IDENTIFICATION OF STRIPE RUST RESISTANCE IN WHEAT RELATIVES AND LANDRACES

By

ALEXANDER LOLADZE

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To the Faculty of Washington State University:

The members of the Committee appointed to examine the thesis of ALEXANDER LOLADZE find it satisfactory and recommend that it be accepted.

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Chair

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Abstract

by Alexander Loladze, MS.
Washington State University
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Chair: Kimberly Garland Campbell

Stripe rust, caused by *Puccinia striiformis* Westend. f. sp. *tritici* Eriks, is a major disease of wheat (*Triticum aestivum* L. em Thell.) in regions with a temperate climate. Two types of resistance have been identified, seedling and adult-plant resistance. Seedling, or all-stage, resistance is race specific and is expressed in all stages of plant development. One type of adult plant resistance is high-temperature adult-plant (HTAP) resistance. HTAP resistance is non-race specific and is expressed in adult stages of plant development at higher temperatures and is durable. Selection pressure on the pathogen enhances the prevalence of new virulent races and, as a result, all-stage resistance genes are frequently defeated over time. New sources of durable resistance are needed to protect improved cultivars from this disease. The first objective of this research was to develop a new evaluation technique for all-stage resistance on detached wheat seedling leaves. Detached leaf assays are more efficient then intact seedling assays since the need for greenhouse and dew chamber space is eliminated. A detached leaf assay has not been developed for evaluation of stripe rust resistance due to the long latent period of the pathogen, which

requires detached wheat leaves to survive on artificial media for extended periods. The goal of this experiment was to create such an assay. The second objective of this research was to evaluate resistance to stripe rust among 164 accessions from nine species of the genus *Triticum* collected from Georgia, which is considered a center of origin of stripe rust. The germplasm was obtained from U.S. National Small Grain Germplasm Collection. We expected to identify resistant host genotypes from this region that had co-evolved with the pathogen. Field trials for stripe rust evaluation were conducted in 2005 at four locations in Washington, under natural infections. Accessions identified as resistant in the field were tested for all-stage resistance to five races in the seedling stage using the detached leaf assay. The optimum artificial media for prolonging the senescence of the detached leaves for 21-25 days consisted of 0.5% water-agar with 10mg/l kinetin, which was used as a plant senescence retardant, and with pH adjusted to 7. The pathogen produced uredia on the detached leaves 12-15 days after inoculation. Disease ratings from the detached leaf assay corresponded to those from the intact seedling assay. Results of the germplasm evaluation indicated that seventy-four of the164 accessions tested were resistant to stripe rust in the adult stage in the field. Fifty-nine of those had adult plant resistance, since they were susceptible in the seedling stage but resistant in the field. Fifteen accessions had all-stage resistance, since they were resistant in both adult and seedling stages. The adult plant resistance from eight accessions of the species *T. dicoccum* and four accessions of *T. timopheevii* was similar to HTAP resistance, since infection types (IT), which rate disease reaction of host genotypes on a 0 (no infection) to 9 (completely susceptible) scale, reached 8 prior to the flowering stage and decreased to 2 after flowering. In conclusion, the

new detached leaf assay for evaluation of all-stage resistance to wheat stripe rust eliminates the need for greenhouse and dew chamber access, and provides reliable results. The majority of the resistant genotypes from the Georgian accessions had adult plant resistance, which may be novel sources of stripe rust resistance for cultivar improvement efforts.

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To my best friend Gilduccia, a.k.a. Matucana

CHAPTER 1

LITERATURE REVIEW

1. INTRODUCTION

Wheat (*Triticum aestivum* L. em Thell.) is one of the most important grain crops in the world. Global wheat production in 2004-2005 was approximately 626 million metric tons and was second after maize production (708 million metric tons), and was followed by rice production (402 million metric tons) (USDA, 2006). In the United State called stripe rust, or yellow rust (caused by *Puccinia striiformis* Westend. f. sp. *tritici* Eriks.), a fungal disease, is a major yield limiting factor in commercial wheat production. Wheat yield losses due to stripe rust epidemics were estimated to be more than 19 million metric tons of grain from 2000 to 2003 (Chen, 2005).

Although stripe rust can be controlled effectively through fungicide application, the most economic and environmentally sustainable way of controlling the disease is breeding for genetic resistance to the pathogen (Chen, 2005). Because of the evolution of new virulent races of stripe rust, deployed resistance genes are often overcome by the pathogen; therefore, new genes for resistance are needed to develop new improved varieties with more durable resistance. A practical strategy aligned with this goal is utilizing wheat relatives and landraces as new sources of resistance to the pathogen, a strategy which has already provided many valuable genes for resistance to various pathogens of wheat. (Jones et al., 1995; Friebe et al., 1996; Repellin et al., 2001)

The goal of the study was to identify potential new sources of genetic resistance to stripe rust of wheat. For this purpose a set of germplasm including wild relatives and landraces of wheat originated or collected from Georgia (The Caucasus) was used. The rational behind selecting these genotypes was based on the hypothesis that the source of resistance to a particular pathogen should be sought in the center of co-evolution of the pathogen and the host (Leppik, 1970; Swiezynski et al., 1991), and stripe rust is considered to have originated from the Caucasus (Zhukovsky 1965; Stubbs, 1985, Line, 2002). An improved method of screening for resistance in the seedling stage using detached leaves was developed for evaluation of disease reactions among the Georgian germplasm accessions.

