate and growth duration equals biomass and harvest index determines the portion of biomass allocated to grain. In the Corn Belt of USA growth duration of spring-sown oats is limited to 100-110 days and harvest index is optimal in current varieties at 45%. Thus, grain yield can only be elevated by increasing growth rate.

Growth rate is quantitatively inherited and there is limited genetic variation for this trait in cultivated oats. Tippecanoe variety has alleles for growth rate that are diverse from other cultivars, but most other cultivars carry similar alleles. Matings of *A. sativa* x *A. sterilis*, in general, produce many transgressive segregates for high growth rate, which shows that the latter species has growth rate alleles that are different from and complementary to the alleles in cultivated oats.

SHOOT:ROOT INTERRELATIONS IN OATS

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Like other small grains, oats show a considerable allometric constraint as to shoot and root development. For a world collection (n = 93), the correlation coefficient (r) was found to be 0.50*** for plant height versus root depth, 0.43*** for number of tillers versus number of crown roots and 0.87*** for dry weight of shoot versus root at end of vegetative phase. The interrelations indicate difficulties to combine an increased harvest index, obtained mainly by straw shortening, with an acceptable root system. A direct selection with respect to root development is expected to be rewarding, since a considerable genetic variation in root patterns does occur in oats both within the _sativa_ type and between species. Although there exists a correlation between root dry weight and root depth (r = 0.45***), modern short-strawed oat cultivars may be found with an acceptable root depth, although a larger part of the root volume tends to be more concentrated to the top soil. Experiments using defoliation and reduction of tillering as stress factors indicate that the short-strawed type (cv. Leanda) suffers less as to shoot but more as to root growth compared to the tall type (cv. Sol II). Such a reaction is interesting to combine with the experience that short-strawed oat cultivars generally show a lower phenotypic stability compared to the tall older varieties.

RELATIONSHIPS AMONG SINGLE CULM YIELD COMPONENTS AND GROAT PERCENTAGE IN SPRING OAT CROSSES

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In the Wisconsin oat (Avena sativa L.) breeding program, it has been noted that vigorous, productive breeding lines often have hully kernels. The purpose of this study was to determine the relationships of groat percentage with vegetative growth and grain production on a phenotypic and genetic basis. A panicle-to-line experiment was conducted with early generation lines grown in a typical pedigree-method head row series. Primary groat percentage of panicles selected in 1982 was correlated with several productivity traits measured on progeny lines in 1983 and 1984. Also, plants selected in 1983 were correlated with their 1984 progenies. Correlation coefficients between groat percentage and the productivity traits were generally negative and all were significantly negative when 1982 and 1983 groat percentages were correlated with 1984 productivity traits. A pure line experiment with 15 genotypes was grown in 1984 in which r values were similar to those obtained in the panicle-to-line experiment. Two crosses were made between genotypes with high groat percentage and average grain yield per panicle and genotypes with low groat percentage and high grain yield per panicle. The progenies evaluated were F_2 plants grown in 1986, F_3 lines and F_3 derived F_4 lines grown at one location in 1987, and F_3 lines and F_4 derived F_5 lines grown at a second location in 1987. Phenotypic and genotypic relationships were determined between generations for groat percentage and single culm yield components. Although several negative relationships suggest that unilateral selection for high groat percentage may be accompanied by decreased vegetative and seed productivity, some lines in this study had relatively high groat percentage and moderately high productivity, a type of balance or compromise frequently encountered when multiple traits must be considered.

Abstract

Developmental stability in oats (Avena Sativa L.)

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This paper deals with stability of Nordic oat lines and cultivars over years and locations. In one series during the years 1981-84 significant interaction between genotypes and locations, and between genotypes and years was found for grain yield. The former interaction component of variation was splitted up into ecovalences, linear regressions and deviations from linearity, and principal components. The main results can be summarized as follows:

1) There seems to be good agreement between the stability parameters calculated by the different methods.
2) The principal component methods both divided the cereal growing area in Norway into the following four sub-regions: Northern inland, Southern inland, South-western areas and Mid-Norway.
3) Temperature and rainfall from tillering until harvest had large influences and opposite effects on the genotype-location interaction. KA1 and PA1 also contributed to the interaction.
4) There was a large genetic variation in developmental stability for grain yield.
5) No close relationship was found between average grain yield and stability over a range of environments.

Homogeneity of Oat Cultivars with Respect to Out-Crossing.

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Yield and quality are the first characters screened for in oats. In Germany however, homogeneity and stability are additional, very important characters of cultivars.

The flowering behaviour in oats is strongly wheather depending. Warm and dry wheathers induce widely separeted lemmas. Anthers are bursting at this moment. The viatality of pollen lasts about 15 minutes. It is possible to catch flying pollen in 80 meters distance of the experimental field. The presuppostions of spontaneously occuring cross-fertilizations are given.

An experiment with ten cultivars and wild oats (Avena fatua L.) at three locations generated 0,4% of cross-fertilizations in total. Suppression of selfing in oats by emascultation of flowers in the field yielded 56% of inter-varietal and inter-specific crosses and 44% of intra-varietal crosses. Therefore about 0,3% of intra-varietal crosses are expected in normal, non-emasculated plants of the same experiment. In single cultivars 4% of out-crossings have been identified and 3% of intra-varietal crosses are expected. Crosses with A. fatua as male parent in crosses had the same importance as any of the cultivars in this experiment.

Oat cultivars are screened for homogeneity of their main characters. There is a certain variability in cultivars concerning characters not screened for. It will be discussed the importance of intra-varietal crossings for homogeneity of cultivars and moreover for the origin of fatuoids.

INTERNATIONAL TRADE IN OATS

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This analysis is based on a global investigation program carried out in late 1986, funded by the New South Wales Oats Marketing Board.

Oats are grown in many countries around the world. Global production has averaged 47.1 MT in the period 1982-86. Most oats are consumed in countries of origin, with little entering commercial channels and only about 3 per cent enters international trade. The Soviet Union is by far the largest producer, followed by the United States of America, Canada, FR Germany, Sweden, France and Australia.

Australian oats are widely used in the livestock area, particularly for sheep, on which Australia depends heavily on income from wool and sheep meats. Oats supplement grass feeding of animals and is an important grain source in times of drought. While Australia ranks about seventh in global output, Australia occupies fourth position amongst the principal oat exporters. Australian exports have been focused on Pacific Rim Countries and South America.

While recognising the role of oats as a feed grain, its application as a food grain, especially as a source of fibre is receiving greater emphasis. This has led to a stimulus in world trade, whereby the United States of America has become a major importer of quality oats for human consumption and for its racehorse industry. U.S. oat production has been declining for almost three decades and while USA is endeavouring to reverse the trend under current farm legislation, it may be difficult to change grower attitudes in the short run.

In Europe, Switzerland is a major importer, while Scandinavia and France feature as principal external sellers. Within the European Community, oats are not covered by the Common Agricultural Policy as are barley, corn and wheat and oats is traded as a "free" grain. Production is static in the UK and is declining in Denmark, Italy and the Netherlands.

With increasing awareness of the nutritional value of oats for human consumption across a broad band of fibre-based foods, opportunities exist for more quality oats to enter into international trade.

P O S T E R S

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H.W. Rines and L.S. Dahleen	-	Recovery of haploid oats following application of maize pollen to emasculated oat florets. USDA-ARS and University of Minnesota.
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SVALÖF AB - SLR	-	Swedish oats - breeding, trading and overseas export.