WHEAT DIVERSITY & HUMAN HEALTH

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Book of Abstracts

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Scientific Topics

- Overview of wheat diversity and human health,
- Wheat landraces, heritage and ancient wheats: diversity and health impact,
- Beneficial components in wheat grain: minerals and phytochemical,
- Beneficial and adverse effects of wheat on human health,
- Production technologies for nutritious and healthy grain,
- Socio economic basis for on-farm wheat diversity,
- Improvement of key traits by genetics and breeding,
- Improvement of wheat end-products by processing,
- Nutritious wheat for animal feeding
- Climate change and wheat quality

Dear Colleagues,

We are happy to present the book of abstracts of presentations at the International Conference on Wheat Diversity and Human Health which will take place in Istanbul, Turkey, October 22-24, 2019.

The conference comes at the time when the importance of global food security is as high as ever. In the past the efforts of the wheat community were focused on producing sufficient volume of grain with quality suitable for industry, with impressive progress. At the present time, there is increasing interest in the nutritional quality and of wheat products and their impact on health. Wheat as a crop has evolved into a very diverse commodity with a wide range of modern varieties, landraces, ancient grains, colored wheat, and different species. This diversity has huge potential to enrich our diet. However, we are still only beginning to discover how best to utilize this diversity in order to sustain us and improve our health.

This is the first conference devoted to this important subject. We, as co-chairs, are very pleased that we have been able to put together an outstanding scientific program addressing important topics relating to wheat diversity and its exploitation for improving diet and health. We hope the conference participants will learn from each other and will take home new ideas, new knowledge, new contacts and new friendship which will benefit their work in the future. They will also have the opportunity to enjoy the beautiful city of Istanbul!

Conference Scientific Committee Co-Chairs

Peter Shewry and Calvin Qualset

Local Organizing Committee Co-Chairs

Alexey Morguno, Fatih Ozdemir, Mesut Keser

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First Session: The role of wheat diversity in human health

The role of wheat in diet and health

Prof.Dr. Peter Shewry*

Rothamsted Research, GB

Wheat is the third most important cereal crop in the world in terms of total production, and the dominant crop grown and consumed in temperate zones. The demand for wheat-based foods is also increasing in countries undergoing urbanisation and industrialisation, including countries which are outside its area of adaptation (such as parts of sub-Saharan Africa). Whereas the contribution of wheat to total calorific intake is about 20% in Western Europe, it can range between 50% and 70% in other countries. In addition to providing calories, wheat is also an important source of protein, vitamins (particularly B vitamins), minerals (particularly iron and zinc), bioactive phytochemicals and dietary fibre. I will discuss the challenges for wheat production and utilisation, including how the contribution to human health can be maximised by exploiting diversity and processing.

Keywords: wheat, fibre, phytochemicals, calorific intake, minerals

First Session: The role of wheat diversity in human health

Wheat diversity in Turkey

Prof.Dr. Alptekin Karagöz[1], Dr. Alexey Morgunov[2], Dr. Fatih Özdemir[3*]

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Wheat has been cultivated in Turkey for more than 12.000 years. Remains of wheat found in almost every excavation site indicate its long history. Wheat entered the life of human beings in south east Anatolia (Asian part of Turkey) which forms the northern edge of Fertile Crescent. In addition to be a center of origin, Turkey is a transit route between east and west. Several cultures including, Hittites, Hellenic, Byzantine, Romans, and Turkic cultures have successively occupied Anatolia since the beginning of agriculture. While some of them passed through, some others settled there, all carrying and leaving plant material to improve the diversity. Consequently, wild relatives and cultural forms of wheat developed huge diversity in Turkey.

Turkey is a home to great variety of wild and cultivated species, subspecies, and morphotypes of wheat. In terms of the number of wild relatives, Turkey ranks the first in the world. All the ancestors, constituting the primary gene pool of modern wheat, namely *Triticum urartu, Aegilops speltoides, T. dicoccoides* and *Ae. tauschii* are present in the flora. Einkorn (*Titicum monococcum var. monococcum*) and emmer (*T. dicoccum*) are still cultivated in an increasing rate in Turkey and are becoming more and more popular as healthy food.

Interspecific hybridization between wild and cultivated species of wheat is still ongoing in nature especially at south east Anatolia which is the gene center of wheat. This process reveals that wheat evolution is still ongoing by introgression and gene exchange, consequently generating new forms of diversity.

Crop landraces covered all the cultivated areas 70 years ago. Comparing to the first quarter of the XXth Century the reduction in the number of wheat landrace varieties is estimated as 70% in some regions. Although wheat landraces are produced in relatively small area, their diversity keeps its significance as a source for plant breeders and as popularly preferred products.

First Session: The role of wheat diversity in human health

Wheat landraces: Incentives for on-farm conservation with implications for human health and safety

Dr. Calvin Qualset[1]* Ana Christina S. Albuquerque[2], Ivan Ortiz-Monasterio[3], and Mesut Keser[4]

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Crop landraces evolved with agriculture, guided by founding farmers. To this day, many crop landraces are still being grown and provide sustenance for farmers' families and livestock. But many landraces have succumbed to changes in farming and marketing practices. The remaining landraces must be conserved *in situ* and *ex situ.* This presentation will address some issues of conservation and one major concept for providing farmers incentive to sustain their landrace production systems. There are human safety issues with pesticide application (mainly chemical seed treatment) and human health issues related to nutrient deficiencies. Examples will be given based on wheat landrace research in Turkey, for example, wheat plant resistance to covered smut (caused by a *Tilletiicia f*ungus) will alleviate the need for chemical seed treatment. Brief consideration to implications of zinc deficiency in wheat grain to incidence of human cancer, especially breast cancer, will be presented.

Keywords: Turkish wheat, Agrobiodiversity conservation, Breast cancer, Covered smut

First Session: The role of wheat diversity in human health

WHEAT: Healthy for most but to be avoided by some of us, Why?

Prof.Dr. Fred Brouns*

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Wheat is the third most consumed cereal in the world and as such a significant contributor to global energy and micronutrient intake. Consumption of wheat-containing whole grain foods and eaten in recommended amounts are associated with a significant reduction of risks for type 2 diabetes, heart disease, colon cancer and a more favorable long-term weight management. Many of these effects are assumed to be due to bioactive components that are present in significant amounts in the aleurone layer (1,2). Related metabolic changes such as improved blood glucose control, improved cholesterol levels, reduced blood pressure and lower serum concentrations of high sensitivity C-reactive protein support favorable disease risk reduction. In this respect, exchanging refined flour foods by more whole grain (whole meal) products is now world-wide recommended by leading food authorities. During recent years, however, 'social media fingers' point to wheat consumption as being a cause of overweight and diabetes, as well as a range of gastrointestinal complaints and autoimmune diseases. Suggestions have been that one reason is that wheat has been genetically modified resulting in a changed protein composition, including higher levels of gluten and components that drive chronic diseases. However, this is not substantiated by any evidence. Specific wheat components such as amylase trypsin inhibitors (ATI's), wheat germ agglutinins (WGA, lectins) and rapidly fermentable carbohydrates (FODMAPS) have been suggested to be involved in adverse reactions. New developments show that most studies that focused on the effects of gluten proteins as a single factor on bio-reactivity, did not address the fact that along with gluten other proteins are simultaneously present and may play a causal role. Undoubtedly, individuals with a specific genetic predisposition can develop celiac disease (CD). In case, these persons show elevated blood biomarkers as a result of immune and inflammatory responses, may develop small intestinal epithelial damage and microbiota overgrowth. In addition, a very small percentage of people are sensitive for wheat components in the absence of CD. In all cases, sick making changes will be lessened or reversed by avoiding all grains that contain gluten (which includes wheat) or have low levels of FODMAPs and ATI's. Today, using available data, careful estimates indicate a global prevalence of < 1% celiac disease. This figure, however, may be an underestimate since many celiac patients appear to remain undiagnosed. In addition, non-celiac-gluten/wheat sensitivity has recently been defined as a multi-factorial disorder, which significantly overlaps with irritable bowel syndrome and for which no diagnostic test exists (3). Mean-while "gluten free" has become a kind of "healthy life style hype", with a followers-percentage of up to 30%, much higher than what may be explained based on current insights. This presentation will highlight background data and current developments.

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First Session: The role of wheat diversity in human health

Evidence of health impacts of wheat intake – epidemiological perspective

Prof. Dr. Janet Cade*

University of Leeds, GB

Wheat comes second to rice as a main food crop; with many nutritional benefits. In wholegrain form providing fibre, carbohydrate, protein including bioactive peptides, B vitamins and minerals. However, it is often highly processed losing many of these benefits. Whole grain foods can include a health claim in the US linked to reduced risk of cancer and heart disease. In Europe, whole grain foods do not merit claims due to inconsistent characterisation.

I will review some benefits and concerns to health for wheat products differentiating between whole grain and refined foods.

Diabetes: a recent review related to cereal biodiversity suggested that some ancient cereal varieties may support lowering glucose and insulin level in healthy and diabetic participants. However, evidence for whole grains, which was more extensive, was conflicting (1). A meta-analysis of cohort studies suggested that a high whole grain intake, but not refined grains, was associated with reduced type 2 diabetes risk (2). A further review of randomised controlled trials (RCT) found that a low glycaemic index diet showed better improvement in glycated haemoglobin levels in people with diabetes than high-cereal/wheat fibre diets (3).

Heart disease: specific types of whole grains including whole grain bread, whole grain breakfast cereals, and added bran, as well as total bread and total breakfast cereals, fibre from cereals and insoluble fibre have been associated with reduced risk of cardiovascular disease and/or all-cause mortality, but there was little evidence of an association with refined grains (4). Our own cohort has shown that greater intake of cereal sources of fibre in those with higher BMI may be associated with reduced stroke risk (5).

Weight control: a review of 20 RCTs concluded that consumption of cereal beta-glucans decreased body weight and BMI, though did not affect energy intake. However, prospective studies have not shown this effect for whole-grains. Whilst evidence is consistent around breakfast cereal linked to healthy weight it may not be a causal association, and for wheat does not appear to be linked to satiety.

Cancer: the WCRF systematic reviews have shown that wholegrain consumption reduces risk of colorectal cancer – 17% decrease per 90g wholegrains/day; concluding that the evidence is strong enough to state that wholegrains probably protects against colorectal cancer. However, cereals contaminated with aflatoxin are convincing causes of liver cancer.

The challenge for food producers is to maintain beneficial components during processing. More than 80 countries fortify flour, though evidence of effectiveness in reducing the prevalence of anaemia is limited. Flour fortification appears to reduce risk of low ferritin in women. The UK is currently consulting on fortification of flour with folic acid, linked to reducing neural tube defects. Whilst not all wheat products are classed as ultra-processed foods, some (biscuits, noodles, snacks) are included with potentially negative health implications. Much of the epidemiological evidence is limited by lack of detailed methods measuring food and nutrient intake. New technologies, such as myfood24, using online approaches could help us to collect more robust and meaningful data.

Keywords: health, wheat, whole grain, diabetes, heart disease

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First Session: The role of wheat diversity in human health

Is non-coeliac gluten sensitivity an epidemic or just a myth?

Dr. Atilla Bektaşı[1], Prof. Dr. Hamit Koksel[2]*

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Coeliac disease is a disease of proximal small intestine that develops as a permanent intolerance against gluten or other gluten-like cereal proteins in individuals having genetic predisposition by autoimmune mechanisms. Coeliac disease is a serious disease with a prevalence of approximately 1% in global population. It is necessary to completely remove foods containing gluten, a group of proteins found in wheat, barley and rye from the diet in order to treat the coeliac disease. Non-coeliac gluten sensitivity / intolerance (NCGS)is a situation that we have often heard about especially in the last decade. Even though the prevalence of NCGS in the general population has been asserted to be 6%, there is often no clear data on the actual frequency of the disease owing to self-diagnosis without a medical evaluation.

Since prevalence studies consist of heterogeneous groups, most of the time including anecdotal observations, the prevalence is reported to have such a wide range as 0.63 - 6%. According to several researchers, NCGS which happens to be slightly more common than Coeliac Disease, constitutes a small subgroup of irritable bowel syndrome. Complaints about NCGS are similar to those about Irritable bowel syndrome. However, neither of them is a serious disease as compared to celiac disease. In recent years, a disproportionately growing gluten-free food market has been created in the world in line with the rate of incidence of the “gluten-associated diseases”. Some NY Times bestseller books have also contributed to growth of this market. These books having no clear scientific evidence point out gluten in cereals as the cause of many different diseases such as depression, obesity, arthritis, infertility, while at the same time presenting the gluten-free diet as if it were the elixir of life. On the other hand, there may be different “food sensitivities” or “food allergies” to not only cereals but also several other foods, food ingredients and food additives.

Cereals such as wheat are economic and easily accessible. They are the main constituents of the Mediterranean diet, which is considered to be the world's healthiest diet. It has been demonstrated in scientific studies that gluten-free diets consumed by individuals without coeliac disease cause an increase in the incidence rate of chronic diseases (cardiovascular diseases, diabetes, obesity, etc.) and certain cancers. Hence, the recommendations of professional food activists giving unhealthy medical advice to replace cereals that have been the basis of our diet for thousands of years are considered illogical.

Keywords: Gluten, Non-coeliac gluten sensitivity / intolerance, Coeliac disease, gluten-associated diseases, irritable bowel syndrome

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Second Session: Wheat products and health

AXOS: From wheat bran to Arabinoxylan Oligosaccharides: Production, demonstration of prebiotic effects, regulatory aspects and product applications

Prof. Dr. Jan Delcour*

KU Leuven FEB, BE

Prebiotics are selectively fermented ingredients that allow specific changes, both in the composition and/or activity of the gastrointestinal microflora, that – as defined – confer benefits upon host well-being and health. The most studied prebiotics are the fructans inulin and fructo-oligosaccharides. Over the past years, we used a multidisciplinary approach to study the properties of arabinoxylan oligosaccharide (AXOS) as a novel prebiotic. We here report on a pilot scale enzymatic process for extracting AXOS from wheat bran, a milling co-product which is rich in the dietary fibre arabinoxylan. We executed studies of their prebiotic effects in chickens and rats as well as in humans. We also demonstrate the feasibility of in situ production of AXOS in breadmaking by using appropriate enzyme technologies and deal with their regulatory status in view of the most recent definitions of dietary fiber and the views on health effects of prebiotics. A major feature of AXOS is that, in the colon, it is selectively fermented to short chain fatty acids in general and butyric acid (a fuel for colon mucosa cells) in particular. AXOS induces specific changes, both in the composition and/or activity of the gastrointestinal microflora, that confer benefits upon host well-being and health. It thus meets the criteria needed for classification as prebiotics. However, EFSA does not allow health claims which are based on changes in the gastro-intestinal microflora.

Second Session: Wheat products and health

Importance of wheat diversity in human health

Prof.Dr. Hakan ÖZKAN*, Mr. Uğur SESİZ

University of Çukurova, TR

The transition from hunting and gathering to agriculture had revolutionary consequences for the development of human societies. Crops such as wheat, barley, lentil, pea, and chickpea played a crucial role in the establishment of complex civilizations in Fertile Crescent. It is generally accepted that during the process of wheat domestication and the spread of domesticated wheat, new adaptive traits suitable for new environments were selected by the farmers. Thousands of years of cultivation aided by natural and human selection have resulted in the evolution of immense diversity of genotypes in the predominantly self-pollinated wheat species. A number of socio-cultural factors, food traditions, and agro-ecological environments favored the cultivation and utilization of diverse wheat genetic resources, including primitive or hulled (e.g., *Triticum monococcum*, *T. dicoccum, T. spelta*), and free-threshing wheat species (e.g., *T. durum, T. aestivum*), constituting what is now known as landraces. Each wheat species or landrace has particular significance in the food culture, as a source of the daily diet, and of food and drink for special occasions.

The Green Revolution, which occurred throughout the 1940s to the 1960s, led to the development of high-yielding, disease resistant wheat varieties with dwarfing genes. The success of these varieties is probably the most important event in the history of modern agricultural research. However, increasing reliance on relatively few varieties in most breeding programs has led to the loss of well-adapted landraces. It is well known that wheat landraces provide a rich source of genes, not only for creating new high-yielding varieties, but also human diet. Wheat landraces generally have both private and public values. The farmers grow for their private goods. However, the purpose of research institutions is to use them for the wheat breeding program as a source of useful genetic material. Actually, both of them are very important for sustaining food security and coping with current and future climate change effects. In this presentation, I will discuss wheat diversity and how we can use wheat diversity for human health.

Second Session: Wheat products and health

The historical image of wheat: from "The principal nutriment of man" to health concern

Prof.Dr. Åsmund Bjørnstad*

Norwegian University of Life Sciences, NO

The title – adopted from the Roman writer Pliny (Book 18) exhorts bread wheat as the very choicest of all the varieties of wheat. It is "white, destitute of all flavor, not oppressive to the stomach and furnishes bread of the very finest quality and the most esteemed delicacies of the bakers". Wheat was both nutrition and a class marker, and already the ancient Greek elites discussed which grain was the more wholesome. The Roman Empire, that followed the cultivation limits of winter wheat and vines and made wheat a world crop, destined for supplying Rome, also formed the taste of the two later millennia. Eighteenth century nutrition pioneers like Parmentier advocated white wheat bread without bran, a century later made available for all by roller mills and mechanized baking. The roller mill and the “imperialism of wheat”, inherent in the colonial or settler economies, eventually made wheat a world crop. Then, numerous health pioneers like Graham and Kneipp promoted whole grain. The triumph of white loaves in the twentieth century argued from nutritional science, class and sometimes race, but also did away with the competitors, artisanal and home baking - and often qualities like taste. Its revival paradoxically also revived bread as a class marker, and Pliny’s praise is more controversial than ever.

Second Session: Wheat products and health

Minerals and phytochemicals composition in a diverse set of wheat: contribution to daily intake requirements

Prof. Dr. Eva Johansson*, Ramune Kuktaite, Mahbubjon Rahmatov, Maria-Louisa Prieto Linde, Anders Ekholm, Yuzhou Lan, Hans Larsson

The Swedish University of Agricultural Sciences, SE

This study encompass a wide array of wheat material, including more than 300 spring and winter wheat genotypes of selections, old landraces, primitive wheat, spelt, old cultivars and cultivars types, around 50 locally adapted spring and winter wheat of cultural origin (older Swedish origin) and around 50 wheat genotypes of spring and winter wheat with alien chromosome fragments translocated. These genotypes were either grown in multiple locations and years or in the green-house with multiple treatments, from well-watered to drought treated. Then samples were analyzed for twelve nutritionally important minerals (B, Cu, Fe, Se, Mg, Zn, Ca, Mn, Mo, P, S and K), content of various heavy metals and/or for phytochemicals composition of carotenoids, tocols and phenolic compounds. The amount and composition of the various evaluated compounds were found to vary widely among the wheat samples. Generally, high content of some of the compounds were observed in primitive wheat, old cultivars and genotypes of cultural origin as compared to more modern wheat material, e.g., cultivars and spelt wheat. Furthermore, some of the alien translocated material was found with high content of some of the compounds. The evaluated compounds varied mostly independent of each other making it possible to select genotypes for cultivation and breeding with high content of several of the compounds. High nutritional yield and high nutrition density was observed for a number of the evaluated wheat genotypes while cultivated in certain cultivation systems. This study also showed that a very high mineral concentration, close to daily requirements, as well as high content of certain phytochemicals, can be obtained by selecting genotypes with high content of certain compounds and growing them in suitable cultivation conditions. Thus, by selecting genotypes for further breeding with a high nutritional value, environment and cultivation conditions that favor a high nutritional content in wheat and by defining the genetic origin and environment x genotype interactions for nutritive content of the wheat, the nutritive value of wheat flour for human consumption can be improved.

Second Session: Wheat products and health

Environment, nitrogen management and genotype effects on nitrogen dynamics and quality traits of durum wheat varieties

Ms. Marina Mefleh*, Prof. Dr. Rosella Motzo, Prof. Dr. Francesco Giunta

Università Degli Studi di Sassari, IT

Old durum wheat cultivars have been proposed as a sustainable management option for cultural systems with low input of the less fertile areas of the Mediterranean environment (Guarda et al, 2004) where old cultivars can achieve a grain yield comparable to the modern ones but with a higher nitrogen grain content better suited for the production of traditional products such as bread (Mefleh et al, 2019).
The grain quality traits and the grain yield of old durum wheat cultivars have been intensely explored in response to nitrogen (N) application. However, it is lacking an analysis where the variation of grain protein fractions and subunits are explained according to a physiological frame where the role of grain number per unit area and the N available to the grain are recognized. In our study, we have tested the role of grain number, their components and the N absorbed by the crop to explain the variation in grain protein content and percentage in a set of 12 old durum wheat cultivars compared to two intermediate and two modern durum wheat cultivars specifically selected for grain quality and grown in a two years field trial under two different low levels of nitrogen (N46 and N86kg/ha-1). Among the parameters studied were, nitrogen uptake and content in the various plants parts at anthesis and maturity, mg of N in the grain (GNmg) and protein percentage, gluten fractions (gliadins, glutenins) and their subunits (omega, alfa and beta, gamma and high molecular and low molecular weight (HMW and LMW)) in the grain (as a function of mg of N), extractable and un-extractable proteins (UP%), un-extractable polymeric proteins percentage (UPP%) and the allelic composition of gliadin and glutenin. 2017 was much drier and hotter than 2016 and our results showed that at anthesis, old cultivars accumulated more N in their biomass due to their higher dry matter. However, N percentage was not different among cultivars. At maturity, the N source in the drier 2017 was limited to the N present at anthesis for old varieties. Whereas, in 2016, N uptake continued after anthesis and represented 14 to 26% of N source. In spite of the larger source of N in old varieties, they had a lower N harvest index concluding that N was structural and was not translocated to growing grains. Old cultivars displayed a superior GNmg and grain N percentage due to their lower grain number. The drier 2017 increased UPP%, gliadins and the subunits alfa, beta and gamma. Fertilization treatment increased UPP% and all proteins fractions and subunits except alfa, beta and gamma. Genotypes had an effect on all quality parameters. One of the modern varieties had the least amount of GNmg and all proteins fractions yet keeping a high UPP%. At N46 and in both years, gliadins showed a greater increase than glutenins with the increase of GNmg. However, at N86, the increase of glutenins was much greater and especially in 2017 where the increase of gliadins with the increase of GNmg was not significant.

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Second Session: Wheat products and health

Improving nutritional quality, productivity and profitability of wheat production through conservation agriculture in Indo-Gangetic plains of south Asia

Dr. Hanuman Jat[1 *], Dr. Parbodh Sharma [2], Dr. Raj Gupta[2], Dr. Ashim Datta[2], Dr. Madhu Choudhary[2], Dr. Mangi Jat[3]

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Indo-Gangetic plains (IGP) of South Asia contributing bulk of food, employ a large portion of work force (~46%) and contributes significantly in economy (17-25% of GDP). Yet, approximately 40% of the children (at the age of 5 years) are malnourished that lead to poor health. Wheat is one of the major food staples of the region where several millions of people depend on wheat and rice as a primary source of food and nutrition. Because of high prices of pulses in South Asia, people rely mostly on cereals and green vegetables that are low in proteins. More than 60% of the vegetarian diet are lack of required amount of proteins. The rice-wheat (RW) production system of the region delivers relatively high economic returns to investment. Due to yield dilution effects in this highly productive conventionally managed RW system of the IGP, the grain quality has remained a concern to meet the nutritional requirement of the wheat eating vegetarian population. Further, in the face of projected climate change, higher CO2 concentrations will sap the protein contents of rice and wheat by ~7.7% by 2050. Better soil health, crop diversity, and favourable growing environment are the key indicators to determine nutritional quality and agricultural sustainability in the region. Among several non-sustainability factors in traditional RW system, intensive tillage, residue burning and over-pumping of ground water are the major causes of concerns. To address these issues, conservation agriculture (CA) based sustainable intensification of RW system has shown potential to sustain productivity, improve profits while arresting natural resource degradation.

A production scale long-term strategic research platform was established in 2009 at ICAR-CSSRI (Central Soil Salinity Research Institute) in collaboration with International maize and Wheat Improvement Centre (CIMMYT) Karnal (29°70′N, 76°96′E), India. Four management scenarios (Sc) consisting of i) conventional-till (CT) rice-CT wheat (Sc1; farmers' practice; FP); ii) CT rice-Zero tillage (ZT) wheat-ZT mungbean (Sc2; partial CA); iii) ZT rice-ZT wheat-ZT mungbean (Sc3, full CA); ZT maize-ZT wheat-ZT mungbean (Sc4; full CA with crop diversification) were evaluated. On 6-year mean basis, productivity and profitability of wheat was increased by 16 and 32%, respectively in full CA- based systems over farmers' practice (5.02 Mg ha-1 and USD 988 ha-1). After 6 years of continuous cropping with different management practices, wheat grain quality parameters viz., protein content, wet gluten and sedimentation value were increased by 15.89, 15.17 and 6.47%, respectively under CA-based system (Sc2 to 4) compared to FP/Sc1 (8.9%, 19.63% and 51.33 ml). Our results provides a new science based evidence that CA based sustainable intensification of wheat based systems in IGP not only improves the productivity, profitability and sustainability of the production systems but also improves the grain nutritional quality (protein and wet gluten content) and reversing the 'Yield Dilution Theory'. Therefore, adoption of CA systems can be seen as resource conserving, farmer profit enhancing, and sustainable production paradigm for future food and nutritional security in densely populated wheat based vegetarian people so as to contribute to Sustainable Development Goals (SDGs) in South Asia.