3. STRIPE RUST

P. striiformis is an obligate parasite with a hemicyclic lifecycle since it consists only of dicaryotic uredinial and telial stages. The teliospores can form haploid basidiospores to infect an alternate host, however, none has been identified for stripe rust to date. The sexual cycle of *P. striiformis* is unknown and urediniospores are the only identified supply of inoculum.

The distribution of stripe rust is usually limited to the locations of northern or southern latitudes at high elevations with temperate climates, and higher precipitation levels (Roelfs et al., 1992). Although the exact center of origin of stripe rust is not known, the pathogen is thought to have originated from the Caucasus (Georgia, Armenia, and Azerbaijan) and afterwards distributed into Western Europe and Asia (Zhukovsky, 1965; Stubbs, 1985), since the region's topography and climatic conditions create favorable environment for the disease. Stripe rust was present in the United States from the end of the 19^{th} century and has been an increasing problem for the last forty years (Line, 2002; Chen, 2005).

The symptoms and signs of the disease include chlorotic or necrotic flecks, and formation of uredia, a pustule-like structure enclosing abundant amounts of yellow to orange urediniospores. (Chen, 2005). The uredinium form stripes along the leaves of adult plants as the pathogen development follows the elongation of leaf vascular system. The germ tubes of *P. striiformis* grow around condensation droplets, penetrate the stomata and the mycelium colonizes the host leaves and in some cases spikes (Burrage, 1969; Rapilly, 1979; Roelfs et al, 1992). The pathogen feeds on the nutrients of the host and in cases of severe and early infections the wheat plants are stunted.

The major factors affecting *P. striiformis* germination, infection, latent period, sporulation, spore survival and host resistance are moisture, temperature and wind (Chen, 2005). Moisture directly affects the urediniospore germination, infection and survival. Three hours of uninterrupted moisture are needed for urediniospore germination and infection to occur along with other necessary environmental conditions, such as temperature and light (Rapilly 1979; Tu and Hendrix, 1970; Chen, 2005). The spores require a relative humidity near 100% saturation and the hydration of the spores before inoculation increases germination (Line, 2002). On the contrary, free moisture also negatively affects the viability of the urediniospores, decreasing overall survival of the spores. This occurs due to the absence of inhibition mechanism of fungal growth, otherwise known as fungistasis, which causes the death of the fungus (Chen, 2005). In the Pacific Northwest (PNW) region of the United States, in addition to rainfalls, cool night temperatures are frequent in spring and cause dew formation on wheat leaves further promoting infection.

Temperature influences the germination, infection and survival of the urediniospores as well as sporulation and host resistance. Germination of urediniospores is best at 9.7 ^{o}C, although germination can occur at 2.8-21.7 ^{o}C (Rapilly, 1979). Subsequent growth of the pathogen is best at 12 ^{o}C to 15 ^{o}C although the minimum and maximum temperature requirements for the pathogen growth are 3 ^{o}C and 20 ^{o}C, respectively. (Sharp, 1965; Tollenaar, 1966; Stubbs, 1967; Roelfs et al, 1992; Line, 2002). Sporulation also can occur from 5 ^{o}C to 20 ^{o}C (Roelfs et al, 1992). The winter survival of dormant stripe rust mycelium in the leaf tissue depends on the winter survival of the host, which is highly influenced by temperature (Sharp and Hehn, 1963). The latent period of stripe rust varies between isolates and can last from 11 days at optimum conditions to 180 days at temperatures near freezing (Roelfs et al, 1992).

Wind decreases the moisture content of inoculum inhibiting the spore germination, which reduces the rates of infection. Wind also simultaneously increases the viability of the inoculum as a result of decreased moisture content of the urediniospores, which inhibits the immediate germination (Chen, 2005). Wind also facilitates the spread of the inoculum over territories determining the time, rates, and extent of infection.

Puccinia striiformis infects and specializes on various host genera and, therefore, has been categorized into various formae speciales, some of which, such as *P. striiformis* f.sp.

tritici and *P. striiformis* f.sp. *hordei*, extend beyond their host specialization and overlap their host range by infecting barley and wheat, respectively (Line, 2002; Chen, 2005). *Puccinia striiformis* f. sp. *tritici* is further differentiated into races based on virulence/avirulence reactions on a special set of wheat genotypes called differentials, which serve to distinguish among various races of the pathogen based on disease symptomology. Current race composition, available wheat differential cultivars, and identified resistance genes for to this pathogen have been reviewed extensively by Boyd (2005) and Chen (2005).

The use of genetic resistance in wheat is the most economic way of controlling the disease (Röbbelen and Sharp, 1978; Line and Chen, 1995). In general, there are two mechanisms of resistance to stripe rust: seedling resistance, which can be expressed in all stages of plant development, and adult plant resistance, which expresses in adult stages. Chen (2005) suggested that the term seedling resistance could be misinterpreted and proposed to refer to the seedling resistance as all-stage resistance. All-stage resistance, and some types of adult plant resistance, are race specific (Chen and Line, 1992; Chen, 2005). Genotypes possessing only race specific resistance in most cases lose their resistance over time due to the occurrence of more virulent stripe rust races. These races evolve due to high selection pressure on the pathogen, which is caused by growing resistant wheat cultivars on large numbers of acres (Line and Qayoum, 1992).

