

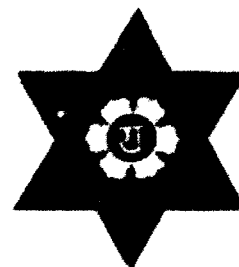
TERMINAL REPORT**Breeding For Stress Tolerant Wheat Genotypes for Foliar Blight Stressed, Warm and Dry Environments of South Asia**

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EXECUTIVE SUMMARY

Along with devastating disease, foliar blight of wheat different types of abiotic stresses (most commonly heat and moisture stress) are constraints of yield in non-traditional “tropical” wheat-growing regions of South Asia. These stresses affect livelihood of millions of small marginal farmers depend upon wheat cultivation. Thus development of resistant or tolerant varieties has been major focus of different breeding programs in this region. The progress severely constrained by robust screening techniques. The experiments were conducted with objective development of suitable criteria as well as development stress tolerant genotypes for stressed environments of South Asia. Also development of resistant genotypes is thought to be in dilemma due to undesirable associations. The two major objectives of the project were i) development of elite wheat lines tolerant/resistant to major stresses of wheat (include *Helminthosporium* leaf blight, heat) in non-traditional tropical wheat growing areas ii) Development of physiologically efficient breeding technique by identifying physiological traits associated with major stresses of wheat. There two genetic materials included in experimentation include breeding populations as well as elite genotypes (adopted as well as unadopted control). Experiments were done field and greenhouse at Rampur, Nepal during wheat growing main season of 2006 and 2007. The experiments included i) association study of physio-morphological traits in south Asian wheat genotypes and characterization for tolerance or sensitivity to single or combined stresses ii) study association at three elite breeding populations and evaluation of genetic association and effectiveness of selection (heritability) for associated traits under HLB stressed conditions. Different physiol-morphological traits (including canopy temperature depression, chlorophyll content and fluorescence, leaf senescence) and yield and yield components were evaluated in both experiments. The results show that genotypes show variation of stress tolerance and foliar blight resistance. Also variation was found for physiological traits and traits including chlorophyll fluorescence, chlorophyll content and canopy temperature depression were associated with foliar blight tolerance and heat stress tolerance showing that their possibility in breeding application. These traits showed very high heritability in the three elite population evaluated. Also there was no undesirable association of spot blotch resistance with other physio-morphological traits showing possibility of developing genotypes physiologically efficient plant types without affecting resistance level. The results from this study will help breeders to screen genotypes with high level of resistance and tolerance. This will help in development of stress tolerant, high yielding cultivars, helping to circumvent hunger, malnutrition and poverty of millions of people living in tropical plains.

The report includes the following articles at different level (from submission, acceptance to final printed) to different international, peer reviewed journal. The articles are based on full to partial support (may include using equipments purchased) of the Eiselen-Foundation Ulm grant.

1. Variation in photosynthetic efficiency related traits in genotypes differing spot blotch severity and heat stress tolerance in spring wheat – *Journal: Euphytica*
2. Spot blotch and terminal heat stress tolerance in south Asian spring wheat genotypes *Journal: Acta Agronomica Hungarica*
3. Heritability and association of chlorophyll content and fluorescence under spot blotch and heat stress condition *Journal: Plant Breeding*
4. Field resistance to spot blotch is not associated with undesirable physio-morphological traits in three spring wheat populations *Journal: Journal of Plant Pathology*
5. Genetics of physiological traits under natural spot blotch epiphytotics in spring wheat (*Triticum aestivum*) *Journal: Cereal Research Communication*
6. Heritability of stay green traits and association with spot blotch resistance in three spring wheat of populations *Journal: Journal of Genetics and Breeding*
8. Variation in south Asian wheat germplasm for seedling drought tolerance traits. *Plant Genetic Resources: Characterization and Utilization*

Journal: Euphytica

Type: Full length paper

Status: submitted

Variation in photosynthetic efficiency related traits in genotypes differing spot blotch severity and heat stress tolerance in spring wheat