Keywords: Indo-Gangetic plains, Rice-wheat sysytem, nutritional quality

Third Session: Exploiting wheat diversity for health benefits

Exploiting genetic diversity in wheat breeding to improve the nutritional value

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Wheat is the dominant staple crop in many countries of the world. Despite the health beneficial effects of a whole-grain diet, the majority of wheat products are processed from refined flour. Neglected wheat varieties and species, and genetic stocks developed during the height of wheat cytogenetics in the 20th century, pose an important genetic reservoir, which can be exploited manifold in wheat breeding with respect to end-use quality. For example, genes for grain colour (Ba, blue aleurone; Pp, purple pericarp) and endosperm colour (Psy, phytoene synthase) can be stacked to develop wheat with a specific functional whole-grain flour quality and high antioxidant activity. On the other hand, several adverse health effects were ascribed in recent time to wheat compounds such as amylase-trypsin inhibitors (ATIs) or fermentable oligo-, di- and monosaccharides, and polyols (FODMAPs). Breeding activities to reduce the fructan concentration in wheat grains have been demonstrated e.g. for spelt wheat. However, a significant reduction in the FODMAPs burden can be more easily attained by processing, e.g. sourdough fermentation. With respect to ATIs a significant lower concentration was observed in some accessions of the underutilized hulled wheat species einkorn and emmer. The activity of the ATIs, however, was high for most einkorn accessions while it was also comparable low for emmer. Currently available data also suggest a significant genotype by environment interaction with respect to ATIs. Therefore, the breeding of a 'low-sensitive' wheat remains a major challenge.

Keywords: *Triticum aestivum*, anthocyanin, antioxidant, FODMAPs, ATIs

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Third Session: Exploiting wheat diversity for health benefits

Exploiting genetic variation to improve wheat quality to deliver health benefits

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The role of food in the prevention of chronic diseases, such as type 2 diabetes, obesity and cardiovascular disease has been increasingly recognised. As wheat remains a staple in very many temperate countries, improving the quality of wheat to deliver health benefits, by processing or genetic improvement, is an attractive and cost-effective option to combat the rise in these chronic diseases. Wheat is usually consumed after processing substantially reducing the levels of beneficial components such as minerals dietary fibre and phytochemicals. There is now a substantial body of evidence suggesting that increased consumption of highly refined products (including bread and other products from white flour) contribute to increases in chronic diseases. Furthermore, there are a number of accepted health claims for cereal dietary fibre including reduced risk of a range of cardio-metabolic diseases. The major DF components of wheat grain are cell wall polysaccharides, arabinoxylan (AX) and β-glucan which both vary in their amount, composition and are markedly depleted in white flour.

The content of AX varies between different genotypes of wheat and is highly heritable. The exploitation of this variation to develop improved wheats has been limited by the lack of tools for selection, with biochemical analyses being slow and costly. I will discuss results from the Designing Future Wheat (DFW) strategic programme where we have determined the genetic control of AX content in white flour of wheat, by exploiting crosses between high AX cultivars and developed markers for use by breeders. This will allow the production of high-yielding wheat cultivars with increased DF content in white flour. Improved health outcomes could thus be delivered without the need for significant change in consumer preferences.

Third Session: Exploiting wheat diversity for health benefits

Importance of ancestral hulled wheats in healthy nutrition

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Einkorn (Iza, *Triticum monococcum* ssp. *monoccum*) and emmer (*T. dicoccum* Schrank.) wheats, which have been grown in mountainous areas with a history dating back 12 thousand years, are the ancestors of today's wheat (1). However, they are replaced by modern wheats like Kızıltan 91 durum (*T. durum*) and Bayraktar 2000 bread wheat (*T. aestivum* L.), which are the new generation of high-yielding, can be processed more easily. The consumption of high carbohydrate-based foods is considered to cause an increase in chronic diseases such as obesity and diabetes. (2). In recent studies, carbohydrate nutrition and glycemic index of foods have been reported to be the main factors in the development of type 2 diabetes, insulin resistance and cardiovascular diseases (3,4). Due to the rapid increase in blood glucose and insulin levels, an increase in free fatty acids, dyslipidemia, and endothelial damage occur in the blood due to feeding with foods with a high glycemic index (4). Diets with high glycemic index alter high-density lipoprotein (HDL) cholesterol metabolism and reduce blood HDL-cholesterol levels (5). Ancestral wheats are found to reduce total cholesterol and low-density lipoprotein (LDL) cholesterol levels and prevent inflammation by affecting some enzyme levels in the body due to the antioxidant effect (6).
Cereals are the main source of many micro and macro nutrients (7). When the content of wheat is examined, they are indicated that folate, iron, magnesium and zinc ratios of einkorn (Iza) and emmer wheats are higher than modern wheats (8-9-10). Moreover, gluten content of einkorn (Iza) and emmer wheats are lower than bread and durum wheat. This is due to the fact that the amount of gluten in wheat species is related to the number and structure of chromosomes.
In this study, when the ancestral wheats were compared with modern wheats, we aimed to evaluate the effect of feeding by ancestral wheats against obesity, type 2 diabetes and dyslipidemia, antioxidant and anti-inflammatory activity and iron deficiency anemia, zinc deficiency, folic acid deficiency. We also aimed to determine the ratio of gluten in the wheat content of einkorn (Iza), emmer, durum and bread wheats and to see its effect on rats.

Keywords: Einkorn (Iza) , Emmer , Gluten , Healthy nutrition , Turkey

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Fourth Session: Biofortification with mineral micronutrients

Biofortification of wheat with micronutrients for better human nutrition

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Despite increasing availability of adequate amounts of food to most people, micronutrient deficiencies ("hidden hunger") still represent a major health problem in human populations, affecting over 2 billion people and causing serious health complications and chronic diseases. Inadequate dietary intake of micronutrients is the root cause of hidden hunger. Despite implementation of several intervention programs against iodine deficiency, such as use of iodized salt, inadequate iodine intake is also still growing health concern today, even in well-developed countries.

High prevalence of micronutrient deficiencies is commonly associated with the regions where cereal-based foods with low amount of micronutrients are extensively consumed. For example, wheat contain usually 10 to 15 µg iodine per kg grain that is far too low to meet daily iodine requirement of human populations (i.e., requirement is 150 µg per day). Similarly, in the major wheat-consuming countries, grain Zn and Se concentrations are very commonly low. Generally, grain Zn concentration ranges between 15 and 25 mg kg-1, whereas the target concentrations of Zn to ensure better human Zn nutrition around range from 40 to 50 mg kg1.

Plant breeding, transgenic technologies and agronomic tools (e.g., fertilizer applications) are recommended strategies for biofortification of wheat with micronutrients. Recent results obtained under HarvestPlus and HarvestZinc projects in different countries indicate that targeted foliar fertilizer applications provide highly useful and effective opportunities to improve significantly grain accumulation of micronutrients, particularly in new biofortified wheat genotypes by HarvestPlus program. It is very obvious that plant breeding and fertilizer strategies are complementary and synergistic in enrichment of wheat with micronutrients. Combining of these agricultural approaches result in additive and synergistic impacts on grain micronutrient concentrations. Consuming foods biofortified with micronutrients through plant breeding and agronomy is expected to significantly alleviate human nutritional problems and improve human health.

Fourth Session: Biofortification with mineral micronutrients

Accessing genetic diversity for biofortification breeding in wheat for improved nutritional quality

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Breeding wheat with enhanced levels of grain zinc (Zn) and iron (Fe) provides a cost-effective, sustainable solution to the malnutrition problems in the developing world. Modern wheat varieties have limited variation for grain Zn and Fe, hence a large scale screening of wheat genetic resources at the germplasm bank of the International Maize and Wheat Improvement Center (CIMMYT) was initiated to explore variation for Zn and Fe amongst the wild relatives. Einkorn wheat, wild emmer wheat (*T. dicoccoides*) and diploid progenitors of hexaploid wheat such as *Ae. tauschii*, *T. monococcum*, *T. boeticum* and landraces, were the most promising sources for high grain Fe and Zn concentration, followed by *T. spelta*, *and T. polonicum.* A recent field evaluation of a set of core-collection accessions of landraces (conserved at the CIMMYT gene bank) screened under Zn-enriched soil conditions at Cd. Obregon, Mexico showed that there were more than 2-fold variation for grain Zn (40-96 mg/kg) and Fe (27-56 mg/kg). Interestingly, *T. dicoccoides* introgression lines within bread wheat background showed upto 88 ppm grain Zn concentration. The available genetic variation from different species and landraces were utilized in the biofortification breeding program to develop nutrient-enriched wheat germplasm with competitive yield potential and stress tolerance. A more recent success was the development and deployment of Zn-enriched wheat varieties such as 'Zinc Shakti (Chitra)' and 'WB-02/HPBW 01' adopted by more than 500,000 farmers in India as these varieties were developed from the introgression of a synthetic hexaploid (*Ae. squarrosa*) progenitor crossed into elite CIMMYT germplasm. The 'Zinc Shakti' variety has 40% higher grain Zn with profitable yield potential and matures nearly two to three weeks earlier than the non-biofortified wheat grown in the target regions of South Asia. The first high zinc wheat variety 'Zincol 2016' released in Pakistan, having *T. spelta* in its pedigree. The next wave of biofortified high Zn lines developed using wild ancestors of wheat are being evaluated in large scale on-farm trials in South Asia and Sub-Saharan Africa for commercial cultivation and widespread adoption of smallholder farmers in target regions.

Keywords: wheat, biofortification, zinc, nutrition

Fourth Session: Biofortification with mineral micronutrients

Studying differences in soil and foliar uptake and seed deposition of zinc in HarvestPlus-biofortified wheat genotypes grown in greenhouse conditions.

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More than two billion people around the globe are suffering from malnutrition syndrome specially Zn deficiency. Women and children in developing countries are affected the most and the main reason is reliance on cereal based food to meet daily energy requirement. Wheat being the primary staple food in South Asia (Northern India and Pakistan) is important part of almost every meal and in every house. More than 26% of the population living in region consuming wheat as staple food is diagnosed as Zn deficient. Wheat, like other cereals (maize and rice) are inherently low in micronutrients, therefore, cereal-based foods do not provide enough Zn to meet the individual's daily Zn requirement. Agriculture strategies offer a practical and cost-effective solution to the problem by increasing the Zn concentration in staple food like cereal crops through breeding (genetic biofortification) or fertilization (agronomic biofortification) or combining both approaches. Agronomic biofortification provides an instant solution to the problem by applying Zn fertilizer to the soil and/or to plant as a foliar spray. As an international group, HarvestPlus program along with collaboration of public and private partners has taken initiatives to develop the biofortified high Zn wheat cultivars along with desired agronomic traits. Current study aimed to evaluate the performance of the high Zn biofortified wheat genotypes developed through long-term breeding activities under the HarvestPlus program in Pakistan and India. Ten advanced breeding lines and two mega varieties as check were tested under four fertilizer treatments i) Deficient Soil Zn (or control) ii) Foliar Zn application iii) Soil Zn application iv) both soil and foliar Zn. The results indicate that biofortified lines have higher capacity to absorb and accumulate Zn in grain from soil and foliar Zn fertilizer as compared to check cultivars. A positive correlation was observed in grain yield and grain Zn concentration of biofortified lines. As an average of all biofortified genotypes, 18 % increase in yield and 3.5 folds increase in grain Zn concentration were recorded with the application of both soil and foliar fertilizers. Highest grain yield and grain Zn concentration was observed in an Indian biofortified genotype with both Soil + Foliar Zn application. In south Asian countries like India and Pakistan where soils are calcareous and Zn deficient, the strategy of growing genetically biofortified wheat cultivars with an added application of Zn in soil and foliar form is the best approach to improve yield and grain Zn accumulation. Under such a scenario, the targets for biofortification will be rapidly achieved by combining agronomic and genetic strategies and hence to overcome the malnutrition problem.

Fourth Session: Biofortification with mineral micronutrients

Breeding biofortified wheat for future nutritional security

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National nutritional surveys indicate that the United States population is deficient in a number of minerals necessary for proper function. Mineral inadequacies are hard to diagnose and predispose individuals to many chronic diseases such as cancer, cardiovascular disease, and osteoporosis. Further compounding the issue is the expected drop in the nutritive status of many crops as concentrations of atmospheric CO_2 increases. Without plant breeders actively selecting for mineral concentration more individuals will be at risk of micronutrient deficiency in the coming decades. The consumption of whole grain wheat can provide humans with a number of essential minerals. However, in order to maintain high concentrations of these minerals, it is imperative that wheat breeders focus on nutritional quality. A panel of 237 spring wheat lines selected from ten different breeding programs in North America will be used to conduct a genome-wide association study to identify loci associated with increased grain concentrations of nutritionally important minerals including Ca, Cu, Fe, Mg, Mn, P, Se, and Zn. Mineral bioavailability, determined by indirectly measuring phytic acid levels using a colorimetric assay for inorganic phosphorus, and the connection between mineral content and agronomic traits will also be investigated. The importance of identifying lines low in phytic acid, a large molecule that prevents the absorption of minerals in the gut, could potentially improve the nutritional benefits of whole grains. Loci identified in this study will be useful for creating wheat varieties with improved nutrition and broaden our understanding between the environment and grain micronutrients.

Objectives of this study include:
(1) Identify loci for increased mineral concentration for Ca, Cu, Fe, Mg, Mn, P, Se, and Zn.
(2) Identify significant correlations between increased mineral concentration and agronomic traits.
(3) Identify loci and genotypes with low phytic acid content to improve mineral bioavailability in biofortified wheat.

Keywords: Biofortification, Wheat Breeding

Fourth Session: Biofortification with mineral micronutrients

The effect of biofortification on mineral content and various quality parameters of wheat samples

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Micronutrient deficiency is one of the most important risks for human nutrition and the term 'hidden hunger' has been used to define the micronutrient malnutrition in human diets which are acceptable in calories but lack of minerals (Cakmak et al, 2010; White and Broadley, 2008). World Health Organization defined biofortification as "the process by which the nutritional quality of food crops is improved through agronomic practices, conventional plant breeding or modern biotechnology". Although cereals are generally low in micronutrients compared with other food crops, they can be enriched by biofortification to tackle with the hidden hunger.

The objective of this study was to investigate the effects of biofortification on physical, chemical and physicochemical quality parameters and determine the enrichment in mineral content of wheat cultivars. Six bread wheat cultivars were biofortified with a solution including, zinc (Zn), iodine (I) and selenium (Se) in Ankara and Sivas locations. The results were evaluated by using one-way analysis of variance. When significant differences were found the least significant difference (LSD) test was used to determine the differences among means.

The differences between various quality parameters (thousand kernel weight, hectolitre weight, SKCS hardness index and protein content) of biofortified and non-biofortified wheat samples were not significant.

The results indicated that, in Ankara Location, Zn, I and Se concentrations of non-biofortified samples were in range of 21.2-24.4 $mg.kg^{-1}$, 1.7-35.8 $\mu g.kg^{-1}$ and 17.9-39.1 $\mu g.kg^{-1}$, respectively while the corresponding values of the biofortified samples were in range of 38.0-42.0 $mg.kg^{-1}$, 185.1-448.4 $\mu g.kg^{-1}$ and 184.4-221.5 $\mu g.kg^{-1}$. Similarly, in Sivas location, Zn, I and Se concentrations of non-biofortified samples were in range of 22.8-30.0 $mg.kg^{-1}$, 5.5-39.1 $\mu g.kg^{-1}$ and 20.1-39.1 $\mu g.kg^{-1}$, respectively while the corresponding values of the biofortified samples were in range of 34.0-45.0 $mg.kg^{-1}$, 145.7-409.2 $\mu g.kg^{-1}$ and 188.7-261.1 $\mu g.kg^{-1}$.

According to these results, in Ankara location, Zn, I and Se contents of biofortified samples were 1.5-1.8, 12.5-107.0 and 5.7-10.3 fold higher than the respective values of non-biofortified samples. Likewise, in Sivas location, Zn, I and Se contents of biofortified samples were 1.5, 10.5-26.4 and 5.3-9.4 fold higher than those of non-biofortified samples, respectively.

Keywords: wheat, biofortification, quality, hidden hanger, micronutrient deficiency

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Fifth Session: Beneficial components in wheat-1

Anthocyanins in wheat grain: Health benefit, bread-making quality and marker-assisted breeding

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We used two wheat near-isogenic lines having almost similar genomes with the exception of a small part of chromosome 2A, which contains the Pp3/TaMyc1 gene regulating anthocyanin biosynthesis. The use of such an accurate model has allowed relating the observed differences precisely with anthocyanin biosynthesis. Using mice as a model for neurodegenerative changes caused by Alzheimer's and Parkinson's diseases and natural aging, we revealed the beneficial effect of a grain diet with a high content of anthocyanins on the working memory and molecular processes of neuroregeneration. Further important task was to evaluate the resistance of anthocyanins to the backing process. Therefore, anthocyanin content was evaluated not only in the end-use product, but also in mixtures of flour and bran used for baking and separately in the bran. As a result, significant differences were detected in samples obtained from anthocyanin-rich grains, compared with the control including the products that had passed a full processing cycle. For the extraction of anthocyanins conditions were simulated most similar to those in the process of digestion in the stomach, in order to assess the amount of assimilable anthocyanins. By our estimates one can get up to 1.03 mg of assimilable anthocyanins with 100 g of whole-grained bread produced from anthocyanin-colored grains. It was shown that bread-making quality and organoleptic properties of bakery products made from anthocyanin-rich grains did not concede, or in some cases were higher than the corresponding properties of products obtained from control grains. It was found that the presence of anthocyanins increases the shelf life of bakery products and their resistance to molding in provocative conditions. These results, combined with the data about the beneficial health effects of anthocyanins, suggest that wheat bakery products made from anthocyanin-rich grains can be included to the list for dietary food. In addition, we have worked out an optimal scheme for the accelerated creation of wheat breeding lines with a high content of anthocyanins in the grain pericarp.

Fifth Session: Beneficial components in wheat-1

Biological Activities of Secondary Metabolites in Wheat Varieties

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Generally, the structure of wheat contains antioxidants such as phenolics, flavonoids, and carotenoids (1). The nutritional content of the hulled wheat is completely different from that of bread (*Triticum aestivum* L.) and durum (*Triticum durum*) wheat. Low carbohydrate content, high protein and the fiber content of the grain are easy to digest and low cholesterol levels are known to have a positive effect (2).

Wheat is known to have important contributions to human health and nutrition. When consumed daily, health benefits are related to the content of wheat (3). Phenolics in wheat are secondary metabolites that are responsible for protecting the plant from UV rays, inhibiting pathogens and maintaining cell wall structural integrity (4; 5; 6). The concentration of phenolic matter in wheat varieties according to species, genetic diversity and the part of the grain used (7). Wheat has antioxidant properties against free radicals and reactive oxygen species which cause cancer and cardiovascular diseases in terms of phenolic compounds they contain (8; 9). The amount of phenolic acid in whole wheat products was higher than processed wheat. Emmer (*Triticum dicoccon*) wheat had higher phenolic acid content than einkorn (*Triticum monococcum* ssp. *monococcum*) (10; 11). Flavonoids are extensively found in the outermost part of wheat germ (12). They affect various cellular activities such as cell signal transduction, apoptosis, and reactive oxygen. Consuming wheat with high flavonoids content reduces cancer and chronic diseases, including Alzheimer's (13). Flavonoids, which have antioxidant properties, can serve as anti-inflammatory and anti-cancer prevention and control of obesity (14). Einkorn wheat has a higher flavonoid amount than bread and durum wheat. Emmer wheat is also beneficial for health due to its high flavonoid content (15; 11). Carotenoids; can be found in plants. Animals cannot directly synthesize carotenoids. Therefore, humans can take carotenoids through plant food. In humans, carotenoids play various roles in metabolic and physiological functions. Due to their antioxidant activity, carotenoids in wheat have a role in preventing cardiovascular diseases, various cancers and neurological diseases, and delaying aging. Some carotenoids are converted to vitamin A (16). Vitamin A deficiency causes anemia in humans (17). Wheat may play a role in the prevention of this disease. Also, wheat has an anti-cancer effect. Scientific studies on the stomach, lung, colon, and breast cancer have shown that the consumption of whole wheat can reduce the risk of cancer formation (18). Cereal-based nutrition would reduce the risk of colon cancer and insoluble fiber-containing fruits and vegetables have proven to be effective in reducing the risk of disease compared to dissolved fiber. Wheat bran oil was shown to prevent colon cancer (19). Recently, due to the increase in antibiotic-resistant infections, research into new drugs to combat these infections has become a major necessity (20). Wheat germ can use as a natural antibacterial agent against Listeria monocytogenes. It can also be effective hospital-acquired bacteria *Staphylococcus aureus* and *Escherichia coli*. In addition to wheat germ, wheatgrass has an anti-bacterial effect against gram-positive (*S. aureus* and *Bacillus subtilis*) and gram-negative (*E. coli*) bacteria (21; 22).

Keywords: antioxidant, anticancer, antibacterial, einkorn, emmer, durum wheat, bread wheat

Fifth Session: Beneficial components in wheat-1

Chemical contents of wheat varieties in the world

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Wheat is one of the main food sources in the world. According to 2017 statistics of United Nations`s Food and Agriculture Organization, 771.7 million tons of wheat is produced from 218.5 million hectares of harvested area in the world and the average yield is 35312 t/ha (1). China takes the lead of production, although Russia and the USA produce remarkable wheat, as well. Turkey also has taken place in the top ten in the world. In 2017, Turkey got 21500 t/ha average yield of wheat from 7.669 million ha harvested area (2). Therefore, it is important to know the health benefits of this plant. First of all, it is rich in polyphenols. Phenolics are mainly in bound form and attached to the cell wall in wheat. Because of that, they cannot be digested until they reach the colon microflora (3). Thus, these features reduce colon cancer risk. The major form of phenolic compound in wheat is phenolic acid and mostly found in bound form (4). Phenols have got antioxidant, antimutagenic, anti-inflammatory and anticancer abilities. Antioxidant ability lowers the risk of DNA damage, because of that it protects to happen mutation. Moreover, they lower the risk of chronic disease. Secondly, tocols are included in the wheat, too. Vitamin E has known as an antioxidant, and tocopherols with tocotrienols are vitaminers of vitamin E (5). Tocopherol and tocotrienols reduce LDL cholesterol, and tocotrienols reduce the risk of breast cancer formation (6). Third, carotenes which give yellow-orange pigment to the seeds have been found in wheat. They are antioxidant compounds that reduce the risk of age-related and chronic disease (5). Carotenoid and xanthophylls are two main classes of carotenes. As tocols, carotenes are not produced by animals; they must take these compounds from plants (7). Fourth, macro and microelements have been seen in wheat. Minerals are important for living organisms, as they perform in the enzymatic reactions. That means all body process needs minerals (8). Even though some minerals in cereals are seen in low concentration, usage of specific organic systems and genotypes make it possible to gain a high concentration of minerals (9). Finally, some types of vitamin B including B1 (thiamine), B2 (riboflavin), B3 (Niacin), B6 (pyridoxal) and B9 (folate) were found in wheat (4). Basically, B1 vitamin maintains blood level and helps to produce energy; B2 decreases the cardiovascular disease, skin lesion anemia and nerve degeneration, also plays in the role of energy producing; B3 places in energy making in cells, as well; B6 takes places in amino acid, lipid and carbohydrate metabolism; B9 serves protein and blood formation.

Genotype, agrotechnical, thermal treatment processes and environmental factors can change the concentration of these components (4,10). Also, these ingredients can be seen in different density in the wheat layers (11,12,13). In this study, tocols, carotenes, macro and microelements, phenolic compounds and types of B vitamin contents will be discussed between wheat varieties found in Turkey and in the world. Moreover, the importance of the human health of wheat will be examined.

Fifth Session: Beneficial components in wheat-1

Diversity in grain nutritional and industrial quality traits of durum wheat landraces from Iran and Mexico

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Durum wheat is one of the most important crop in the world, and since its origin in the Fertile Crescent thousands of landraces were generated worldwide, being part of them conserved in Germplasm Banks. The local character of a landrace could stem from its grain quality characteristics that often are suitable to produce a specific local product according to the consumer´s preferences in a given area (processing, cooking, baking and taste). Because of this, landraces could be interesting sources of novel genetic variability for grain quality traits. In this study, thirty-seven Iranian and forty-two Mexican durum wheat landraces were characterized for grain quality traits, including industrial quality traits (grain morphology, protein content, flour yellowness, gluten strength and extensibility, and bread-making quality) and nutritional quality traits (iron, zinc and phytic acid content, soluble and insoluble fiber content in the endosperm, and phenolic compounds). A wide range of variation was found with accessions showing characteristics that are not present in the modern durum gene pool such as high gluten extensibility or medium to high bread loaf volume. The variation for compounds related with nutrition and health were also significant. The landraces were also analyzed for high and low molecular weight glutenins composition. Several novel alleles were described: four for Glu-B1, three for Glu-A3, and twelve for Glu-B3. These results substantiate the importance of Iranian and Mexican landraces as potential sources of genetic diversity for key quality traits in the development of modern durum wheat cultivars with different grain characteristics.

Fifth Session: Beneficial components in wheat-1

Marketing of wheat landraces in Turkey: Actors and models

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Scholars argue that market-oriented mechanisms, such as niche markets, voluntary standard systems (e.g., organic, fair trade) and protected designation origins, can support conservation of wheat landraces and rural livelihoods, promote biodiversity, as well as address climate change adaptation and nutrition security. However, in contemporary agricultural markets, small farmers often face disadvantages compared to large-scale commercial farmers who can provide larger volumes at market-demanded standards, bargain better for their economic interests, and have better access to information, technology and capital. In the last decade, there has been a growing emphasis in Turkey on "miracle foods," wheat landraces as a source of nutrition and health food, and conservation of local seeds as Turkey's heritage and source of pride. This paper discusses different models of market-oriented mechanisms for Turkey's wheat landraces, and argues that different actors, such as municipalities, artisan bakers, local traders, are critical in sustaining the market access of wheat landraces. The findings are based on fieldwork in Malatya, Tokat, Amasya, Balikesir, Canakkale, Istanbul and Ankara, in May-July 2019, funded by partners in the International Treaty on Plant Genetic Resources for Food and Agriculture Project. The fieldwork includes semi-structured interviews with several stakeholders including farmers, farmer-traders, traders, artisan bakers, mayors, NGO representatives, and focus groups with consumers on factors affecting their consumption, knowledge and choice of wheat landraces (particularly Sari Bursa and uveyik). The preliminary findings from the focus groups suggests that consumers are knowledgeable about one or two wheat landraces that are nationally marketed, but they are also confused by misinformation circulated by the media, TV celebrities and social media. Moreover, while access to wheat landraces through local, regional or online markets allows consumers a steady source of wheat landraces, lack of regulation (e.g., protection of origin) and profit concerns (of the markets) can limit this access for majority of consumers. This paper aims to highlight these changes in Turkey's markets in the last decade related to marketing of wheat landraces, and discuss some of the successes and problems of different models that have emerged.

