Vern Burrows
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Canada

WPBS

2nd INTERNATIONAL OAT CONFERENCE

ABERYSTWYTH

July 15 - 18 1985

INTERNATIONAL OAT CONFERENCE

PROGRAMME

UK Coll of Wales - founded 1915.

Monday July 15th

8.50 E.T. Jones 1922.	**Opening of the Conference and Welcome to delegates** Dr. E.L. Breese, Deputy Director, Welsh Plant Breeding Station
	Genetic resources and their use in breeding of oats. Chairman: **Dr.G. Ladizinsky, The Hebrew University of Jeruslam, Israel.**
9.00-9.30	Genetic resources and their use in the breeding of oats. K.J. Frey, Iowa State University, USA.
9.30-9.45	Genetic resources in dwarf oats. B.M. Singh, National Bureau of Plant Genetic Resources, New Delhi, India.
9.45-10.00	The transfer of oat stem rust resistance gene PG-16 from tetraploid *Avena barbata* Pott to hexaploid *Avena sativa* L. P.D. Brown R.A. Forsberg and R.I.H.McKensie, Agriculture Canada Research Station, Winnipeg, Canada.
10.00-10.15	Production of octoploid oats: introgression of wild species into *Avena sativa*. Sue Fritz, Cornell University, USA
10.15-10.30	Interspecific hybrids in *Avena*. M.J. Leggett, Welsh Plant Breeding Station, Aberystwyth, UK.
10.30-11.00	COFFEE
11.00-11.20	Tissue culture derived variation in oats: occurrence and utility. H. Rines, St. Paul, Minnesota, USA.
11.20-11.40	Phylogenetic relationships between *Avena* species revealed by the restriction endonuclease analysis of chloroplast and mitochondrial DNA. K. Murai and K. Tsunewaki, Kyoto University, Japan.
11.40-12.00	Molecular biology of *Avena* germplasm evolution using cloned storage protein genes. S.F. Fabyanaski, S. Miller, S. Chang, L. Robert. K. Adeli and I. Altosaar, University of Ottawa, Canada.
12.00-12.45	Discussion
12.45-2.00	LUNCH
2.00	Pest and Diseases of Oats Chairman: **J. Sebesta, Research Institute for Crop Production, Prague, Czechoslovakia.**
212 - 242. 2.00-2.30	Diseases of Oats. M.D. Simons, USDA, Iowa State University, USA

2.30-2.45	Pathogenicity of crown rust, stem rust and powdery mildew on oats in Europe. J. Sebesta, Research Institute for Crop Production, Prague, Czechoslovakia.
2.45-3.00	Adequate stem rust resistance in oats. R. Rothman, USDA, University of Minnesota, USA
3.00-3.15	Genetic analysis of crown rust and phytoalexin production in oats. T. Morikawa and S. Mayama, Osaka, Japan.
3.15-3.30	Variation and distribution of the oat crown rust fungus, *Puccinia coronata avenae*, in Britain. B.C. Clifford, Welsh Plant Breeding Station, Aberystwyth,UK.
3.30-4.00	TEA
4.00-4.15	Transgressive segregation for increased levels of adult plant resistance to mildew in oats. I.T. Jones and H. Roderick, Welsh Plant Breeding Station, Aberystwyth,UK.
4.15-4.30	The Nature of Horizontal Resistance of Oats to crown rust. H.H. Luke, University of Florida, Gainesville, USA.
4.30-4.45	Resistance and tolerance in oats (*Avena sativa*) to the cereal cyst nematodes (*Heterodera avenae*). A.R. Barr and A.J. Dube, Department of Agriculture, Adelaide, South Australia.
4.45-5.00	Transmission of barley yellow dwarf virus isolates by the aphid *Rhopsalosiphum inertum*. H. Jedlinski, USDA, University of Illinois, Urbana, USA
5.00-5.45	Discussion

Tuesday July 16

Efficiencies of breeding methods for oats.
Chairman: **V.D. Burrows, Ottawa Research Station, Canada**

907· 9:37 9.00-9.30	Development of breeding methods for oats. D. Stuthman, University of Minnesota, St. Pauls, USA
9.30-9.45	Inheritance of Primary:Secondary seed weight ratios and secondary seed weight in oats. A.C. Tibelius and H.R. Klinck, McDonald College, Quebec, Canada.
9.45-10.00	Stability of German oat cultivars (*Avena sativa* L.) special consideration is given to non-typical oat florets. U. Bickelmann and N. Leist, Karlsruhe, Germany.

Combine

10.00-10.15	Mass (gravimetric) selection in diseased nurseries. I. Agronomic traits. C. Jimenez, V.A. Maldonado, D.D. Stuthman, INIA, Chapingo, Mexico and University of Minnesota, USA.
10.15-10.30	Mass (gravimetric) selection in diseased nurseries. II.Disease reactions. U. Maldonado, D.D, Stuthman and C. Jimenez, INIA, Chapingo, Mexico and University of Minnesota, USA.
10.30-11.00	COFFEE
11.00-11.15 .18	Mechanical mass selection for improved milling performance. E. Souza and M.E. Sorrells, Cornell University, New York State, USA.
18 .33 11.15-11.30	Present status of research to develop ueful semidwarf oat germplasm. H.G. Marshall, USDA, Pennsylvania State University, USA
33 48 11.30-11.45	Hybridizing of oats utilising chemical hybridizing agents. M.E. McDaniel, Texas A & M University, USA.
55 -1200. ~~48~~ ~~03~~ 11.45-12.00	Breeding winter oats - special considerations. J. Valentine, Welsh Plant Breeding Station, Aberystwyth,UK.
1155 - 12.00-12.45	Discussion
12.45-2.00	LUNCH
	Crop physiology and production methods of oats. Chairman: **C. Brown, University of Illinois, Urbana, USA**
2.00-2.30	Crop physiological approaches to increased productivity in oats. J.B. Brouwer, Victorian Crop Research Institute, Australia.
2.30-3.00	Some metabolic constraints to oat productivity. D. Peterson, USDA, University of Wisconsin, USA.
3.00-3.15	Effects of genotytpe, seeding rate and the grain yield components on the Primary:Secondary seed weight ratio in oats. A.C. Tibelius and H.R. Klinck, McDonald College, Quebec, Canada.
3.15-3.30	Breeding oats by selection of parental pairs according to the ecological-geogaphical principle. E.V. Lyslov and H.D. Kueuets, Moscow and Estonia, USSR.
3.30-4.00	TEA
4.00-4.15	Tolerance of oat genotypes to Hoegrass(R) (Diclofopmethyl). A.R. Barr, Department of Agriculture, Adelaide, Australia.

4.15-4.30	The chemical control of wild oats in cultivated oat - A progress report. H.F. Taylor, Long Ashton Research Station, Weed Research Division, Oxford, UK.
4.30-4.45	Effects of herbicides on oats. D.L. Reeves and J. Lammers, South Dakota State University,USA.
4.45-5.40	Discussion

Wednesday July 17

	Quality, use and marketing requirements for oats. Chairman: **J. Lea (Morning Foods), Crewe, UK**
9.00-9.25	World oats use and marketing. D.J. Schrickel, Quaker Oats, Chicago, USA.
9.25-9.50	Oat quality - present status and future prospects. R. Welch, Welch Plant Breeding Station, Aberystwyth, UK
9.50-10.05	Oil and protein content in oats. M. Gullard, Apelsvoll, Norway.
10.05-10.20	Influence of fertilizer on the quantity and composition of oil. R. Lampinen, Exp.Farm, Lansi-Hahkiala,Hauho,Finland.
10.20-10.35	Quality in oat breeding - a question of priorities. B. Mattson, Svalof, Sweden.
10.35-11.00	COFFEE
11.00-11.15	The effect of lemma colour on grain quality in oats. A. Plourde, R.I.H. McKenzie and P.D. Brown, Research Station, Winnipeg, Canada.
11.15-11.30	Prospects for the naked oat crop in the UK. J.E. Jones, Welsh Plant Breeding Station, Aberystwyth,UK
11.30-11.45	Hull-less oats for the milling industry. S. Weaver, Quaker Oats, Chicago, USA.
11.45-12.00	Oats - the health story. G.A. Smith, Quaker Oats (UK), Southall, UK.
12.00-12.45	Discussion
2.00	Depart for the Welsh Plant Breeding Station

1% protein = 2% in yield. -5- Mattson
1% fat = 2% in yield.

Thursday July 18

	World status of oats and biological constraints to increased production. Chairman: **B. Mattson, Svalof, Sweden.**
9.00-9.30	World status of oats and biological constraints to increased production. R.A. Forsberg, University of Wisconsin, Madison, USA
9.30-9.45	Oat breeding in South Brazil during 1976/1984. E.L. Floss, University of Passo Fundo, Brazil.
9.45-10.00	not printed Oat improvement and breeding in Ijui, R.S. Brazil. R.B. De Medeiros, Ijui, Brazil.
10.00-10.15	Performance of oats in the Quaker - South American Nursery 1983-84. M.A. Brinkman, University of Wisconsin, Madison, USA.
10.15-10.30	Breeding oats for New Zelanad conditions. Collaboration between New Zealand and Canada. M. McEwan, Palmerston North, New Zealand.
10.30-11.00	COFFEE
11.00-11.15	Oat breeding research at Pantnagar, India. S.N. Mishra, Pantnagar, U.P. India
11.15-11.30	Results of oat breeding in the USSR and its initial material. V.D. Kobylanski, N,.A. Rodionova and H. Kueuets, Leningrad, and Estonia, USSR.
11.30-11.45	Oat breeding and production in Hungary. A. Palagyi, Cereal Research Institute, Szeged, Hungary.
11.45-12.00	The oat crop in the United Kingdom. D.A. Lawes, Welsh Plant Breeding Station, Aberytwyth, UK
12.00-12.45	Discussion
12.45	**Closing of the Conference**

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Genetic Resources and their use in Breeding of Oats
K.J. Frey

Major emphasis in this paper will rest upon the use of genes from wild and weedy relatives of cultivated oats for improvement of the crop. Most introgression of genes from wild and weedy relatives has occurred from the hexaploids Avena fatua and A.sterilis. However, some successful tansfers of disease-resistant genes from the diploid and tetraploid species to the hexaploid cultivated oats has been accomplished.

Weedy and wild hexaploids are the best candidates as germplasm sources for improving oats because mating with them involve no sterility or difficulty in gene transfer. Matings involving the tetraploids or diploids as donors usually require long and detailed use of special techniques to overcome barriers to gene transfer.

A.fatua has been used as a source of genes for improving disease resistance. To date, however, this has not been a terribly good gene source, primarily because the two gene pools represented by A.fatua and A.sativa seem to be so similar. Most A.fatua accessions in the World Oat Collection were collected from North America and Canada, and either because A.fatua evolved from A.sativa in North America or because of recent gene flow between the two species, the gene pools appear quite similar. A.sterilis, on the other hand, has been an accessible and useful gene donor, especially for resistance to crown rust disease, aand yellow dwarf resistance or tolerance from A.sterilis should be usable in cultivted oats. Furthermore, genes for high protein and high oil content in groats from A.sterilis can be used to improve cultivated oats for these traits. Genes for improving growth rate of oats also have been transferred in interspecies matings between A.sterilis and A.sativa. The degree of improvement in biomass and grain yield has been reported as high as 25% in lines adapted to the midwestern USA. These yield increases are due to larger leaf area and a different senescence pattern, probably due to genes introgressed from A.sterilis.

Several crown rust and stem rust resistant genes have been transferred to the hexaploid level from diploid x hexaploid matings. Most lines derived from such matings tend to be suitable in breeding behaviour, and to date, most genes transferred have not been used in cultivars.

Genetic Resources in Dwarf Oats

B.M. Singh,
IARI, India

Genetic resources holdings in *Avena* (mainly exotics obtained through correspondence) at National Bureau of Plant Genetic Resources, New Delhi total over 1000 collections which present an array of non-descript types, commercially grown varieties, improved lines and different species. Some collections received from specific countries could be introductions into that country from other countries. Evaluation of these collections for different agro-morphological characters is being carried out.

Breeding dwarf oats

Tall oat varieties tend to lodge with increased plant height and with no real gain in the yield of grain. In view of this, as a part of utilisation programme, a varietal-cross was attempted between NP 101 (a medium tall, grain type with lax panicles) and EC 56175 (short statured, stiff-straw with compact panicles) - both from Australia, and new selections with wide diversity of characters, viz. plant architecture, reasonably good grain type and high leaf-stem ratio, haave been identified and subsequently evaluated for a set of descriptors and for their potential as grain and green fodder types. This data (along with illustrations) will be presented in detail.