Although certain types of adult plant resistances are sometimes race-specific, high-temperature adult-plant resistance (HTAP), also known as 'temperature sensitive resistance' (Roelfs et al., 1992) is race-non-specific and is one of the most effective types of adult plant resistance, which is triggered in the late stages of plant development when temperature increases. HTAP resistance is activated by high temperatures and causes the initial infection types and severity to decrease preventing secondary infections for occurring (Chen, 2005). HTAP resistance expresses only in adult stage of plant development. Wheat genotypes possessing only HTAP resistance are susceptible to all races of stripe rust in seedling and early stages of plant development. The combination of non-race specific HTAP and race-specific all-stage resistances is the most effective approach for controlling the disease, since all-stage resistance provides high levels of resistance, until new virulent races circumvent and HTAP resistance still provides reasonable protection against the pathogen in advanced stages of plant development (Chen, 2005).

According to Chen (2005), some seventy genes for resistance to stripe rust have been identified in wheat. However, the large majority of those genes provided all-stage resistance and only a few provided adult and HTAP resistances. Several genes have been derived from various relatives of *T. aestivum* covering primary, secondary and tertiary gene pools of wheat, which had been categorized according to the degree of introgression of genes that can potentially occur between the cultivated wheat and its relatives (Harlan and de Wet 1971). Theses genes for stripe rust resistance originating from the wheat relatives are described below.

3. WHEAT GENETIC RESOURCES

When wheat cultivars with race-specific, vertical resistances against various pathogens are grown over vast territories, significant pressure is placed on the pathogen to develop virulent races to circumvent deployed resistance genes. Gene pyramiding, or combining several resistance genes into one genotype, is one strategy for developing durable resistance that the pathogen may not be able to overcome. For this reason, a constant search for new genes for resistance is required, and wild relatives of wheat may be a rich resource for identifying novel resistance genes for stripe rust. Many of wheat relatives contain important disease resistance genes, which have already been transferred into bread and durum wheat cultivars (Knott, 1987; Cox, 1991; McIntosh, 1991; Jiang et al., 1994).

The genus *Triticum* comprises three ploidy levels and approximately 30 species. The wild relatives of bread wheat are grouped into subcategories in accordance with their phylogenetic relationship to hexaploid wheat and morphological differences such as dispersal mechanism, growth habit, defensive adaptability, disease and pest resistance. (Hawkes, 1986). Harlan and de Wet (1971) developed a concept of *gene pool*, which allowed phylogenetic separation of the germplasm based on the rates of introgression that can potentially occur between the cultivated crops and their ancestors. Those gene pools are differentiated into three categories: primary, secondary and tertiary gene pools.

The *Triticum* genus includes the following primary gene pool: *T. monococcum* L. (2n=14, AA), *T. turgidum* L (2n=28, AABB) and *T. aestivum* (2n=42, AABBDD) (Feldman and Sears, 1981). Although *T. timopheevii* (2n=28, A^tA^tGG) also is a tetraploid, according to Snyman et al (2004), in relation to bread wheat falls between the primary and secondary gene pools based on the degree of potential for introgressing genes into *T. aestivum*. Its A^t genome is homologous to the A genome of *T. aestivum*. However, its G genome is only homologous to a certain degree to the B genome of *T. aestivum* and introgressing genes from *T. timopheevii* is more complex (Rodrìquez et al. 2000). *T. aestivum* and *T. turgidum* consist of multiple subspecies and landraces, and of those, the most important and widely cultivated are *Triticum aestivum* L. subsp. *aestivum* (common or bread wheat) and *Triticum turgidum* L. subsp. *durum* (Desf.) Husn. (durum or macaroni wheat). The other species are somewhat less important agronomically due to unfavorable traits, such as grain shuttering and spike brittleness, and are not widely cultivated.

All three gene pools of wheat had been used for introgressing stripe rust resistance genes into wheat cultivars. The resistance genes *Yr5, Yr15, YrH52* and *Yr36* were derived from the primary gene pool of wheat: the gene *Yr5* was derived from *Triticum aestivum* L. subsp. *spelta* (L.) Thell. (= *Triticum spelta album*) (2n=42, AABBDD) and mapped on chromosome 2BL of *T. aestivum* (Macer, 1966; Law, 1976). The three genes, *Yr15* and *YrH52*, on chromosome 1BS and *Yr36* on chromosome 6BS, were derived from wild emmer, *Triticum turgidum* L. subsp. *dicoccoides* (Körn. ex Asch. & Graebn.) Thell. (2n=28, AABB) (Gerechter-Amitai et al., 1989; Peng et al., 1999, 2000; McIntosh et al., 2005; Uauy et al., 2005).The gene *Yr17* was transferred to chromosome 2AS of *T. aestivum* from *Aegilops ventricosa* Tausch, syn. *Triticum ventricosum* (Tausch) Ces. et al. (2n=28, $D^vD^vM^vM^v$). The gene *Yr28* was transferred to chromosome 4DS of *T. aestivum* from *Aegilops tauschii* (Coss.) Schmal. (2n=14, DD). Both *Ae. Ventricosa* and *Ae. tauschii*, from which the genes *Yr17* and *Yr28* were derived, belong to the secondary gene pool of wheat. The gene *Yr8* was transferred into chromosomes 2D, 3D and 2A of *T. aestivum* from *Aegilops comosa* Sm. var. *comosa* (previously known as *Triticum comosum* (Sm.) K. Richt.) (2n = 14, MM). The gene *Yr9* was derived from rye (*Secale cereale* L. subsp.