Fifth Session: Beneficial components in wheat-1

Tir as a landrace and a sowing method

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Tir wheat (*Triticum aestivum* L. ssp. *vulgare* Vill. v. *leucospermum* Körn.) is a landrace of bread wheat grown around The Lake Van Basin in Eastern part of Turkey. The altitude of this region is between 1600-2000 m. The average annual precipitation is 300-600 mm. Tir is also the name of a sowing method applied as a solution to undesirable soil properties of the region. Tir wheat has been grown in the region on a silty soil by the local farmers for centuries. Also, the Tir sowing method (sowing in furrows) has been used to ensure the emergence of the wheat plants after sowing. There is a synchronization between the genotypes and sowing method. For example, in Tir Sowing Method, the seed must be sowed at least at 8 cm down below of the soil surface, this may cause in taller coleoptile in Tir wheat over centuries. Like other wheat landraces, the baking quality of Tir wheat is moderate, and it is not preferred by the bread wheat industry. However, local people mostly use its flour for making the traditional lavash bread baked in tandoor. Tir has considerable variations concerning many traits. Its specific characters are a long coleoptile length, strong stem, resistance to diseases, stable yield in its region.

Fifth Session: Beneficial components in wheat-1

Oats − a crop for functional nutrition

Prof.Dr. Igor Loskutov*

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The evaluation of cereals genetic resources is important for the selection of source material for plant breeding. Recently, the most important directions of breeding for oats are, in addition to grain productivity, grain characters associated with properties for functional nutrition. The traditional directions of breeding these crops are increasing the content of protein, lysine and starch, and the dietary properties of grain are now in demand. The grain quality of oats depends on the resistance to fungal diseases. Diseases not only reduce the grain productivity of crops, but also worsen crop quality due to the accumulation of toxic metabolites. Fusarium of grain − a disease that, first of all, significantly reduces the quality of products and their safety. Mycotoxins that accumulate in the kernels reduce the consumer properties of these crops and, when used, adversely affect human and animal health. Many researchers note that naked varieties of oats are more resistant to grain damage by fusarium and less accumulate mycotoxins.

Complex field and laboratory evaluation of accessions of cultivated species of the genus *Avena* collection at VIR were conducted. When studying samples of oats of grain contrasting in parameters of resistance to fusarium (joint work with VIZR) on protein content, oil, fatty oil composition, an negative correlation relationship was found between protein content in oat grain, linolenic acid content in oat oil and infection with fusarium. Conducting joint research with the Department of Biochemistry and Molecular Biology of VIR on biochemical characteristics allowed us to identify high-quality genotypes of oats. The results of metabolic analysis revealed a variety of spectra at the species and intraspecific levels. It was found that naked oat varieties had large total indicators for organic, fatty and amino acids, sterols, disaccharides and total sugars, and covered varieties had high values only for monoacylglycerols, polyatomic alcohols and monosaccharides. A large variety of metabolic spectra was found at the species level of cultivated oats and between varieties of different levels of breeding. The analysis of the micronutrient composition (joint research with St-Petersburg State University) in *A. sativa* accessions showed genotypes with a high content in the groat of such essential elements as Fe, Zn and Mn.

Therefore, the global oat collection at VIR is an essential and valuable source of material for ensuring food, bioresource and ecological security, as well as for functional food. Thus, varieties of oats with increased level of economically valuable traits and quality parameters of grains, such as increased content protein, oils with well-balanced fatty acid composition and micronutrients, as well as resistance to fusarium infection and free from mycotoxins, can be sources for breeding of new varieties to improve the quality of grain for the production of safe high-quality, dietary and functional foods.

Sixth session: Beneficial components in wheat-2

Comparison of ancient grains einkorn, emmer and spelt with bread and durum wheat for food diversity and bread wheat breeding

Prof. Dr. Friedrich Longin*

University of Hohenheim, DE

Einkorn, emmer and spelt are old wheat species that have fed the world for centuries before they have almost completely been replaced by modern bread wheat. Today, their diversity lies frozen in gene banks and rare attempts aim to exploit them as source for genetic diversity and pre-breeding in modern bread wheat breeding. Although of high importance for bread wheat, I want to raise the attention on a more holistic exploitation of ancient species via their direct introduction to the consumer market as high quality products. I speculate that several of them can be reintroduced as crops by creating markets for specialty products, along with a rediscovery of traditional recipes and customs.
A two-step approach for bringing ancient grains back to the consumer is proposed: First, the interests and needs of the market players and consumers have to be identified to establish stable and self-financing product chains with these ancient species. Second, the potential, risks and demands in their holistic production from farm to fork have to be elaborated. This requires intensive interdisciplinary research collaborations involving besides several scientific disciplines like agronomy, cereal technology, human nutrition, and social sciences also stakeholders and policy makers. I am convinced that this concept allows to not only increase the biological diversity in our agro-ecosystems, but also to enrich our food diversity. A central requirement of this concept is an intensive communication, coordination, and interdisciplinary research along the entire production chain from farm to fork.
Using this concept, I have elaborated with co-workers that einkorn, emmer and spelt have lower yield compared to bread wheat and that especially einkorn and emmer have a high risk of lodging requiring higher prices for farmers in order to attract their interest. Protein content appears higher in these ancient wheat species than in bread wheat but the protein quality is lower with higher gliadin/glutenin ratio leading to doughs of low stability. Mineral contents are higher than in bread wheat with increasing amounts in the order spelt, emmer and einkorn. Especially einkorn appears also rich in secondary ingredients like vitamin E and lutein making its products very tasty and with bright yellow colour.

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Sixth session: Beneficial components in wheat-2

Comparison of old and modern bread wheat and landraces genotypes in terms of the arabinoxylan composition and physical properties

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The aim of this study was to compare the contents and composition of arabinoxylans (AXs) in modern and old bread wheat genotypes and Turkish landraces to determine whether there has been a major alteration on wheat genotypes during the last century. The second aim was to determine the correlations between AX composition and physical properties of wheats.

The results indicated that there were no extreme differences between old and modern bread wheats in terms of thousand kernel weight and test weight. Comparison of the wheat genotypes consisting of the old and modern bread wheats and landraces has provided no evidence that modern breeding has had negative effects on the contents of AX components. On the other hand, PCA results indicated that there were no extreme differences between the old and new wheats in terms of AX composition and physical properties. However, the old varieties were generally softer than the modern varieties.

Although, there are a number of publications claiming that wheat has been changed and there are major differences between the old and new wheats, the results indicated that there were no extreme differences between the old and new wheats in terms of their various quality parameters investigated in this study.

Keywords: Bread wheat, arabinoxylan, SKCS, PCA, landrace

Sixth session: Beneficial components in wheat-2

Genome-wide association analysis for arabinoxylan content in common wheat (*T. aestivum*) flour

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Arabinoxylans (AX) are a group of non-starch polysaccharides, which constitute the major component of plant cell walls. Thanks to their biochemical properties, these polysaccharides are able to form highly viscous water solutions exerting a great impact on wheat flour technological properties but also a positive effect on human health. In fact, AX constitutes around 80% of the total dietary fiber in wheat. However, despite the importance that AX have on both wheat processing and nutritional quality, genetic regions associated with variation in AX in common wheat flour have not been clearly identified yet and more studies are needed in order to be able to genetically control this trait. In the present study, the genetic control of both total arabinoxylans (TOT-AX) and water-extractable arabinoxylans (WE-AX) in wheat flour, was investigated in a set of 200 common wheat lines through genome-wide association study (GWAS). The same lines were also evaluated for dough mixing and strength characteristics and bread baking quality. From the AX analysis, wide variation in TOT-AX (10.3-23.4 mg/g) and WE-AX (2.4-8.6 mg/g) was found across the population. Interestingly variation in arabinoxylan content did not appear to have a strong effect on the overall flour rheological properties and modest positive associations were identified between both TOT-AX and WE-AX and sodium dodecylsulfate sedimentation volume (r = 0.13 and 0.22, respectively), mixograph torque (r = 0.14 and 0.16, respectively) and alveograph deformation energy (W) (r = 0.19 and 0.17, respectively). Preliminary GWAS results revealed the presence of 4 markers significantly associated with TOT-AX variation located on chromosomes 1A, 2B, 6A and 7A whereas 15 markers all located on chromosome 7A were found to be significantly associated with variation in WE-AX. These preliminary findings suggest that AX content (especially WE-AX), is controlled by a relatively small number of genes and that molecular markers could be effectively used for the selection of wheat lines with desired AX content.

Keywords: Arabinoxylans, Dietary Fibers, GWAS

Sixth session: Beneficial components in wheat-2

Wheat diversity and grain quality for healthy food

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The interest in natural and organic products led to the reopening of ancient wheat as a source of grain for healthy nutrition. Several wheat species are used and further adapted to cultivation in industrial scale, e.g., *T.turgidum, T.spelta, T.compactum*. In previous studies, wild and primitive wheat species such as *T.monococcum, T.dicoccum* and *T.dicoccoides* have been identified as more promising genetic sources of microelements, compared to modern wheat varieties and breeding lines. It is known that *T.dicoccoides* samples show greater variability and higher concentrations of Zn and Fe in the grain.
It is considered that one way to overcome nutrition problems is a return or resynthesis the ancient wheat species as more nutritious and digestible. Another approach prioritizes creation of modern wheat varieties using new breeding tools, and use of new processing methods. In our case, we created new material following successful hybridization between *Triticum* and *Aegilops* species with modern commercial varieties *T. aestivum*.
Various species of wheat and *Aegilops* have been used, namely: a) diploide (T.monococcum), tetraploide (*T.turgidum, T.dicoccum, T.polonicum, T.persicum, T.militinae, T.timopheevii, T.dicoccoides, T.aephiopicum*), hexaploid (*T.petropavlovskyi*, *T.kiharae, T.compactum, Ae.triuncialis, Ae.triaristata, Ae.ovata*); b) constant introgressive forms. This material have been investigated for (1) macro- and microelement content, especially Zn, Fe, Cd; 2) protein and fractions content, including α6 - gliadine components; 3) content of amylose and β-glucan. It has been found that the highest sources of investigated elements are the *Aegilops* in the following order: *Ae.triuncialis* > *Ae.ovata* (K, P, Mg, Fe, Zn) > *Ae.cylindrica* (Fe, Mn) > *Ae.triaristata* (S) > *Ae.squarrosa* (Ca). The source of high N, Mg, Mn and Fe, Zn contents can be considered *T.kiharae*; of N, P, S - *T.militinae*; Mn, Fe, Zn - *T.petropavloskyi*; of K and Zn - *T.compactum*.
The protein content in the grain of various species was formed to the predominance of different protein fractions: globulin in grain of *Ae.triaristata* (40,6% to the total) and *T.militinae* (35.7%); the gliadin in *T.dicoccoides* (38,9%), *T.dicoccum* (34,5%) and *T.timopheevi* (33.7%).
Maximum content of globulin has been found in three forms: Erythrospermum 350 x *T.militinae*; (Bezostaya 1 x *T.militinae*) x *T.militinae*-6; Steklovidnaya 24 x *Ae.cylindrica*, which can be explained by the presence in their origin of the *T.militinae* germplasm with globulin content in the same reproduction of up to 35.7%.
Wild relatives differed by original electrophoretic spectra of gliadin, including the ω-zone and α-zone for *Aegilops*.
The maximum content of β-glucan is characteristic for *Aegilops* (*Ae.triaristata* and *Ae.cylindrica*), then *T.dicoccoides* and *T.macha*. Consistently high content of β-glucan was observed for in *T.shaerococcum* and *T.timopheevi* grain.
Wild relatives were characterized by an amylose content in the range of: *T.timopheevi* (31,5%) > *T.dicoccoides* (29.3%); *T.macha* (28.1%); T.persicum (27,7%) > T.spelta (27,0%) > T.militinae, T.spharacoccum (26.4%). Amylose content in *Aegilops* ranged from 9,6% (*Ae.triaristata*) to 13,3% (*Ae.triuncialis*).
Nutritional properties of wild and modern wheat was evaluated in processing by old and new technology.

25 - Improvement of key traits by genetics and breeding – Oral

Development of soft wheat (*Tr. Aestivum* L.) varieties suitable for demands of the biscuit industry

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Biscuit sector, which has high exports and value-added capacity, has grown rapidly in the last twenty years in Turkey. The competitiveness of the sector in the domestic and foreign markets depends primarily on the desired quantity and quality of wheat flour. Technological quality of the wheat varieties used for obtaining this flour is not in accordance with the demands of the industry. Enzymes are necessary to weaken gluten strength in the process for adjusting dough properties to target products baking. In this case, production costs increase due to the price of proteolytic enzymes and the waiting period in the process. Besides, irregularities in dough structure are formed in the first, middle and last batch products depending on the activity of the enzyme. As a result, continuous arrangements are necessary for the continuing process and some problems are occurred in standard product weight and packing at the end. Due to the increasing the importance of high bread-making quality varieties in wheat production, determining the wheat price in the market according to the protein content, good care conditions in recent years the chance of using the existing cultivars has declined. So, it is very important to develop new soft wheat varieties suitable for different environmental conditions to meet the biscuit sector demands.
The project, which is within the scope of Scientific and Technological Research Council of Turkey (TUBITAK) priority areas, biscuit wheat developing studies were carried out in the Directorate of the Transitional Zone Agricultural Research Institute. With this project, it was aimed to develop new soft wheat varieties for the production of wire-cut and extruded type biscuits, which are the most critical type of the sector, in cooperation with the university, industry and research institutes. For this purpose, 20 different developed advanced lines for rainfed and irrigated conditions were used. The trials were planted under two different environmental conditions: 7 locations in rainfed and 5 locations in irrigated locations during three crop seasons. Grain yield, some plant morphological and physiological parameters, and disease tolerances were evaluated in the field. Grain physical characteristics, milling performance (break and total flour yield), protein content and protein quality properties (Zeleny sedimentation, GlutoPeak, and Mixolab thermo-rheological properties, and solvent retention capacity tests) were used to evaluate the lines during three years. High Molecular Weight (HMW) glutenin subunits and wheat-rye translocations were also used to contribute to the selection. The lines that have been highlighted have been processed to the final product in order to determine the suitability of end-use quality in the private sector. Product and sensory properties of the lines were determined by the experts and a conformity assessment was done according to reference biscuits. As a result, 2 lines for rainfed and 3 lines for irrigated conditions were found suitable for the demands of the biscuit industry. Two lines were sent to registration trials and two will be sent this year. This study summarizes the studies and results carried out within the scope of the national priority areas of the project.

Keywords: soft wheat, breeding, biscuit sector, technological quality, cultivar

Sixth session: Beneficial components in wheat-2

Advanced analysis for prediction of Yufka quality

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Yufka is a traditional paper-thin flatbread of Turkey and in the Middle Eastern countries. Hence that various quality parameters of wheat varieties are important for yufka production. Aim of this study is to determine advanced analyses for prediction of wheat suitable to yufka. According to some chemical (protein, wet gluten, dry gluten, Zeleny sedimentation, modified Zeleny sedimentation) and rheological (extensograph, farinograph, alveoconsistograph and mixograph) results, 16 Aegean coastal genotypes which are originated from breeding programs of research institute and university, are selected. In this study, advanced analyses were determined by correlations ($r>0.50$, $r<-0.50$; $p<0.05$). It is observed that protein, wet gluten, dry gluten, Zeleny sedimentation, modified Zeleny sedimentation, extensograph 45´, alveoconsistograph, FAR-DDT, FAR-Stab. and MIX-MTAL tests are advanced for the prediction of yufka quality. Textural analyses' results that are called as PEN-Work, KIEFF-Ext., KIEFF-Res., INF-P, Yufka STRECH-Res. and Yufka BURST-Tough were coherent with chemical and rheological results of dough and yufka. The forward genotypes searched in chemical, rheological, textural and structural base of protein for yufka production are stated as EBVD 1-16-E, EBVD 1-8-E, EBVD 2-48-E, KASIFBEY-E, EVD 2.1.2013-E, SAGGITARIO-T, RUMELI-T and ESPERIA-T.
Also, we studied HMW-Glutenin and gliadin subunits with the cluster analysis for these 16 wheat genotypes. According to the cluster analysis, five groups were determined. Some HMW-Glutenin and gliadin subunits have high correlations with these advanced analyses.

Keywords: Yufka, rheology, texture, HMW-Glutenin, gliadin

Sixth session: Beneficial components in wheat-2

Bulgur of ancient wheat species

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Anatolia and Mesopotamia, the homeland of einkorn (*Triticum monococcum* ssp. *monococcum*) and emmer (*Triticum turgidum* ssp. *dicoccum*) wheat, known locally as "siyez" and "gernik", is also the birthplace of the bulgur, the first processed wheat product in history. Bulgur is a tasty, nutritious, long-lasting and non-additive natural product, produced commercially from durum wheat by cleaning, cooking, drying, crushing and grading stages in general. Because of these features, bulgur has increasing popularity and production amount both regionally and worldwide. Bulgur was first started to be produced from einkorn and emmer wheat, but due to low harvest yields, difficult processing and not being able to find enough wheat, durum wheat has taken their place. It is preferred that the wheat for bulgur production has a high protein and hard character as in the same pasta. Ancient bulgur, which has different sensory characteristics than modern bulgur due to its different physical, chemical and technological properties, is still being produced in limited areas today, and the demand is increasing. Einkorn and emmer bulgur are still generally produced in very small quantities at home scale by traditional methods but industrial enterprises are increasing due to increasing consumer interest.

Although there are many studies on the various features of bulgur, only very limited studies investigated bioactive components and their changes. In many studies, it has been reported that einkorn and emmer wheat are richer than modern wheat species for various bioactive components (especially carotenoids and tocols), can retain a significant quantity of these components after bulgur production. It is known that processes such as cooking, drying, bran separation and classification adversely affect the amount of bioactive components. In this study, as well as the bioactive properties of primitive wheat species grown in Turkey, bioactive components such as phenolics, carotenoids, tocols and antioxidant activity of the bulgurs were clarified and compared with bulgur of modern wheat species.

Keywords: Einkorn, Emmer, Bulgur, Bioactive, Antioxidant

Sixth session: Beneficial components in wheat-2

Determination of performance of east Anatolia wheat landraces under Erzurum conditions

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The study was carried out under dry conditions of Erzurum using 180 local wheat landraces and 5 cultivar which had been collected and purified between 2012-2013 and 2013-2014 years. Plant height, number of spikes per square meter, spike length, number of spike grains, spike grain weight, grain yield, 1000-grain weight, hectoliter weight, zeleny sedimentation value and protein content were determined according to two years results.
In each year of the study, drought occurred in different vegetation periods. Therefore, it was observed the decrease in yield and yield components, but the quality values increased. Approximately in half of the local genotypes, spikes occurred before than the registered varieties. In the second year, due to the high rainfall in May and annual total, plant height was taller. The number of spikes per square meter of local genotypes is 243,41 and 81 genotypes are over the average number of genotypes (245,19 spikes) and 42 local genotypes are over the registered varieties average (298,50 spikes).
In the second year, the spikes length of local genotypes was longer, especially as climate conditions are better. Also, local genotypes have more kernel numbers than the average of registered varieties. The early drought that occurred in the first year of the experiment may have caused the kernel number in the spike to be lower. Due to the higher rainfall during the grain filling period, the lengthening of grain filling period caused the number of grain in the spikes of local genotypes to increase in the second year. The average grain weight in per spike was 1,35 g in local genotypes and 2.58 g in registered varieties.
In the first year of the experiment, the average yield of local genotypes was 1472.2 kg/ha, and the average yield of registered varieties was 3508.5 kg/ha; in the second year the average yield of local genotypes was 1640.3 kg/da), and the average yield of registered varieties 1995.4 kg/ha.
The genotypes 1000 kernel weights ranged from 55.13 – 28.05 g. Although local genotypes hectoliter weights were not significantly affected by ecological conditions (81.66 kg and 81.56 kg respectively for years), the hectoliter weights of registered varieties in second year (78.87 kg) were lower than the first year(82.18 kg).
In terms of zeleny sedimentation values, the average of the registered cultivars (35.33 ml) was higher than the average of the local genotypes (34.25 ml). Grain protein is directly related to climate. In both years of the study, the rates of protein were high because of drought during the maturation period. 87 local genotypes had a protein ratio below the average of registered cultivars (14.23%).
In the years when the study was carried out, local genotypes were less affected by drought than registered varieties. In this case, local genotypes may be said to have higher drought resistance potentials. They can be used in drought resistant varieties development studies as it is determined that local genotypes maintain yield stability under drought conditions.

Keywords: Wheat, yield, yield components, quality, Erzurum, Turkey

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Seventh session: Exploiting wheat diversity: international initiatives

Society is grounded because of landrace diversity

Dr. Thomas Payne*

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Crop and food diversity often are emblematic of cultures. This conference focuses on the importance of landrace diversity and its affects on human heath. It has long been recognized that a diverse diet is an important element to health. Currently, humanity depends on a few dozen crops, but the diversity within those crops is extensive. CGIAR genebanks safeguard some of the largest and most widely used collections of crop diversity in the world, critical to attaining global development goals to end hunger and improve food and nutrition security, which arguably gives their stewardship an imperative and prominence unsurpassed by any other single undertaking in CGIAR. Genesys is an online platform where you can find information about Plant Genetic Resources for Food and Agriculture (PGRFA) conserved in genebanks worldwide. Wheat depicted in various forms -- food, art and music -- by diverse cultures is a means to portray security, strength, beauty and health.

Keywords: diversity, culture, health

Seventh session: Exploiting wheat diversity: international initiatives

Genetic treasure of Anatolia: "Landraces"

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Wheat has a very important place in the nutrition and culture of the Anatolian people and including Turkey the Middle East is the center of divesity for wheat. It has reached present day by continuing its genetic progress despite all kinds of climatic events experienced in this geography for thousands of years. From past to present there are lots of proverbs and idioms about bread or using "Bread Word" which is a part of our life such as "The table without bread is incomplete", "Bread is in the lion's mouth" (means that Money doesn't grow on the tree or making money is very hard), "Giving his bread" (means that giving to somebody a job, facility or chance to make money for life), "interfere to one's bread or play with bread" (means that threaten one's job) and these expressions show how bread is important as a part of our life traditionally.

While need for production increases with the rapidly increasing population in the world and the problems that accompany it, the term Food Safety has become a part of our life. Due to reasons such as more production need, better quality products, increasing importance of disease-pest resistance, Genetic Treasure "LOCAL WHEAT-LANDRACES" could not find a place in the large production areas in the high yield potential plains of Anatolia.

Although the production of Landraces is important for local products and similar features, in a broader sense, the real importance of our genetic resources is that they are not the inherit of our ancestors, but keep in trust for future generations. So, our main duty is preserving them without losing genetic heritage for thousands of years and also contributing to Food Security not only for Turkey but also for world.

For all the reasons mentioned above, there were Landrace collection missions in different times in Turkey. In additions to those studies a quite laborious and intensive study "Collection and classifications of Landraces" was made by International Winter Wheat Improvement Program-IWWIP that is carried out coordination of Agriculture and Forestry Ministry, CIMMYT and ICARDA between 2009-2014, FAO supported this activity last two years. The collection study has been carried out under the leadership of Bahri Dağdaş International Agricultural Research Institute in 65 provinces, 165 districts and 506 villages, finally 155 different Local Wheat populations were identified in the project in collected more than 1800 samples. During the material collection, 1795 questionnaires were conducted with the farmers who still produce Landraces, and the demographic, socio-economic structures and characteristics of the region where they were produced were determined. In addition, important data were obtained by asking questions as to why producers still produce Landraces, how they use it and what is the source of seed of landraces.

As a result of the study; Landraces are still being produced by wheat producers especially in high elevated and remote areas and generally since they like taste of the products of landraces, making use of local products, high straw yield and also suitable for their animals.

Seventh session: Exploiting wheat diversity: international initiatives

The global information system of the international treaty

Mr. Marco Marsella*

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The increasing worldwide exchange of Plant Genetic Resources requires a more accurate identification of the material when it is moved outside of its original collection. To address this need, the International Treaty has proposed the adoption of Digital Object Identifiers (DOIs). Assigning DOIs to Plant Genetic Resources for Food and Agriculture (PGRFA) is the first service of the Global Information System (GLIS) being developed by the Secretariat according to Article 17 of the Treaty. Assigning DOIs to PGRFA also facilitates information exchange and improves data quality.
One of the International Treaty's most successful areas of work, the Multilateral System of Access and Benefit Sharing, that aims at facilitating access and exchange of PGRFA for food and agriculture through the Standard Material Transfer Agreement, also benefits form the adoption of DOIs and the presentation will demonstrate how combining SMTA and DOIs facilitates access to PGRFA and associated information.
New developments in DOI system technologies offering interesting value-added services will be presented through which scientists will be able to access a wide range of publications and datasets related to the PGRFA they are working on.
Finally, advanced functions offered by GLIS will be presented demonstrating how its global scope provides unprecedented opportunities to extract useful information regarding the provenance and utilization of PGRFA.