The transfer of oat stem rust resistance gene PG-16 from tetraploid Avena barbata pott. to hexaploid Avena sativa L.

P.D. Brown, R.A. Forsberg, and R.I.H. McKenzie,
Agriculture Canada Research Station, Winnipeg, Manitoba, R3T 2M9.

Oat stem rust (Puccinia graminis Pers f.sp. avenae Eriks. and E. Henn.) is a serious disease of hexaploid (2n = 42) oats (Avena sativa L.). Stem rust resistance gene Pg-16, found in tetraploid (2n = 28) A.barbata Pott. collection D203, conditions resistance to all but one of the current North American stem rust races. Lack of chromosome homology and pairing has made gene transfer between A.barbata and A.sativa difficult. The objective of this study, using two meethods, was to induce and identify a transloction of Pg-16 in A.sativa lines.

Approximately 100,000 seeds of stem rust resistant, disomic alien addition lines of the cross D203/5* Rodney O were irradiated with gamma radiation (15,20,25 or 30 kilorads) and progenies were rust tested for four generations in an attempt to induce and identify a translocation for stem rust resistance gene Pg-16. To eliminate the barbata chromosome pair and verify the presence of a translocation, plants in nine R4 families identified as potential carriers of a translocation were used as donor parents in crosses and backcrosses with stem rust susceptible Rodney O. BC1F2 and BC1F3 progenies were then rust-tested to verify the presence of a translocation. One translocation line, derived from a seed exposed to 20 kilorads of gamma radiation, was identified.

One hundred fifteen monosomic alien substitution (MAS) seeds, developed by crossing stem rust susceptible oat cultivars with a resistant disomic alien substitution line, were irradiated with 25 kilorads of gamma radiation. Test crosses (TC) using these resistant MAS plants as the males and Rodney O as the female were made. Rust reactions of the progenies in the TCF1, TCF2, and TCF3 generationss were recorded in an attempt to identify lines in which radiation had induced a translocatin. A control series, in which the F1, F2 and F3 generations of non-irradiated MA seeds were rust tested, was performed to determine if a translocation had occurred naturally. The presence of monogenic ratios in the TCF2 and TCF3 generations indicated that several TCF3 families carried a translocation of Pg-16 with the two most promising lines originating from TCF2 nos. 436 and 487. No translocation occurred naturally through pairing and crossing over in the non-irradiated control series.

Both methods resulted in the successful identification of translocation lines. In all these translocation lines the added gene, Pg-16, was not transmitted entirely normally through the gametes.

Production of octoploid oats: introgression of wild diploid species into <u>Avena sativa</u>.

Sue Fritz, part of PhD study.
Cornell University, USA

A project has been initiated to introgress variation from the wild diploid species into the cultivated <u>A.sativa</u> via the production of octoploid oats. The objectives were to produce amphiploids, assess the raw amphiploids for agronomic traits and cytological stability, and intercross selected octoploids to generate segregating gene pools. Replicated trials were conducted to compare 8x genotypes with 5x checks. Ocotoploids incorporating six 2x species were provided for these trials by Dr. H. Thomas, while 4x/6x octoploids were obtained from Dr. I. Nishiyama. A combined three year analysis indicated 2x/6x octoploids yielded significantly more grain than 4x/6x octoploids, but yielded less than 6x checks. There were highly significant G,E and G x E interactions. Stability parameters calculated over environments for yield indicate two genotypes which yield well to be stable over environments. Preliminary agronomic data on three additional 2x/6x amphiploids suggests that one genotype may yield more than 6x checks. Cytological studies of root tip cells show somatic chromosome instability. Meiotic analysis indicate pairing is primarily as bivalents, but 1-3 trivalents, 1-3 quadrivalents and up to seven univalents can occur at metaphase 1. Laggards and microunuclei are common in miocrosporocytes. Gametes receiving irregular compliments do not function as envidenced by the octoploid chromosome number being maintained in some somatic cells of the progeny. Ten successful octoploid intercrosses have been made. Cytological studies show somatic instability and more complex meiotic chromosome pairing.

A. longiglumis
Canariensis
hirtula
Wiestii.
Strigosa.

AA × AACCDD

Interspecific hybrids in the Avenae.

Mike Leggett,
Welsh Plant Breeding Station, Aberystwyth, UK

The autotetraploid oat species A.macrostachya is sufficiently winter hardy to survive a Quebec winter, it is reported to be tolerant to Barley Yellow Dwarf Virus (BYDV), and it has a perennial outcrossing habit. It would be of considerable value to breeding programmes if the winter hardiness of this oat could be transferred into the cultivated species A.sativa. It is also a unique species in that it is the sole occupant of the section Avenotrichon and thus its cytogenetic position in relation to the annual oat species is of some interest.

The F1 hybrid between A.sativa and A.macrostachya was produced and the mean chromosome pairing observed was 0.04 IV + 0.24 III + 9.37 II + 15.43 I. Of the bivalents, 64% were ring configurations and the multivalents observed in recordable pollen mother cells (PMCs) were of the open type although two ring quadrivalents were observed in othrwise obscure PMCs.

The autotetraploid nature of the A.macrostachya parent would lead one to expect at least seven bivalents in any hybrid with the annual oat species, but the number of bivalents observed was in excess of this number indicating that homoeologous chromosome pairing between the A.sativa genomes was occurring. This level of chromosome pairing is in excess of the known chromosome pairing of haploid cultivated oats which suggests that there may be a homoeologous chromosome pairing promoter in the A.macrostachya genomes.

Preliminary data on the chromosome pairing of progeny of the first backcross indicate that the A.sativa chromosomes pair leaving the A.macrostachya chromosomes as univalents. The formation of quadrivalents in the F1 hybrid indicates that there is some homology between the chromosomes of A.sativa and A.macrostachya but the frequency of quadrivalents indicates that the relationship is weak. This supposition is also borne out by the preliminary observations of the BC1 progeny where the A.maacrostachya chromosomes remain as univalents and seem unable to compete for pairing sites in the presence of truely homologous A.sativa chromosomes.

The diploid oat species A.strigosa variety Saia is known to be tolerant to BYDV and resistant or tolerant to some rust races, cereal cyst nematode and the wild oat herbicide Hoegrass R.

In an effort to incorporate some or all of these characters into the cultivated oat, hybrids were created using the diploid species as the female parent. F1 hybrids were self sterile as expected from the known chromosome pairing between the species. In an attempt to restore some degree of fertility the F1 hybrids were treated with colchicine to double the chromomsome number.

Resulting 56 chromosome progeny which had chromosome numbers from 43 to 47 are being tested for tolerance to BYDV. Initial observations indicate a differential response to the presence of virus particles which is probably due to the different numbers and or combinations of chromosomes present. However, some plants appear to be extremely tolerant to the virus and it is hoped to produce addition lines as the next step to incorporating this and other useful characters into the cultivated oat.

Tissue Culture-induced Variation in Oats

H.W. Rines*, S.S. Johnson and R.L. Phillips
USDA-ARS* and University of Minnesota

The purpose of our studies were to further document the occurrence, frequency and types of cytogenetic and genetic variation in oat plants regenerated from tissue culture and to investigate the origin of this variation. In oats McCoy, Phillips and Rines (Can. J. Genet. Cytol.24:27,1982) reported cytological abnormalities in 12% of 'Tippecanoe' and in 49% of 'Lodi' plants regenerated from 4-month-old tissue cultures. The frequency of cytological abnormalities increased to 48% in Tippecanoe and 88% in Lodi among plants regenerated from 20-month-old tissue cultures. Among the characterized abnormalities, about 85% were due to chromosome breakage and often involved partial chromosome loss. It was postulated that there may be regions of late replicating pericentromeric heterochromatin in oats and that these regions may be involved in chromosome breakage in tissue culture. Evidence in support of this hypothesis has been obtained. Pachytene analysis shows that oat chromosomes have large regions of heterochromatin flanking the centromeres. Detailed characterisation of the progeny of a regenerated plant with partial loss of a satellite chromosome showed that the break was in centromeric heterochromatin. Also, labelling patterns in autoradiographs following ^{3}H-thymidine uptake in root tip cells indicate late replication of DNA in heterochrommatic regions of oat chromosomes.

Lines derived from regenerated plants which appeared normal both cytologically and morphologically were tested for yield performance in hill plot tests. The mean yield of 53 progeny-derived lines from Lodi plants regenerated from 4-month-old tissue cutlures was about 4% below that of the non-cultured controls. The mean yield of 123 progeny-derived lines from Tippecanoe plants regenerated from 16-and 20-month-old cultures was about 25% below that of controls. Two tissue-culture derived Tippecanoe lines with extended maturity did yield slightly more than controls in these tests. These preliminary results indicate that extended periods in culture produce genetic variation additional to the cytologically detectable changes. Most changes tend to be detrimental, but potentially useful genetic and cytogenetic variants may be produced in oat tissue cultures.

Phytogenetic relationships between *Avena* species revealed by the restriction endonuclease analysis of chloroplast and mitochondrial DNAs.

K. Murai and K. Tsunewaki,
Laboratory of Genetics, Kyoto University, Kyoto 606, Japan.

In order to clarify the phylogenetic relationships between 18 *Avena* species, a comparative restriction endonucleae analysis of their chloroplasty DNA has been performed, using the following eight restriction endonucleases; *Bam*HI, *Eco*RI, *Hind*III, *Kpn*I, *Pst*I, *Sal*I, *Sma*I and *Xho*I. Among them the following seven chloroplast genome types are identified: Type Ia in five diploids (*A.damascena*, *A.prostrata*, *A.hirtula*, *A.strigosa* and *A.wiestii*) and all tetra- and hexaploid species except *A.magna*; Type Ib in *A.magna* (tetraploid); Type Ic in *A.canariensis*; Type II in *A.longiglumis*; Type III in *A.clauda*; Type IV in *A.pilosa*; and Type V in *A.ventricosa*. All species of type Ic to V are diploid. Four chloroplast genomes, Ia,b,c and II, are closely related with each other, but differ greatly from the three other types, III-V. The former group consists of A genome diploids and all polyploids. The latter group includes only C genome diploids. Chloroplast genome variation is mostly confined among the diploids, indicating that chloroplast genome divergence has occurred at the diploid level. A fact that all but one polyploid species carry the same chloroplast genome type, Ia, suggests their recent origin. The sites of mutations occurred in chloroplast genome during speciation have been specific through construction of the physical map of chloroplast DNA. In order to identify the cytoplasm donor to polyploid species, restriction endonyuclease analysis of mitochondrial DNA isolated from the species carrying Type Ia chloroplast genome has been carried out using two endonucleases, *Bam*HI and *Hind*III. Combining all these results phylogenetic tree of the genus *Avena* is constructed.

Molecular biology of *Avena* germplasm evaluation: Use of cloned storage protein genes.

Steven F. Fabijanski, Shea Miller, Shirley Chang, Laurian Robert,Khosro Adeli and Illimar Altosaar.
Biochemistry Department, University of Ottawa, Ottawa, Canada.

Recombinant DNA methodologies were used to generate DNA libraries and genomic libraries of *A.sativa* in pBR322 and gt10. Clones were characterized by hybridisation to DNA (Southern blots) and RNA (Northern blots) sequenced by dideoxy polymerization and used as probes to screen the various karyotypes for genome organisation. Gene copy number as well as gene arrangement was determined by restriction enzyme analysis of many different oat species. In general, the wild oat species show much more variation in the gene sequences than the cultivated varieties. For example, using prolamin gene probes, most of the wild species contain more genes for these alcohol soluble proteins than *A.sativa* and these genes show a more diverse arrangement in the wild oats. Clone p383 codes for a low molecular weight prolamin in *A.sativa* but was not detectable in the AA diploid (*A.abyssinica*). In the AABB tetraploid (*A.barbata*) the gene is present on two restriction fragments, and in *A.magna* (AACC) three separate hybridization signals were observed.

Variation in gene regulation and expression controls seed protein composition and functionality. We have also evaluated the *Avena* species for the presence of high moelcular weight storage proteins potentially equivalent to the viscoelastic wheat glutenins by both direct electrophoresis and by gene screening using cloned and sequenced gliadin and glutenin genes from wheat. We will also report on preliminary genome evaluation for legume-like protein genes in the cereals using cloned vicilin and legumin probes.

The usefulness of cloned DNA probes to study direct gene transfer during breeding of commercial cultivars will also be discussed.