cereale) and translocated onto chromosome 1B of *T. aestivum* (McIntosh, 1998). Both *Ae. comosa* and *S. cereale*, from which the genes *Yr8* and *Yr9* were derived, belong to the tertiary gene pool of wheat. All of the genes described above, except the *Yr36*, are genes for all-stage race-specific resistance. Only the gene *Yr36* provided a non-race specific HTAP resistance.

The goal of this study was to investigate stripe rust resistance in wheat landraces and relatives originating from Georgia, and the plant material used in the study included the following wild relatives of wheat: *Triticum turgidum subsp. carthlicum*, *T. turgidum subsp. dicoccum*, *T. turgidum subsp. paleocolchicum*, *T. aestivum subsp. macha*, *T. timopheevii subsp. timopheevii*, and *T. zhukovskyi*. The species are reviewed in the next sections of this chapter in regards to their resistance genes identification to various diseases and pest insects. Although a number of landraces of *T. turgidum subsp. durum* and *T. aestivum subsp. aestivum* collected in Georgia also were used in the study, these species will not be reviewed here, since their gene composition for resistance to various pathogens had been extensively reviewed previously (Hammond-Kosack and Jones, 1997; Kolmer, 1996; Messmer et al., 2000; Hulbert et al., 2001).

2.1. *Triticum turgidum subsp. carthlicum*

Persian wheat, *Triticum turgidum* L. subsp. *carthlicum* (Nevski) Á. Löve & D. Löve, also known as *T. carthlicum* or *Gigachilon polonicum* subsp. *carthlicum* (Nevski) Á. Löve or *Triticum persicum* Vavilov ex Zhuk. (USDA-ARS, 2006) is an endemic tetraploid (2n=28, AABB) subspecies of the Caucasus (Carthli in Georgian language stands for a name of a province of central Georgia), distributed in Georgia, southern Russia, Armenia and northern Turkey (Vavilov, 1949/50; Aliev et al., 2001).

A powdery mildew (caused by *Blumeria graminis* (DC.) E.O. Speer f.sp. *tritici*) resistance gene, *Pm4b*, had been transferred from *T. carthlicum* and mapped on chromosome 2AL of bread wheat (The et al, 1979; McIntosh and Arts, 1996; Jørgensen and Jensen, 1972). Two other powdery mildew resistance genes transferred from the same species had been reported, and temporarily designated as *PmPs5A* and *PmPs5B* on chromosomes 2AL and 2BL, respectively (Zhou et al., 2005). Later, *PmPs5A* was suggested to be a member of the complex *Pm4* locus and the gene *PmPs5B* was designated as *Pm33* (Zhu et al., 2005). In addition, unspecified resistance for Moroccan biotypes of Hessian fly was successfully introgressed from *T. carthlicum* to durum wheat (Nsarellah et al., 2004). No information was available in regards to stripe rust resistance identification in this species.

2.2. *T. aestivum subsp. macha*

Triticum aestivum L. *subsp. macha* (Dekapr. & A. M. Menabde) Mackey, also known as *T. macha* Dekapr. & A. M. Menabde (USDA-ARS, 2006), is an endemic hexaploid (2n=42, AABBDD) species of the Caucasus (Vavilov, 1949/50). According to Aliev et al. (2001), it is available *in situ* (within its natural habitat) in Georgia.

Arraiano et al (2001) reported that *T. macha* had quantitative resistance to several isolates of *Mycosphaerella graminicola* (Fuckel) J. Schröt In Cohn] (anamorph *Septoria tritici*), and race specific resistance to two isolates of *M. graminicola* originating from the

Netherlands. Resistance to fusarium head blight (caused by *F. culmorum* (Wm. G. Sm.) Sacc. or *Fusarium graminearum* Schwabe) in *T. macha*, was identified on chromosome 4A by Grausgruber et al. (1998) and Mentewab et al. (2000). No information was available in regards to stripe rust resistance identification in this species.

2.3. *T. timopheevii subsp. timopheevii*

Triticum timopheevii subsp. timopheevii, previously known as *Triticum militinae* Zhuk. & Migush. (free threshing form of the species, Badaeva et al.,1994) or *Gigachilon timopheevii* (Zhuk.) Á. Löve (USDA-ARS, 2006), is a tetraploid (2n=28, A^tA^tGG) endemic species of western Georgia (Vavilov, 1949/50) and is available in *in-situ* locally (Aliev et al., 2001).