Keywords: DOI, PGRFA, International Treaty, Information exchange, Global Information System

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2. http://www.fao.org/plant-treaty/areas-of-work/global-information-system
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Seventh session: Exploiting wheat diversity: international initiatives

GrainGenes: Integrated web resource for wheat

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GrainGenes (https://wheat.pw.usda.gov; https://graingenes.org) is the centralized, curated USDA-ARS database for wheat, barley, oat, and rye, ensuring long-term data sustainability for small grains researchers. GrainGenes hosts a JBrowse genome browser instance for the IWGSC RefSeq assemblies, which is populated with multiple diversity tracks generated by the Akhunov (Kansas State Univ.) and Dubcovsky (UC Davis) Labs. Svevo GrainGenes contributes to the JBrowse genome browser development and is developing a BLAST plug-in that can perform sequence similarity searches from the genome browser tracks. This plug-in will be available for implementation by other JBrowse users. Large curated mapping projects available via the comparative mapping tool CMap were added to GrainGenes including the Spring Wheat Nested Association Mapping (NAM) population based on 2,100 recombinant inbred lines from 28 families used to construct 588 chromosome-specific genetic maps. The genome assembly for the most recent tetraploid genome, Svevo, is shown in the GrainGenes genome browser with links to QTLs to the GrainGenes pages. GrainGenes is an active participant of the Wheat Information System (WheatIS) under the Wheat Initiative: for facilitated data discovery, GrainGenes indexed maps, QTL, germplasm, and genes from the Wheat Gene Catalogue into WheatIS. (Citation: Blake et al. GrainGenes: centralized small grain resources and digital platform for geneticists and breeders. Database (2019) Vol. 2019: article ID baz065; doi:10.1093/database/baz065)

Keywords: database

Seventh session: Exploiting wheat diversity: international initiatives

The international wheat genome sequencing consortium phase II: Towards a diversity platform that represents the breadth of global wheat diversity

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The International Wheat Genome Sequencing Consortium (IWGSC), with 2,400 members in 68 countries, is an international, collaborative consortium, established in 2005 by a group of wheat growers, plant scientists, and public and private breeders focused on delivering genomic tools and resources for wheat improvement. In 2018, the IWGSC completed Phase I when it published the first high quality reference sequence of the bread wheat variety Chinese Spring (IWGSC RefSeq v1.0; (International Wheat Genome Sequencing Consortium (IWGSC), Appels et al. 2018)). The IWGSC RefSeq v1.0 represents 94% of the hexaploid wheat genome organized in 21 chromosome-like pseudomolecules and identifies the structural features of the wheat genome, including 107,891 high confidence gene in their genomic context, along with 4.7 million molecular markers. This sequence allows for analyses to a level that has never been achieved before. Phylogenomic analyses indicated specific amplification of gene families characterized the hexaploid genome when compared to diploid progenitors and other closely related species.

The IWGSC has now entered Phase II whereby gaps will be closed in the reference sequence, functional and manual annotation will be integrated to form annual annotation releases, and a wheat diversity project has begun which aims to complete high quality sequences of landraces which represent the full breadth of global wheat diversity. Already, since the publication of IWGSC RefSeq v1.0, the reference has been improved using whole genome optical maps and contigs assembled from whole genome shotgun (WGS) PacBio SMRT reads (Zimin, Puiu et al. 2017) permitting the reconstruction of the pseudomolecules of the 21 Chinese Spring chromosomes into IWGSC RefSeq v2.0. The latest version has been released to the community via the IWGSC sequence repository at INRA-URGI in July 2019 under the Toronto pre-publication agreement. The development of annotation v2.0 is also now underway and will include manually and functionally curated genes provided by the community with an estimated release date of January 2020.

Recent work by (Balfourier, Bouchet et al. 2019) has delivered new insights into worldwide wheat genetic diversity and its evolution. Significantly, recent selection and the spread of wheat has led to modern germplasm that is highly unbalanced compared to ancestral ones found in landraces. Asian landraces have been rarely used in modern breeding programs and this represents a significant fraction of the worldwide diversity that remains largely unexploited. The IWGSC believes it is critically important to better characterize the breadth of wheat diversity so that they can be better exploited into pre-breeding programs. As such, nonadmixed landraces from the eight genetic groups described by Balfourier, et al., (Iberian Peninsula, Southeast Asia, Central Asia and Africa, Northwest Europe, Southeast Europe, Mediterranean Basin, Indian Peninsula, and the Caucasus) can be considered as founder lines and are ideal candidates for high quality sequencing. The IWGSC project aims to more fully characterize the breadth of wheat diversity. These activities lay the foundation for genomics-based crop improvement in wheat in response to challenges imposed by population expansion and climate change. An overview of IWGSC activities and future plans will be presented.

Seventh session: Exploiting wheat diversity: international initiatives

International treaty on PGR Project: Preservation of on-farm diversity of currently grown wheat landraces in Afghanistan, Iran and Turkey

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Wheat is a staple food crop in the region of Central and West Asia contributing up to 50% of the daily calories. The region primarily produces modern semi-dwarf wheat varieties. However, wheat landraces are still grown in mountainous rainfed regions of Afghanistan, Iran, Tajikistan, Turkey and Uzbekistan. The objectives of the project were to inventory wheat landraces currently grown in these countries, and their collection for conservation and evaluation, description, characterisation, improvement and return to the farming communities from where they were collected. The collections were made in 60 provinces and 1500+ farmers in Turkey (2009-14); two provinces each in Afghanistan and Iran (2015-16). The diversity of the landraces was evaluated using botanical descriptors and genomic tools. Some landraces were distinct and localized geographically while others were widely dispersed across regions, demonstrating movement and exchange among the farmers. Socio-economic surveys accompanying the collections, demonstrated that the main reasons farmers still keep them, despite the availability of modern varieties were: Suitability for homemade products, rated as the highest trait; resistance to abiotic stresses; and quality and quantity of the straw. The regions with the highest wheat landrace diversity were identified to focus potential conservation efforts. A landraces evaluation and improvement pipeline was established comprised of evaluation of head-rows and subsequent evaluation of selections in trials for grain yield, disease resistance and grain quality. The genetic variation within landraces gave the opportunity for relatively fast and efficient population improvement using selection of the best individuals while maintaining the integrity of the population. The resulting improved lines and populations were multiplied for repatriation to the farming communities where they were selected. For the 2019 season more than 1000 farmers received seeds of improved wheat landraces for evaluation and utilization. In a separate program, selection of superior wheat landraces was conducted based on multilocational evaluations. These landraces were utilized in the a crossing program with two objectives: a) to improve the landraces through incorporation of disease resistance genes from modern varieties using a backcrossing program and through crosses between complementary landraces; b) to improve the modern germplasm by crosses with landraces to incorporate resistance to stresses and drought specifically. In both programs grain quality and suitability for local products remains an important objective. The crossing programs are supplemented by genomic tools, using the results of GWAS and other studies. The populations destined for landraces improvement are subjected to on-station and on-farm selection.

Eighth session: Exploiting wheat diversity: breeding

High-yielding and nutritious wheat: Is this realistic?

Prof. Dr. Richard Trethowan*

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Wheat breeders have developed cultivars with enhanced concentrations of key nutrients including Zn and Fe. These healthier grains meet the requirements of different communities and can improve human health. However, these modified grains often yield less than commonly adopted cultivars, thus limiting their adoption by farmers. In the case of micronutrient enhanced wheat grains, much of the benefit is found in the aleurone and the ratio of starch to aleurone reduces with increased yield thus diluting micronutrient concentration. The reduction of grain phytate has been suggested as an avenue for enhancing micronutrient bioavailability in human diets. However, phytate should not be reduced below a threshold level otherwise seed germination is impeded.

More than 2,000 adapted wheat lines developed from crosses to low grain phytate and grain high-micronutrient materials were extensively evaluated for grain yield and micronutrient status to determine if materials with high yield potential and enhanced nutritional status could be achieved. As expected, negative relationships between yield and micronutrient status were observed; however, genotypes with the stay-green character produced both high yield and higher Fe and Zn concentrations. Grain phytate concentration and yield were uncorrelated. Thus, high grain yield and improved nutritional value might be achieved by breeding for elevated grain Fe and Zn concentration, stay-green and reduced grain phytate. Putative QTLs linked to key nutritional traits were identified and genomic estimated breeding values calculated to improve rates of genetic gain for both agronomical and nutritional traits.

Keywords: Grain yield, Micronutrients, Phytate

Eighth session: Exploiting wheat diversity: breeding

Plant Genetic Resources collection, characterization and using in breeding; from a breeder`s perspective

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Traditionally and as a common practice PGR are collected from a target region and stored in a genbank. Genbank staff characterize the PGR in a later stage and combine generated data for a given entry. Each year, thousands of PGR are distributed for research and breeding purposes to the scientific community. Unfortunately, in most cases, most of the data generated on this material is not returned to the genbank that would be very valuable for future request and use. Most of the data on a given entry in the genbank is generated by genbank staff.

International Winter Wheat Improvement Program (IWWIP) is carried out by Turkey, CIMMYT and ICARDA and located in Turkey. IWWIP develops Winter Facultative germplasm and provides it to winter wheat community globally. Turkey has rich in wild and land race wheat genetic resources and Wheat Land Races (WLR) are still grown in niches in most part of Turkey. The nation-wide WLR collection is made by Mirza Gokgol in 1930`s. Since then, there were WLR collections in some regions but not nation-wide. IWWIP, during 2009-2014, collected more than 1700 WLR from 65 of 81 provinces of Turkey to document how largely they are grown, characterize, store in genbank and use in breeding. More than 90 % of the collections were from the farmers fields as spike with 100-150 spikes per sample. Surveys have also been done to define the farmers` socio-economic conditions and try to understand why they still grow WLR though there are many modern varieties in the market. Each population is grouped as described by Slageren (1994), Dorofeev et al. (1979) and Zuev et al. (2013) before they are planted. At least 100 spikes per sample are planted a 1 m Head Row (HR). HR selections are made based on the phenotype and disease reaction trying to keep the groups balance in the populations. Selected HR`s are tested in non-replicated trials with augmented design, at the same time they were screened for rust reactions. Selected entries are tested in replicated and multilocation trials repeating the disease screening and adding some more phenological and morphophysiological measurements. In this study, more than 30000 HR were evaluated and a core collection is developed with 3000 entries. The material is further grouped as diploid, tetraploid and hexaploid wheats. Molecular analysis with functional and KASP markers is made. At the end of the study, 5276 genotypes/WLR with hundreds of data point on each entry including morphological, phenological, pathological, molecular and yield data are deposited in Turkish genbank.

The breeders are involved in all work, but after collection of the samples whole work is carried out by breeders, which is substantially different from traditional PGR collection, storing and characterization. The work is reversed as collection, grouping, characterization, selection and storing them in genbank. The genbank stored material from this study is well characterized and easily, and readily can be used for fit-for-purpose in later studies. Some crosses are made between WLR and modern germplasm either to transfer trait of interest from WLR to modern germplasm or to correct some deficiencies of WLR such as lodging and disease susceptibility.

Eighth session: Exploiting wheat diversity: breeding

Landraces complement Afghan wheat scenario

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Wheat is the life sustaining food grain of Afghanistan. An Afghan diet is incomplete without a slice of wheat bread. It is so crucial that wheat occupies 80% of Afghan acreage devoted to food crops in Afghanistan. However, wheat research and development efforts have not been able to support Afghan wheat in full, and up to 50% of wheat acreage is still sown to landraces and or old varieties making Afghan wheat a low yielding crop compared to other countries in the region. Country's seed system is producing less than 10% of national seed requirement forcing farmers especially in remote countryside to grow land races and old obsolete varieties. Landraces therefore play an important role in Afghan wheat scenario. Under the multi country ITPGRFA project involving Turkey, Iran and Afghanistan, over 25 landraces were collected from farmer fields in the remote regions of two provinces of Herat and Balkh. Landraces in general are poor yielding but if selected carefully, improved landraces can be almost as profitable as any improved commercial cultivar. Many a times farmers prefer landraces over commercial cultivars on account of adaptation and end use suitability. Out of the 25 initially sampled landraces from the farmer fields, years of testing helped us shortlist five of them that had resistance to prevalent rusts and were upto 90% as high yielding as the commercial cultivars. Sometimes, however farmers use landraces as the last option but these landraces enrich and bring diversity to the total wheat scenario right from farmer fields to bakeries and to the research stations in form of useful and utilizable diversity. Several of these landraces have been found to possess hitherto unutilized variability for grain hardness, disease resistance and several other traits. Also, Afghan group of landraces yielded highest among the groups collected from Turkey, Iran and Afghanistan.

Eighth session: Exploiting wheat diversity: breeding

Study on genetic diversity of wheat landraces in north west of Iran

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Wheat is a major crop and cultivated more than 4 million ha in Iran. Wheat landraces are cultivating in some part of country especially in North West of Iran and are valuable genetic variation source for breeding program. This project was conducted to improve two wheat landrace populations; Germezghen (BW, 174 genotypes) and Qerdish (DW, 232 genotypes) under rainfed conditions for three cropping seasons, 2016-19 in Maragheh and Hourand, Iran. All genotypes were evaluated for grain yield, heading date, plant height, maturity, grain filling period, and grain quality. Multivariate analyses were used to explore the diversity of these populations. Combined analysis of variance indicated significant differences ($P<0.01$) for years, genotypes, and year × genotype interaction effects, indicating high variability for each studied trait. Most of the landraces exhibited a high combination for yield and stability for both drought and cold stresses compared to checks. Results showed that traits such as TKW, HI, PLH had significant correlation with grain yield. In conclusion, selected landraces could be used in pre-breeding program to improve genetic variation for measured traits, drought, cold stress and specific adaptation.

Keywords: Landraces, Wheat, Genetic Diversity, Germezghen and Qerdish, Iran

87 - Beneficial components in wheat grain: minerals and phytochemicals - Poster

Fatty acid and antioxidant profiles of selected Turkish wheat landraces

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In recent years, dietary bioactive compounds are getting huge attention due to their health beneficial attributes. Despite the importance that fatty acid and antioxidant profiles of wheat, current understanding of these profiles and their link to public health is incomplete. The time is convenient for a large-scale coordinated project on Turkish wheat landraces that includes cross-directorate funding, involvement of laboratories around the world, and cooperation with utilities and the public. In here, as a preliminary research, fatty acid and antioxidant profile of four Turkish wheat landraces (*Triticum dicoccum* 1178, 1180, 1181 and 1191) supplied from Field Crops Central Research Institute were investigated for their functional food properties. Whole wheat grain samples were extracted with hexane and antioxidant profile of obtained extracts was accomplished by using different antioxidant assays such as MTT (3-(4,5-dimethylthiazole-2-yl)-2,5-diphenyltetrazolium bromide) and LPO (lipid peroxidation). The extracts were applied on TLC plate for preliminary identification of the bioactive profile. After that purification and characterization of bioactive components were carried out by NMR (^{1}H and ^{13}C) and GC-MS in hexane fractions of one whole wheat variety (*T. dicoccum* 1191). All four hexane extracts of whole wheat grain samples have absorbance of 0.14, 0.11, 0.13, 0.15 in MTT assay; and % inhibition of 48.5, 52, 46.5, 52.5 in LPO assay at 100 µg/mL concentration, respectively. Whereas, palmitic (C16:0), stearic (C18:0), oleic (C18:1), linoleic (C18:2) and linolenic (C18:3) acid are identified as major fatty acids in bioassay guided purification of hexane extract of whole wheat. Both MTT and LPO assay results were compatible with antioxidant activities for hexane extracts of all whole wheat samples. For this study, presence of omega-3 and omega-6 are also first evidence for importance of Turkish wheat landraces. Along with hexane extract, more in-depth study is further planned to discuss the characterization of bioactive components in methanolic extracts of whole wheat grain.

Keywords: Turkish wheat landraces, Bioactive components, Essential fatty acids, Antioxidant activity

120 - Beneficial components in wheat grain: minerals and phytochemicals – Poster

Impact of boiling duration on the bioactive carotenoid content of durum wheat pasta

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Pasta consumption has become very popular and is considered a main component of western diets. Consumer preference in the selection of durum wheat pasta is highly driven by an appealing bright yellow color indicating a good quality product with high carotenoid content. Carotenoids including lutein and zeaxanthin found in grain cereals have health benefits associated with their regular consumption. In this study, we evaluated the effect of boiling duration on carotenoid stability of pastas made from three different Canadian Western Amber durum wheats: Spitfire, Precision and Transcend. Each variety was milled into semolina and extruded using a customized micro-extruder (Randcastle Extrusion System INC, New Jersey, USA) at a moisture content of 30%. Representative samples of dried pasta were boiled at three cooking duration time points to achieve and al dente, optimally cooked and overcooked pasta samples (8, 12, 16 mins respectively) representing the firmness preferences of consumers. Lutein content showed an increasing trend with cooking duration with an average low content ranging from 4.0-4.4mg/kg dry weight in al dente pasta to 5.0-5.6mg/kg dry weight in overcooked pasta among all varieties. Carotenoid profile did not change with boiling duration. Lutein and zeaxanthin were sensitive to the different thermal treatments with Transcend showing greater retention trend (>60%) comparatively. The results so far suggest that all three varieties of durum wheat are good sources of bioactive carotenoid compounds and overcooking pasta by 6mins above the optimal cooking time of 12mins enhances the release of carotenoids from the food matrix. Further research is underway to investigate pasta physical properties as well as bioaccessibility of carotenoids following *in-vitro* digestion.

147 - Climate change and wheat quality - Poster

Development of a core set of single copy SSR markers for purity testing of bread wheat varieties

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Common wheat/bread wheat (*Triticum aestivum* L.), is an annual *Poaceae* (grass family) species, native to the Mediterranean region and southwest Asia. *T. aestivum* is one of the several species of cultivated wheat, now grown in temperate climates worldwide. Bread wheat is hexaploid, with three complete genomes termed A, B and D in the nucleus of each cell. Compared to diploid crops, molecular genetic research in *T. aestivum* is challenging due to the high complexity and duplication of large genomic segments in the bread wheat genome. Purity testing is an important portion of breeding programmes. A high level of genetic purity in wheat varieties must be established and reliable tests should be available to monitor the purity for stable agronomic performance. Phenotypic characterization is a regular method for basic purity testing protocols; however, phenotypic assessments are subjective, highly prized and unreliable; as phenotype is influenced by environmental conditions as well as agricultural practices. In the present study, 36 single copy, co-dominant SSR markers were developed via bioinformatics from bread wheat genomic sequences and experimentally tested for amplification efficiency and polymorphism rate. As a result, nine out of 36 SSR markers were found to be adequate for purity testing of bread wheat varieties based on their polymorphism rate and amplification reproducibility. These nine single locus SSR markers can be used as a core set for genetic purity and stability testing in bread wheat genotypes.

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153 - Climate change and wheat quality - Poster

Determination of the effect of different growing conditions on bread wheat quality with Glutopeak device

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Bread wheat is one of the most important cereal crops in the world for human nutrition. Wheat quality has a great effect on determining the market value of wheat and being demandable by consumers. Genotype and growing conditions are effective on wheat quality. Different devices are used to determine the quality parameters of wheat and GlutoPeak is one of them used for this purpose. It is a rapid shear-based device that has been recently proposed for the rapid evaluation of wheat flour traits by using little amount of sample. It measures the aggregation behavior of gluten. Beside gluten aggregation parameters, the GlutoPeak protein, GlutoPeak wet gluten, GlutoPeak W-value, GlutoPeak water absorption are determined by using Rapid Flour Check Method. The aim of this study was to determine the effect of growing conditions on some quality criteria of wheat varieties with the device, GlutoPeak. For this purpose, 10 winter bread wheat genotypes, grown at Bahri Dağdaş International Agricultural Research Institute in rainfed and irrigated conditions during 2017-2018 growing period, were analyzed according to randomized block design with two replications. Mean quality values of genotypes in rainfed conditions were found as 67 GlutoPeak Unit (GPU) for maximum torque (BEM), 57 seconds for peak maximum time (PMT), 1524 GPU for aggregation energy (AE), 12.63 % for protein content (PC), 29.02% for wet gluten (G), $397*10^{-4}$ J for energy (W) and 63.65% for water absorption (WA). For irrigated conditions, on average, BEM was determined as 62 GPU, PMT as 64 seconds, AE as 1398 GPU, PC as 11.98%, G as 27.15%, W as $336*10^{-4}$ J and WA as 61.88%. Obtained results exhibited that except for PMT, mean values of all other parameters were higher in the samples grown in rainfed conditions. Low PMT value for these samples is an expected result because wheats with strong gluten reach high peaks in a short time in GlutoPeak test. As a result of study, differences between the quality parameters examined with GlutoPeak were found to be statistically significant in rainfed and irrigated growing conditions.

Keywords: Bread wheat, growing conditions, quality, GlutoPeak

158 - Climate change and wheat quality - Poster

Relationships between durum wheat quality and heat weather under the South East Anatolia conditions.

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A total of 5 field experiments were carried out during the 2014-2018 growing seasons in the south east Anatolia. The experiments were conducted under irrigated conditions. Five durum wheat genotypes were used in this study. Quality determinations consisted of 1000-kernel weight (TKW), test weight, vitreousness, protein content, pigment content and SDS sedimentation test. The influence of climate was predominant in determining the majority of quality traits, although pigment content and SDS volume were also genetically controlled. Climate effects, studied by the mean of the climatic patterns influencing each trial, negatively affected grain quality by reducing test weight, grain vitreousness, and SDS volume. High seasonal temperatures increased pigment content in the grain, but reduced TKW. From the correlations between quality parameters, an inverse and interesting relationship was found between protein content and SDS volume. Relationships between quality traits appear to be influenced to a certain extent by climatic conditions during grain filling and, depending on temperatures and water input during this phase, correlation coefficients was either positive, negative or close to zero.

103 - Climate change and wheat quality - Poster

Identification and characterization of heat responsive miRNA-SSRs in wheat

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Terminal heat stress is an important abiotic stress constraint to successful wheat (*Triticum aestivum* L) production worldwide and is regulated by different molecular mechanisms. During the last two decades the importance of microRNAs (miRNAs) in gene expression under various biotic as well as abiotic stresses is well known. Molecular markers, especially co-dominant markers such as simple sequence repeats (SSRs), play an important role in marker-assisted breeding. The discovery of SSR markers from non-coding regions has been a challenge therefore; the development of novel markers from the conserved regions will thus be useful for studying the genetic diversity of heat responsive-miRNA genes in wheat. In order to understand, SSR markers were mined from 96 members of heat-responsive miRNA genes of wheat and validated among the contrasting panels of tolerant as well as susceptible 30 wheat genotypes, each with 21 and 9 genotypes respectively. Although 10 miRNA-SSRs were found to be polymorphic, only two SSRs miR156a and miR159 were able to differentiate the tolerant and susceptible genotypes in 2 different groups. It had also been found that miRNA genes were more diverse in susceptible genotypes than the tolerant one (as indicated by polymorphic index content) which might interfere to form the stem-loop structure of premature miRNA and their subsequent synthesis in susceptible genotypes. Thus, we concluded that length variations of the repeats in salt responsive miRNA genes may be responsible for a possible sensitivity to heat adaptation. This is the first report of characterization of trait specific miRNA derived SSRs in wheat.

Keywords: Wheat, Heat Tolerance, Micro-RNA derived SSR markers

26 - Improvement of key traits by genetics and breeding - Poster

Effect of salt stress on productivity traits of primary synthetic wheat in Azerbaijan

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Considerable genetic variation for salt tolerance has been found in synthetic hexaploid wheats (SHW). In order to determine the performance of wheat lines under salinity stress conditions and screening quantitative indices of salinity tolerance, 43 SHW lines were tested under salinity and normal conditions in Absheron and Ujar regions, Azerbaijan Republic. Result of analysis of variance showed that there were significant difference between studied quantitative traits among wheat genotypes. For better evaluation of SHW lines for salinity tolerance, six selection indices, including sensitivity to stress index (SSI), tolerance index (TOL), geometric mean productivity index (GMP), stress tolerance index (STI), mean productivity index (MP) and harmonic mean index (HM) were used. Grain yield had a positive highly significant correlation with all calculated tolerance in control condition, whereas, the correlation between yield under stress conditions (YS) with SSI and TOL indices was negative. Salinity significantly affected all of the measured traits, except spikelet per spike, 1000 kernel weight and fruiting efficiency traits. The interaction between genotypes and salt stress were significant for all studied characters, except 1000 kernel weight. It means that some wheat lines showed much better performance than the tolerant cultivars under salt stress conditions. The genotypic coefficient of variation ranged from 8.54 percent to 41.42 percent. The result of genotypic coefficient of variation revealed that spike fruiting efficiency and grain weight per spike exhibited highest genotypic coefficient of variation of 41.42 percent and 35.37 percent, respectively. The high coefficient of genetic variation (GCV) observed are evident from their high variability that in turn offers good scope for selection in both salinity and normal conditions. Heritability values under salinity stress were found to be lower as compared to under controlled conditions during both phases of experiment. In our investigation high estimates of heritability (above 80%) in broad sense were recorded for all characters studied, except number of spike per m2 (58%). The highest heritability values indicate that heritability may be due to higher contribution of genotypic component. In this study lines № 2, 5, 6, 8 in non-salinity condition and lines № 8, 16, 18, 19 and 27 in salinity condition had high performance in grain yield. Within 124 days lines № 5 and 125 days № 2, 3, 6, 17, 21, 23 and 27 were early in initiation of heading, while № 35 with 137 days and 36, 43 both with 136 days in non-salinity condition were evaluated as a late heading cultivar. Wheat lines № 1, 5 and 6 were early heading, while № 32, 33, 34, 40, 42 and 43 were late heading in salinity condition.