ABSTRACT

Heat stress and spot blotch disease (caused by *Bipolaris sorokiniana* Sacc.) are the two most important stresses in non traditional, tropical wheat-growing areas of the world, causing significant yield losses. This includes CIMMYT's Mega environment 5A where millions of small, poor farmers are growing wheat. Few genotypes have high level of resistance or tolerance spot blotch and heat stress tolerance. Reduced efficiency of photosynthesis has been considered important parameter used to monitor plant response to abiotic and biotic stresses. However information are limited on how these two stresses affect the traits related to photosynthesis and their potential application for screening resistance or tolerance screening. The study was initiated with objective of evaluating photosynthesis-related traits (including Chlorophyll fluorescence, Chlorophyll content, and canopy temperature depression) and their association with resistance or tolerance to heat stress, spot blotch or combined heat and spot blotch stresses. Eleven genotypes with difference in tolerance or resistance to spot blotch and heat stress were evaluated under spot blotch stress (non-fungicide protected plots), heat stress (late planted and fungicide protected), both stresses (non-fungicide protected and late planted) and normal planting situations (fungicide protected and normal season planted). Both stresses have similar consequence to the photosynthesis associated traits on susceptible or sensitive genotypes and the magnitude of the effect was further higher when both of stresses are combined. Resistant or moderately resistant to spot blotch genotypes show low reduction in photosynthesis associated traits. Generally genotypes that are tolerant to spot blotch also showed tolerance to heat stress, showing some common mechanism of tolerance to both of the stress. PAT traits have potential to complement empirical selection for high performing genotypes for spot blotch and heat stress environments.

Keywords: *Bipolaris sorokiniana* Sacc., foliar blight, late planting stress, Chlorophyll fluorescence, SPAD reading, Canopy temperature depression

Journal : Acta Agronomica Hungarica

Type: Full length paper

Status: Submitted

SPOT BLOTCH AND TERMINAL HEAT STRESS TOLERANCE IN SOUTH ASIAN SPRING WHEAT GENOTYPES

ABSTRACT

Terminal heat stress and spot blotch disease (caused by *Cochliobolus sativus*), are most important stresses responsible significant yield losses every year in warm south Asia plains. Both of these stresses are very severe in late planted wheat, which is common in rice-wheat and rice-rice-wheat cropping systems. Development of genotypes tolerant to both stresses might be very useful for increasing yield and reducing yield losses. Information are limited on how different genotypes respond to both of stresses (individually and combined) and degree of tolerance property in south Asian wheat genotypes. The study was done to evaluate tolerance property of South Asia wheat genotypes to both of stresses by comparing stress factor susceptibility index (SFSI). Eleven diverse south Asian genotypes were evaluated under spot blotch stress (non-fungicide protected plots), heat stress (late planted and fungicide protected), both stresses (non-fungicide protected and late planted) and normal planting situations (fungicide protected and normal season planted) at Rampur, Chitwan, Nepal. Both stresses reduced grain yield and thousand kernel weight (TKW) but not other yield components including grains / spike and spikelet / spike. BL1473, Gautam, and NL971 were moderately to highly tolerant to all type of stresses. Generally genotypes that are tolerant or resistant to spot blotch also showed tolerance to heat stress, showing possibility of some common physiological mechanism to combat against both of stresses in tolerant genotypes.

Keywords: *Bipolaris sorokiniana* Sacc., foliar blight, late planting stress, Stress factor susceptibility index

Journal : Journal of Plant Pathology

Type: Full length paper

Status : Accepted (in press)

Field Resistance to Spot Blotch is not Associated with Undesirable Physio-Morphological Traits in Three Spring Wheat Populations

SUMMARY

Spot blotch [caused by *Cochliobolus sativus*(Ito and Kurbayzshi) Drechsler ex Dastur] is a serious constraint to wheat (*Triticum aestivum* L.) production in tropical and sub-tropical environments. Previous efforts to develop genotypes with high level of resistance combined with other desirable agronomic features have been unsuccessful. The failure of the previous efforts was assumed to be largely due to undesirable associations, and currently available genotypes have inadequate level of resistance. Information on existence of undesirable genetic association between spot blotch resistance with agronomically and physiologically important traits is limited. Recently, high levels of resistance have been reported in CIMMYT synthetic wheat genotypes. The study was done in three populations derived from three spot blotch resistant wheat genotypes 'Milan/Shanghai # 7', 'Chirya. 3' and 'NL 971' crossed with susceptible commercial cultivar 'BL1473'. Fifteen different physio-morphological traits and area under disease progress curve (AUDPC) were evaluated in F₂ and F₃ generations during 2005-2006 at Rampur, Chitwan, Nepal. The majority of traits showed weak negative significant ($p < 0.05$) or non-significant ($p > 0.05$) genetic and phenotypic correlation with AUDPC except Area Under SPAD (soil plant analysis development) decline curve (AUSDC) ($r = -0.61^{**}$ to -0.86^{**}) and flag leaf duration ($r = -0.45^{**}$ to -0.69^{**}). Results showed no undesirable genetic association of resistance with physio-morphological studied and independent selection for individual traits is possible. In addition the AUSDC and flag leaf duration have potential application as complementary traits in selection of genotypes with high level of resistance.