The powdery mildew resistance gene *Pm2* originating from *T. timopheevii* was introgressed to chromosome 2B of *T. aestivum* (Jørgensen and Jensen 1972), as well as the gene *Pm6,* to chromosome 2BL (Tao et al., 2000). Another powdery mildew resistance gene *Pm27* had been identified and translocated with a segment of chromosome 6G of *T. timopheevii* to chromosome 6B of *T. aestivum* (Järve et al., 2000). Resistance to leaf .rust, caused by *P. triticina* Eriks. & E. Henn., has been reported in *T. timopheevii* (Gill et al., 1983; Dhaliwal et al., 1993; Antonov and Marais, 1996; Brown-Guedira et al., 1996) and the gene *Lr18* originating from *T. timopheevii* was mapped on chromosome 5BL of bread wheat (Dyck and Samborski, 1968; McIntosh et al. 1995; Yamamori, 1994; Kolmer, 2003). Another gene for leaf rust resistance introgressed from *T. timopheevii* and temporarily designated *LrTt1* had been mapped on chromosome 2A of bread wheat (Leonova et al., 2004). The gene *Sr36* (previously *Sr9c*) for resistance to stem rust (caused by *P. graminis*

Pers.:Pers. f. sp. *tritici* Eriks. & E. Henn.) was transferred from *T. timopheevii* to chromosome 2BS of *T. aestivum* (Allard and Shands, 1954; Jørgensen and Jensen, 1973; Gyarfas, 1978, McIntosh et al., 1998, Tao et al., 1999). It has been characterized as a gene for durable resistance (McIntosh, 1992), which remains effective in cultivars that are widely grown for a long period of time. A single gene *SnbTM* for resistance to *Septoria* nodorum blotch [caused by *Phaeosphaeria nodorum* (E. Müller) Hedjaroude (anamorph *Stagonospora nodorum* (Berk.) Castellani and E.G. Germano)], transferred from *T. timopheevii* was located on chromosome 3A of durum wheat (Ma and Hughes, 1995; Cao et al., 2001). No information was available in regards to stripe rust resistance identification in this species.

2.4. *T. turgidum subsp. dicoccum*

Emmer wheat, *Triticum turgidum* L. subsp. *dicoccum* (Schrank ex Schübl.) Thell., also known as *T. dicoccum* Schrank ex Schübl. (USDA-ARS, 2006) is a tetraploid (2n=28, AABB) relative of wheat. Its center of origin is not known precisely and it has been found and collected in Eastern and Western Europe, Africa, Near and Middle East regions (Vavilov, 1935; Sinskaia 1969; Ben Yehuda, 2004)

Genes for resistance to powdery mildew, *Pm5a* and *Pm4a* (*Pm4a* was previously referred to as *Pm4*), were introgressed from *T. turgidum subsp. dicoccum* and were located on chromosomes 7BL and 2AL of *T. aestivum*, respectively (Law and Wolfe, 1966; The et al., 1979). Another powdery mildew resistance gene, *MlRE*, was introgressed from *T. dicoccum* (Robe and Doussinault, 1996) and mapped on the chromosome 6AL of *T. aestivum* (Chantret et al., 2000). The gene *Pm5* was introgressed from *T. dicoccum* into the

T. aestivum cultivar Hope (CItr 8178) and located on 7BL (Law and Wolfe, 1966). Later, Hsam et al. (2001) suggested that there could be either different alleles at the *Pm5* locus, or a closely linked cluster of genes and the *Pm5* found in cultivar Hope was designated as *Pm5a*. The gene *Sr17* for stem rust resistance was found to be closely linked to the gene *Pm5a* (McIntosh et al. 1967). Since both *Sr17* and *Pm5a* were closely linked to *Lr14a* it has been suggested that the later was introduced to wheat from *Triticum dicoccum* as well (Park et al., 2001). Another, very important gene for stem rust resistance *Sr2* (McIntosh, 1998) was mapped on chromosome 3BS and assumed to be transferred from *T. dicoccum* to the cultivar Hope (Spielmeyer et al., 2003). It was postulated that the *T. dicoccum cv.* Vernal (PI 168673) carries another stem rust resistance gene *Sr9e* (*SrA*) on chromosome 2BS. However, many other durum wheats carry the same gene (Singh et al., 1992; McIntosh et al., 1998). A gene for leaf rust resistance from *T .turgidum subsp. dicoccum* had been located on chromosome 4A and temporarily designated as *Lrac104* (Hussein et al., 2005). An undesignated gene for Hessian fly resistance was transferred from *T. dicoccum* to chromosome 1AS of bread wheat (Brown-Guedira et al., 2005). No information was available in regards to stripe rust resistance identification in this species.

2.5. *T. turgidum subsp. paleocolchicum*

Georgian emmer, *Triticum turgidum* L. subsp. *paleocolchicum* Á. Löve and D. Löve, also known as *Gigachilon polonicum* subsp. *paleocolchicum* (Á. Löve and D. Löve) Á. Löve, *Triticum karamyschevii* Nevski, and *Triticum paleocolchicum* A. M. Menabde (Rehm, 1994; USDA-ARS, 2006) is another endemic tetraploid (2n=28, AABB) subspecies of Georgia. In total, 10 synonyms of the species are available in the Germplasm

Resources Information Network (GRIN) database (http://wheat.pw.usda.gov) No information is available on its disease resistance or gene composition, and the genetic resources of this subspecies are limited and unexploited.