Diseases of Oats

M.D. Simons

This review paper includs a very brief description and review of the history and importance of each major oat disease. Current research work (published within the last several years) is briefly reviewed with the idea of showing what areas or research thrusts are now of primary interest to oat researchers and what progress is being made in these areas. Highly specialised work,on oat pathogens that was judged to be of less general interest was not reviewed. Specific areas reviewed fall mainly in the categories of pathogenic specialisation, epidemiology, general resistance, and genetics and breeding. Pertinent research has not been published in all of these areas for all of the diseases. The major diseases considered include crown rust, stem rust, smut, powdery mildew, *Septoria* blight, *Helminthosporium* leaf blotch, bacterial blight, and yellow dwarf.

Pathogenicitiy of Crown Rust, Stem Rust and Powdery Mildew on Oats in Europe.

J. Sebesta, D.E. Harder, I.T. Jones, M. Kummer, B.C. Clifford, B. Zwatz.

Crown rust, stem rust and powdery mildew occur on oats in Europe every year but severity depends on region and year.

Crown rust and stem rust occur more commonly in southern countries and powdery mildew in more humid areas. The number of virulences possessed by the pathogen populations appears to be related to disease severity and it is supposed that these virulences are dispersed as inoculum moves between different parts of the continent. In crown rust in eleven European countries the highest frequency of virlences is on resistance genes Pc35,Pc40, Pc45 and Pc47, averaging 38.8, 47.6, 41.9 and 43.8% respectively. Average virulence frequencies for all resistances tested differ widely between countries e.g. Switzerland 10.7%, FRG 9.5%, Denmark 10.5%; Italy 38.9% and Portugal 35.8%. No virulence corresponding to genes Pc58 and Pc59 haas been detected. Of the standard differential cultivars, the most effective are Trispernia (CI7008), Bondvic (CI7009), Landhafer (CI7005)and Sante Fe (CI7006). The gene combinations in cvs Dodge and Garland are of particular value in Czechoslovakian resistance breeding programmes.

The occurrence of stem rust is regional. In Austria, Czechoslovakia and Poland virulence to genes Pg1,Pg2,Pg3,Pg4,pg8,pg9 and pg12 occurs and in addition, in Poland the race P1 was isolated in 1978, possessing the virulence to pg13. Virulence to Pg1,Pg2,Pg3,pg8,Pg15 and less pg9 occur in the FRG and Switzerland. No virulence has been found on Pg4 and pg13. In both FRG, Switzerland and Czechoslovakia the more recent identified resistance genes Pg16 and, in particular pga seem to be most effective.

In the years 1979-83, powdery mildew on oats was recorded at various levels in Czechoslovakia, FRG, GDR, Poland, Spain, United Kingdom and Yugoslavia. In Czechoslovakia the highest incidence was in 1981. Mostyn and Cc6490 (*A.barbata* translocation line) have been completely resistant in Czechoslovakia and Germany but in the UK virulence to both resistances has been detected. The resistance of Pc54 has proved effective in the field in UK and Central Eurpoe. Adult plant resistance (APR) found arlier in cvs Maelor, Maldwyn and Roxton has proved effective in central Europe. Breeding for multigenic resistance to crown and stem rusts is proposed for Czechoslovakia whilst the necessity of combining seedling and adult plant resistance to powdery mildew is emphasized.

Adequate Stem Rust resistance in Oats

P.G. Rothman,
USDA/University of Minnesota, USA

For the past 60 years, the use of single genes for specific resistance has formed the basis for most conventional breeding programmes for oat stem rust improvement. While somewhat successful in keeping ahead of the rust fungus, new resistant cultivars were replaced in a rapid whirl. The paucity of specific resistances to Puccinia graminis avenae also played a role in limiting this use. However, there is no justification for totally abandoning the use of specific resistances in oats for there is good evidence, particularly in wheat, to show that combinations of genes can be more effective in decreasing the vulnerability of new cultivars to the rust. The combination of various sources of specific resistances has now lead to the development of germplasm lines resistant to all of the prevalent races of oat stem rust found in North America. The development of such lines includes; i) the use of commonly ignored sources of resistance, 2) extraction of resistance genes from other species of Avenaa, 3) emphasis of minor or modifying genes, and 4) the use of disease reducing physiologc attributes of the oat plant.

Genetic analysis of crown rust resistance and phytoalexin production in oats

T. Morikawa and S. Mayama
College of Agriculture, University of Osaka Prefecture and Faculty of Agriculturee, Kagawa University, Japan.

The antifungal compounds accumulated only in the incompatible oat cultivar and crown rust interactions. They are regarded as phytoalexins and given the trivial names avenalumins I, II and III (Mayama et al. 1982). In order to examine genetic behaviour of avenalumin production, diallel cross was made ammong four hexaploid oats. Those are cultivars, Victoria (Pc-2) and Shokan I which are resistant to race 226 and susceptible to race 203, CW-491-4(Pc-38) which is resistant to race 203 aand susceptible to race 226, and Kanota which is susceptible to both races. The F1 hybrids derived from crosses CW-491-4 x Shoken I and Kanota x Victoria showed resistance to race 226 but their avenalumin aaccumulations were about 1/2 - 1/3 of that of resistant parent. The same trend was observed in the F1 hybrids, Cw-491-4 x Shokan I, infected by race 203.

It is well known tht Hv-l(Pc-2) gene controls the susceptibility to the host specific toxin, victorin. This is also known to be an elicitor of avenalumin. Avenalumin accumulation and sensitivity to victorin (1-100 ng/ml) were examined in the F1, F2 and BC1 of Kanota (hv-lhv-l) x Victoria (Hv-l Hv-l). The sensitivity of the F1 (Hv-l hv-l) to toxin was 5-10 times less than that of Victoria. The gene dose-effect was also observed by the induction of avenalumin accumulation. Segregation ratio for the sensitivity to toxin in 120 F2 plants fitted the expected ratio of 1 sensitive (28) : 2 intermediate (64) : 1 resistant (28). The same F2 plants were then checked for resistance to crown rust race 226. All plants either sensitive or intermediate to toxin were resistant to crown rust. The remainder resistant to toxin were mostly susceptible to the race except 4 plants which were resistant. Segregation ratio for the resistane to race 226 fitted the expected ratio of 3 resistant : 1 susceptible. In the BC1, segregtion ratio for both characters fitted the expected ratio of 1 resistant toxin (but crown rust susceptible) : 1 sensitive toxin (but crown rust resistant). The results indicate that genetic behaviour of avenalumin accumulation is closely linked with crown rust resistance gene and is the codominant single factor inheritance.

Variation and distribution of the oat crown rust fungus, *Puccinia coronata avenae*, in Britain

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Oat crown rust caused by *Puccinia coronata avenae* is endemic in Great Britain and Northern Ireland but causes only occasional damage to cultivated oats. Its sporadic and declining presence reflects a reducing oat acreage over the last fifteen years or so. During this period, annual surveys of virulence have been carried out at the Welsh Plant Breeding Station under the auspices of the UK Cereal Pathogen Virulence Surveys. Virulence frequencies and combinations have been determined by reference to the standard set of differential cultivars. Specieis resistances in popular cultivars are limited and derive mainly from cv. Landhafer. A number of unnecessary or 'non-matching' virulences occur commonly in the field. General observations suggest that *P.coronata avenae* has a high epidemic potential in Britain which would be realised with expanding oat cultivations. There is thus a continuing need for resistant cultivars.

Oat crown rust (<u>Puccinia</u> <u>coronata</u> f.sp. <u>avenae</u> Fr. et Led.) races, identified in the West region of the USSR.

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The investigations of race structure of the agent of oat crown rust had been started in 1967 in the Lithuaniaan SSR, in 1974 in the Latvian SSR, the Estonian SSR, and the Byelorussian SSR, in 1984 in Kalinigrad region (the RSFSR).

At first, races of this agent had been identified according to international methodics (M.D. Simons, H.C. Murphy, 1955) and since 1974 aaccording to G. Fleischman and P. Baker's (1971) new collection of indicators, consisting of 10 isogenic lines (Pc-35, Pc-38, Pc-40, Pc-45, Pc-46, Pc-47, Pc-48, Pc-49, Pc-50) and according their to methodics too.

Besides investigations on oat crown rust races a considerable amount of work (B. Namajunas, 1970, 1972, B. Namajunas, M. Strukcinskas, 1977,1977, B. Namajunas, 1979) has been carried out on problem of biology of the agent and on a problem of resistance of breeding material to the agent.

Among the oat crown rust uredial examples, collected in 1981-1984 in the Lithuanian SSR, the Latvian SSR, the Estonian SSR, the Byelorussian SSR and Kaliningrad region (the RSFSR) more than 300 monouredial cultures had been singled out. These cultures had been used for the identification of the agent races. After investigation of singled isolates by indicators, 53 combinations of virulence of the agent were identified. Here are the following races: Cl,2,3,9,14,26,74,153,258,259,266,265,268,269,274,281,297, 299,301,313,315,531,522,524,525,528,537,586,587,769,770,771,772,777,778, 780,781,793,796,800,801,802,809,811,812,843,844,859,874,905,908,910.

In investigated populations dominated clones having 0-3 genes of viurlence and they made up more than 50% of inivestigated populations.The most aggressive clones having 6-7 genes of virulence occurred rarely and made up only 10%.

Transgressive segregation for increased levels of adult plant resistance to mildew in oats

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Powdery mildew (*Erysiphe graminis avenae*) is the most serious foliar disease of oats in Britain. It can cause up to 40% loss in grain yield, and probably accounts for an average loss of 5-10% annually. Because of the failure of major gene controlled, hypersensitive type resistances to provide effective control for more than very short periods of time, attention has been given to adult plant resistance. Certain cultivars (e.g. Maldwyn) have maintained a moderate level of partial resistance over a period of 35 years and the mechanisms of resistance have been extensively studied in this cultivar. The expression of resistance is of a non-hypersensitive nature and can be regarded as of the rate reducing type. Genetical studies have indicated that up to eight additive effective factors control the adult plant resistance of this cultivar.

Studies of the progeny of crosses involving Maldwyn with other more susceptible cultivars have shown that transgressive segregation can occur for enhanced levels of resistance exceeding the level shown by Maldwyn. The results of a field experiment grown in 1984 showed that in F8 lines of the cross Mostyn x Maldwyn sown lines showed significantly less mildew than Maldwyn, with only 3% leaf area infected compared with 16% on Maldwyn and 23% on Mostyn. Transgressive segregation has also been identified in other crosses with Maldwyn, e.g. with the very susceptible cultivar Selma.

In order to identify the components of resistance mainly accounting for this increased level of resistance, laboratory and glasshouse studies on detached leaf segments have been carried out to estimate such characters as length of the latent period, percentage leaf segment area infected with mildew and amount of sporulation. Results of these studies will be presented and the importance of breeding for 'additive' type resistance discussed.

The Nature of Horizontal Resistance of Oats to Crown Rust

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Development of Puccinia coronata in an oat cultivar with horizontal resistance (HR) was assessed using fluorescence microscopy.The first visible response was fluorescence in mesophyll cell walls.This reaction occurred about 18hr after inoculation, and seemed to depend upon development of substomatal vesicles. The growth of the parasite at individual infection sites was inversely related to the degree of host response, which was expressed as the number of fluorescing cells. A rapid and severe host reaction resulted in the arrest of growth of the parasite before haustorial mother cells formed, but slow host response retarded hyphal growth. The arrest of growth was associated with a reduction in the number of uredinia, while the retardation of hyphal growth reduced size of the uredinia and increased the latent period. Thus, fluorescence of the mesophyll cell walls was correlated with these three components of HR. In some sites, the host did not react to invasion by the parasite. When this happened, the hyphae grew at a normal rate. Seven days inoculation, the average area of the uredinia of a susceptible type was about three times larger than that of the cultivar with HR. My results suggest that the substomatal vesicle produces a compound that is recognised my mesophylll cells, and that the time of host recognization and the speed of host response condition three major components of HR to crown rust.

Resistance to tolerance in Oats (*Avena sativa*) to the cereal cyst nematode (*Heterodera avenae*)

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Resistance (i.e. inability to support nematode multiplicatin) to cereal cyst nematode *Heterodera avenae* in oats has been known since 1938 (Millikan, 1938) and researched more thoroughly in the last 25 years. However, during all that time only one study (Mathison, 1966) reported tolerance (i.e. ability to withstand nematode attack with little or no damage).