Key words: *Bipolaris sorokinina*, *Cochliobolus sativus*, plant ideotype, trait association, physiological traits

Journal : Cereal Research Communications

Type: Full length paper

Status: Submitted

Genetics of physiological traits under natural spot blotch epiphytotics in spring wheat (*Triticum aestivum*)

SUMMARY

Spot blotch, caused by *Cochliobolus sativus* (Ito and Kurbayzshi) Drechsler ex Dastur, is a serious constraint to wheat production in tropical and sub-tropical region of the world. The cultivars currently available possess low level of resistance and low genetic improvement has been assumed due to undesirable associations. The study was done to study genetic association of physiological traits with spot resistance and hundred grain weight (HGW) and estimate heritability of the traits under natural epiphytotics of spot blotch in populations involving new resistance sources. Three populations were derived from two way crosses between CIMMYT resistant wheat genotypes- 'Milan/Shanghai # 7', 'Chirya. 3' and 'NL 971', with a susceptible Nepalese cultivar 'BL1473'. Different physiological traits were evaluated in F₂ and F₃ generations during 2005-2006 at Rampur, Chitwan, Nepal. Majority of physiological traits had higher heritability estimates than HGW and Area Under Disease Progress Curve (AUDPC). Area Under SPAD Decline Curve (AUSDC) and flag leaf duration showed significant positive association with HGW and negative association with AUDPC. Days to maturity, flag leaf angle, and plant height showed weak association with AUDPC and HGW. Chlorophyll content at anthesis and peduncle length had significant positive genetic correlation with HGW and a weak genetic correlation with AUDPC. The results will help in development of genotypes for spot blotch stressed environments.

Index words: *Cochliobolus sativus*, *Bipolaris sorokinina*, physiological traits, trait association

Journal: Journal of Genetics and Breeding

Type: Full length paper

Status: Submitted

Heritability of stay green traits and association with spot blotch resistance in three spring wheat of populations

Abstract

Spot blotch (caused by *Cochliobolus sativus*) is a serious constraint to wheat production in tropical and subtropical wheat areas causing severe yield reductions. Combined with other biotic stresses, spot blotch causes chlorophyll reduction of leaves and premature senescence. Stay green property has been considered as trait of interest for development of cultivars in stressed environments. Some of CIMMYT's new synthetic wheat has been found to possess high level of resistance and stay green traits. Studies are limiting about heritability and genetic association of stay green traits with spot blotch in populations derived from such synthetic wheats. This study was done in three spring wheat population derived three spot blotch resistant wheat genotypes - 'Milan/Shanghai # 7', 'Chirya.3' and 'NL 971' crossed with 'BL1473', a susceptible wheat cultivar. Both stay green related traits as well as disease severity was evaluated in F₂ and F₃ generations during 2005-2006 at Rampur, Chitwan, Nepal. Area under SPAD progress curve (AUSDC) ($r = -0.72^{**}$ to -0.88^{**}) and Flag leaf duration ($r = -0.56^{**}$ to -0.69^{**}) showed high phenotypic and genetic correlation whereas Chlorophyll content at anthesis (CCA), days to heading, days to anthesis, days to maturity and days peduncle dryness showed low and non-significant correlation with Area Under Disease Progress Curve (AUDPC). Moderate to high heritability estimates were observed for AUDPC (0.52 to 0.74), chlorophyll content at anthesis (0.77 to 0.81), AUSDC (0.68 to 0.88), flag leaf duration (0.62 to 0.72), days to maturity (0.88 to 0.94) and days to peduncle dryness (0.42 to 66). The results show that AUDPC, AUSDC and flag leaf duration has potential complementary trait for selection whereas independent selection for maturity related traits is possible.

Key words: *Bipolaris sorokinina*, *Cochliobolus sativus*, Chlorophyll content, Stay green trait, trait association