27 - Improvement of key traits by genetics and breeding - Poster

Diversity analysis of wheat (*Triticum aestivum* L.) genotypes for yield and yield attributes under temperate ecology

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In the present investigation 98 wheat genotypes including three checks were evaluated under temperate ecology of Kashmir valley in order to estimate the extent of genetic variability in the available wheat germplasm for quantitative traits including days to heading, tillers per m, leaf length (cm), leaf width (cm), peduncle length (cm), plant height (cm), days to maturity, spike length (cm), grains per spike, and grain yield per plot (g). An augmented experimental field design was used to evaluate these wheat lines at Mountain Research Centre for Field Crops, Khudwani, SKUAST-Kashmir (Alt :1590 m amsl) during rabi 2017-18 with a major objective to identify elite wheat lines that could be used as potential donors in future breeding programs specifically for improvement of earliness and yield. Analysis of variance revealed that this wheat germplasm possesses a significant level of genetic variability for most of the traits. Principal component analysis revealed that PC1 and PC2 explained most of the variability in the data with 28.59 and 25.40 per cent respectively. It further revealed that relative attributions of yield and yield attributing traits viz. grains/spike, spike length, tillers/m and grain yield (g) per plot contribute proportionately more variability to the available germplasm ranging from 0.46-0.50. Phenotypic association analysis revealed a highly significant and positive correlation of yield (g) per plot with grain/spike (@ 0.79) and tillers/m (@ 0.84), respectively. Among the studied wheat genotypes MP3382 (560 g per plot), MP3336 (540 g per plot), DBW-110 (530 g per plot), KO 40-2 (520 g per plot) and PHSL-5 (515 g per plot) out yielded other genotypes and the best check Shalimar Wheat -1. These genotypes can be used as donors for high yield in wheat breeding programs under temperate ecological conditions of Kashmir valley.

Keywords: Wheat, Diversity, Yield, Principal Component Analysis, Genetic variability, Phenotypic association

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Resistance evaluation of wheat varieties/lines to leaf rust and stripe rust at seedling and adult-plant stage in China, Gansu Province

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China is the largest wheat-consuming country in the world and stable wheat production plays an important role in the Chinese economy. Stripe rust and leaf rust, caused by *Puccinia striiformis* f.sp. *tritici* and *Puccinia recondita* f.sp. *tritici*, are two of the most damaging diseases of wheat in China. In recent years, leaf rust has migrated to some wheat growing areas previously suitable for stripe rust, resulting in a mixture of the two diseases occurring in the same area and at the same time, and seriously damage wheat production in China, Gansu Province. The most effective method of prevention those two diseases are through the use of resistant cultivars. However, many studies have only carried out of resistance of wheat varieties for a single disease; resistance to both diseases is unknown. In order to definite the resistance composition of wheat varieties to these two diseases, 715 wheat varieties/lines from 8 breeding units in Gansu province were collected to test for the resistance to stripe rust and leaf rust at seedling stage in greenhouse and at adult plant stage in field in 2016-2018, respectively. Spore suspensions with the fresh mixture races of CYR32, CYR33 and CYR34 of *Puccinia striiformis* f.sp. *tritici* and mixture races of THTP, THTT, TKTT and THTS of *Puccinia recondita* f.sp. *tritici* were used for inoculation separately. The result show that only 4.74% of the varieties show comprehensive resistance to strip rust and leaf rust at all growth stages, and there are 34 wheat varieties including Tianxuan 67,Qingnong 21,Lenghan 5, 03-139-1-2-2-1-2-1,2006-1-4-1-4-2-7-2-3-10,04-203-1-1-1 and so on. In seedling stage, the frequencies of resistant varieties to wheat strip rust and leaf rust were 56.64% and 30.23%. While the materials were susceptible to these diseases were 43.36% and 69.77%. 71 varieties were resistant to those two diseases, accounted for 9.93%. 10 varieties, accounted for 1.4%, were highly resistant (including immune/near immune) to those two diseases. In adult-plant stage, the frequencies of resistant varieties to wheat strip rust and leaf rust were 76.53% and 36.11%. While the materials were susceptible to these diseases were 23.47% and 63.89%. 137 varieties were resistant to those two diseases, accounted for 19.16%. 59 varieties, accounted for 8.25%, were highly resistant (including immune/near immune) to those two diseases. Overall, the 715 varieties /lines had high resistance to wheat strip rust, but poor resistance to leaf rust. This study found out some resistant materials which had better comprehensive resistance to leaf rust and strip rust, also pointed out the resistance characteristics of 715 varieties to those two diseases at the seedling stage and adult-plant stage. This will be of great guiding significance in wheat resistance breeding and comprehensive control those two diseases in China, Gansu Province in the future.

Keywords: Puccinia striiformis f.sp. tritici, Puccinia recondita f.sp.tritici, resistance, wheat

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Study of Baking Quality Related Traits in Some Bread Wheat Landraces of Iran

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Bread wheat is the staple food in 43 countries and is accounted as food for at least 35% of world population. In Iran, more than 90% of produced wheat is used for bread making and 30% of the produced breads are wasted due to low quality. Breeding for improved bread-making quality is an important breeding goal. This character is associated to a large extent with the amount and composition of endosperm seed proteins in the wheat kernel. Landraces carry superior traits which could be used in breeding programs for improvement of different traits. To identify the sources of quality traits, 5000 bread wheat landraces with the Iranian origin were evaluated for important quality traits, and 49 landraces with superior quality traits were selected for further studies. These selected bread wheat landraces were studied for determination quality traits for incorporation in breeding bread wheat cultivars with desirable quality. Variation in protein content ranged from 11.2% to 13.55%, and SDS sedimentation volume varied between 40 and 60 milliliters. For grain hardiness and zeleny sedimentation volume also exist high variation among selected landraces. Grouping of landraces based on quality traits and similarity in Euclidean distance also determined three distinct clusters, as 4 and 10 landraces were grouped in clusters 2 and 3, respectively. It is concluded that variation in quality traits in bread wheat landraces of Iran are potential sources to be incorporated in bread wheat breeding programs for improving baking quality.

Keywords: Bread wheat, Landraces, Baking quality, Quality traits

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The relationships of some traits in Turkish winter bread wheat landraces and breeding lines

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In this study, 20 bread wheat (pure lines obtained from landraces, collected from different regions in Turkey) and 16 breeding lines were evaluated under rainfed conditions of Konya, Turkey in 2016-2017 growing seasons.
Experiments were conducted in a 6×6 lattice design with 3 replicates. Both genotype-traits (GT) biplot analysis were used to investigate the relationships between grain yield and 6 traits.
Applying both types of analyses to the multiple traits data revealed that GT biplot graphically displayed the interrelationships among traits (breeding objectives), identified traits that are positively or negatively associated, and facilitated visual comparison trait profiles (strength and weakness) of genotypes, which is important for parent as well as variety selection.
The results showed that landraces pure lines and breeding lines combined with favorable traits can be evaluated in multi-environment trials for a candidate of winter bread wheat registration trial.
Some landraces pure lines that had high quality traits might be good parents for enhancing quality. In conclusion, for the short-term improvement of Turkish bread wheat landraces may be possible through an indirect selection of some traits, or direct selection for grain yield per se.
In the long-run, crossing programs between indigenous and introduced landraces germplasm may be necessary for high industrial quality characters of bread wheat.

Keywords: wheat, landraces, breeding line, biplot

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Preliminary screening of leaf rust reactions of two winter wheat populations containing landraces and modern varieties from Western-Central Asia

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Leaf rust (caused by *Puccinia triticina* (Pt)) can cause important yield and quality loss when susceptible or moderate susceptible genotypes are grown. Landraces are a potential source for resistance to abiotic and biotic stress. The aims of this study are to identify resistant germplasm, and discovery of new leaf rust resistance genes in winter wheat landraces in comparison to modern wheat varieties

In total 281 landraces and 240 modern wheat varieties were evaluated for seedling plant reactions in February-March 2017. The experiment was carried out under glasshouse conditions in Field Crops Central Research Institute in Ankara, Turkey. The two populations were inoculated with urediniospores in mineral oil suspension on Zadoks growth stage 11 or 12. The test materials were incubated first at 16±1oC with 100% humidity during 24 hours after inoculation and after at 15-25oC glasshouse conditions and scoring took place 14 days later using a 0-4 scale. Pt isolate is virulent on Lr1, 2c, 3a, 16, 26, 3ka, 11, 17a, 30, B, 10, 14a, 18, 3bg and 14b resistance genes. Infection types on the susceptible checks (cv. Gün-91 and Thatcher) were 3+ scores.

Twenty five (9%) genotypes were resistant to Pt.in the landrace population however sixty three (26%) genotypes showed resistance in the modern winter wheat population showing the positive breeding efforts to integrate resistance to Pt in new wheat varieties. SNP markers related to resistance will be identified in both populations.

Acknowledgement: “Addressing the challenges of climate change for sustainable food security in Turkey, Iran and Morocco, through the creation and dissemination of an international database to promote the use of wheat genetic resources and increase genetic gains” (CFP 2014/2015-W3B-PR-18-Turkey)

Keywords: Leaf rust (*Puccinia triticina*), Seedling stage,

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The reactions to yellow rust of winter wheat elite genetic materials

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For sustainable food safety, development of a wheat germplasm adapted to climate change (ex: resistance to yellow rust, drought, and high or low temperature) and a combined multidisciplinary approach should be developed. Yellow (stripe) rust, caused by Puccinia striiformis f. sp. tritici (Pst), is an important fungal disease of wheat occurring cool and moist climate conditions during the production season in Central Anatolian Plateau in Turkey. The goal of the study was determining of the 240 bread wheat lines and some cultivars in advance yield trials germplasm to Pst. For this purpose, seedling and adult plant stage test were conducted for Pst. Evaluations were carried out at the research facilities of Field Crops Central Research Institute for seedling tests at Yenimahalle and adult plant tests İkizce locations in Ankara in the 2017 season.
For seedling test; the seedling was inoculated with local Pst (virulent on Yr1, 2, 3, 4,-, 6, 7, -, 9, -, -, 17, -, 25, -, -, 32, SU, SP, SD, 3N, 3V and AvS resistance genes) populations. Yellow rust development on each entry were scored after 14 days with 0-9 scale. ITs on the susceptible checks (for stripe rust; Morocco and Little Club) were high (IT = 8 (Pst) scores. For adult plant test; the genotypes were inoculated with local Pst populations (). Yellow rust development on each entry were scored using the modified Cobb scale (Morocco and Little Club had reached 80-100S) in June and July 2017. Coefficients of infections were calculated and values below 20 were considered to be resistant.
Both seedling stage fifteen (6%) and field stage eighty-seven (36%) were resistant to the local Pst populations. Fifteen materials that are determined to be resistant in both seedling stage and adult plant stage can be registered as yellow rust resistant materials.

Acknowledgement: “Addressing the challenges of climate change for sustainable food security in Turkey, Iran and Morocco, through the creation and dissemination of an international database to promote the use of wheat genetic resources and increase genetic gains” (CFP 2014/2015-W3B-PR-18-Turkey)

Keywords: Yellow rust, (*Puccinia striiformis f. sp. tritici*), Seedling stage, Adult plant stage

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Overview on the Tunisian durum wheat breeding programs: selection for yield, adaptation and improved resistance to Septoria tritici blotch

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Durum wheat (*Triticum turgidum* var. durum) is an important cereal crop grown in many parts of the world, especially in the Mediterranean region, because of its crucial nutritional value and its significant share in daily energy intake. It is not surprising that efforts devoted to the genetic improvement of this important cereal species, which are more than a century old, account for the oldest research activity in Tunisia. Significant productivity gains and evolution were achieved since, through genetic improvement and improved agronomic practices. The introduction and wide adoption of the early and high yielding fertilizer responsive semi dwarf varieties was crucial in this respect. Collaboration with International Centers (CIMMYT and ICARDA) was very strong and interactive and achieved all planned objectives. Durum wheat production is largely influenced by environmental stresses (drought, heat, nutrient deficiency) and biotic stresses, especially foliar diseases which is the main factor limiting and reducing yield under favorable conditions. Among these, Septoria leaf blotch is the most productivity threatening biotic constrain in the main durum wheat production area. Overall resistance to this important disease was upgraded overtime through selection. Continued breeding efforts lead to the release of higher yielding, better disease resistant and more drought tolerant durum wheat varieties (Mâali, Salim, INRAT 100 and Dhahbi) that have positively impacted yield at the farmer in national level. Monitoring gains from increased yield potential, adaptation, showed that grain yield of the recently released varieties is up to 4 times that of the tall and late maturing landraces grown before the 1970's and up to 2.5 times that of varieties of the early years of the green revolution together with combinations of improved resistance to Septoria leaf blotch, leaf rust and stripe rust.

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Use of triticale in wheat breeding

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For centuries farming wheat breeding continuously subjected to improvement by using all the available science materials and methods for the transfer new valuable traits, and advancing the current from the other species of cultural and wild-growing cereal plants (Mahalin, 1992).

One of the relatives of wheat with a number of positive traits is rye. Wheat varieties, created with the participation of rye, as show cytogenetic research, bear rye translocation in individual chromosomes (Vlasenko, 2008). Translocation 1BL/1RS was detected in the varieties of the German scientist Riebesel (Neuzucht, Riebesel 47/51, etc.) and transferred by Lukyanenko in high-yielding varieties Kavkaz, Aurora, Bezostaya 2, Predgornaya 2 (Zeller, 1973; Bartos et al., 1973). Varieties Aurora and Kavkaz are valuable source material. With their participation considerable breeding material was developed in many scientific institutions (Gritsay, Bespalova, 1998).

We purposefully use triticale in practical breeding of bread winter wheat (Timofeev, 1995, 2001). Transfer of 1B/1R rye translocation to the genome of a wheat plant by triticale-wheat crosses ("triticale bridge") is an effective method of enrichment and expansion of the genetic basis of winter wheat. This method is established and included in the state register of the Russian Federation: twelve varieties of "translocated" wheat: Polovchanka, Knyazhna, Krasota, Yashkulyanka, Khasyr, Bair, Pamyat, Lebed, Vershina, Dolya, Tanya.

The wheat varieties with triticale participation created by us have: high productivity and adaptability, drought and heat resistance, resistance to several diseases. A powerful deep-penetrating root system promotes their cultivation after “hard” and late-harvested predecessors (cereals, sunflower, corn), in the rice system, on saline, low-lying and flooded soils. On a high agricultural background, they form a grain corresponding to valuable wheat. Variety Pamyat for stable yield and high quality of grain were sown as standard by the State Commission for testing varieties in the Krasnodar region in the group of medium height varieties.

Thus, the use of triticale in wheat breeding has become one of the methods of enrichment and expansion of the genetic base of bread wheat. The transfer of information from rye to wheat genome allows the creation of highly adaptive varieties of winter wheat, combining increased grain productivity with good baking properties.

Keywords: triticale, soft wheat, breeding

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The effect of genotype and environment interaction on flowering of the bread winter wheat

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The paper presents the results of studies of the effect the genotype and environment interaction on the pattern of flowering and some elements of yield structure of bread winter wheat. The shares of the genotype and environment interaction effect and the year and variety factors on flowering, the number of spikelets and flowers were evaluated. It was shown, that contribution of the "genotype", "years", "genotype x years" factors into the general variability for the primary elements of the yield structure was obtained. In wheat 16.5-95.5 percent of the general phenotypic variation were accounted for by the share of vegetation conditions respectively. The contribution of "genotype x years" interaction made 0-74.7 percent, and for genotype 0.8 – 35.2 percent (4).

The pace of agricultural production requires the introduction of the new varieties featuring high and stable productivity, increased food and technological advantages, and the resistance to adverse environmental conditions (Zykin V.A., Belan P.A., Kozlova G.Ya., Antipova G. P., 2001, Nettevich E.D., 1992). The varietal renewal and varietal change carried out by the farms do not always lead to increase in productivity. This is primarily due to the fact that the potential of the new varieties, even under optimal conditions, is realized only by 50-60% due to the relatively low adaptability of the varieties to be created, which is able to provide the high and stable productivity in variable environmental conditions (Zhuchenko A.A., 2001, Nettevich E.D., 2001, Sapega V.A., 2013).

The phenomenon of "genotype-environment" interaction accompanies the entire history of plant breeding and is a significant factor in reducing the accuracy of the varieties estimates. The genotype-environmental interaction is a main reason that in different years and at the different points the varieties differ in rank in terms of crop productivity level, since the different genotypes respond differently to one and the same environment and the same genotypes respond differently to the different environments (Komarov N.M., 2012, Hill J., 1975).

Keywords: winter wheat, genotype, "genotype-environment" interaction, factor, pattern of flowering.

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Morphological and molecular study of the Saharan bread wheat in Algeria

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Climate change has significantly affected wheat yield. Many studies have suggested that rising temperatures could be harmful to cereals around the world. Thus, the valorization of the desert wheat resources is essential to improve the resistance of this species to climate change. In this context, we have studied for the first time in Algeria the morphological and the genetic biodiversity of the species *Triticum aestivum* L. cultivated in the Sahara. Twenty-eight accessions of autochthon bread wheat were analyzed by the use of nine quantitative agro-morphological traits and ten SSR markers. The results proved the high diversity of the Saharan bread wheat in Algeria. The morphological parameters revealed a high Shannon-Weaver diversity index (H') with an average of 0.59 and a clear distinction of the different studied accessions based on the hierarchical clustering. The molecular analysis confirm the morphological biodiversity of this species. A total of 20 alleles were produced by 10 SSR markers with allele frequency varied from 0.1 to 1 and the PIC values ranged from 0 to 0.5 with an average of 0.34. The molecular variance (AMOVA) revealed the highest level of intra-population differentiation of local Saharan bread wheat (97%) and the statistical geometric distribution of the tested varieties based on PCoA, NJ method and structure analysis confirm the existence of four major class of bread wheat in the Algerian Sahara and confirmed the previous works based on the morphological markers. Thus, our results contribute for the first time in Algeria to create the genetic fingerprint of the Saharan bread wheat resources and to employ their drought resistance potential through breeding programs.

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Quality evaluation of some durum wheat genotypes and relationship between some quality characteristics and Glutopeak parameters

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The aim of the study was to evaluate the quality of 12 durum wheat genotypes (3 cultivars and 9 advanced lines) obtained from the breeding program in Turkey. The wheat samples were grown in 6 different locations under rainfed conditions in 2014-2015 crop year. In the study, vitreousness, thousand kernel and test weights of wheat samples were firstly determined. After physical analyses, protein content at wholemeal and colour values (L, a, b) at semolina were determined. Then, durum wheat samples were milled into the flour for determining SDS sedimentation value, gluten content, gluten index value, Glutograph, and GlutoPeak characteristics.

The GlutoPeak is relatively new instrument to predict wheat flour quality by measuring gluten aggregation properties in a short time. Besides quality evaluation of durum wheat genotypes, correlation coefficients were calculated between GlutoPeak characteristics and the other quality parameters. The statistically significant correlations were found between GlutoPeak AM (torque 15s before maximum torque) and grain protein content (r = 0.57**), dry gluten content (r = 0.43**), SDS Sedimentation (r = 0.41**), wet gluten content (r = 0.39**). Between GlutoPeak BEM (maximum torque) and grain protein content (r = 0.54**), dry gluten content (r = 0.32*), SDS Sedimentation (r = 0.51**). Between GlutoPeak LOT (lift of time) and gluten index (r = 0.75**), SDS Sedimentation (r = 0.68**), Glutograph stretch (s) (r = 0.55**), Glutograph relaxation (r = -0.72**) values. Furthermore, GlutoPeak PMT (peak maximum time) was significantly correlated with gluten index (r = 0.80**), SDS Sedimentation (r = 0.74**), Glutograph stretch (s) (r = 0.46**) and Glutograph relaxation (r = -0.77**) values. The correlation results indicated that the GlutoPeak test is suitable for prediction of durum wheat quality with a small amount of sample.

Keywords: durum wheat, breeding, quality, GlutoPeak

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Evaluation of some bread wheat genotypes for making of Kahramanmaraş's tarhana with biplot analysis methods

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The most important raw material in making Kahramanmaraş tarhana is wheat dovme. Dovme is removed from the shell and grain of wheat germ. Tarhana wheat used in the production of white, easy peeling and dovme efficiency is desired to be good. In this study, to determine the suitability of making Kahramanmaraş tarhana white grain of bread wheat genotypes.
One hundred sixty-seven genotypes were evaluated for tarhana production suitability using biplot method. Varieties Doğankent, Dariel, Cumhuriyet-75 and Atay-85 were used as preferred standard for tarhana dovme. Thousand seed weight (TSW), zeleny sedimentation (ZSDS), brightness (L), redness (A), yellowness (B), protein content (CPR), moisture content (MC) and hardness (PSI) values were evaluated.
Biplot analysis method was applied to evaluate inter-traits and genotype-traits relationships. As a result of the analysis, related traits and superior genotypes for specific traits were shown visually.
Superior grain hardness, protein content, zeleny sedimentation, redness and yellowness combined with thousand seed weight identified several best genotypes (82, 93, 76, 128, 129, 122, 47, 133 and 26).

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Using of embryo rescue methods in interspecific wheat hybridization

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Interspecific hybridization studies have been made to improve the genetic base of durum and bread wheat. However, cross-breeding among plants of different ploidy level usually ends up with incompatibility issues that results in failure to establish cross-bred embryos. Potentially these immature embryos could maintain normal growth if they are isolated as immature embryos and may be kept alive by culturing them on basal medium resulting in hybrid plants. This study reports embryo rescue among different crosses of wheat with varying ploidy level with aim to gather desired features. Twelve (13) different crosses were performed (Bezostaja×Kızıltan-91, YDF-28×Kızıltan, *A. cransa*×Bezostaja, *S.cereale*×Jaguar, Kamut×Quality, *A. columnaris*×KateA-1, *A. columnaris*×Pehlivan, Bayraktar-2000×Kızıltan-91, YDF-15×Bezostaja, YDF-25×Tosunbey, YDF-26× Tosunbey, *T. dicoccon*×Eminbey, *T. monococcum*/Zenith). Experiments were performed related to selection of optimal number of days for selection of immature embryos after hybridization, the best conditions for sterilization of spikelets, and the appropriate basal media for growth of rescued embryos. It was determined that the immature embryos needed to be collected 18 days after hybridization. There was a need of 30% bleach concentration for sterilization and R9 regeneration medium was ideal for embryo culture. The plantlets were rooted and grown under in vitro conditions and vernalised at +4 oC for 4 weeks followed by transfer to greenhouse. Colchicine was applied to 50% plants for chromosome doubling. Seeds were collected from treated plants in the greenhouse.

Keywords: wheat, interspecific hybridization, embryo rescue

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Screening of selected durum wheat landraces for salt stress tolerance: Biochemical and molecular assessments

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Salt stress is one of the major abiotic stresses that cause adverse effects on plant growth and development. The aim of this study was to investigate the effect of salt stress on growth, biochemical responses, yield, and the expression of heath shock proteins (HSP70, HSP26.3, HSP17.8) of ten Jordanian durum wheat (*Triticum durum*) landraces. Seeds were grown on Petri-dishes or soil and irrigated with tap water as control or 300 mM NaCl. ISSR analysis showed significant differences between the collected landraces. Landrace K222 showed the highest germination percentage, shoot and root lengths, number of tillers, number and length of leaves, number of spikes and seeds, weight of seeds and the lowest levels of protein content, lipid peroxidation and proline content. Landrace WS5 showed moderate growth and biochemical responses followed by MM8 under increasing salt stress. Transcript levels of DHD15.1, HSP70, HSP26.3, and HSP17.8 were enhanced significantly by NaCl treatment in all landraces. These transcripts were highest in K222 and corresponded, respectively, to increases of 323%, 256%, and 224% (relative to control). In conclusion, our results indicate that salinity caused significant reduction in several growth parameters, enhanced degree of lipid peroxidation and proline content and expression levels of heat shock proteins for all studied wheat landraces. K222 was the most tolerant landrace in growth parameters, and expression of heat shock proteins.

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Expansion of genetic diversity and selection of new sources of bread wheat resistance to leaf and stripe rust

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Kazakhstan is among the 10 largest grain exporters in the world. In Kazakhstan, spring wheat is mainly cultivated in Northern Kazakhstan, where climatic conditions are more favorable for obtaining high-quality food grains. The sown area is 15.5-17.1 million hectares, annual grain production is 21.3-28.3 million tons. Winter wheat is mainly cultivated in the southern and south-eastern regions of the republic on an area of 1.5-2 million hectares, including 140.5-170.4 thousand hectares on irrigated land. In south-eastern Kazakhstan, the most dangerous diseases of winter wheat are yellow and brown rust. A significant role in the protection of crops of this culture is the resistance of varieties. Currently, by crossing *Triticum turgidum* tetraploid wheat and *Aegilops tauschi* forms of hexaploid synthetic wheat were obtained. The goal of our work is the expansion of genetic diversity by the method of distant hybridization, as well as the selection of new sources of bread wheat resistance to brown and yellow rust in southeastern Kazakhstan. The objects of research are diseases of winter wheat: stripe (pathogen *Pussinia striiformis* West fungus) and leaf rust (pathogen *Pussinia triticina* Eriks fungus). The subject of research are 49 breeding lines of the Kyoto University of Japan, CIMMYT and commercial varieties of winter wheat in the Almaty region: Almaly, Naz, Zhetysu, Farabi, Steklovidnaya 24, Azharly. Since 2014 the breeding and immunological study of synthetic hexaploid wheat were conducted on the experimental fields of the Kazakh Institute of Agriculture and Plant (KazNIIZiR) according to generally accepted in phytopatology breeding and crop production methods. Hexaploid synthetic wheat breeding of the Kyoto University of Japan were well adapted to the conditions of southeastern Kazakhstan. The study of the inheritance of resistance showed that in the first generation of hybrids of 15 lines showed resistance to leaf and stripe rust. Evaluation of phenotypes of inheritance of resistance traits in hybrids in the F2 generation showed that nine hybrids of synthetic wheat (Langdon / ig 48042 // Zhetisu, Langdon / ig 48042 // Farabi, Langdon / ku-20-8 // Ajarly, Langdon / ku- 2075 // Ajarly, Langdon / ku-2097 // Zhetisu, Langdon / ku-2075 // Farabi, Langdon / ku-2100 // Steklovidnaya, Langdon / ku-2144 // Naz, Langdon / ku-2076 // Naz) contain dominant brown rust resistance genes. Seven lines contain from one to several dominant yellow rust resistance genes.