This study examines the resistance of 23 oat, 2 barley and 2 wheat genotypes in the field and laboratory. The level of resistance in oats, for instance cv. New Zealand Cape, is similar to that of the resistant barley cv. Galleon and wheat cv. Festiguay. Two genotypes from Texas, TAM-O-301 and TAM-O-312, show good resistance to *H.avenae* but unfortunately these genotypes have proven to be intolerant.

Split plot nematicide treatments in field experiments conducted in 1980,1981 amd 1982 were used to estimate the tolerance of the same genotypes as in the resistance experiment. New Zelanad Cape appers to be at least as tolerant to *H.avenae* as tolerant 'benchmarks' in wheat (cv. Festiguay) and barley (cvs. Clipper and Galleon). Few oat varieties responded to nematicide in the 1980 trials yet in both cases wheat cv. Eget responded markedly. This, coupled with the 1981 and 1982 data which generally showed larger responses in all species, indicates that an intolerant wheat such as Egret is similar to the intolerant oat cultivars.

New Zealand Cape is an ideal source of resistance and tolerance to *H.avenae* and these traits are evident in selections derived from Western intolerant, susceptible genotype) and New Zealand Cape crosses.

In another series of experiments a small proportion of *Avena sativa* type derivatives from the *Avena sterilis* genotype Cc4658 have exhibited tolerance to *H.avenae* at a level similar to that of New Zealand Cape. Crosses have been made between New Zealand Cape and Cc4658 derivatives in the hope that transgressive segregation for tolerance may ocur.

Genotypes have now been characterised which represent all 4 combinations of resistance and tolerance viz:

Resistance class	Tolerance class	Representative genotype
Resistant	tolerant	New Zealand Cape, many breeders lines derived from New Zealand Cape and Cc4658.
Resistant	intolerant	Avon
Susceptible	tolerant	Breeders lines derived from New Zealand Cape
Susceptible	intolerant	West, Early Kherson

Transmission of Barley Yellow Dwarf Virus Isolates by the aphid Rhopalosiphum insertum (Walker)

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Alate fundatrigeniae of Rhopalosiphum insertum (Walker) from Hawthorne (Crataegus spp) were transferred to Michigan Amber winter wheat (Triticum aestivum). Alincolae progenies established from single aphids initially exhibitrd underground habitat and subsequntly very slow or rapid multiplication on the foliage. In parallel experiments, they transmitted the R.padi-specific isolate (RPV) and a vector nonspecific isolate (PAV)of barley yellow dearf virus (BYDV) but failed to transmit the Sitobion (Microsiphum)avenae-specific isolate (MAV) to Coast Black oats (Avena byzantina). Transmission rates with R.insertum were highest with the RPV isolate, equal to those of R.padi with PAV and RPV isolates, and lowest (about 50 percent) with thee PAV isolaate. The possible implications to BYDV epidemiology will be discussed. Identification of R.insertum by D.J. Voegtlin, the Illinois Natural History Survey, Section of Faunistic and Insect Identification is gratefully acknowledged.

- Virus genome 10,000,000 in size.
- Phloem restriction caused by BYDV.

- interdependent steps in infection.
  - genotype
  - transp
  - growing conditions

Development of breeding methods for oats

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Ever since man advanced from the hunting and gathering stage of food acquisition, people have practiced selection. As people harvested their crop, they would select outstanding ears or grains and save them for planting in the next season. Such an approach produced some improvement, but we now know many of the limitations of that procedure.

The rediscovery of Mendel's Laws, Johannsen's development of his "pure-line theory", and Biffen's initial report of genes controlling resistance to a pathogen, all happening in less than a decade, individually and collectively had a profound impact on breeding and selection methods. A few years later, Barrus first demonstrated the existence of physiological races within species of a pathogen. Together, this research shaped much of the plant breeding effort in small grains for nearly half a century. It was primarily a qualitative approach with emphasis on disease resistance.

Nearly 20 years later R.A. Fischer published two classical papers, one on correlation among relatives and the other on statistical methods. These efforts were, for all practical purposes, the forerunners for the quantitative approach. In the 1940's other initial efforts which contributed to the quantitative approach were a paper by Hull on recurrent selection and specific combining ability and one by Hazel et al. on single versus multiple trait selection.

In the 1960's and 1970's, some of the breeding and selection emphasis shifted from yield per se to either components of yield and/or morphological or physiological traits that might determine grain yield. Ideas such as Grafius' geometry of yield components and Donald's ideotype, the success of semi-dwarfs and concern about photosynthetic capacity greatly influenced breeding and selection methods.

We are now entering the biotechnology era. The exact impact that these new technologies will have on plant breeding methodology is not yet clear. It does appear that oat breeders will, either directly or indirectly, have access to more tools and thus, may be able to make genetic menipulations which previously were difficult or impossible.

Ultimately, however, the successful plant breeder will: 1) choose parents capable of producing progeny that meet the objectives of the programe and 2) match the appropriate selection method with the trait or traits which are be improved and the breeding nursery situation.

Inheritance of Primary:Secondary seed weight ratios and Secondary seed weight in oats

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The examinatin of segregation patterns in F2 and F3 generation progeny, and the sub-divisin of hereditary variance into its additive and non-additive components were used to provide information on the inheritance of primary:secondary seed weight ratios (weight of primary seeds/weight of an equal number of secondary seeds) and secondary seed weight,. Six oat genotypes, chosen to represent a range of 1000-grain weights and primary:secondary seed weight ratios were crossed in a half-diallel. Parents, F2 and F3 generation material were grown at two locations in the summer of 1983.

Segregation patterns and combining ability analysis indicated that additive and non-additive genetic effects were involved in the inheritance of both traits. For the ratio, epistatic gene action, rather than dominance, accounted for most of the non-additive component. However, dominance appeared to play an important role in the inheritance of secondary seed weight, in some crosses. Heritability estimates for primary:secondary seed weight ratios and secondary seed weight were high, ranging from 0.71 to 0.91 to 0.94 respectively. Broad and narrow sense estimates were similar and narrow sense estimates did not increase in the F3 generation, emphasizing the importance of the additive component.

Transgressive segregates with low primary:secondary seed weight ratios were observed for six of the crosses, indicating that genetic material exists from which selections can be made to improve the ratio. Transgressive segregates with high secondary seed weights occurred with even greater frequency. Large amounts of additive genetic variance indicate the substantial progress can be made using standard selection schemes for the development of pure-line cultivars.

$\frac{P}{S}$ = High. $\frac{P}{S}$ = low.
desirable

Some breeders believe that increasing the seed size of secondary kernels would be desirable to improve the overall uniformity of seeds in oat samples. Tibelius and Klinck ~~at Macdonald College~~ studied the inheritance of primary : secondary seed weight and secondary seed weight in F2 and F3 populations grown at 2 locations and derived from crossing in a half diallel 6 genotypes differing in 1000 KW. Their genetic conclusions are reported in their abstract but from a breeding standpoint they concluded that genetic material existed in the populations to select for ~~both~~ a more favorable ~~improvement~~ P/S ratio and a larger secondary seed size.

Stability of German oat cultivars (Avena sativa L.): special consideration is given to non-typical oat florets.

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Utmost superiority is attributed to oat breeding of homogene and unvarying cultivars which are improving charactertistics of yield, quality and resistance. Quality and morphology of florets must not be negatively influenced by genetic alterations. Therefore, new possibilities and actually occurring frequencies of mutations and undesirable hybridizations with special attention to Avena fatua are to be carefully observed and tested.

All German oat cultivars presently licensed are derived from two traditional cultivars. It is a remarkable fact that most cultivars that generate fatuoids are descendants of one Scandinavian cultivar. This tendency of forming fatuoids seems to be a genotypical characteristic. In this connection it has to be examined to which extent this property is influenced by environmental factors, considering that the frequency of fatuoids differs from year to year.

We radiated 7 cultivars in order to test frequency of fatuoid development under stress. Fatuoid generation was directly proportional to radiation intensity, whereas it must be said that there was general development of fatuoids in those cultivars in which this phenomenon had occurred before, under natural conditions. As it is thinkable that hybridization between Avena sativa and Avena fatua also can lead to fatuoids, we grew 8 cultivars of different relationship under very different environmental conditions, which was to prove to which extent open flowering is due to genotype or environmental conditions. All cultivars under equal climatic conditions had very open flowering in different places. Under these conditions we got a mean of 18% of florets at emasculated flowers. By experiments of electrophoresis and progeny we are testing presently which kind of polinating partners were active parts in these crossings.

In order to examine the morphological behaviour of hybrids we tried crossings of different Avena sativa cultivars with Avena fatua and observed the following generations. Firstly there was a great morphological variety of florets, in which a very small percentage of fatuoids was found. These fatuoids occur even in cultivars that never had shown fatuoids under natural conditions.

The homozygous fatuoids show the following characteristics: plant morphology and florets remain unchanged in the following generations, there is no dormancy and caryopses are fully developed. All other experiments according shape and size of lodicules, fluorescence of lemma and phenol reaction of caryopses were not helpful for a clear classification as homozygous or heterozygous fatuoids and hybrids. At present we are investigating whether our material of fatuoids, hybrids and Avena sativa differs in contents of lipids, proteins and glumes or in protein banding pattern by electrophoresis.

By secure findings of characteristics, investigations allow a clear assessment of genetic influence on the growth of non-typical oat florets.

In breeding new high performance cultivars, it is important to release cultivars that are stable with respect to floret morphology, Fatuoids do occur and it is important to know how they arise, Their frequency in an oat sample is dependent upon both genetic and environmental factors. Bickelmann and Leist found that fatuoids in German cultivars can be traced back to one Scandinavian cultivar and the frequency is greatly influenced by the intensity of solar radiation. Outcrossing to wild oats is common and they found a low frequency of true, non-dormant, true breeding fatuoids from

hybrids between A. fatua and A. sativa; even when the A sativa parent had never showed fatuoids under natural conditions.

Mass (Gravimetric) Selection in Diseased Nurseries I. Agronomic Traits

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Since its beginning more than 25 years ago, the Mexican oat breeding program has utilized pedigree selection. Priority traits include stem rust resistance earliness, kernel and grain yield. About 10 yers ago the program began using a form of mass or bulk selection, attempting to take advantage of a heavy and rather uniform stem rust infection occurring annually at the main breeding nursery at Chapingo.

After visually selected F2 plants were harvested the remaining plants were combine harvested, Because plants less affected by stem rust would be expected to produce plumper grain, this bulk seed sample was then subjected to additional threshing in a head thresher, fanning, screening and water flotation to eliminate the lighter seed. This heavy seed sample was planted again both at Celeya (winter nurery with heavy BYDV infection) and at Chapingo. Plots were combined harvested and the bulk seed sample handled as described above.

After five cycles of bulk (gravimetric) selection were completed, 377F8 lines were extracted from the bulk for comparison with 15 F8 lines remaining after six generations of pedigree selection. Eight cultivars were also included and all were grown in four environments, two summer and two winter.

The bulk lines averaged 397 g/plot, the pedigree lines yielded 388 g/plot and the cultivars produced 405 g/plot. The best individual line from each group yielded 558, 437 and 443 g/plot for the bulk, pedigree and cultivars, respectively. Thus it appears that this rather simple selection procedure is effective for identifying high yielding lines.

Maldonado, Jiminez and Stuthman demonstrated that lines of superior agronomic and disease performance in Mexico could be ~~isolated~~ selected using gravimetric methods from bulk populations of plants heavily infected with stem rust.

Mass (Gravimetric) Selection in Diseased Nurseries II Disease Reactions

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The oat breeding program in Mexico was started some 25 years ago because of a desire for more protection from stem rust. The program began by importing germplasm from the USDA and testing it at three sites, Chapingo, Celeya (winter crop) and Chihuaha. As oat acreage increased in the Mexico City area, stem rust became a serious problem because inoculum is always present and climatic conditions in the area are usually very favourable for stem rust development.

In 1968 the oat program at the University of Minnesota and the USDA Cereal Rust Laboratory joined forces with the program at Chapingo to develop stem rust resistant varieties. C.I. 3034 was chosen as the principal source of resistance. The program was mainly pedigree selection and backcrossing to incorporate that resistance into Mexican varieties.

In 1976 a new approach to developing stem rust resistance was initiated. Because plants which suffered less from stem rust were expected to produce plumper seed, the F2 nursery (after plant selections were harvested) was combined harvested in bulk. The seed obtained was rethreshed in a head thresher, fanned and screened, and finally separated into different size groups by water flotation. This selection process was repeated several cycles at Chapingo and also once in the winter at Celeya where BYDV is a serious problem.