2.6. *Triticum zhukovskyi*

Zanduri wheat, *Triticum zhukovskyi* A. M. Menabde & Eritzjan (USDA-ARS, 2006) is an endemic hexaploid (2n=42, $A^mA^mA^tA^tG^tG^t$) species of Georgia presumably originating from a cross of *T. timopheevii* and *T. monococcum* (Upadhya and Swaminathan, 1963; Dvorak et al., 1993).Extensive research had been conducted in relation to the genome composition of *T. zhukovskyi* and lethal genes (hybrid necrosis and chlorosis) it carries (Aliev et al, 2001). However, with regards to its resistance gene composition, no information was available other than reports on the visual observations of resistance for certain diseases (Zhukovsky, 1965; Badaeva et al., 1994).

Among all the relatives of the cultivated wheat used in this study, *T. turgidum subsp. dicoccum* and *T. timopheevii subsp timopheevii* have been studied and exploited most extensively in regards to identifying novel genes for resistance to various diseases, including powdery mildew, stem rust, leaf rust, *Septoria* nodorum blotch, and insect pests, such as Hessian fly. *T. macha* and *T. carthlicum* also have been investigated as potential sources of resistance for *Mycosphaerella graminicola*, powdery mildew and Hessian fly, to a lesser extent. No information is currently available on genes for resistance to any disease from *T. paleocolchicum* and *T. zhukovskyi*. Despite all the reported genes for resistance reviewed above, no genes for stripe rust resistance were reported in any of those species and subspecies.

Based on the current literature review, the wheat alien species utilized in this study have been valuable resources for resistance gene for many important wheat diseases. They also may potentially provide novel genes for stripe rust resistance.

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CHAPTER 2

DEVELOPMENT OF A DETACHED LEAF ASSAY FOR STRIPE RUST RESISTANCE SCREENING

A. Loladze, Department of Crop and Soil Sciences, Washington State University, 201 Johnson Hall, WSU, Pullman, WA, 99164-6420,

K. Garland Campbell, Wheat Genetics, Quality, Physiology and Disease Research Unit, USDA-ARS, 209 Johnson Hall, WSU, Pullman, WA 99164-6420

X. M. Chen, Wheat Genetics, Quality, Physiology and Disease Research Unit, USDA-ARS, 209 Johnson Hall, WSU, Pullman, WA 99164-6420

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ABSTRACT

Stripe rust, or yellow rust, caused by *Puccinia striiformis* Westend. f. sp. *tritici* Eriks. is a major disease of wheat (*Triticum aestivum* L. em Thell.) worldwide causing significant yield and quality losses. Screening wheat germplasm for resistance to stripe rust is conducted using greenhouse and field-based trials in seedling and adult stages of plant development, respectively. Because of their efficiency, detached leaf assays have been developed for screening cereal crops for resistance to several foliar pathogens; however, the long latent period of stripe rust complicates detached leaf assay development for resistance to this pathogen. The objective of this study was to develop an effective, efficient detached leaf assay for screening wheat germplasm for resistance to stripe rust. Detached seedling leaves of seven wheat differential cultivars were placed on the artificial media, which consisted of 0.5% water-agar with the addition of 10mg/l Kinetin, a plant senescence retardant, and the pH of the media was adjusted to 7. Leaf segments were inoculated with three races of stripe rust using a fine paintbrush and placed in a dark growth chamber fro 24h at 10 ^{o}C. After the 24-h incubation period, the photoperiod conditions were set to 16/8 hours (day/night) at a temperature of 15-17/11-13^{o}C (day/night). Simultaneously, the same plant material was grown for 10-14 days and inoculated in the greenhouse conditions with a mixture of stripe rust spores and talcum powder (1:20). The reactions of the wheat genotypes to stripe rust races were recorded as infection types on a 0 (no infection) to 9 (very susceptible) scale. Infection types from the detached leaf assay matched those of the whole seedling assay for all cultivars. The detached leaf assay provides a new method for screening for stripe rust resistance that requires less space and time than seedling evaluation methods and eliminates the need for greenhouse space and dew chamber access.

INTRODUCTION

Stripe rust, also known as yellow rust, caused by *Puccinia striiformis* Westend. f. sp. *tritici* Eriks., an obligate fungal parasite, is a major disease of wheat (*Triticum aestivum* L. em Thell.) worldwide (Stubbs, 1985). Wheat germplasm typically is evaluated for resistance to stripe rust in the greenhouse and the field using whole seedlings and adult plants (Newton et al., 1936; Line et al., 1992; Line, 2002); however, these screening trials are often influenced by environmental factors that affect disease development (Sharp, 1965; Sharp, 1962; McCracken, 1962; Stubbs, 1967; Tollenaar, 1966). In addition, field screening trials are seasonal and are generally conducted once per year. In both seedling and adult plant screening trials, infected plants cannot be completely isolated from other plants, limiting the number of pathogen races that can be evaluated simultaneously.