Keywords: wheat, selection

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Genetic diversity analysis of elite Pakistani wheat germplasm to identify high resistant starch genotypes for type-2 diabetic patients

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In Pakistan, the majority of the population derives more than 90% calories from starch obtained mostly from wheat. This starch is readily digested to glucose leading to rapid increase in glycaemic index (GI). This rapid increase in GI on daily basis can render an individual susceptible to type-2 diabetes. At present, more than 7.2 million people in Pakistan are suffering from type-2 diabetes. Although, type-2 diabetes is influenced by many factors, but significant contributors are; type of food and life style. Thus, increased uptake of high starch food is considered as a major cause of type-2 diabetes. In contrast, resistant starch (RS), exhibits naturally or artificially modified structure. Therefore, it is not digested by the α-amylases of human digestive tract. This undigested starch in the large intestine is utilized by the inhabitant microbiota leading to production of many useful bio-molecules including short chain fatty acids (SCFA). The production of SCFA has many health benefits. Use of RS results in production of less glucose and ultimately fewer calories. Therefore, blood sugar level does not increase rapidly. Thus, increased RS uptake in daily food can significantly help in preventing colon cancer, early occurrence of type-2 diabetes, improves cardiovascular health and reduces risks of obesities. Naturally, this modification in starch structure occurs due to alterations in the activities or post-translational modifications in the enzymes involved in starch biosynthesis pathway. The biological events involved in the natural synthesis of RS are genetically controlled. Therefore, the purpose of this study was to determine the genetic diversity in elite wheat germplasm collected from different areas of Pakistan to identify suitable wheat variants which can be used for the development of resistant starch enriched lines to reduce the risk of type-2 diabetes occurrence. Also, to understand the mechanism of synthesis of higher resistant starch content in wheat. SSR markers were used to determine the genetic diversity and results indicated that genotypes collected from different areas, exhibit variations for suitability to breeding program aimed at increased RS. However, this genetic diversity was narrow due to more emphasis on selection for yield. Increased, RS is associated with altered physico-chemical starch properties, which can be used as markers to identify high RS genotypes. It was found that proportion of B-granules and altered granule morphology was highly correlated with increased RS content. Our results also indicated that granule bound starch synthesis (GBSS) and starch branching enzymes (SBEs) play major role in increasing RS content. Genetic diversity targeting SBEs is more effective for high RS genotypes identification. Alteration in protein complexes compared to wild type also add in increased RS content. This study is first of its type in Pakistan, which shows that Pakistani wheat germplasm exhibits genetic diversity which can be significantly used to develop high RS genotypes.

Keywords: Wheat, Resistant Starch, Genetic Diversity, SSR Markers

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71 - Improvement of key traits by genetics and breeding - Poster

Identification of the pathotypes races of *Puccinia triticina* the causal agent of wheat leaf rust in the Iran in 2018-2019

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Wheat leaf rust caused by *Puccinia triticina* Eriks is the most important wheat disease due to the extent of dispersion and damage in the world. Due to race variations and the emergence of new race of pathogens due to the migration of spores from other world's wheat fields, achieving durable resistance to cereal rust is a major challenge for wheat breeders. Due to the high importance of rust diseases in worldwide, many laboratories carry out race analysis of leaf wheat rust. This research project was conducted in order to determination of Virulence/Avirulence formula of the causial agent of wheat leaf rust disease under greenhouse conditions. The experiment consisted of 39 differential lines, each line carrying a resistant gene to leaf rust, and with susceptible Bolani variety. In this study, 38 samples were randomly collected from the wheat fields of Khuzestan, Lorestan, Ardebil, Mazandaran, Gorgan and Khorasan Razavi provinces for race analysis and variation in the population of the leaf rust disease in spring of 1397. The isolates were purified and proliferated gradually on a sensitive cultivar Bolani under greenhouse condition. Spores of 22 isolate after purification and increasing were inoculated separately at international standard differentials in seedling stage to Identification of pathotypes based on Virulence/Avirulence formula. Their response was recorded using a sacle that described by McIntosh et al. (1995). In this study, 21 pathotypes were identified as the cause of the disease. The results of this study showed that the differential cultivars carrying *Lr28*, *Lr19* and *Lr9* genes were resistant to all isolates, and there no virulence was detected for these genes. Some genes were susceptible to other genes. The gene *Lr2a* was resistant to 17 isolates, the most effective gene after the three genes mentioned.

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Evaluation of reaction in wheat genotypes of preliminary and advanced regional wheat yield trials (2017-18) to leaf rust

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Wheat leaf rust caused by *Puccinia triticina* Eriks is the most important wheat disease due to the extent of dispersion and damage in the world. In Iran, yellow rust is more important than leaf rust but in Khuzestan province the importance of leaf rust is more than yellow rust. This research project was conducted in order to evaluate the reaction of 1290 wheat genotypes of preliminary and advanced regional wheat yield trials genotypes to leaf rust. In the 2017-2018 cropping seasons, each of the wheat genotypes were planted in two rows of one-meter length with 30cm distance and Boolani susceptible wheat was planted as spreader between each 10 genotypes at the rows and around the field. All lines tested under artificial inoculation at field conditions with two isolates of Ahvaz and Gorgan using mist irrigation system at adult plant stage. Field assessments were based on disease severity at the stage of emergence of flag leaf and according to the modified Cobb's scale (Peterson et al., 1948) and disease reaction (Roelfs et al., 1992). The resultes showed that among of 1290 wheat genotypes, 259 (20%) genotypes were resistant and semi-resistant in adult plant stage. The remaining genotypes showed moderately to susceptible responses. Among North genotypes (127), South (53) Moderate (46),) and Cold (33) genotypes had acceptable resistance to the cause of leaf rust.

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Evaluation of genetic diversity in Iranian wheat genotypes using linked molecular markers to strip, leaf and stem rusts resistance loci

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Wheat rusts consist of yellow, leaf and stem rusts are considered as the most devastating diseases of wheat in Iran. A significant amount of chemical is used to control these diseases throughout the country, even in non-epidemic years. The use of resistant cultivars is the most effective and environmentally sound approach to control these diseases. Most identified rust resistance genes specifically confer resistant to only one or few races of pathogens. Therefore, deployment of the adult plant resistance genes against wheat rusts has received more attention in the recent years. To date, a significant number of molecular markers linked to the rusts resistance loci in wheat have been identified and are widely used worldwide. This study was carried out to evaluate genetic variation of 188 promising and pre-released wheat lines or commercial cultivars in four major wheat climate zones of Iran using linked molecular markers to four race non-specific resistance loci including Lr34/Yr18/Sr57/Pm38, Lr46/Yr29/ Sr58/Pm39, Lr67/Yr46/Sr55/Pm46 and Sr2 as well as linked markers to seven race-specific genes including Sr26, Sr24/Lr24, Sr31/Yr9/Lr26, Sr38/Yr17/Lr37, Lr21, Lr25/Lr29 and Lr35/Sr39. The results showed that the frequency of studied rusts resistant genes in Iranian wheat germplasm was low and most of the genotypes did not have any of these rust resistance genes. In total, 24 alleles were scored for 17 markers used in this study and a binary matrix of data was compiled. Cluster analysis using the unweighted pair group method of arithmetic averages (UPGMA) classified genotypes into four major groups. Principle component analysis (PCA) of data verified the results of clustering. Based on the findings of this study an overall perspective on the rust resistance of Iranian promising and pre-released wheat lines was made which can be efficiently used for targeted crossing in the breeding programs to pyramid effective rusts resistance genes into breeding lines and new varieties. Using resistant cultivars will help framers to avoid spraying chemicals which can pose serious threats to human health.

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Development of early maturity, nutrient dense wheat varieties for North-Western Himalayas of State Jammu and Kashmir

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Wheat is one of the most important cereal crops in the world. Successful rice-wheat crop rotation is considered very crucial to achieve self-sufficiency in food production in Kashmir valley. However, wheat crops take ~8 months from sowing to harvesting (October- June) in Kashmir valley and thus do not vacate land for rice cultivation on time (before June 21). Therefore breeding early maturing wheat varieties is considered the most important area of wheat research. Efforts have been made during the present study to procure ~1200 wheat lines from different national/international institutes and a set of 80 breeding lines have been selected for breeding early maturity and nutrient dense wheat varieties for the Kashmir region. The selected breeding lines mature by first week of June (thus vacate land on time for rice cultivation) and possess high seed Zn and seed Fe content. The selected set of 80 breeding lines/candidate lines have been characterized using trait linked markers (markers linked with seed Zn and seed Fe content and markers linked with photoperiod/days to flowering/maturity) and random SSR markers and based on data analyses best candidate genotypes have been identified and some markers have been also validated/found associated with early maturity and seed Zn/Fe content. Efforts have been also made to cross a set of 8 breeding lines in different combinations (MAGIC crosses) to combine early maturity, disease resistance and high seed Zn and seed Fe content. The double cross F1 hybrids of MAGIC crosses are being evaluated in the field during current Rabi season. The segregating progenies will be phenotyped for targeted traits and MAS will be exercised that will lead to selection of best recombinants possessing multiple genes for development for next-generation wheat varieties for Kashmir region.

Keywords: Wheat, Early maturity, Nutritional traits

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Identification of resistance wheat cultivars using molecular marker against yellow rust in Azerbaijan

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Wheat is the most widely grown crop in the world and is the key commodity for food security in central Asia, Caucasus, West Asia and North Africa (CWANA).
A study was conducted between 2014 and 2016 aiming at determining resistance of 51 local wheat cultivars. The cultivars were evaluated in 5 different agro-ecological zone against three of the rusts pathogens under natural conditions with four repetition at each region. Field responses under natural infection were recorded according to Modified Cobb's scale for major field responses R, MR, MS, and S and diseases severity (0-100%).For molecular analysis genomic DNA was extracted from leaves and the following 7 markers (*Yr5, Yr9, Yr10, Yr15, Yr17, Yr18*, and *Yr26*) were used to identify resistance genes at Plant Genomics College of Agronomy Northwest A&F University China. Marker analysis revealed that *Yr5* was present at least in 12 cultivars which include Murov, murov-2, Shafag, Shafaq-2, Nurlu-99, Fatima, Azamatli-95, Agali, Gunashli, Saba, Giymatli 2/17, Pərzivan-1, Tale-38. In addition, *Yr9* was present in 7 culitivars (Pirshahin-1, Layagatli-80, Shafag-2, Zirva-85, Fatima, Agali, Gunashli). Further more, *Yr10* was present in 8 cultivars (Yegana, Garagilchig-2, Yagut, Pirshahin, Shirvan-5, Barakatli-95, Bayaz, Girmizi bugda). Finnaly, *Yr18* was present in Mirbashir-128, Azamatli-95, Gunashli, Akinchi-84, Shirvan-3 cultivars. *Yr26* worked well but was not founded in any of cultivarsıo In contrary, *Yr17*,*Yr15* did not work very well with this method.

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Wheat genotypes performance for water use efficiency under rainfed conditions (Sétif Town, Algeria)

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Genotypes of durum wheat (*Triticum durum* Desf.) were tested during crop year 2013/2014. Aim of investigation was to evaluate their reponse for rainwater use efficiency (RWUE). At this, an experiment was conducted at Agricultural Experimental Station of Technical Institute of Field Crops (TIFC) in Sétif Town (Eastern Algeria). Results showed that RWUE differs significantly between genotypes. Thereby, Megress was examined as an efficient genotype. However, Djenah Khetaifa appeared less efficient. Relative RWUE gain was 116.1%. Average of RWUE wheat genotypes was estimeted for 8.85 kgha-1mm-1. Water productivity of wheat is an excellent parameter to evaluate performance of wheat resilience to drought under rainfed semi-arid conditions. Performance for water use efficiency under rainfed conditions of the High Plateaus of Sétif recommends preservation water in the soil horizons. However, soil sustainable management is an approach to improve water use by plant.

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138 - Improvement of wheat end-products by processing - Poster

Identification and evaluation of selected wheat cultivars for their suitability to milling and baking quality

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The current study was conducted to evaluate the quality of different wheat cultivars for their suitability for milling and baking quality. Twenty wheat varieties NARC-09, NARC-11, Pakistan-13, Zincol-16 and Borlaug-16, Ufaq-02, Inqlab 91, Bhakkar 2001, Seher-2006, Lyallpur 1973, Lasani, Iqbal-2000, Punjab-11, AARI-11, Millat-11, and Chenab-2000 were taken from the NARC and AARI Pakistan. Other 4 lines of wheat T-9, T-11, C-217, MH-97 under investigation stage in AARI were included in the study. The results for different physical, chemical and rheological parameters revealed significant differences among the tested cultivars. During the physical evaluation Lyallpur 1973, Punjab-11, NARC 2009, Iqbal-2000 and wheat line T-11 exhibited significantly higher extraction rate i.e. 77.1-77.5%, 76.1-77%, 76.1-76.8%, 75.8-76%, 75-75.7%, respectively. With respect to chemical characteristics, the flour of the wheat cultivars Ufaq-02, Inqlab-91, Sehar-06, NARC-2009 and wheat line T-9 showed the maximum protein content in the range of 15.7-16%, 15.9-16.1% 16-16.2%, 14.5-14.7% 13-13.1%, respectively, The wheat cultivars Ufaq-02, Inqlab-91, Sehar-06, NARC-2009, Borlaug-16 showed higher sedimentation rate i.e. 33-35mL,34-36mL, 34-35mL, 35-36mL, 35-37mL, respectively. The gluten content of Ufaq-02, Sehar-06, NARC-09 and one wheat line MH-97 was significantly higher i.e. 11.5-11.7%, 12.4-12.7%, 11.4-11.6%, 10.2-10.5%, respectively. As regarding the rheological properties, the water absorption of Ufaq-02, Sehar-06, NARC-09, and MH-97 was found to be significantly higher i.e. 55.5-56.1%, 54.1-55%, 48-49.3%, 46-47.5%, respectively. The dough development time of Inqilab-91, NARC-09, Zincol-16, and MH-97, was 6-6.5min, 6-6.5, 4-5min, 4-4.4min, respectively whereas, dough stability of these cultivars was 8.9-9.2min, 8.6-8.7min,8.2-8.4min, 5.6-5.9min. The alpha-amylase activity exhibited by Lyallpur-1973, Chenab-2000, NARC-11, and Pakistan-13 was 611-624, 648-656, 347-357, 385-391, respectively. The study exhibits that Pakistani wheat varieties differ significantly in their physicochemical, rheological and technological characteristics. Thus, the information obtained in this study can be useful for millers and bakers for the selection of suitable variety for their intended uses. It was concluded from the results that Lyallpur 1973, Punjab-11, NARC 2009, were suitable for miller due to high extraction rate and wheat cultivar Ufaq-02, Sehar-06, NARC-09 were found suitable for baking. While wheat lines, T-11 and MH-97 need further study for milling and baking properties.

Keywords: Wheat cultivars, Quality traits, Rheological properties, Physical-chemical properties

155 - Improvement of wheat end-products by processing - Poster

Development of soft wheat (*Tr. aestivum* l.) varieties suitable for demands of the biscuit industry

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Biscuit sector, which has high exports and value-added capacity, has grown rapidly in the last twenty years in Turkey. The competitiveness of the sector in the domestic and foreign markets depends primarily on the desired quantity and quality of wheat flour. Technological quality of the wheat varieties used for obtaining this flour is not in accordance with the demands of the industry. Enzymes are necessary to weaken gluten strength in the process for adjusting dough properties to target products baking. In this case, production costs increase due to the price of proteolytic enzymes and the waiting period in the process. Besides, irregularities in dough structure are formed in the first, middle and last batch products depending on the activity of the enzyme. As a result, continuous arrangements are necessary for the continuing process and some problems occurred in standard product weight and packing at the end. Due to increasing importance of high bread-making quality varieties in wheat production, determining the wheat price in the market according to the protein content, good care conditions in recent years the chance of using the existing cultivars has declined. So, It is very important to develop new soft wheat varieties suitable for different environmental conditions to meet the biscuit sector demands.

The project, which is within the scope of Scientific and Technological Research Council of Turkey (TUBITAK) priority areas, biscuit wheat developing studies were carried out in the Transitional Zone Agricultural Research Institute. This project was aimed to develop new soft wheat varieties for the production of wire-cut and extruded type biscuits, which are the most critical type of the sector, in cooperation with the university, industry and research institutes. For this purpose, 20 different advanced lines for rainfed and irrigated conditions were used. The trials were planted under two different environmental conditions: 7 locations in rainfed and 5 locations in irrigated locations during three crop seasons. Grain yield, some plant morphological and physiological parameters, and disease tolerances were evaluated in the field. Grain physical characteristics, milling performance (break and total flour yield), protein content and protein quality properties (Zeleny sedimentation, GlutoPeak, and Mixolab thermo-rheological properties, and solvent retention capacity tests) were used to evaluate the lines during three years. High Molecular Weight (HMW) glutenin subunits and wheat-rye translocations were also used to contribute to the selection. The lines that have been highlighted have been processed to the final product in order to determine the suitability of end-use quality in the private sector. Product and sensory properties of the lines were determined by the experts and a conformity assessment was done according to reference biscuits. As a result, 2 lines for rainfed and 3 lines for irrigated conditions were found suitable for the demands of the biscuit industry. Two lines were sent to registration trials and two of them will be sent this year. This study summarizes the studies and results carried out within the scope of the national urgent areas of the project.

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Protection of GTA durum wheat by indigenous rhizobacteria from the Setif region

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Durum wheat (*Triticum durum* Desf.) is the first cereal grown in Algeria. It occupies more than one million hectares annually. Domestic production of durum wheat is still low due to abiotic, biotic and human constraints. The wheat crops are also damaged by several diseases such as fungal diseases including fusariosis. The intensive use of chemical plant protection products to control wheat pathogens has caused environmental problems with increased production costs; and created imbalances in microbial communities and the development of resistant pathogenic strains. Biocontrol through the use of microbial technologies represents an alternative approach to controlling these diseases. The aim of this work is to evaluate the ability of native rhizobacteria in the SETIF region to protect the durum wheat *Triticum durum* Desf from the GTA variety against the multiplication of *Fusarium graminearum* during their development cycle. In this context, preselected bacterial strains belonging to the genera *Pseudomonas* and *Bacillus* were tested by soaking wheat seeds in bacterial suspensions and sowing in soil infected with the pathogen. The results showed that some strains protected wheat seedlings against *Fusarium* and that no mortality rate was recorded especially with *Pseudomonas* protegens XI3 and *Pseudomonas* sp. (XI13 and P37). Gram-positive strains have also been very effective in protecting seedlings at rates of protection ranging from 20 to 90%. These results demonstrate that the tested isolates may represent a very promising alternative to minimize agrochemical inputs in the semi-arid region.

Keywords: *Triticum durum*, *Fusarium graminearum*, rhizobacteria, biocontrol

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Identification and evaluation of selected wheat cultivars for their suitability to milling and baking quality

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The current study was conducted to evaluate the quality of different wheat cultivars for their suitability for milling and baking quality. Twenty wheat varieties NARC-09, NARC-11, Pakistan-13, Zincol-16 and Borlaug-16, Ufaq-02, Inqlab 91, Bhakkar 2001, Seher-2006, Lyallpur 1973, Lasani, Iqbal-2000, Punajb-11, AARI-11, Millat-11, and Chenab-2000 were taken from the NARC and AARI Pakistan. Other 4 lines of wheat T-9, T-11, C-217, MH-97 under investigation stage in AARI were included in the study. The results for different physical, chemical and rheological parameters revealed significant differences among the tested cultivars. During the physical evaluation Lyallpur 1973, Punjab-11, NARC 2009, Iqbal-2000 and wheat line T-11 exhibited significantly higher extraction rate i.e. 77.1-77.5%, 76.1-77%, 76.1-76.8%, 75.8-76%, 75-75.7%, respectively. With respect to chemical characteristics, the flour of the wheat cultivars Ufaq-02, Inqlab-91, Sehar-06, NARC-2009 and wheat line T-9 showed the maximum protein content in the range of 15.7-16%, 15.9-16.1% 16-16.2%, 14.5-14.7% 13-13.1%, respectively, The wheat cultivars Ufaq-02, Inqlab-91, Sehar-06, NARC-2009, Borlaug-16 showed higher sedimentation rate i.e. 33-35mL,34-36mL, 34-35mL, 35-36mL, 35-37mL, respectively. The gluten content of Ufaq-02, Sehar-06, NARC-09 and one wheat line MH-97 was significantly higher i.e. 11.5-11.7%, 12.4-12.7%, 11.4-11.6%, 10.2-10.5%, respectively. As regarding the rheological properties, the water absorption of Ufaq-02, Sehar-06, NARC-09 and MH-97 was found to be significantly higher i.e. 55.5-56.1%, 54.1-55%, 48-49.3%, 46-47.5%, respectively. The dough development time of Inqlab-91, NARC-09, Zincol-16, and MH-97, was 6-6.5min, 6-6.5, 4-5min, 4-4.4min, respectively whereas, dough stability of these cultivars was 8.9-9.2min, 8.6-8.7min,8.2-8.4min, 5.6-5.9min. The alpha amylase activity exhibited by Lyallpur-1973, Chenab-2000, NARC-11, and Pakistan-13 was 611-624, 648-656, 347-357, 385-391, respectively. The study exhibits that Pakistani wheat varieties differ significantly in their physicochemical, rheological and technological characteristics. Thus, the information obtained in this study can be useful for millers and bakers for the selection of suitable variety for their intended uses. It was concluded from the results that Lyallpur 1973, Punjab-11, NARC 2009, were suitable for miller due to high extraction rate and wheat cultivar Ufaq-02, Sehar-06, NARC-09 were found suitable for baking. While wheat lines, T-11 and MH-97 need further study for milling and baking properties.

Keywords: Wheat cultivars, wheat milling, Baking quality, physicochemical properties

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Phenotypic diversity and physiological characterization of durum wheat (*Triticum durum* L.) landraces under rainfed conditions

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Wheat landraces represent a large reservoir of genetic variation of various traits. Genetic diversity in wheat breeding program is an essential issue for breeder. Turkey is considered as a diversification centre of durum wheat (*Triticum durum* Desf.). An experiment was conducted to assess genetic diversity by cluster analysis for yield, agro-physiological parameters. In this study a total of 35 durum wheat cultivars and landraces were tested during 2018-2019 season. The experiment was conducted in randomized completely blocks design with three replications. Biomass, chlorophyll content, canopy temperature, days of heading, plant height, flag leaf area and number of stomata were investigated. There were various significant relations based on investigated parameters among landraces and cultivars. The mean values of biomass at GS55 were 0.76, chlorophyll content 56.8, canopy temperature 24.8 oC, days of heading 97.6, flag leaf area 30.0 cm2 and plant height 109.9 cm. According to result landraces Yerli/Bağacak and Sevinç had higher biomass (NDVI) was scaled from GS25 up to GS55 growth stages. Chlorophyll content was evaluated at heading stage (GS55) and there was significant difference among genotypes. Canopy temperature was evaluated at heading stages (GS55) and landraces Akbaşak and Sevinç had lower canopy temperature (22.4 oC). Landrace Akbaşak was the late (Days of heading) genotype. Landraces had higher plant height than modern cultivar. Landraces Kızılbuğday, Cafari and Sevinç had large flag leaf area. Three landraces, Yerli/Bağacak, Menceki and Devedişi, had more number of stomata than other landraces and cultivars. All germplasm presented average diversity showing a large genetic variability. These genotypes can, therefore, be used as parents for the improvement of durum wheat. The cluster analysis revealed that there is considerable variation among genotypes that could be implicated in selection of durum wheat for the development or improvement of cultivars.

Keywords: Triticum durum, genotypes, landraces, agro-physiological diversity

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Technological and nutritional properties of isogenic wheat lines carrying purple pericarp (Pp) allels

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Pigmented wheat grains have health beneficial effects. Purple pigmentation is associated with the deposition of proanthocyanidin in the wheat pericarp. *Pp-1* and *Pp3* genes are responsible for the purple grain color. Grain color and the source of *Pp3* gene (*Pp3P* and *Pp3PF*) influences technological and nutritional properties of wheat. The study objective was to evaluate the effect of (i) the grain color and source of gene *Pp3PF* (entry 160027) and *pp3PF* (entry 160029); *Pp3P* (entry 160031) and *pp3P* (entry 160033); (ii) the grain color for both sources of gene means for *Pp3PF* (entry 160027) and *Pp3P* (entry 160031) versus *pp3PF* (entry 160029) or *pp3P* (entry 160033). For this purpose, two sets of isogenic lines (four entries) and Seri, commercial white bread wheat, are used as a material. This isogenic lines are derived from old Russian spring wheat variety Saratovskaya 29 and were developed by Novosibirsk Institute of Cytology and Genetics. Two entries (160027 and 160031) have the purple grain color with *Pp3PF* or *Pp3P* genes, respectively. Other two isogenic lines have *pp3PF* (entry 160029) or *pp3P* (entry 160033) genes and red grains. Compared with commercial wheat Seri all isogenic lines had superior protein quality (Zeleny and macro SDS sedimentation, SIG and SRC-lactic acid values), gluten and dough rheological (GlutoPeak, Farinograph, Mixolab, and Mixograph) and same or better bread-making properties. Isogenic lines have also higher protein content, amino acid content (nearly all both in whole-wheat flour-WWF and in bread), some mineral content, soluble and total dietary fiber content (both in whole wheat flour, WWF and bread) and also insoluble in bread. According to our study when *Pp3PF* gene compared with *Pp3P* both genes decreased L*, a*, b* values in WWF and bread crust and crumb. While grain physical properties (test and kernel weight and diameter) remains nearly constant in both genes, higher flour yield was obtained from *Pp3PF* gene. On the other hand, better protein quality and gluten and dough rheological properties values were obtained in *Pp3P* comparing to *Pp3PF*. Both genes generally have a positive effect on the bread-making properties and protein content. Nearly all amino acids increased with *Pp3P* gene while decreased in *Pp3PF* gene in whole-wheat flour and bread. While most of the minerals content increased with both genes in WWF, the increase was found in bread made from *Pp3PF* line and decreasing from Pp3P line. Both genes had a positive effect on total phenolic substance and antioxidant activity in WWF and bread. The *Pp3P* gene caused an increase in insoluble and total dietary fiber. When the means of purple and white isogenic lines compared purple grains had higher flour yield with same grain physical properties and higher flour protein content compared to white lines. Both groups had very good technological quality parameters. In WWF and in bread purple grain lines had significantly higher total phenolic substance and antioxidant activity and insoluble dietary fiber content in WWF.