Ten F8 lines identified by this gravimetric method were entered into the 1983 International Oat Rust Nursery so their performance could be evaluated under a number of different environmental conditions and diseae levels. Of the 164 total entries, the lowest of the ten Mexican lines ranked 34th for stem rust infection coefficient. These ten lines also were above average for crown rust resistance and BYDV tolerance. CI 3034, the most likely contributor of stem rust resistance, also has good crown rust resistance,but is highly susceptible to BYDV. We conclude that under these experimental nursery conditions this gravimetric selection method was highly effective in identifying superior progeny with a minimum of resources needed.

Mechanical Mass Selection for Improved Milling Percentage

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Milling percentage is a major quality factor of oats (avena sativa) milled for human consumption. Oat seeds with a high groat to hull ratio may be selected from a heterogenous population on the basis of specific gravity, since the groat is denser than the hull and surrounding air space. During the 1984 growing season a trial was conducted, comparing three mechanical selection techniques for improving oat milling percentage. Seed of two bulk F5 populations was selected by aspiration, a gravity table alone and a gravity table with a seed polishing pre-treatment. The selected populations were grown and compared in a randomized complete block design; measurements were taken for groat percentage, stand establishment, yield and other agronomic triats. The aspiration treatment and the gravity table coupled with the seed polishing pre-treatment produced significant improvement in the groat percentage of selected populations; the gravity table alone had less of an effect. Mass selection also had significant effects on plot yield and seed test weight.

Souza and Sorrells ~~also~~ were successful in using a combination of an aspiration treatment, gravity table and a seed polishing pretreatment to select segregating oat population for lines superior for milling percentage.

Present Status of Research to Develop Useful Semidwarf Oat Germplasm

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A co-operative ARS-USDA and Pennsylvania State Agricultural Experiment Station program to develop lodging resistant, semidwarf spring oat germplasm was initiated in 1974. The initial source of semidwarfness was the winter oat CI 8447. This line has a compact panicle and carries a partially dominant gene (Dw 7) which causes the reduced plant height. Development of useful, adapted lines with tht gene has been difficult because of a close linkage between the short plant height and the compact panicle. Also, semidwarf derivatives from various crosses generally have been too late in maturity. A few short, lodging resistant lines with open panicles have been developed, and one line may be entered in national tests for 1985.

The semidwarf parent OT 207, carrying the Dw 6 gene, has been used to a lesser extent. A few lines with complete panicle emergence have been developed and evaluated in advanced tests. These lines also are too late in maturity, but they are potentially valuable parental lines.

Unexpectedly, the best semidwarf lines were found in certain populations derived from crosses involving either Egdolon 26 (CI 8434) or Astro (CI 9160). Two lines, Pennlo and Pennline 6571 were released as parental lines in 1983, and they have been used extensively as parents in the current breeding progam. These lines and several similar derivatives are highly resistant to lodging, and their grain yield is similar to that of most modern cultivars used in the USA. The genetic control of semidwarfness in Pennlo and Pennline 6571 is complex, and crosses with taller genoypes produce a wide range of variability for height and lodging resistance. These lines and more recent derivatives should be valuable parents for the development of superior, lodging resistant cultivars.

There is worldwide interest in breeding high yielding semi-dwarf oats that are resistant to lodging. Marshall has examined the suitability of using the Dw6 and Dw7 dwarfing genes and reported that stocks carrying these genes are too late in maturity in Pennsylvania. Two semidwarf lines Pennlo and Pennline 6571 derived from ~~Eg~~ Egdolon 26 or Astro are high yielding and lodging resistant but the genetic control of semidwarfness is complex.

Hybridising of oats utilising chemical hybridizing agents

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Previous work with seven winter oat hybrids grown in stands approaching normal field plantings convinced us that appreciable grain yield heterosis exists in oat hybrids. One hybrid surpasses the best pure line entry by more than 35% at each of two experimental locations in Central Texas. Heterosis for forage production also was evident visually, but forage production was not measured quantitatively.

Since striking heterosis was evident in these hand-crossed oat hybrids, we have been interested in producing larger quantities of hybrid oat seed to allow testing hybrids for both forage and grain yield in standard nursery plots. Chemical hybridising agents might make it possible to obtain large quantities of seed for such tests. At present, this appears to be the only possible way that an adequate supply of F1 seed could be obtained, since suitable male sterile-restorer systems have not been developed in oats.

We have conducted preliminary oat research for two years with two 'wheat' chemical hybridising agents. Both appear to 'sterilise' oats with pollen supplied by adjacent untreated male genotypes has been quite low in most cases. It appears that the oat flowers of chemically sterilized plants may not 'open' adequately to receive pollen from the male parent.

Results of 1985 experiments, including tests to determine female fertility of oats treated with chemical hybridizing agents, will be presented. These test results are not yet available for inclusion in this abstract.

Oat breeders would like to take advantage of heterotic responses in oat hybrids but a practical method has yet to be found to produce F_1 seed in large quantities. McDaniel confirmed that large heterotic responses can be expected (reported one case as 35%) and evaluated two chemical wheat ~~[illegible]~~ hybridizing agents as gametocides. Both appeared to sterilize oats but natural crossing between sprayed female and unsprayed male rows was quite low but the frequency may already be ~~[illegible]~~ useful for breeding purposes.

Breeding winter oats - special considerations

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The winter oat breeding programme at the Welsh Plant Breeding Station results from only five successive cycles of hybridisation and pedigree selection. Valuable 'genetic sources' have been obtained from European spring oats and, lately, from North American winter oats. Invariably, more than one cycle of breeding is necessary to optimise the genetic advance obtained by the introduction of unadapted genotypes.

The consensus of evidence in oats and other cereals is that visual assessment of yield in rows in the F3 generation is worthwile. The value of selection between individual plants or ears in the F2 generation is more questionable but may not be without some merit. Accelerated pedigree selection (APS) is an alternative approach to pedigree selection. It replaces selection between plants by selection between rows, with a shortening of the breeding cycle. Two important advantages of APS in comparison with single seed descent (SSD) are the avoidance of the risk of genetic shift inherent in SSDF particularly in winter cereals, and an earlier assessment of breeding material under field conditions.

The provision of APS in unselected single plant progenies may also allow greater emphasis to be placed on breeding for characteristics for which special early generation tests are required, such as high nutritional quality or high winter-hardiness. APS has been successfully used for breeding naked winter oats.

Reliable procedures must be sought to select superior lines in early generations to improve the efficiency of breeding programs. This is especially important when introducing unadapted gene donors from special breeding programs or from around the world where the number of cycles of breeding to adaptive cultivars is necessary. Valentine and Middleton proposed an accelerated pedigree selection (APS) protocol as an alternative approach to pedigree selection. APS replaces selection between ~~rows~~ plants with selection between rows, with a shortening of the breeding cycle. It lowers the risk of genetic shift inherent in ~~SSDF~~ single seed descent in winter cereals and permits an early assessment of breeding material under field conditions.

Crop Physiological Approaches to Increased Productivity in Oats

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Limitations to oat productivity are evident in both favourable and less favourable environments. Manipulation of growth of developmental patterns can assist in further improving oat genotypes for existing cultural practices or in adapting oats to less than optimum growing conditions. Utilisation of variability in crop physiological responses may produce cultivars more tolerant of environmental stress, or alternatively, may allow crops to escape stress periods or to endure such problems during less sensitive developmental phases.

Where insufficient cold hardiness is a limiting factor for growing winter oats, incorporation of seed dormancy would allow autumn-sown crops to overwinter, thus having the benefit of early emergence. Differential response to photoperiod, temperature and vernalisation would enable earlier plantings and establishment of crops before they become subject to water logging. A change in flowering date may avoid frost damage at heading or would alleviate drought stress during the grain filling period.

Timing and duration of developmental phases influence grain productivity by associations with yield components and growth factors. Morphological and physiological factors affecting yield or tolerance to environmental stress have been studied in the seedlng and adult plant phases. Parameters such as root:shoot ratio, seedling vigour, harvest index, photosynthetic activity growth rates and leaf area duration are only some of the selection criteria suggested for use in breeding.

The need for simple and rapid tests of heritable and yield related physiological traits is emphasized, examples of such techniques being used, are given, and analogies with other crops are drawn. Prospects for further improvement as based on the availability of genetic variation in the cultivated oat and its wild relatives, are considered.

Germ
Emergence.
Floral induction
Heading
Anthesis
Maturity.

Some metabolic constraints to oat productivity

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USDA, ARS, Agronomy Department, University of Wisconsin, Madison, USA

Possible metabolic limitations to the productivity of oats under conditions where the environment is not limiting will be considered. Both dry matter yield and protein yield will be discussed. it is believed that if rate limiting processes can be identified, genetic diversity for these processes can be exploited in breeding programs. This approach will become particularly more useful when it becomes possible to use recombinant DNA techniques to alter specific genes in plants, without effecting other desirable genes already present.

In consideration of dry matter yield, we are concerned with growth rates, uptake and transport of soil-borne nutrients,partitioning of dry matter into the grain, and leaf senescence. Any of these processes may be limiting the growth of the plant or the filling of the grain during certain growth stages. Our task as plant physiologists is to find out specifically which enzymes or physiological processes may be rate limiting, and then, working with plant breeders, determine the means and effects of their enhancement.

To enhance protein yield, we need to consider, in addition to dry matter yield, the processes of nitrogen assimilation, partitioning of assimilated nitrogen and remobilization of amino acids released by leaf and stem protein degradation during senescence. The regulation of C : N balance of assimilates supplied to the grain effects protein percentage of the grain. There is evidence that the transport mechanisms of amino acids and sugars into developing grain are controlled differently.

Much of the relevant data are not available for oats, but data from other species may be pertinent. Data from experiments on wheat and other cereals will be considered where oat data are lacking, with the assumption that in general, the species behave similarly.

Meeting 1988

Effects of genotype, seding rate and the grain yield components on the primary:secondary seed weight ratio in oats

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Macdonald College,McGill University

Field experiments were conducted over three growing seasons to study the efects of genotype and seding rate on the primary:secondary seed weight ratio (weight of primary seeds/weight of an equal number of secondary seeds) and to examine the relationship between the ratio and the grain yield components - panicles per plant, seeds per panicle and 1000-grain weight.

In all experiments, significant effects of genotype on the ratio were found. However, when the genotypes were ranked according to their ratios in the different experiments, their relative rankings changed, indicating that the ratios of some genotypes are more susceptible to environmental variation than are others. When selecting parents for use in crosses to lower the ratio, it is important to consider both the value of the ratio and its stability. Examination of individual genotypes indicated that this stablity arises from consistency in overall grain weight or from similar responses of primary and secondary grains to different environments. Coefficients of variability were greater for secondary grain weight than for primary grain weight, in all but one experiment, indicating that secondary grains are more influenced by environmental variation.

Significant effects of seeding rate on the primary:secondary seed weight ratio were found in 1980 and 1981 but not in 1983. Ratios were lower at the reduced seeding rate, where interplant competition was lower.

Correlation and covariance analysis did not reveal a relationship between primary:secondary seed weight ratios and either panicles per plant or seeds per panicle. Significant negative correlations were found between ratios and 1000-grain weight in some of the 1981 trials, but not in 1980 or in 1983. While the coefficients wre not high (-0.40** - -0.54**), the relatinship was substantiated by covariance analysis.

Breeding oats by selection of parental pairs according to the ecological-geographical principle

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The new oat varieties developed in the Soviet Union in the last ten years such as Hecules, Sinelnikovsky, Kirovsky, Mirony. Horizont, Ruslan etc. possess a sufficiently high potential of productivity (7,000 to 7,500 kg of grain per ha). However, the majority of these varieties have a tendency to lodge, are infected by plant diseases and greatly reduce their yield in dry summers. The best west-European oat varieties suffer from drought to a still greater degree. Even in conditions of a temperate climate of the Moscow Region the coefficient of variation of the yield during ten years of the variety Hercules constituted 34.6%, while that of the vaariety Astor constituted 42,5%. The problem of drought resistance is still more critical in the steppe and forest-steppe zones of the USSR.