In order to mitigate time and space constraints of seedling and adult plant screening trials, Brown and Wolfe (1990) developed a detached leaf assay to evaluate virulence of barley races powdery mildew (*Blumeria graminis* f. sp. *hordei*) on barley genotypes and to assess their resistance to fungicides. The assay was conducted in a growth chamber using excised barley (*Hordeum vulgare* L.) seedling leaves plated onto agar media. In wheat, a detached leaf assay was developed to rapidly evaluate large numbers of accessions for resistance to *Stagonospora nodorum* (syn. *Septoria nodorum*) (Benedikz et al., 1981). The disease resistance ratings from the detached leaf assay were highly correlated with whole seedling assay screening results, validating the technique for screening large sets of wheat germplasm for resistance to *S. nodorum* in a short period of time (Mebrate et al., 2001). A strong positive correlation ($P < 0.001$) also was observed between disease resistance ratings obtained from detached leaf screening method compared with adult plant resistance screening methods for *Fusarium* ear (head) blight, also known as scab (most commonly caused by *F. graminearum* Schwabe and *F. culmorum*) (Diamond and Cooke, 1999). Arraiano et al (2001) developed a detached leaf assay to evaluate resistance to *Mycosphaerella graminicola* and reported that it was a useful compliment to adult plant trials and an alternative to a whole seedling screening method. Wehling at al. (2003) identified two leaf rust (*Puccinia recondita* f. sp. *secalis*) resistance genes in rye (*Secale* *cereale L.*) that were expressed both in a detached leaf assay using leaves excised from seedlings and in adult plants in a field-based trial.

Although several of the above detached leaf assays were developed for wheat and two were developed for evaluation for resistance to obligate parasites, no detached leaf assay has been developed for stripe rust to date. The latent period required for stripe rust sporulation to occur after inoculation under optimum conditions is 12−13 days (Hungerford, 1923) and infection types (IT) are normally evaluated 18-20 days after inoculation (Chen and Line, 1992), which is substantially longer than for the diseases referred to previously. Due to the extended latent period, it is difficult to keep the detached leaves from senescing and resulting leaf chlorosis or necrosis, interferes with accurately rating the disease response.

Stripe rust also has specific temperature and moisture requirements for inoculation and infection to take place, and it is an obligate parasite that is difficult to culture on artificial media. Germination of urediniospores is best at 9.7^{o}C, although germination can occur between 2.8 and 21.7^{o}C (Rapilly, 1979). Hydration of spores before inoculation increases germination (Line, 2002), and spores require a relative humidity near 100% saturation for germination. The germ tubes grow around condensation droplets during infection (Burrage, 1969; Rapilly, 1979) and subsequent growth of the pathogen is best at 12^{o}C to 15^{o}C (Sharp, 1965; Tollenaar, 1966; Stubbs, 1967; Line, 2002).

The goal of this study was to develop a detached leaf assay for evaluation of wheat germplasm for resistance reaction to stripe rust. The study was conducted as three experiments. The objective of the first experiment was to evaluate sporulation of stripe rust on detached leaves of wheat in artificial media. The second experiment was conducted to identify the most optimum growth media for the reduction of senescence, prevention of contamination by other fungi, and development of stripe rust disease symptoms. The third experiment was conducted to compare disease development and resistance reactions for several wheat stripe rust differential genotypes and stripe rust races using the detached leaf and whole seedlings assays.

MATERIALS AND METHODS

Experiment 1: Evaluation of stripe rust sporulation on detached leaves using artificial media.

A trial was conducted in order to determine if stripe rust would sporulate on detached seedling leaves placed on 0.5% water agar medium in a controlled environment for 15 days. Wheat seedlings of the cultivars 'Lemhi' (CI 011415) and 'Druchamp' (CI 013723) were selected as susceptible and resistant genotypes, respectively to race PST-45 of *P. striiformis* f. sp. *tritici.* Plants were grown at 21^{o}C in the greenhouse for 10-14 days until they reached the two-leaf stage. Each second leaf was detached from the seedlings with scissors and surface-disinfected with a solution of 20 ml 6% sodium hypochlorite per liter of sterilized water. The leaves were rinsed in distilled water and dissected into 1.5-2 cm long segments. Water-agar (0.5%, Select Agar #3, Sigma) media was prepared and autoclaved at 120^{o}C for one hour. The media was cooled to 60^{o}C in a water bath and 100 mg l^{-1} benzimidazole (Benzoglyoxaline) was added as a plant senescence retardant (Arraiano et al., 2001). Approximately 40 ml of media was dispensed into Petri dishes (60x15 mm sterile polystyrene, VWR International). Three replications (individual Petri dishes) were used and all replications were placed on the same shelf of the growth chamber to avoid temperature variation observed between shelves (2 to 4 ^{o}C). Six surface-disinfected (0.2% sodium hypochlorite) leaf segments were placed on the media with their adaxial surface uppermost (Browne and Cooke, 2004). Urediniospores of PST-45 were increased from stock culture (Roelfs, 1992) and were applied to the leaves using a fine paint brush (#0.3) dipped first in the spore stock and transferred onto the excised leaf in the Petri dish. Spore quantification was not conducted. Inoculated Petri dishes were covered, but left unsealed so that air exchange could occur, and placed in a dark growth chamber, (Forma Scientific Inc., USA, model 3740) at 10^{o}C for 24 h. The low temperature in the growth chamber resulted in dew formation on the detached leaves in the covered Petri dishes; therefore, additional hydration of the spores was not needed. After a 24-h incubation period, the photoperiod conditions in the growth chamber were set to 16/8 hours (day/night) at a temperature of 15-17/11-13^{o}C (day/night).