Keywords: purple wheat, Pp allel isogenic wheat lines, technological quality, nutritional property

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Overview of wheat diversity and human health in Afghanistan

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More than three billion people especially from developing countries are the victims of micronutrient deficiencies also known as hidden hunger. This is attributed mainly to the scarcity of essential micronutrients like iron, zinc and vitamin- (SAM) is a common condition among Asian children. It affects about 20 million children globally and about one million of them die annually About 0.6 million children suffer from SAM in Afghanistan. Wheat is staple food item for Afghanistan's 35 million people. Though, Afghans rank among the highest consumers of wheat in the world, however, cereals as such are known to be a poor source of micronutrients like iron and zinc, especially when soils are deficient in these minerals. Around 1.2 million children younger than 5 years and 550,000 pregnant or lactating mothers are at high risk of severe malnutrition in Afghanistan. In addition, more than half of Afghan pre-school children are chronically malnourished and the rates of acute malnutrition in children are between 6 and 10%, to as high as 16%. Iodine and iron deficiency are estimated at 70%, and over half of children are anemic. Conditions like diarrhea, scurvy, and stunting are also prevalent. 40.9% of Afghan children suffer from stunting and 20.5% of them are underweight because of malnutrition. (www.nutritionintl.org) report claimed that 40 to 60% of 6 to 24 month old children are at risk of disrupted brain development because of iron deficiency. Also, that 2600 young Afghan women die every year during pregnancy and child birth because of iron deficiency. Research has confirmed that there exists genetic variability to enhance micronutrient content in wheat grain. CIMMYT has been working to enhance the iron and zinc content in wheat grains to offer an affordable solution to tackle malnutrition among wheat eating communities. CIMMYT is breeding for enhanced Zn and Fe in wheat grain and have focused on transferring genes governing increased Zn and Fe from *Triticum spelta,* landraces, *T. dicoccon* × *Ae. tauschii*-derived synthetics, and other high Zn and Fe sources to high-yielding elite wheat backgrounds using a limited back-cross approach. Research has revealed that the range of values for Fe concentration in grain among hexaploid wheat, *Triticum dicoccum* and landraces grown under field conditions was from 25 to 56 mg/kg, with a mean of 35 mg/kg. Bread wheat was found to have zinc in the range of 26 to 32 mg/kg, however its relatives were shown to carry upto 142 mg/kg of zinc. Researchers have succeeded in developing varieties having zinc up to 39 mg/Kg, and iron upto 43 mg/kg. Varieties with higher zinc and iron contents have already been released in India (Zinc Shakti and HPBW 01) and Pakistan (Zincol) Though the two micronutrients show a very high genotype-environment interaction but they also display correlation meaning that lines showing high zinc also show high iron and vice versa. Introduction and release of such varieties in Afghanistan hold promise to bring health and wellbeing to Afghan people in general and to Afghan women and children in particular.

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Microbial seed dressing for wheat with *Trichoderma harzianum* KUEN 1585

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For extensive use by arable crops, seed dressing (coating) may be the most convenient concept for supplying a biological agent. Seed coating is used for commercial seed dressings. However, seed coating with PGPR's is often challenging, requiring a long shelf life, and compatibility with other seed dressings. *Trichoderma harzianum* KUEN 1585 (commercial brand name Sim Derma) formulations for wet and dry seed coating are patented (TR/2007/09242, 31.12.2007; EP8866322,4, 13.11.2008; TR/2009/08397, 05.11.2009). Although *Trichoderma harzianum* is commonly known as a fungus with bio-control effects, the strain *Trichoderma harzianum* KUEN 1585 has strong root growth promoting effects.
The seed dressing formulation is mixed together with fungicides and insecticides slowly by continual stirring in water and this solution is sprayed on cereal seeds. Coated seeds can be packed in bags and sown in up to 6 months.
Trichoderma harzianum KUEN 1585 colonize roots of the wheat. The result is longer, stronger, more capillary roots and higher chlorophyll content. In addition *Trichoderma harzianum* KUEN 1585 makes soil micro elements like phosphorus available for the plant.
Field results between 2010 and 2014 in Turkey and Ukraine show that *Trichoderma harzianum* KUEN 1585 application can reduce sowing by 10%, results in strong and early sprouting, increases flag leaf chlorophyll content by 30-109%, flag leaf nitrogen content by 39-185%, and coefficient of tillering by 33%, improves dry matter content of green parts up to 33 %, wall thickness of the stem up to 75% and the yield by 6-27% and gluten content by 11-39%.

Keywords: microbial seed coating, *Trichoderma harzianum*, organic wheat farming

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Climate change impact on durum wheat production and gross margin of farms (Tunisia) and adaptation forms, using a bio-economic approach

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Tunisia is a Mediterranean country, which is not spared from the climate change effects and their predictable impacts on global food reserves. Some studies predict drastic decline of cereals production, vegetables, meats and probably the disappearance of certain crops and fauna on the planet (Easterling, 2008 and FAO, 2016).
To obtain an adequate yields and sustainable gross margin for farmers in Bizerte region of northern Tunisia, we studied the climate change impact on durum wheat production and adaptation forms. We adopted a preventive bio-economic methodological approach, based on coupling a biophysical model constructed by "CropSyst" allowing long-term yield simulations, with an economic model developed with "GAMS" (General Algebraic Modeling System) based on mathematical programming.
We surveyed 120 farms and aggregated them into 3 distinct groups and we selected from groups G1 and G3, too (2) farm-types (F1 and F3), which are producing cereals: respectively durum wheat (F1); durum wheat, soft wheat, oat and faba bean (F3).
We collected the observed climate data (1983-2015) of the region and farms soil textures. We generated (using a sub-program in CropSyst) 40-year-climate data (2016-2055) for bio-economic modeling and we carried out simulations.
Results showed that around the year 2055, the temperature average will reach 19.6°C compared to 1983-2015 (18.4°C), increasing of 1.2°C. The annual rainfall average (438mm) will reach 346mm, decreasing of 92 mm. Therefore, in the 4th decade (2045-2055) climate change will decline the average of durum wheat yield that could reach 73%/ha compared to the average of the observed yield (1.8 tons/ha). Reduce of the average of gross margin (GM) can reach 79%/ha compared to the average of observed GM (1.2 MTND/ha) for F1 (Operating monoculture).
For F3 (crop diversifying, the average of durum wheat decline will be only about 25%/ha and the average GM reduce did not exceed 51%/ha. With fertilization, F1 can improve yield about 100%/ha and GM about 54%/ha. For F3 climate change impact is reduced by diversified crop production. The gross margin is more or less stable in the long term.
Taking into account that Tunisia is a country with a semi-arid to arid climate, fertilization and crop diversification could be two adaptation forms to climate change. F3 GM is greater than F1, therefore diversification is recommended.

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Effect of foliar Zn application on the response of bread wheat to elevated carbon dioxide

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One of the drastic effects of elevated CO2 on wheat plants is reduction of Zn concentration in the grains posing serious threats to food security. Agronomic biofortification (foliar application of Zn) is one of the proposed methods to increase Zn concentration in grains to eliminate Zn deficiency in humans. However, there is scarcity of information about the effect of elevated CO2 on agronomic biofortification. This study was designed to elucidate the possible effect of elevated CO2 on the response of wheat to foliar Zn application in terms of grain yield and quality. Bread wheat was cultured in a marginally Zn-deficient soil (DTPA-Zn: 0.59 mg kg-1) under ambient (400 ppm) or elevated (700 ppm) CO2. At heading stage, half of the pots from each CO2 treatment were sprayed with 0.2% (w/v) ZnSO4.7H2O solution. At full maturity, plants were harvested to determine grain yield, number of spikes per plant, thousand grain weight and grain Zn concentration. Foliar Zn application significantly interacted with atmospheric CO2 on grain yield causing significant increase in grain yield under elevated CO2 in contrast to ambient CO2. Both elevated CO2 and foliar Zn application had non-significant effect on thousand grain weight while interaction between them was significant. Under ambient CO2 foliar Zn application reduced thousand grain weight while under elevated CO2 it significantly increased thousand grain weight. Foliar Zn application increased grain Zn concentration under both ambient (32%) and elevated (47%) CO2, whereas elevated CO2 alone reduced grain Zn concentration. Our results also conclude that foliar Zn application can enhance the “CO2 fertilization effect” on grain yield through improving grain filling and thousand grain weight.

Keywords: Biofortification, Wheat, Zinc, Elevated CO2, Climate change

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Influence of Zn seed priming and coating on seedling growth of two wheat varieties under different growth conditions.

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Seed priming in Zn containing solution and seed coating with Zn are simple and practical ways to enhance seed Zn prior to sowing and contribute to better seedling growth. The effect of seeds priming (2.5 and 5 mM) and coating (1.5, 2.5 and 5 g Zn/kg seeds) on early growth stages of two wheat varieties difference in Zn content (Imam low Zn content and Altindane high Zn content) were carried out under two germination conditions. In experiment 1. Which conducted in petri dish, Zn seed primed with 5 Mm significantly improved seed germination, seedling growth and water uptake for both wheat varieties. Furthermore, Zn coated seed relatively in all concentration did not mitigate seed germination and had a deleterious and suppressed effects on the above parameters. On the other hand, the experiment 2. which carried out in sea sand soil have observed contrast results in comparison with experiment 1. Where Zn primed seed with 5 Mm and coated seeds with 1.5 g Zn/kg seeds have revealed good response and induced crucial consequents for all seedling parameters in comparison with Hydropriming and untreated seeds respectively and for both wheat varieties particularly that with low Zn content. In conclusion, to make seed germination test for seed coating with Zn and to get appropriate results may be better to conduct the experiment in sea sand soil rather than petri dish. Also, the results suggest that using varieties with low Zn content could show more response to Zn seed priming and coating. Applied smallest concentration of seed coated with Zn (1.5 g Zn/kg seeds) had positive impact on seedling growth as well as it completely economic and safe for environment.

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Soil tillage effects on growth, grain yield and quality of three wheat (*Triticum aestivum* L.) varieties

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Conservation tillage, such as minimum tillage, has been practicing worldwide as a means of conserving soil moisture, reducing soil erosion, and improving soil organic C, plant-available water capacity, aggregation, and soil water transmission. The aim of the present study was to evaluate the influence of conventional and minimum tillage system on soil properties, growth, grain yield, and quality parameters of three wheat (*Triticum aestivum* L.) varieties. A field experiment was conducted in Western Greece (Agrinio region) in 2014. The experiment was laid out in a split plot design, with three replications, two main plots (conventional and minimum tillage) and three sub-plots (wheat varieties: Dodoni, Estero, Yecora-E). The results indicated that the highest soil porosity (40.29-41.05%) and total nitrogen (0.134-0.154%) were found in soils subjected to minimum tillage. Root length density was significantly affected by soil tillage, and the highest values (2.951-3.799 cm cm^{-3}) were observed under minimum tillage. Grain yield was both influenced by the tillage system and variety, and the highest grain yield (5083 kg ha^{-1}) was found under the conventional tillage system with 'Yecora-E' variety. Finally, the grain quality traits were only affected by variety. The 'Yecora-E' variety had the highest protein content (13.66%) and Zeleny sedimentation value (30.43 ml), as well as the lowest Hagberg falling number (364 sec), resulting in a high-quality flour as compared to the other varieties.

Keywords: Conventional tillage, Grain yield, Minimum tillage, Quality, Zeleny sedimentation value

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Introducing genetic diversity to wheat breeding using CRISPR/Cas9 and other proteins

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Genome editing (CRISPR) can be used for wheat precision breeding to (1) introduce genetics diversity and (2) develop new wheat genotypes with higher yield and improved end-use quality. CRISPR can also be used as a powerful tool for knockout gene(s), precise and multiplex modifications, and the activation and repression of target gene(s) of interest in cereals. In this presentation, we will talk about two RNA-guided genome editing for introducing genetic diversity in to wheat breeding programs using different CRISPR proteins such as Cpf1 and its ortohologus and commonly used Cas9 for common genes. We will also talk about the Cas9 efficiency in wheat and compared to other species. History and current status of the editing efficiency of Cas9 and two Cpf1 orthologs, AsCpf1 and LbCpf1 will be discussed in wheat and barley.

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Utilization of date seed powder for production of cookies

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Malnutrition is creating major health issues, especially in developing countries. The recent research is focused on the development of value-added products from date pits to combat the problem of malnutrition. Date seed powder (DSP) was developed and supplemented at different levels (5%. 10% 15% and 20%) with wheat flour for the development of cookies. The DSP was characterized by physico-chemical and nutritional profile. The DSP supplemented cookies prepared in standard condition were stored for two months and analyzed at 15 days interval i.e. 0, 15, 30, 45 and 60th day of storage. The results manifested that the mean values ranged from 3.38% to 3.47% for moisture, 8.85-10.27% for protein, 2.06-3.07% for fiber. Ample quantity of other nutrients was exhibited in DSP, like calcium (327.00-469.2 ppm), magnesium (400.42-427.31%), total phenolic content (3.29-3.68 µg GAE/100g) and Radical scavenging activity (DPPH) (10.95-11.02). The significantly higher moisture content (3.47%), protein (10.27%), fiber (3.07%), calcium (469.26), magnesium (427.31), TPC (3.68 µg GAE/100g) and DPPH (11.02 µg/ml) was found in T4 (20% DSP) while significantly lower content of these components was found in T1 (5% DSP). The sensory evaluation was also conducted for color, taste, texture, flavor and overall acceptability of supplemented cookies. The scores for sensory recommended 15% supplemented cookies. This study concludes that date seeds have good functional properties and can be supplemented in wheat flour to produce various food products.

Keywords: Wheat flour, Functional foods, Date seed powder, Supplementation, Cookies

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Organic treatments of stored cereals and grains

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Organic commodities have been in increased demand for the past three decades. To achieve this goal, commodities must be treated from field to fork using technologies that are environmentally user friendly and without residue leaving chemical pesticides. When dealing with post harvest processes, such as storage of cereals and grains, the losses due to biological factors, can reach up to 50%. However, the use of hermetically sealed structures has proved itself as a successful technology in quality preservation of grains. Hermetic storage is based on biogenerated atmospheres; the generation of oxygen-depleted and carbon dioxide-enriched interstitial atmosphere as a result of the respiration of the aerobic organisms living in the commodity. In hermetic storage of dry cereal commodities, the airtight environment is altered through the respiratory metabolism of normally occurring insects. The system is most effective at temperatures at or above 20°C resulting in an atmosphere with reduced oxygen level of 3% or below. This is achieved due to insect respiration rate and very low oxygen penetration rate, leading to the continuous reduction of oxygen levels, until the point where all insects in their various life stages are dead. When treating dry organic commodities, the process could be accelerated using non-chemical fumigation which is applied using an inert gas (N2/CO2) to generate a modified atmosphere (MA) by flushing the commodity confined in the gastight structure. MA treatments have been proved not only to control insects but also to preserve the quality of the commodity with no residues after treatment. These MA treatments are affordable and may compete with refrigeration because of the lethal environment that is created either in a natural way or via non-chemical residue treatment. However, when applying MA, the level of gas tightness of the storage facility, whether it is a rigid or a flexible structure must be first tested for its gas tightness. A simple common test is the half time pressure decay test which has its recommended standard parameters.

Keywords: Organic treatments, cereals, hermetic storage, modified atmospheres

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Quality parameters of wheat landraces in Turkey.

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Wheat has been a significant crop which is grown throughout Turkey. Due to its economic, social, cultural and historical value, wheat is seen as an indicator of fertility and sacred product of spiritual value in Turkey. Wheat production is about 18-22 million tons on an area of 7.5 - 8.0 million hec , however, wheat landraces constitute 1% of the total wheat production area. Furthermore, Turkey is one of the most important centers of wheat landraces. Modern varieties with higher yield and good quality are developed by breeding Einkorn (*Triticum monococum* ssp monococum) and Emmer (*Triticum dicoccum*). To cope with global warming and assure the world wheat market, wild and local wheat sources must integrate in national breeding programs. Also, it is highly important to use genetic diversity of wheat landraces to develop new varieties which can cope with biotic and abiotic stress in future. Demand for healthy food is increasing day by day; therefore, the interest in wheat landraces has been increased in recent years. Farmers used to produce landraces to meet their own needs but they started to increase their production to meet higher demand of consumers. In this research, my objective was to evaluate quality parameters of different wheat landraces. Wheat landraces (52) were grown in the same location in 2017. Quality parameters, which are thousand kernel weight (tkw), hardness, protein content, SDS sedimentation value and whole meal color (L, a and b) were determined. Thousand kernel weight (tkw), hardness, protein content, SDS sedimentation value and whole meal color (L, a and b) values are 21,25.1, 9.8, 8, 80.2, 1.9 and 11, respectively. Based on the quality parameters, the characterization of wheat landraces in Turkey has been done.

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Attempts to reduce the damage of yellow rust on wheat using biocontrol agents under field conditions

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Wheat is a dominant cereal crop worldwide and very important as a staple food resource. Yellow rust (YR) caused by *Puccinia striiformis* f. sp. *tritici* (Pst) is considered one of the major threats to wheat production. To reduce the damage of YR, actions of different biocontrol agents (BCAs) were evaluated on a susceptible variety of bread wheat "Rumor" under field conditions at the research station Heidfeldhof (Hohenheim, HOH) in 2018. The results indicate that YR indices were 2.7%, 3.5% and 4.5% in case of HG77, To4, and T16 treatments, respectively - compared to 10.9% for the water control. Disease index was 0.5% in case of Folicur when used once and 0.2% when applied twice. Similarly, the YR index was additionally reduced to 1.4%, 2%, and 4.5% in case of HG77, To4 and T16 treatments, respectively. Although no significant differences among the treatments were recorded, disease severity and incidence were negatively correlated with production parameters e.g. TKW and yield. The highest yield was recorded for the fungicide, followed by HG77, To4, and T16, while no significant differences were recorded in TKW compared to the control - except fungicide. In conclusion, our results show the importance of BCAs in reducing the damage of yellow rust on wheat, if used in a timely manner with the indication that the results may vary, if the climatic conditions suitable for the development of YR disease in the field exist

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Wheat: cultivation perspective for cold arid Himalayan region of Ladakh

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Wheat is among the major summer crop of cold arid region and constitutes staple food of the majority of population. Due to change in food habits, area under wheat is steadily increasing but climatic constraints do not permit wheat cultivation after certain altitude in the region. It is cultivated in lower and central agricultural zones of cold arid region whereas temperature restricts its cultivation in upper agricultural zones mainly falling above 11,800 feet above mean sea level. Wheat is being cultivated in the cold arid region since long and presently covers about 6,250 hectare area with major chunk of acreage lying in Leh district of Ladakh. Wheat witnessed a revolution in India in early seventies when several high yielding varieties were released for various wheat zones but the cold arid zone remained untouched as even today local cultivars predominate the agriculture though they are poor yielders and susceptible to several diseases and insect pests. Research efforts by the research establishments resulted in the development of several high yielding wheat varieties namely, Kailash, Mansarover and Singchen. Lately Shalimar Wheat 1 is performing exceedingly well with good yield and dry matter recovery. Unlike local varieties these are resistant to yellow rust and lodging and responsive to higher doses of fertilizer application. Wheat productivity was boosted immensely with the introduction of these high yielding varieties. Wheat finds use in various kitchen and bakery preparations. Mostly it is consumed in the form of chapatti. Its increased consumption has raised the nutritional status of the people. High yielding varieties add to this as they excel the local cultivars in quality characters, too. Farmer's preference for wheat cultivation is not only the grain yield but it is intimately related to its fodder yielding ability. Animal husbandry, the main source of successful human settlements in such remote areas like Ladakh is dependent on wheat straw which enables domestic animals to tide over long severe winter of 7-8 months. Hence farmer's choice is dual purpose wheat varieties with high grain yielding ability and better biomass recovery. Importance of wheat in cold arid region economy is self-evident keeping in view the agricultural challenges and opportunities available in the region. Animal and human survival in cold arid zone is largely dependent upon wheat productivity for food and fodder needs. If the region is to be made self-reliant then wheat cultivation must receive top priority in policy planning. Wheat productivity is low due to inadequate research on various aspects of production technology and whatever has been evolved that is yet to reach the farmers. It demands strengthening of both research and technology transfer mechanisms.

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Effects of organic manure and NPK application on quality and quantity of wheat

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Wheat is an important crop in Afghanistan and is a major source of food security in the country where it accounts for up 60% caloric intake with an average annual per capita consumption of over 200Kg. However, one of the challenges in wheat productivity is low organic materials in soil (below 1%) in association with poor soil fertility that caused poor quality and low grain yield of wheat. In addition, little study has been done on proper use of chemical fertilizer to provide adequate nutrients to wheat production.

To determine the effects of organic manure and NPK application on quality and quantity of different wheat varieties, an experiment was conducted during FY2018-2019 in 2 locations, Urdu khan Research Station (latitude: 34.308899, longitude: 62.285969, elevation 954.94m) and Herat University Agricultural Farm (latitude: 34.366878, longitude: 62.208041, elevation 936.02m) respectively in Herat province. The experiment was designed as randomized complete block design (RCBD) with split plot in three replications. The main plots were F1= cattle manure, F2= chemical fertilizer (NPK), F3= cattle manure + NPK and 3 sub plots; varieity1= Gul96, variety 2= Dorokhshan09, and variety 3= Moghawim were considered.

Plant height, stand %, leaf area, dry matter, tiller/plant, SPAD value, protein percentage, biological yield, leaves and stems weight, number of spike, number of spikelet/spike, thousand kernel weight, total yield/plot, number of grain/spike and harvest index were measured to compare the treatments.

These results indicate that cattle manure plus NPK chemical fertilizer significantly increased grain yield of the three wheat varieties at 4154.6 kg/ha which is 15.1 % more than cattle manure at 3527.4kg/ha and 3.2 % more than NPK at 4021.1kg/ha at the University Farm. Similarly, cattle manure plus NPK significantly contributed to increased grain yield at 5122.2/ha,14.23 % more than cattle manure at 4392.9kg/ha and 28.3 % more than NPK at 3673.3kg/ha at Urdo Khan Farm. However, the effects of cattle manure and chemical fertilizer on grain quality is yet to be determined. There was no significant difference among the three varieties in response to cattle plus NPK chemical fertilizer. These findings demonstrate that cattle manure plus NPK can be used in wheat production to increase productivity.

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Biodiversity state of bread wheat and durum wheat in western Algeria

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The diversity of wheat in Algeria is well known. An inventory has been conducted in the west of Algeria (North and South) to collect local accessions of bread wheat *Triticum aestivum* and durum wheat *Triticum durum* for their morphological characterization. In this context, a collection of 42 traditional accessions and modern varieties of durum wheat and bread wheat was investigated using nine quantitative agro-morphological traits. In the second part of this study (experimental square) the collected seeds were sown in experimental squares in order to set the environmental factor and see its impact on this last. The phenotypic diversity was determined by the Shannon-Weaver diversity index (H') at different levels. The H' showed a wide phenotypic variability for different traits with H' average of 0.56 for bread wheat and 0.61 for durum wheat (inventory), and H' average of 0.61 for bread wheat and 0.58 for durum wheat (experimental square).The results of the multiple correspondence analysis and the hierarchical clustering showed a clear distinction between the different accessions of durum and bread wheat species. The studied accessions partially matched the names of varieties because of the existence of homonyms and synonyms in the names given by farmers. Thus, the present study needs to be confirmed by the molecular tools to best understand the genetic profile of bread and durum wheat in the western Algeria.

Keywords: Algeria, morphological diversity, morphometric traits, durum wheat, bread wheat

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Wheat land races studies in Manisa and Izmir province

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This study was conducted in villages of Manisa and İzmir provinces between 2017-2018 and 2018-2019. The aim of this study is to get back wheat land races collected from different villages of Manisa province in 2009-2014 to local farmers. Thus, wheat land races grown in that region for years and adapted to the region will not be lost. In 2017-18, the study carried out 8 farmers in 4 districts, 6 villages in Manisa province. In the first year, 1-2 kg of 24 land races seeds was distributed to the farmers to multiplied and used as seeds for the following year. After harvest the farmers got 200-500 kg/ha seeds from that land races. In this year, we organized field day in Gördes district in Manisa province to introduce the land races the other farmers. In 2018-19, local farmers from 2 districts, 3 villages in Manisa province, 3 districts and 2 village in İzmir province participated in the study. In the second year, the farmers planted seeds on a large area, new participant farmers have started to multiply 12 land races seeds. We will harvest in July this years. We will organize a work shop in June to share the project results.