Taking into account the wide variety of soil and climatic conditions and very considerable fluctuations in the precipitation according to years, it is desirable to cultivate varieties of ecologically wide plasticity. In plant breeding of oats the tasks of raising the adaptability of the new varieties to the physical and biological environment are placed in the forefront with the aim of quarantering the stabiity of the yield. Hybridisation of ecologically and geographically distant forms with the following evaluation of selected lines in various soil and climatic conditions is an efficient method of developing such forms. The best results are achieved when the best Soviet Union and the most lodging-resistant west-European varieties are crossed with varieties which may be less productive but are more drought-resistant and more immune to plant diseases of Canada, USA, Mexico and other countries of the American continent. In the last few years several new oat varieties have been developed which possess a complex of economically valuable characters and a wide ecological range. One of these varieties is Drug. It was selected from the hybrid populations Fraser and L'ovsky 78 with two following assessments at two locations: under Moskow on sod-podzolic soils and in the Ulyanovsk Region on chernozemic soils suffering from shortage of moisture. The new variety revealed a high dgeree of productivity, of drought resistance and of resistance to lodging, a slight infection by loose smut and crown rust, a good quality of grain in combination with increased drought resistance and ecological plasticity. A promising rust resistant oat variety Alo was developed by crossing the varieties Leanda x Lody at the Jogeva Plant Breeding Station (Estonia). More valuable oat lines with a complex of useful characters and with characters of wide ecological plasticity have been developed by hybridization of various ecotypes.

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Tolerance of oat genotypes to Hoegrass(R) (Diclofop-methyl)

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The control of weedy grasses in cultivated oats has traditionally been left to cultural methods. Most herbicides developed for the wheat and barley market show little selectivity between oats and the principal grassy weeds of southern Australia, although Lasso (R) (alachlor) and Gleran (R) (Chlorsulfuron) are suitable for some situations. Two major problem areas remain, namely - the control of wild oats (Avena fatua, A.sterilis and A. barbata) in oats and the control of grasses particularly annual ryegrass (Lolium rigidum) in oat/legume stands.

A herbicide which would be suitable is Hoegrass (R) (375 g/l diclofopmethyl). Annual ryegrass and wild oats are controlled at 1.0L/ha and 1.5L/ha respectively. At these rates annual medics, subterranean clover and most other legumes show little or no damage. However oats are moderately susceptible to this chemical.

The experiments reported here examine the tolerance of local oat genotypes to Hoegrass (R).

Avena strigosa cv. Saia and A.sativa cv. New Zealand Cape are the most tolerant of the genotypes in these studies, but cv.Moore also has useful tolerance. The discovery of tolerance in New Zealand Cape is fortunate as this cultivar is widely used in the South Australian oat breeding programme as a donor of resistance and tolerance to the cereal cyst nematode. Many of the segregating populations from crosses involving New Zealand Cape have been screened for Hoegrass (R) tolerance and whilst no genetic studies have been undertaken, it appears that heritability is high. The prospects of developing a cultivar which combines the cereal-cyst nematode resistance and tolerance, and Hoegrass (R) tolerance from New Zealand Cape appear promising. The level of tolerance in such a cultivar will probably be satisfactory for applications of 1.0 L/ha Hoegrass (R) but may not be adequate for the 1.5L/ha rate. Timing of application may become critical.

While this will represent an advance in weed control options in oat crops, a word of caution should be added. If high levels of tolerance to this and other chemicals and cultivated Avena spp., it is highly likely that it also exists in the closely related weeds, A. fatua and A.sterilis. A suitable strategy to avoid selection of tolerant wild oat biotypes would be to ensure that wild oat herbicides be used in rotation over time. An example of a rotation that could be used in a particular paddock is - Cropping Year 1: Oats - Hoegrass (R); Cropping Year 2: Wheat - Avenge (R); Cropping Year 3: Barley - Avadex BW(R).

Holon. 375g/l. 1 l/ha.
$\boxed{\text{Hoegrass}}$ 1-2 l/ha. - wild oats (fatua, sterilis + barbata).

Moore (australia) fairly good res.
Saia "

$\boxed{\text{Savena 1. best tolerance to Hoegrass — get seed}}$

the dwarfs + weeds off.

The Chemical control of wild oats in cutlivated oat - A progress report

H.P. Taylor and T.M. Codd
Long Ashton Research Station, Weed Research Division, Begbroke Hill, Yarnton, Oxford, UK

The chemical control of weeds in botanically related crops is always difficult and requires the use of highly selective herbicides. These are not easy to discover, are expensive to develop and their introduction is only economically viable for use in major crops. The oat may not come into this category, and new chemicals are therefore unlikley to be produced specially for its cultivation. As the very closely related wild oat is now a serious weed in cereals, our inability to control it in cultivated oat must be seen as a potential threat to the future of this crop in Britain.

With conventional methods of weed control offering no solution to the problem, alternative approaches are being investigated at the Weed Research Organization. Two possibilities are being examined in a programme of research which is funded by the Home Grown Cereals Authority and carried out in collaboraton with staff at the Welsh Plant Breeding Station.

The first of these involves the use of 'herbicide safeners' to protect the oat seedlings against damage from herbicides applied to kill the weed species. This method was pioneered in the United States for use in the maize crop and would seem to be a most promising technique when weed and crop plant are so similar. The second approach has arisen from our chance observation that different oat cultivars could show varying degrees of susceptibility to certain wild aot herbicides. In particular some oats obtained from Aberystwyth and also Twyford Seeds Ltd (Banbury) exhibited sufficient tolerance to encourage further research aimed at the production of herbicide tolerant oats.

The presentation surveys these new developments and reports on the progress made in our efforts to control wild oats in cultivated oats.

Elen,
Flan nos.

- Napthalytic anhydride

Effect of Herbicides on Oats
D.L. Reeves and J. Lammers

Ten oat cultivars were treated with 0.56 kg ha^{-1} MCPA and 0.28, 0.56 and 0.84 kg ha^{-1} rates of 2,4-D at the recommended stage at two locations. Visual differences of the panicles were very evident on 2,4-D treated plants. Significant differences were present for yield, test weight, height, lodging and treatment. Overall the highest yielding treatment was the MCPA followed by the untreated and 0.56 kg 2,4-D then 0.28 and 0.84 kg 2,4-D.

The highest yields for all varieties were either the untreated or MCPA treated. The high rate of 2,4-D was the lowest yielding treatment for almost all varieties. It is interesting to speculate why the 0.28 kg rate of 2,4-D was 21/2% lower yielding than the 0.56 rate.

There was a variety x treatment interaction for test weight but not yield. The untreated oats had the highest test weights followed by 0,.28 kg 2,4-D. The 0.56 Kg rates of MCPA and 2,4-D were equal while the 0.84 kg rate reduced average test weight by 5%. Cultivar height was affected by location and treatment. The 0.28 and 0.84 rates of 2,4-D produced the shortest plants. Lodging was least for untreated and MCPA. The lowest rate of 2,4-D had almost three times the lodging of the untreated. Each additional increment of 2,4-D caused more lodging.

1985
154/21

World Oats Use and Marketing.
Donald J. Schrickel

Approximately 50 millions metric tonnes of oats for grain are produced annually and the Soviet Union is by far the highest producer. Much of the oat grain is consumed on the farm where it is grown in the form of animal feed, and about 16% of total production is used as human food. Per capita consumption of oats by humans varies considerably in different parts of the world.

World oats production is declining due to changes for livestock feed and because of the emphasis on competitive crops which have higher energy, such as corn.

Yield per unit area can be high under the best of management and using high-quality land. However, maany oats are grown on marginal quality land and as a result yields suffer in relationship to other crops. This places pressure on the oat breeder.

All of us in the breeding, production, feeding and milling of oats are severely challenged to do our jobs better and keep oats competitive in the world.

28 bus = 1 Tonne.

Oat quality - Present status and future prospects

Robert W. Welch, Welsh Plant Breeding Station, Aberystwyth, U.K.

The current quality criteria for oats for milling and feeding will be described. Compared with other cereals oats possess a high oil content, good protein quality and high levels of soluble and insoluble fibre. The importance of these and other factors will be discussed in relation to the use of oats in animal and human nutrition and in food processing. Recent developments in our understanding of the factors responsible for the observed therapeutic effects of oats and oat fractions will be reviewed. Variations in the major determinants of oat quality resulting from environmental effects and from genetic differences in cultivated oats and in wild oat species will be described and the prospects for improvements by plant breeding assessed.

all reduced cholesterol.

oil

Protein 3×

Gum. 10×

			β-glucan	
45	10	5	95.5	100.
42.9	11	5	95.5	98.9
42.3	10	6	95.5	98.3

Oil and Protein Content in Oats (*Avena sativa* L.)

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More than one third of the total grain acreage in Norway is sown with spring oats. In 1984 the oat crop was even greater than the barley crop. More than 90% of the total oat crop are used for feeding purposes. Oats, because of their high fibre content are lower in energy value than other cereals. An increase in oil content of oats would increase energy value and make them more valuable for livestock feed.

A breeding program has been initiated in order to increase both oil and protein content in oats. In this experiment 25 adapted oat lines and commercial varieties has been tested in 7 locations in southern part of Norway for 4 years (1981-1984) for yield, protein content and oil content.

There were significant differences between genotypes with respect to both oil and protein content. Oil content in whole grain varied from 4.63% to 6.58%. Protein content of the same material varied from 9.8% to 11.1%. The interaction between varieties and locations and varieties and years were very small and hardly significant both for oil and protein content. This is in agreement with earlier results.

A weak positive correlation ($r = 0.09$) was found between oil content and grain yield. A significant negative correlation ($r = 0.20^{**}$) was found between protein content and grain yield. A weak negative correlation ($r = -.11$) was found between oil content and protein content.

Quality in oat breeding - a question of priorities

Bengt Mattsson,
Svalof B, Sweden

Yield is the first character screened for in oat breeding. In Sweden however, there is continually being more emphasis placed on quality. The main parameters are hectolitre weight,1,000 grain weight, and the amount of husk, fibre, protein, and fat. For the moment it is only the hectolitre weight that influences the price. Roughly, a difference of 2% in hectolitre weight increases the value of the yield by 1%.

Now, more attention is being paid to fibre, protein and fat. One percent increase of each of these characters is worth at least 2% of the yield, when oats are evaluated for cattle feed. Special programmes have been set up to improve the content of protein and fat. Sources of high protein have been investigated and crossed with Swedish cultivars. When analysing the "protein donors" a variation appeared in the lysine content per protein unit. Thus the value of the different donors vary. It has, however, been possible to obtain lines yielding at least as much as the Swedish recurrent parents and with somewhat improved protein content. On the other hand we have not found any real top yielder with high protein content.

Although the fat content of oats is rather high, a great variation can be found among cultivars. The collection of lines with high fat content at Svalof have averaged about 11.5%. Like protein, the fat in oats has a good quality with a favourable composition of the fatty acids. The average amounts of fatty acids in the investigated lines were 14.7; 43.6; 39.7; 1.1 and 0.9% for the respective fatty acids palmitic, stearic + oleic, linoleic, linolenic and C-20 acids. A backcross programme has been started. Some lines have both a high protein and fatty acid content, therefore it should be possible to improve both fat and protein content at the same time. The question is, however, if it is easier to improve our lines with 1% of both protein and fat or to improve yield with 5%.

Effect of Lemma Colour on Grain Quality in Oats, _Avena_ _sativa_ L.

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Agriculture Canada, Research Station, Winnipeg, Manitoba, Canada

The effect of lemma colour on grain quality in oats was studied in a number of crosses through the use of F3 derived near-isogenic F6 lines of contrasting lemma colour. Of the 68 pairs selected, 36 were developed to compare white versus red-seeded oats, 15 to compare yellow versus red, 10 to compare yellow versus white and 7 to study black versus non-black. The contrasting pairs were studied for six grain quality characteristics, viz. percent hull, percent protein, percent oil, test weight, 1000 kernel weight and post-haarvest dormancy and the three agronomic characters heading date, height and yield.

In the white versus red and yellow versus red lemma colour comparisons, red lemma colour was associated with a significantly lower hull percent (1.2% and 1.1% respectively) and a significantly lower test weight (0.73 and 0.74 kg/hl respectively). The red-seeded lines were significantly lower in percent hull than their white and yellow isogenic lines in 34 out of the 36 pairs and in 13 out of 15 pairs respectively. Genetic possibilities to account for this result include pleiotropism or a close lnkage between the gene for red colour and a gene for low percent hull. The results suggest that the association of lemma colour and percent hull was stronger than the association of lemma colour and test weight. It would be easier to detect red-seeded oat lines with a low percent hull and high test weight than white-seeded lines having a low percent hull and high test weight.

Although showing no differences in 1983, white oats were of higher quality in 1984 with a significnalty lower percent hull (1.70% hull difference) and a significantly higher test weight (2.29 kg/hl difference) than the yellow-seeded llines. Blck lemma colour seems to be associated with lower overall quality (2.12% hull higher aand 2.29 kg/hl lower) in comparison to the other colour classes.

Lemma colour was found to have no significant effect on thousand kernel weight, post harvest doprmancy, percent protein or percent oil content. No associations were found between lemma colours and the agronomic characters studied so that it should be possible to select for high yield, short straw and any maturity level within any hull colour class.

Prospects for the naked oat crop in the U.K.

J.E. Jones, E. Chorlton, D.A. Lewis
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Rhiannon, a new naked spring oat variety, bred at the WPBS was placed on the UK National List in 1983. With a yield of 4-5 tonnes of naked oats per hectare valued at £140 per tonne the crop is likely to be economically viable. The crop husbandry required by Rhiannon is very similar to that for covered spring oats but extra care is needed in harvesting and handling. The differences between a maturing crop of naked oats in the field compared with a crop of covered oats will be discussed; standing power, grain filling, ripening, shedding and disease resistance all being modified by the free threshing lemma and palea. The prospects for the development of improved varieties of naked oats by plant breeding will also be discussed.

The high oil content of naked oat (8.5% in Rhiannon) is a key factor in the potential value of the crop for feeding. Thus the oil in naked oats could be used by UK feed compounders, particularly in pig and poultry rations to replace other, often imported sources. The protein content is high and well balanced for a cereal, and this is also important for feeding non-ruminants. The production of oat flakes for human consumption from naked oats should be more economical, as de-husking is unnecessary. Greater awareness of the important health benefits to be gained from eating oats should increased the demand for processed oats in the future.

seeding rate 140 Kg/ha.

N_2 input
60-90 units/ha.

reduce drum speed. 1000 rev/minute

seedhandling after harvest,
storing - dry.

mixing with Barley

weight of husk on head
less than
in covered
better lodging resistance

emphasised oil content

Hull-less Oats for the Milling Industry

S. Weaver
Quaker Oats, USA

Hull-less oats offer many interesting opportunities for commercial oats millers. Some obvious advantages include improved milling yield, reduced energy and storage space requirements, elimination of certain pieces of milling equipment and reduced transporation costs.

Milling yield improvement is probably the most significant cost savings afforded by hull-less oats. Milling yield is measured in units of raw material required to manufacture certain units of finished product. Theoretically, yield improvement of 30% is attainable. Economically, this results in the purchase of approximately 30% fewer oats in order to yield a given amount of product.

With all of the cost savings and advantages of hull-less oats, why are they not used to any large extent by millers in the free-world? Basicallly, because there are no commercial areas seeded to hull-less oats. Producers probably would grow hull-less oats if they had high yielding and adapted varieties to select when making seed purchases. The lack of hull-less varieties to choose from could change in the very near future because of advanced breeding programmes located at various breeding locations in Canada, USA, Mexico and Chile. If farmers find new hull-less varieties advantageous to their farm operation and livestock feeding programmes, oats millers should then be able to enjoy the many benefits exhibited by hull-less oats at reasonable prices.

Comparisons of the utilization of hull-less and hulled oats indicate very minor and insignificant differences in storablity, free fatty acid content, protein content, total oil content, product flavour and product acceptability. Additionally, microbial counts and pesticide contamination have been shown to be at comaprably low levels.

Consequently, the challenge for the plant breeder is to develop high yielding, agronomically acceptable hull-less varieties. Subsequently, farmers must find them advantageous to their operations and be willing to sell their surplus production at reasonable prices. If millers were able to purchase hull-less oats at a price comparable to conventional oats groats, then the many advantages of hull-less oats could be realized by the milling industry.

Concerns.

112 lbs of oats to get 100 lbs groats.

Oats - The health story
Gordon Smith

In the years that followed the founding of Quaker Oats Ltd in 1899, porridge sales expanded regularly until the cereal was as regular a part of the English breakfast as it was in Scotland.

This trend continued until the start of the massive growth of the ready-to-eat cereals in the 1940s and 50s. As speed and convenience took over from the more traditional virtues of natural nutrition and unprocessed sustenance, the porridge habit started to decline. That movement has become a steady slump over the last two decades - until two years ago.

When the opportunity arose for Quaker to buy Scott's Porage Oats, its main branded rival, Quaker clinched the deal to secure one main target - to rebuild the oats and hot cereals market with the money freed from costly and counter-productive branded battles for supermarket shelf space.

With that aim in mind, Quaker committed itself to a long-term campaign at the end of 1982 to get porridge back to the British breakfast table, using the good news from medical scientists and researchers about the valuable contribution of oats to a healthy diet.

A public relations programme was developed around two main activities - the sponsorship by the Quaker and Scott's brands of the Oats Information Bureau, which works to increase the popularity of oats generically, and events such as National Porridge Week in 1983 that included publicity more geared to the specific brands.

In the two years since its launch, the Oats Information Bureau has established itself as a highly credible authoritative source of information for the consumer media, with features, news stores, recipes and other information going to television, radio and newspapers on a national and regional level, as well as the press and specialists in the medical world.

The main message promoted by the Oats Information Bureau has been the soluble fibre story, based on years of research work in America and Britain that shows oats to be one of the best, most readily-available and versatile sources of soluble fibre. This range of plant fibres differs from water-insoluble fibre, of which the best example is wheat, bran, in that soluble fibre is partially digested and has been shown to have metabolic effects, as well as providing some roughage. Some respected researcheers believe these benefits include a reduction on cholesterol levels in the blood, and a levelling-out of blood sugar levels, which is obviously of importance to diabetics.

In the two years since the Oats Informatin Bureau started its work, the country's 30,000 family Doctors have been kept informed by direct post with the developments in the oats story, and hundreds of their requests for further information have been dealt with. Hospital and health authority staff including health visitors and midwives are now far more aware of the benefits of oats, and nearly 100,000 leaflets have been distributed via doctors, hospitals, magazines directly from the Oats Information Bureau.

Many consumer magazines and newspapers have printed stories from the OIB on various aspects of the oats story, most recently a page feature in the Sunday Times Magazine that dealt with the beneficial effects of the soluble fibre in oats, especially for slimmers - the fibre helps slow digestion and reduce hunger pangs. Recent TV coverage includes a piece on soluble fibre and oats on the popular BBC Food and Drink programme, which has a viewing audience of 4 million.

The nett effect to date of the Oats Information Bureau plus major publicity events like National Porridge Week, has been to turn the tide for oats, from steady decline in the hot cereals market to an increae over the last two years.

Last year, the market increased by about 8% compared to the prevous 12 months, and this year looks like showing even stronger growth.

World Status of Oats and Biological Constraints to Increased Production

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

Although oat hectarage world wide has decreased by half during the past 40 years, grain production per unit land area has increased due to genetically improved cultivars and improved production practices. In many countries, grain yield fluctuates considerably from year to year due to uncontrollable climatic fluctuations. High on-farm use, low export volume, and the fact that only a small portion (9.1%) of the oat crop is prepared industrially for human food all combine to cause oat prices in the market place to be influenced mainly by the prices of corn and wheat. Continental or geographical needs generally have been met by production in the same or in a relatively near geographical region.

It is convenient to express oat grain yield in terms of the three primary yield components - number of panicle-producing tillers per unit area, number of florets (seeds) per panicle, and seed weight. While large increases in any one yield component appear highly unlikely, small but consistent improvements in many morphological and physiological traits which influence the three yield compnents can have a comulative and significantly favourable impact on crop yield. The list of direct and indirect biological effects to be considered is lengthy and includes disease resistance; morphological traits - stiffness of straw, leaf area, groat percentage, straww yield, harvest index, and the three main yield components; and physiological traits and processes - photosynthetic rate, photosynthetic capacity, growth rate, photosynthate source-sink relationships, nitrogen and carbon assimilation, leaf area duration, leaf senescence and mineral uptake, transport and deposition.

Intensive crop management as a total production system has focused attention on the need for total integration of management practices to obtain maximum and economically profitable yields. For the small grain cereals including oats, seeding date, rate, and depth, row spacing, fertilisation, pest management in the form of herbicides, fungicides, and insecticides, and the use of growth regulators are all management variables which can be patterned to fit individual cultivars. The use of tramlines facilitates the application of sequential treatments throughout the growing season. The challenge facing oat breders is to develop cultivars, i.e. morphologic and physiologic ideotypes, which maximise the probability of producing high yields of high quality grain under specific management systems in specific environments.

Oat Production and Breeding in Ijui, RS. Brazil

R.E. Medeiros, J.E.G. Zambra, L.V.M. Viau, C.Pittol, R. Carbonera
Cotrijui, C.P. III, Ijui, 98.700, RS/Brazil

The "Cooperative Regional Triticola Serrana Ltda. COTRIJUI" was founded in 1957 and congregates 22,250 mainly small farmers. It is involved with production, industrialisation and commercialisatin of animal and agricultural products in three different areas of Brazil. In Mato Grosso do Sul State, its influence area embraces around 10,000,000 ha of arable land. Only 1,500,000 ha of which are on cropping. The administration office is in Campo Grande (20925'S, 54935'W).

In Rio Grande do Sul State its influence area is in Dom Pedrito (319S;54935'W) where the cereal growing land is 72,000 ha, and in Ijui (28920'S; 53950'W) where 40,000 ha are on very intensive wheat and soybean continuous cropping.

In Ijui, where the had office is placed, the Cooperative has the "Centro de Treinamento COTRIJUI - CTC" where the oat research is being carried out.

In the Ijui area, oat, barley and flax are minor crops in the winter/spring growing season compared to wheat, which is still the main crop in spite of the low yields (Table 1).

The weather of the growing season is Ijui area is usually rainy with high air moisture and temperature during spring. This creates an ideal environment for the attack of crown and stem rusts.

COTRIJUI introduced the varieties Coronado, Suregrain and Epecoen in 1973. From that year up to 1976 Coronado and Suregrain yielded approximately 1,500kg ha^{-1}, while Epecoen yielded less than 1,000kg ha^{-1}.

First these varieties were grown as a dual purpose crop. Later, most of the farmers moved to grain crops due to frequent failures of wheat and a good market for oats.

In 1981 the CTC multiplied seeds of the new cultivars UFRGS 1 and UFRGS 2 from the Federal University of Rio Gande do Sul (Table 2), Unfortunately they were almost completely extinguished by a new race of crown rust.

The University of Passo Fundo, RS, also released the cultivars UPF 3 and UPF 4 was severely attacked by crown rust last year.

The CTC B 207 was selected in Ijui (CTC) out of 35 entries received from the Federal University of Rio Grande do Sul in 1978, which came originally from Madison, Wisconsin. Unfortunately we never could identify its CI number. It is not a good cultivar as far as kernel weight and lodging are concerned but we are keeping it until we have a sufficient amount of better seed varieties.

Though Ijui area has not good weather conditions for oat growing it appears that oats may be one of the main cereal crop in the future. It also fits well in the rotation with the main summer crop of this area - soybean.

As a result of this tendency, in 1983 we started the oat breeding programme at the "Centro de Treinamento COTRIJUI - CTC". This research is done with the support iof the "Breeding Oat Cultivars Suitable for Production in Developing Countries", sponsored by Quaker Oats Company.The objectives are to breed oat for better yield, rown rust and stem rust resistance. Lodging is also considered.

From the International Quaker Oat Nursery we selected 108 F3 panicles in 1983 and 624 F3 panicles in 1984. In 1983 and 1984 we have done 190 and 174 crosses, respectively. The parents used for these crosses came from genetic stocks of the International Quaker Oat Nursery, received in 1982, 1983 and 1984.

Table 1. Mean area and grain yield of wheat, oat, barley and flax in the Ijui area, Ijui, RS.

Crops	1981		1982		1983		1984	
	ha	kg/ha	ha	kg/ha	ha	kg/ha	ha	kg/ha
Wheat	90,400	1,170	166,000	430	81,500	990	70,180	570
Oat	10,340	1,270	14,700	360	8,930	870	5,410	830
Barley	5,100	1,080	5,630	360	5,660	1,130	7,090	670
Flax	4,910	960	1,880	500	2,790	830	7,190	630

Table 2. Area and grain yield of 5 oat cultivars distributed to farmers in 1982, 83 and 84. Ijui, RS.