Keywords: wheat, land races

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Phenotypic and SSR-based genetic diversity analysis of Tunisian ancient durum wheat populations

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Tunisia is one of the main producers of durum wheat. This cereal is the most consumed in Tunisia and represents a trade-mark of several local dishes such as Couscous and Bulgur. Nonetheless, Tunisian durum wheat production essentially affected by climate changes has lengthy been obstructing the fulfillment of the increasing local demand. Old durum wheat populations cultivated over decades in arid and humid areas of Tunisia constitute a potential material towards the identification of adaptive characters for tolerance to drought and heat stress. Characterization and evaluation of these landraces from different traditional agro-ecosystems allows the rehabilitation of such subservient genetic heritage as well as its use for practical and beneficial purposes. In this context, a collection of three hundred and four local accessions of durum wheat collected from five regions and three climatic zones of central and southern Tunisia was studied. The evaluation of the phenotypic diversity was carried out using 12 morphological traits and identified 11 variety-populations namely Mahmoudi, Azizi, Jneh Khotifa, Mekki, Biskri, Taganrog, Biada, Badri, Richi, Roussia and Souri. The Shannon-Weaver diversity index (H') showed a high variability for all of the considered traits. Spike length (H' = 0.98), grain size (H' = 0.94), grain form (H' = 0.87), grain color (H' = 0.86) and spike shape (H' = 0.86) were the most polymorphic morphological traits. The average H ' obtained for the whole collection was 0.80, indicating the presence of a high level of polymorphism in the local populations of durum wheat. This index varies according to the region and climatic stage. Moreover, genetic diversity analysis using 10 SSR markers with a reliable level (PIC = 0.69) has revealed a high level of genetic diversity of the Tunisian landrace populations with a Shannon's Information Index (I) of 0.62 and a gene diversity (He) of 0.35. Population STRUCTURE analysis has distinguished 11 genetic subpopulations and the Mantel test showed a significant correspondence (P = 0.01)) between the genetic structure and morphological characterization. Analysis of molecular variance (AMOVA) showed high genetic variability within regions and wheat subpopulations 81% and 41% respectively, indicating the considerable amount of admixture between landraces realized by farmers as well as a moderate (19%) and high (59%) genetic variability among regions and wheat subpopulations, suggesting the existence of a certain selection pressure conducted by farmers. Variety-populations Azizi and Mahmoudi were largely distributed among four out of the five studied regions highlighting a substantial seed commercial exchange between farmers and a particular preference for these variety-populations for different interests. Furthermore the variety-population Mahmoudi showed spike densities significantly different from the Center to the South of Tunisia, notably loose spikes with open glume in the South and compact ones in the Center, thus representing an adaptation form for tolerance to high temperature by maintaining fertility in the arid climate and warm conditions of the South. This work highlights overall the genetic richness of local resources for better conservation in the genebank, genetic analysis for adaptation to arid conditions and their use in plant breeding programs.

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Mineral composition of wild and wheat introgression forms in breeding on the nutritional properties

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One of the most important problems of our time is providing people with balanced diet by adding all of the essential factors necessary for the health. A wheat-wild hybrids can combine nutritional, technological properties and agronomic suitability.
The content of macro- and microelements in the grain was determined by inductively-plasma-atomic emission spectrometry.
Genotypes Kazakhstanskaya rannespelaya x *T.timopheevii*-1, 2, 3 and Kazakhstanskaya 10 x *T.timopheevii*-1, 2 were distinguished by an increased level of mineral composition in all reproductions in the south of Kazakhstan (KIZ). In northern conditions the Ilyinskaya x *T.timopheevii* (N, K, P, Zn) and the Kazakhstanskaya 10 x *T.dicoccum* (Mg, Mn, Fe, Zn) were characterized by a stably increased level of mineral composition.
Among the spring wheat introgression forms prevailed over wild and cultured on the content of P, K, Mg, Fe and Ca; the predominance of varieties according to the content of Zn and S are at the maximum values. Wild relatives remain with the highest values of protein and magnesium. According to the content of macro- and microelements, the introgression winter forms of wheat occupy an intermediate position between wild relatives and modern varieties.
Among the introgression spring wheat samples the following samples with the maximum content have been selected: Kazakhstan 10 x *T.dicoccum* - for K, P, Ca, Mg; Kazakhstanskaya 10 x *T.timopheevii* - for N, S, Fe, Zn, Mg, Mn; Kazakhstanskaya early x *T.timopheevii* - for F, S.
For tetraploid wheat, the protein content varied from 15.8% for *T.turgidum* to 23.6% for *T.militinae*. Level of 19.0% and higher was in the grain of *T.aephiopicum*; *T.dicoccoides*; *T.monococcum* and *T.persicum*. Among the hexaploid species, the maximum protein content is noted in the *T.kiharae*.
The protein content in the grain of various species was formed due to the predominance of different protein fracti ons: globulin in grain of *T.militinae*; due to gliadin in *T.dicoccoides*, *T.dicoccum* and *T.timopheevi*.
Perspective forms for technological directions, for example, the ratio N: S and nutrient (medical), the ratio of Ca : P are of particular interest. The sources of the high content of elements are wild relatives and synthetic forms: a) for N Kazakhstanskaya 10 x *T.timopheevii*; Kazakhstanskaya rannespelaya x *T.timopheevii*; Kazakhstanskaya 10 x *T.dicoccum T.spelta* (cvs Faraon); b) N, K Kazakhstanskaya 10 x T.dicoccum Kazakhstanskaya 10 x T.timopheevii Kazakhstanskaya rannespelaya x *T.timopheevii T.spelta* (cvs Gremme); c) Fe and Zn Kazakhstanskaya 10 x *T.timopheevii T.timopheevii* = *T.spelta* Kazakhstanskaya 10 x *T.dicoccum*. Thus, these results indicate that in the breeding for a high level of metabolism, the use of wheat-wild forms of the spring type is promising for the extreme continental conditions in the North of Kazakhstan.

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Genetic diversity of quality attributes of Tunisian durum wheat (*triticum durum* desf.) varieties

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The aim of this study was to assess durum wheat, grown during two cropping seasons (2013/2014 and 2014/2015), for quality. Variation in quality attributes of six Tunisian landraces and four improved durum wheat genotypes was determined by evaluating 1000 seed weight, vitreousness, protein and gluten content. A significant genotypic and year (environment) variances were observed for all measured traits. Genotype x environment interaction was also significant for all traits. Landraces, when compared to improved genotypes, exhibited high TKW, indicating high milling yield potential. In addition, milled wheat of all landraces had a high protein (15.32-16.9% on dry weight (DW) basis and semolina (15.1-17.15% DW) content, which did not exceed 10.61% for the improved varieties. Analysis of Pearson's correlation showed that semolina protein content was also highly negatively correlated ($P < 0.01$) with vitreousness degree ($r = -0.94$) but positively correlated with gluten content ($r = 0.70$). Therefore, semolina protein and gluten content can be used as selection criteria to improve grain protein content in durum wheat.

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Utilization of ancient wheats in cereal products

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Emmer and einkorn are the earliest cultivated wheats originated in the Fertile Crescent, an area in the Middle East spreading from Jordan, Palestine, and Lebanon to Syria, Turkey, Iraq, and Iran and are commonly referred to as “ancient” wheats. There is an increasing interest in the utilization of emmer and einkorn wheats due to their nutritional properties. The objective of this study was to investigate the possibility of using emmer and einkorn wheat flours in some cereal products such as cookies, crackers and noodles. For the cookie production 13 emmer wheat flour samples and 6 einkorn wheat flour samples were used. Eight emmer wheat flour samples and 3 einkorn wheat flour samples were used in cracker production. For the production of noodle samples, 7 emmer wheat flour samples were used. Control flours were also used during the production of cookie, cracker and noodle samples for comparison.

The samples showed a great variation (wide range) in terms of their performance in cookie, cracker or noodle (erişte) production. The spread ratio values of einkorn wheat flour samples were similar to that of the reference cookie flour. However, emmer wheat flours had lower spread ratio values indicating inferior quality. Hardness values of cookies made with einkorn and emmer wheat flours were lower than that of the reference cookie sample. Some of the cookie quality characteristics of the ancient wheat flours were comparable to that of the reference cookie quality used for comparison. The cracker quality results indicated that the cracker samples produced from ancient wheat flours gave similar properties as compared to the reference cracker in terms of weight, length, thickness, width, color and texture. The flours produced from emmer wheats were more suitable for cracker making than einkorn flours, because einkorn flours resulted in too soft cracker doughs, not suitable for sheeting and finally the crackers were thinner and damaged. The noodles produced using emmer flour samples required higher cooking time compared to the reference noodle. Most of the noodle samples produced from emmer flours had higher cooking loss value and lower TOM value. The water absorption and volume increase value of the noodle samples produced using emmer flours were higher than those of the reference noodle sample. The results indicated that some of the ancient wheats used in the present study are suitable for the production of high quality cereal products such as cookies, crackers and noodles.

Keywords: Emmer, Einkorn, cookie quality, noodle quality, cracker quality

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Chemical composition of wheat landraces in Turkey

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Wheat, was originated from southeast part of Turkey, represent the most important type of crops both agronomic and economic point of view. The earliest cultivated forms were landraces due to their unique characteristics. Thus, the diversity of cultivated and wild wheat in Turkey plays an important role in global stage for wheat improvement. International Winter Wheat Improvement Program, the Ministry of Agriculture and Forestry of Turkey, CIMMYT and ICARDA were operating breeding activities in Turkey since 1986. Thanks to the consensual efforts, wheat landraces represent a valuable plant resource in term of better quality genotypes with local adaptations. Moreover, the move in recent years towards more natural and sustainable crops for high-quality wheat and wheat products. The aim of this research was to investigate variability of the chemical properties in wheat landraces and strength/weaknesses of wheat landraces based on chemical composition. The study material was represented by wheat landraces from 55 different locations in seven regions. Totally, 300 different wheat landraces were grown in Konya and analyzed for moisture content (%), protein content (%), ash content (%), wet gluten content (%), hectoliter weight (kg/hl), sedimentation (mL), kernel weight (g/1000 kernel), kernel color and whole meal color. Measured protein, hectoliter, sedimentation and whole meal color values were ranging between 13.59-15.22%, 68.04-78.51 kg/hl, 51.73-61.50 mL and 68.07-76.91, respectively. According to the results, chemical characteristics vary significantly ($p<0.05$) between wheat landraces in seven regions. In brief, wheat landraces were pictured based on their chemical composition. In the light of these results, this study has a potential to be the basis for selecting the materials according to the specific end product/production, breeding and nutritional studies.

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Functional quality of wheat flour from wheat landraces in Turkey

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Wheat is the most suitable raw material for the production of a large number of products, ranging from bread, biscuits, patisseries, cakes to pasta and noodles. The nature of wheat functionality and versatility was mainly related with its storage proteins to form a gluten network that exhibits unique viscoelastic properties. Although each wheat flour can produce viscoelastic gluten network, differences in the genotype and environmental conditions can deliver different functional features for certain products. In terms of technological behavior, chemical, rheological and mechanical properties of wheat, flour has great importance. Especially in wheat landraces, such properties have a great influence to determine their potential use in production of certain wheat products. The study material was 300 wheat landraces from 55 different locations in seven regions of Turkey. They were grown in 2018 in Konya under rainfed conditions. The GlutoPeak and Rapid Visco Analyzer (RVA) have been applied to study wheat flour quality in terms of aggregation behavior of gluten and pasting properties, respectively. Furthermore, the GlutoPeak indices have been used for predicting the conventional parameters related to dough mixing stability, extensibility, and tenacity. According to the results, GlutoPeak and RVA results vary significantly ($p<0.05$) between wheat landraces and gives insight about dough characteristic of wheat samples individually. In the light of these results, wheat landraces can be classified due to their gluten strength and pasting/dough characteristics, which gives significantly important information on baking quality, process efficiency and product quality.

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Introduction of hulled wheats into modern wheat breeding program

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The hulled wheats einkorn (*T. monococcum* L.) and emmer (*T. dicoccum* L.) are the among the earliest wheat species domesticated by humans and has been extensively used by early farmers. After the introduction of high yielding and threshable varieties, these hulled wheats were mostly abandoned and only cultivated in marginalized areas in Turkey, France, India, Italy. Recently, increased attention to nutritional quality of the food, has brought new interest from consumers, bakers and farmers for these "ancient" crops. It has been reported that einkorn and emmer wheats are rich in proteins, lutein, and trace elements, such as Zn and Fe. Furthermore, they are known to be resilient to abiotic and biotic stresses including; tolerance to drought, salt and wheat rust. Even though there is an increasing demand for higher quality and stress resilient crops, there has not been much effort to implement these crops into breeding programs. Thus, in the year 2012, einkorn and emmer wheats from different parts of Turkey has been collected and brought to the wheat breeding program in Field Crops Central Research Station at Ankara. These landraces are being utilized as gene source for improvement stress resilience and nutritional value of the modern wheat varieties. Also, einkorn and emmer populations are being screened and selected for developing non-lodging and higher yielding varieties. In 2017 our institute has applied for certification of two new einkorn and one emmer wheat cultivars. They are expected to be released in 2020. New varieties are with improved yield and nutritional values will benefit consumers, bakers and farmers.

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The nutritional and quality properties of einkorn (*Triticum monococcum* L.) wheat cultivated in Kastamonu

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Siyez wheat is one of the rare agricultural culture heritages that have survived to the present day by preserving its form in ancient times. *Triticum monococcum* (Siyez) type named as Einkorn has 2n chromosome structure and glume. In our country it's cultivated only in Kastamonu region in Northern Anatolia. Siyez wheat is grown in Kastamonu province and districts on an area of approximately 4,000 hectares and particularly in Seydiler, Devrekani and İhsangazi districts. It is traditionally processed and consumed as bulgur by siyez growers. In recent years, due to the awareness of the public in terms of healthy nutrition and consumption demand, the cultivation area and production (4,151 hectres; 9.673 tons) in Kastamonu increased 6 times in 2018 compared to 2014 (669 hectares; 1.673 tons). Siyez wheat is grown in winter in this region. In case of any damage due to adverse weather conditions, plantings are renewed as summer crop at the end of winter-spring.

Siyez wheat, unlike other wheats, has a single spike and a tight glumes structure. Therefore, it is one of the most valuable features of healthy nutrition in that it is resistant to diseases and plant pests and can grow organically in arid conditions and in poor soils without any fertilizer and medicine support (Emeksizoglu, 2016).

Siyez wheat is completely different from bread and durum wheats with its nutrients, flour and paste composition. While the carbohydrate content of the grains is low, the protein value is higher. Compared to modern wheat varieties, grains have twice as many carotenoids, 3-4 times as much lutein and 4-5 times as much riboflavin. Due to the low glycemic index value, it also helps to lower blood sugar taken with food. The content of Siyez wheat, which has a high fiber value, is very low in cholesterol and it is easy to digest and digest (Vallega, 1996).

The content of Siyez wheat contains minerals with very high antioxidant effect and high group B vitamins (B1, B2, B5, B6, B12). Siyez wheat has been shown to have higher fat content and more yellow lutein content than bread wheat. In addition to having health benefits and low glycemic index related to whole grain consumption, it has been found that it is richer in terms of protein, phenolics, tocopherols and carotenoids as a functional food compared to other wheat species (Hidalgo and Brandolini, 2014).

For this purpose, Siyez wheat as the raw materials grown in 30 different villages of Kastamonu region were collected, their physical, chemical and antioxidant properties were investigated.

The chemical properties of the samples in terms of dry matter, ash, protein, fat and mineral content were determined. The protein content were varied between 11.19-17.70%.

It's found that the yellow pigment, the total amount of phenolic compounds and the antioxidant activity of Siyez wheat were higher than other wheat varieties, and the antioxidant activities of the samples had high phenolic matter content (Emeksizoglu, 2016).

Keywords: Siyez, Einkorn, *Triticum monococcum*

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Genetic diversity in einkorn wheat (*Triticum monococcum* L. *ssp.monococcum*) populations as revealed by ISSR

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According to archaeological excavations, molecular and genetic studies and current phyto-geographical distribution of cereal crop diversity in centre of origin, the southeastern Anatolia is one of cradle area of agriculture in the world. *Triticum monococcum* L. ssp. *monococcum* (with non-brittle rachis) is a diploid hulled wheat species (2n = 2x = 14 AA) in the genus *Triticum* and it has local names called as siyez or iza in Turkish. Although, the landraces of einkorn (*Triticum monococcum* L) was the prominent cereal crops for agriculture in ancient times, nevertheless it lost its popularity at early Bronze Age. However, it has been still growing in several provinces on the north and north-eastern part of Turkey. In this study, eight einkorn populations from local farmers' fields were investigated by using five ISSR (Inter Simple Sequence Repeats) primers. The data obtained by ISSR PCR were computed by POPGEN (version 1.31), a software program for population genetic analysis. A total of 85 alleles were identified and 79 of which were polymorphic (92.94%) among all analysed populations. The mean number of alleles (na), the mean number of effective alleles (nea), the mean value of genetic diversity (h), the genetic differentiation (GST), and the gene flow (Nm) values between populations were observed as 19, 12, 0.17, 0.40 and 0.77 respectively. According to genetic diversity analysis at locus level, the total genetic diversity (HT) and genetic diversity within population (HS) were detected as 0.17 and 0.10, respectively. The partition of genetic diversity was estimated that 60% of genetic diversity was between populations and 40% of genetic diversity was within populations. The preliminary results indicated that einkorn population have considerably high genetic diversity estimates for a predominately self-pollinating and rare outcrossing crop species. It is important to determine the genetic diversity level and genetic structure of crop species to plan their appropriate usage. The growing of wheat landraces is still continue for several reasons; (i) stable yield, (ii) adaptation to local conditions, particularly marginal and adverse (iii) long straw, important character for animal feeding, (iv) suitable for organic farming and healthy food production, (v) important genetic resources, and (vi) a simple matter for tradition. Although, *T. monococcum*, a relict species is used for animal feeding currently in Turkey, the increasing trend for healthy food made einkorn wheat very attractive crop species for healthy food production. The on farm conservation of einkorn wheat and other efforts such as seed exchange between farmers etc. will enhance genetic diversity in the populations, which grow in farmers' fields and beneficial for their dynamic evolution. The agriculture of wheat landraces should be supported by governments and traditional farmers should be encouraged to keep continue the farming of wheat landraces for future interest such as wheat breeding programs and healthy food production industry.

Keywords: *Triticum monococcum* L. ssp. *monococcum*, Wheat Landraces, Genetic Diversity, ISSR

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Some physical, chemical and physicochemical properties of a local Emmer wheat (Gacer) in Turkey

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In the last thirty years, global warming has been increasing mainly due to technological developments, excessive fuel consumption and population growth. In the future, global warming will lead to changes in agricultural activities and climate changes are expected to force farmers to change their crops, resulting in reduced yield. Due to the fact that wild wheat species have been able to survive in different natural conditions for centuries, they are among the resistant plant species that are foreseen to be processed and used in new products in the future. In addition interest in organic products and tendency to search for functional foods has increased recently. Therefore, old wheats which are rich in vitamins, minerals and nutritional fibers has been rediscovered and evaluated in terms of nutritional and technological properties. Understanding the health benefits of high nutritional products caused to high consumer demand for local wheats with high protein, low allergic properties and high antioxidant content. Emmer wheat (*Triticum dicoccum* Schrank.) has 2n= 28 chromosomes and is a type of glume wheat evaluated in durum wheats. In Turkey, Emmer wheat named as Emmer, Gernik, Çatal Kaplıca, Çatal Siyez and Gacer has been cultivated locally. In this study some physical, chemical and physicochemical properties of a local Emmer wheat known as Gacer in Develi region (Kayseri/Turkey) harvested in 2018-2019 season were determined.

Hectoliter weight was measured and the weight of a thousand grains was determined by counting the sample free of impurities using an electronic grain counter (Tripette & Renaud Numigral II, France). Texture of endosperm (Glassiness) was determined by Grobecker section tool. Color values (*L, a, b*) obtained by Hunterlab Mini Scan XEplus. Moisture (No: 44-15A), protein (No: 46–30) and ash analyses (No: 08 01) were conducted according to the AACC procedures. Farinograph (AACC Method No: 54-21), wet and dry gluten (AACC International Method 38-52.01), Zeleny sedimentation (ICC Method No: 116/1), SDS sedimentation analyses (Williams et al., 1988) were performed.

Results showed that a thousand grain weight was comparable with Eser and Eminbey had the lowest value. Gacer had the highest weight of hectoliters. Gacer was more glassy and *L* (brightness) value was the lowest, a (redness) value was comparable with others. *b* (yellowness) value was the lowest in Gacer wheat. Accordingly, Gacer wheat was the darkest grain in terms of color. In SDS sedimentation test, Eminbey has the highest (76mL).Tosunbey has the highest (46mL) value and Gacer has the lowest SDS (14mL) and Zeleny (16mL) sedimentation values. Gluten index value, wet gluten and dry gluten contents were lower in Gacer. In the farinograph properties, Tosunbey had the highest development time and stability, and Gacer had the lowest value. These results suggested gluten quality of Gacer was lower as compared to the controls.

Keywords: Emmer wheat, Gacer, physical properties, physicochemical properties

Bread and biscuit quality of a local emmer wheat (Gacer)

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The aim of breeding studies is to meet nutritional needs with high yield and quality varieties developed. In the development of varieties resistant to stress conditions, local varieties that adapt to the regions where they are grown for many years are the most important gene sources. It can also contribute to increase in agricultural production. Until now, the selection of wheat varieties has only been considered in terms of economic efficiency, whether it meets the protein and carbohydrate requirements in the diet and suitability to the process. Recently, consumers' desire to control or prevent chronic diseases through improving their nutrition has been increasing and the need to develop phytochemical-rich new wheats. Low glycemic index, high protein and dietary fiber contents, make Emmer wheat suitable for diabetes, coronary heart disease, hypertension, obesity and some gastrointestinal disorders.Emmer wheat (*Triticum dicoccum* Schrank.) has 2n= 28 chromosomes and is a type of glume wheat evaluated in durum wheats. It has a great importance in wheat breeding due to its resistance to some diseases and pests and tolerance to abiotic stresses. In our country, it is known as Gacer in Kayseri; and it is also called as Emmer, Gernik, Çatal Kaplıca and Çatal Siyez.

In this study, Gacer wheat harvested in Develi (Kayseri) region at 2018-2019 season was used to produce bread (AACC Method no: 10-10.03) and cookie (AACC Method No: 10-54). Eser flour for cookie and Tosunbey flour for bread were used as controls. The samples were milled into the flour by Bühler laboratory mill (Bühler MLU 202, Uzwil, Sweden). The flour yields of Gacer, Eser and Tosunbey were 56.1%, 61.6% and 69.3%, respectively. Wholemeal samples were also prepared by mixing of the flours and their milled brans. The yields of Gacer and Tosunbey were 58.5% and 70.1%, respectively. Volume (AACC Method no: 10-11.01), texture (TAPlus Texture Analyzer, Lloyd Instruments, UK) and color (*L, a, b* values) (Hunterlab Mini Scan XEplus) were determined in the breads. Diameter, thickness of the cookies were measured and spread ratio was calculated (AACC Method No: 10.54). Sensory panel was conducted using 5 panelist who are trained to detect and quantify appearance, flavor and texture attributes in cereal products.

Bread and whole wheat bread volumes made from Tosunbey wheat used as control were higher than Gacer breads. Gacer wholemeal bread had comparable values with control (Tosunbey). In Gacer, the pore structure bread was firmer and softness value was lower; the bread color and crust color were darker, the symmetry was comparable to the control bread. Lower *L* value (brightness) and *a* (redness), and *b* (yellowness) values indicating darker color were obtained. Spread ratio value of the control cookie (Eser) was higher and Gacer cookie had comparable values in terms of hardness, brittleness and color.

Keywords: Emmer wheat, Gacer, Bread quality, Cookie quality

Utilization of local Tajik wheat materials in breeding programs

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Tajikistan is known with the rich genetic diversity of many cereal crops, including bread wheat. Wheat landraces are still grown in mountainous areas of the country, where farmers maintain their seed through the generations for centuries. The wheat landraces are adapted at local conditions and became also part of the culture. However, studies revealed that the area under the local wheat material is declining and the risks of losing these valuable materials getting higher. For the first time, local genetic materials were included in the breeding program run jointly by Tajik Agrarian University and Seed Association of Tajikistan. Wheat breeding programs in Tajikistan succeeded to select and submit for official testing more than 30 varieties during last two decades, mainly originating from the materials received International Agricultural Research Centers and Programs (CIMMYT, ICARDA and IWWIP). These crosses included wheat landraces collected from the Tajik Pamirs, which showed desirable agronomic characteristics, such as *Safedaki Razuch* and *Kilaki Bartang*, as well newly released and widely grown wheat varieties, including *Sarvar*, *Krasnodarskaya 99*, *Starshina* and *Najibey*. Exploring local wheat diversity is still continued by Tajik breeders, in order to find the best characteristics and for utilizing these valuable materials in the breeding programs.

High quality seed of new wheat varieties for Tajik farmers

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Wheat is widely grown crop in Tajikistan, where in average 60% of daily calories of the population comes from wheat products. Thus, this staple crop is important for achieving food security in the country. Local wheat production is still not able to cover the overall demand, and more than 50% grain and wheat product still imported from neighboring countries annually. Numbers of factors are influencing the lover production level, where access to high quality seed of best varieties is the important one. Currently, the average yield of the wheat in Tajikistan is 2.9 t/ha, which is unsatisfactory. The Food and Agriculture Organization of the UN, in close collaboration with the Ministry of Agriculture of Tajikistan and the Seed Association of Tajikistan implemented a project "Improving access of small-scale farmers to high quality seed in Tajikistan" during 2012-2018, funded by the Government of Austria. Totally 415,800 kg of high quality seed of mostly new Tajik wheat varieties were delivered to 2359 small scale farms in 15 selected less resourced districts in Tajikistan during the project years. By utilizing the seed revolving mechanism and seed sharing practices the total number of beneficiaries reached more than 5000, and the distributed seed amounted close to 800,000 kg in last six years. As a result of using high quality seed, allowed project beneficiaries to harvest from 15 to 35% higher yield in compare to other farms in their area. The project mainly provided seed of locally bread wheat varieties officially released in Tajikistan. The varieties are selected by Tajik wheat breeders from nurseries received from International Agricultural Research Centers and Programs, such as CIMMYT, IWWIP and ICARDA. These varieties included: Alex (PYN/BAU), Sarvar (CHEN\AEGILOPS SQUARROSA (TAUS0//BCN/3/BAV92), Yusufi (SOROCO), Murodi (CHEN/AE.SQ//WEAVER/3/SSERI1), Durakhshon (ATTILA/3*BCN*2//BAV92). Besides the delivery of seed, organized trainings and delivered basic tools will allow farmers to continue producing good seed for themselves and for their neighborhood.