Cultivar	Identification	1982		1983		1984	
		ha	kg/ha	ha	kg/ha	ha	kg/ha
UFRGS 1	DALX TEX 71C 3039-2	30	70	29	245	Eliminated	
UFRGS 2	DALX TEX 71C 3039-2	22	20	9	100	Eliminated	
UPF 3	CORONADO XX 11779-2	-	-	8	965	90	700
UPF 4	SELECTION FROM A PURE LINE, WIS	-	-	8	2,230	210	1,550
CTC B 207	SELECTION FROM A PURE LINE, WIS	3	1,800	44	1,720	920	1,450

Performance of Oats in the Quaker - South American Nursery, 1983-84

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The performance of the best entries in the 1983 and 1984 nurseries will be described. In 1983 the nursery consisted of 314 test lines (pure lines) and 46 F3 bulks. These were grown in a number of locations throughout North, Central and South America. Data were collected by the cooperatives at each of the locations and submitted to the nursery coordinators for inclusion in the 1983 report.

The final four tables in the 1983 report summarize the performance of 42 test lines that were considered to be the most promising for resistance to one or more diseass. Forty-one of the test lines had good to excellent resistance to crown rust or stem rust, or to both of these diseases. The remaining test lines had good tolerance to barley yellow dwarf virus (BYDV).

Twenty of the 42 test lines were resistant to both crown rust and stem rust at all locations where either or both of these diseases were present. Resistance genes in these 20 entries trace back to two sources. ME 1563 and CI9221. The ME 1563 resistance is derived from _Avena sterilis_. Crosses with these sources of crown and stem rust resistance are being emphasized in the Quaker program, especially with parents that have BYDV tolerance. Only one of the 20 rust resistant test lines had a BYDV score lower than 5.0 on a 1-9 scale at Davis, California in 1983.

Although only a few of the 4 test lines with resistance to one or more diseases had favourable agronomic notes in all of the 1983 locations, many of the lines had favourable comments in a majority of the locations. This indicates that most of the lines with good disease resistance are widely adapted. Most of these lines maintained their high level of resistance to crown and stem rust in 1984. The 1984 nursery at Ijui in southern Brazil was particularly effective in separating resistant and susceptible test lines. Resistant lines produced grain, while susceptible lines did not.

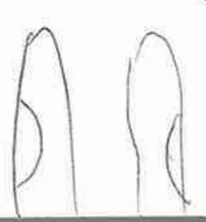
314 test lines — evaluate - get data - make cross → F1 – F2 – F3.
43 F3 bulks.

See report

lines 64 + 65. best.

Entry 97 – BYDV res as well

151 good.



Spermospora avenae

Breeding oats for New Zealand conditions: Collaboration between New Zealand and Canada

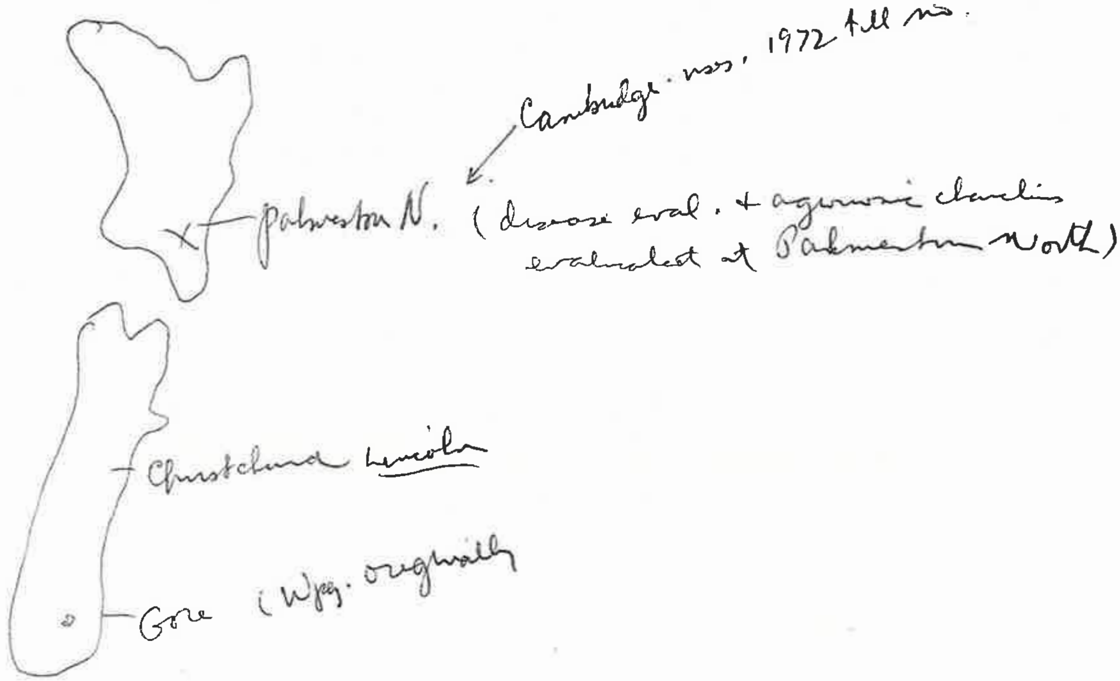
J.M. McEwan
Crop Research Division, DSIR, Palmerston North, New Zealand

Cooperative breeding in oats between Crop Research Division, DSIR, New Zealand and the Canada Department of Agriculture has been carried out since the early 1970's.

Initially the project involved growing early generation populations of CDA material at CRD's southern-most station at Gore, but was later expanded to include disease tolerance evaluation particularly for Barley Yellow Dwarf Virus at the Lincoln and Palmerston North Stations. Canadian material from Quebec, Ontario and Manitoba programmes was included at that stage.

Since 1982 the project has been consolidated at the Palmerston North Station at which screening for BYDV and oat rusts had been possible as well as taking agronomic observations.

The agreed programme allows CRD breeders access to the segregating populations and one selected line from this material, named Awapuni has been released for commercial production. Oat production in the North Island has been restricted by rust and virus infection and Awapuni oat shows good levels of resistance to those diseases.



Oat Breeding Research at Pantnagar, India

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Start. 1972 - present

Oat breeding research at the G.B. Pant University of Agriculture and Technology, Pantnagar, India was initiated in 1972 after obtaining initial germplasm from USA. Later the germplasm was enriched from sources such as Britain, Australia, New Zealand, Canada, Denmark and Argentina. Initially the germplasms were screened to identify lines with such aattribute having relevance to herbage quantity and quality, disease resistance, and recovery after repeated cuttings. Germplasm screening is done every alternative year for different attributes for searching potential sources for use in the hybridisation program.

The breeding program is mainly oriented in producing spring type oats chiefly for fodder production. The major objectives inthe breeding program are: medium maturity, resistance to crown rust and blight, tillering capacity, fast regrowth after repeated cuttings, high herbage yield, high digestibility and palatability of the herbage and moderately good seed yield.

In fulfilling the above objectives, the breeding progam is oriented to produce multiple crosses to concentrate genes from several sources into one. Several promising lines have been developed through this type of mating followed by pedigree method of breeding. Outstanding materials have also been developed through biparental matings (bip) in F2/F3 generations to further accumulate favourable genes and in breaking adverse linkages. It is seen that it brings in greater accumulation of desired genes through greater recombination. It also releases substantial genetic variability for further effective selection to improve yield In addition, the program also exploits genes from such wild oats as Avena sterilis and Avena fatua. It has been observed that the sterilis genes show an improvement in plant height, leaf width, leaf length, tiller number, and days to heading all parameters of increased herbage production.

The oat hectarage is gradually increasing in India for herbage production as it constitutes only cereal fodder during winter months, however, it remains far behind in grain production due to its limited use. It is primarily suited for the northern Indian conditions and it is expected that its area will increase for herbage and grain production.

Green fodder 85-90% - cut & fed Dairy Cows.

Oat acreage

Results of oat breeding in the USSR and its initiaal material

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The breeding of oats in the Soviet Union started at the end of the 19th century and it was directed to the selection of the best aborigine forms. By this method were selected the varieties Sovetski, Sakhalinski I, Jakutski, Onohoiski 547. In the last few years intergeneric and interpsecific hybridization, mutations breeding, etc. haave been widely used. Only in the last decade 30 domestic-bred varieties were recommended for cultivation, of which 28 were based on the collections of WIR. The new varieties are superior to the old ones in yield capacity and in higher adaptability to local conditions. Further increases in yield capacity is inseparably connected with the plasticity of varieties, with tolerance to unfavourable environmental factors, especially to drought. The varieties of the WIR collection differ considerably in drought and heat resistance. The most promising oat forms are Byzantine oats. By using this species the variety L'govsky 1026 has been bred, which is characterised by higher drought resistance and plasticity and which covers extensive areas in different zones of the USSR. On its basis, have been bred the high yielding varieties Mirnyi, Horizont and Sinelnikoski 21.

High drought resistant initial material - Junon, Anita, Fany, Mariner and Miagara have been recommended. High lodging resistance is one of the main requirements to any variety. Among the recommended ones the best lodging resistant variety is Astor; of the domestic varieties Isetsky and Viker belong here. Among the recommended short-straw lodging resistant varieties are Uralski karlik,(USSR), Tiger, Permit, Solidor, Angus, Mapua, Maris Tabard and short straw Gnom (USSR), Omichi, Ohau, K-13093 (USA). Astor has been recommended for breeding on account of its high combinability. The problem of breeding high yielding early ripening varieties is being successsfully solved for Siberia:Kolpashevsky, Tayezhnik for the nonchernozem zone, Kirovsky, Falensky 3; for southern and south-east regions, Kubansky and Sinelnikovsky 28. Recommended donors are: Samarsky samyi ranni (USSR). Orion III, Alba, Putnam 71. The crown rust resistant varieeties: L'govsky 1, Drug, Omski kormovyi and loose-smut resistant varieties: Kubansky, Kirovsky, Ruslan, Tayezknik have been bred. Varieties have been established with: complex resistance to crown rust and loose smut - Holden, K-13360 (Mexico), D-20 (Peru), A-3 (Equador), K-11528 (Algeria), resistance to mildew: Maris Tabard, Sulem, resistance to oat nematodes: Krasnodarsky 73, L'govsky 1026, Minski 17 (USSR), Orient, Manod, Markton. The first hull-less oat variety Uspeh has been recommended for cultivation, it has a high protein (20%) and lysine (4,5%) content. In breeding programmes have been used as donors on account their high protein content: K-6060 (USSR), Garland and Clintland 64. Specialised varieties have been bred for green fodder: Zelenyi, Uzbeksi zirokolistnyi, Omski kormovoi, Ural.

Recommend 60 cvs for growing in USSR.

20 from foreign countries

Oat breeding and production in Hungary

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1950 - 200,000 ha.
60 - 100,000

The acreage of oats in Hungary is 40,000 ha,. that is, as much as 0.7 to 0.9% of the total arable land. It is slightly increasing as compared to the 1970's. Total production is increasing as well, since average yields are higher than 2.4t/ha. This is due both to recently introduced varieties and an improvement in cultural practives.

Now only spring varieties are commercially produced, such as Leanda, Perona (from the Netherlands), Solidor (from GDR), Szegedi orai and GK-3 (Hungary).

Almost all oats produced in Hungary is fed to animals, with only an insignificant amount for human consumption - first of all victuals.

Oats have been bred in Hungary at the Cereal Research Institute since 1970. The main objectives of our breeding programme are as follows: to breed intensive, adaptable varieties with good nutritional value and high resistance to diseases.

We are engaged in the breeding of naked oats as well, for which the demand is increasing more and more.

We can report only a moderate initial success in the breeding of winter oats, as only a few genotypes can tolerate the cold winters in Middle-Europe.

In addition to practical breeding work the interrelations of yield components are studied. We tried to draw conclusions of universal validity, which can enhance selection; such as:

The number of grains/panicle, the ratio between palea and caryopsis and harvest index seem to be the most characteristic for genotype among the studied triats.

In order to develop the suitable ideotype we have to try to diminish the ratio of the tertiary seed in the panicle during varietal development and especially in the seed production practice.

New genotypes with better grain - straw ratio/harvest index should,be developed in order to increae productivity. It seems to be possible to imp[rove harvest index by shortening straw length(increasing of standing ability).

The oat crop in the U.K.

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The area sown to oats in the U.K. has markedly and steadily declined since the late 1940's. In the early 1950's oats were overtaken by barley as the principal home-produced grain for livestock feeding. The factors which influenced this change included the introduction of new short strawed, easier to manage, barley varieties and recognition of the comparatively lower yield of "Metabolisable Energy" produced by oats per unit area of land.

The present crop appears to have stabilised at around 110,000 hectares. This produces some 550,000 tonnes of oats annually and, of this, about 140,000 tonnes are used for milling and the remainder for animal feed. However, there are indications that there is some renewed interest and the factors determining the present status of the crop and those likely to influence its future will be discussed.

Winter oats ½ Tonne more than spring sown oats

decline of spring oats