Experiment 2: Identification of optimum growth media. Based on results from experiment 1, we designed a media experiment to evaluate fungicide and plant senescence retardation additives with the goal of decreasing contamination from non-target fungi, and delaying senescence of detached leaves to maximize the expression of stripe rust signs and symptoms. This experiment was designed as a randomized complete block with three replications. We observed a temperature variation (approximately 2 to 4 ^{o}C) between shelves of the growth chamber; therefore all three replications were placed on the same shelf to minimize variation. Experimental treatments included 0.5% water agar with two fungicide treatments, 0.33g l^{-1} PCNB (Pentachloronitrobenzene) (Vujanovic et al., 2002) and 0.1mg $ml^{-1}l$ Maneb (Dithiocarbamate) (Groves and Restaino, 2000), and two senescence retardants,10mg l^{-1}kinetin and 100mg l^{-1}benzimidazole, used alone and in combination, plus a control treatment of water agar only (Table 1). Race PST-45 was used for inoculation. The wheat cultivars Stephens (CI 017596) and Fielder (CI 017268) were used as resistant and susceptible differentials, respectively. Preparation of excised leaves, media, inoculation and growth chamber conditions were the same as described for experiment 1.

Chlorosis and necrosis were recorded for leaf segments, based on percentage leaf area affected by senescence, on a daily basis from the 7^{th} until the 24^{th} day after inoculation. The degree of fungal contamination was scored every second day from 7 to 27 days after inoculation based on the percentage area on the plate occupied by the contaminant fungi. Evaluation of stripe rust development was conducted from 14 to 27 days after inoculation based on appearance of the disease symptoms, and the rate of pustule development.

Experiment 3: Comparison of Detached Leaf Assay and Whole Seedling Assay Results

Seven wheat stripe rust differential cultivars, ‘Lemhi’ (CI 011415), ‘Druchamp’ (CI 013723), ‘Yr5’ (PI 221419), ‘Stephens’ (CI 017596), ‘Fielder’ (CI 017268), ‘Tyee’ (CI 017773) and ‘Express’ (DA 984034) were evaluated based on their known differential reaction types to races PST-23, PST-45, and PST-100 (Line and Quayoum, 1992; Chen, 2005) (Table 2). Lemhi was expected to be susceptible to all three races, whereas Yr5 was expected to be resistant to all three races. PST- 23 was the only race expected to be virulent on Druchamp. PST-23 and PST-100 were expected to be virulent and PST-45 avirulent on Stephens. PST-45 and PST-100 were expected to be virulent and PST-23 avirulent on

Fielder. PST-45 was the only race expected to be virulent on Tyee, and PST-100 was the only race expected to be virulent on Express.

Seedlings of each genotype were grown and detached leaves were prepared as described above. In experiment 2, 0.5% water agar (5g l^{-1}) and Kinetin (10mg l^{-1}) was identified as the most optimal media, which was prepared as described above except the pH of the media was adjusted to 7 with 5M HCl. Leaf segments were inoculated as described previously, except in cases where spore quantities were limited as was the case for PST-100; PST-100 spores were combined with talcum powder as above and applied on the whole surface of the leaf segments using a fine paint brush (#0.3). The experiment was set in a randomized complete block design with three replications, and each replication representing a Petri dish with inoculated detached leaves. All other experimental conditions were as described above. Simultaneously, the same cultivars were screened for seedling resistance reaction in a growth chamber (Controlled Environmental Conditions Limited, Canada, Model PGR15) at the Washington State University Plant Growth Research Facility in a randomized complete block design with three replications. For each race urediniospores were mixed with talcum powder (J.T Baker Chemical Co., USA) in an approximate proportion of 1:20. The spore-talcum mixture was applied to the second leaves of 10 day-old seedlings using a foam swab (MG Chemicals, Cat. no. 813-50). The inoculated plants were misted with distilled water and placed on an inverted lid of a 52 l plastic container (Sterilite®, 58.5L×42.5W×30.1H cm, cat. no. 1958). The lid was filled with water and covered with the inverted container, then placed in a dark growth chamber at 10°C for 24 hours to promote pathogen infection. After 24 hours, the temperature was reset to 10-11^{o}C at night and 15-16^{o}C during the day for10 and 14 hours for the night and day periods, respectively. After 16 to 21 days, stripe rust pustules were observed on the seedlings. Disease symptoms were rated as infection types on a 0 (no infection) to 9 (very susceptible) scale at 21 days after inoculation in both evaluation methods (Line and Qayoum, 1992). Data from each evaluation method were analyzed by ANOVA as a completely randomized design with individual Petri dishes as the experimental units using the statistical procedures of SAS (SAS Institute Inc., 1999).

RESULTS

Experiment 1: Evaluation of stripe rust sporulation on detached leaves using artificial media.

After 15 days, stripe rust sporulation was observed on detached leaves of susceptible cultivar Lemhi with 0.5 % water-agar with addition of 100 mg l^{-1} benzimidazole. The amount of sporulation was not quantified. Contamination of the media by fungi other than *P. striiformis* also was observed that may have interfered with stripe rust growth and disease development. The stripe rust spores were likely source of the contamination since the non-inoculated control treatment was not contaminated.

Experiment 2: Media for Stripe Rust Detached Leaf Assay

The 10 mg/l kinetin treatment proved to be the most appropriate media for the detached leaf assay since pustules formed on the susceptible cultivar Fielder on the 15th day after inoculation with only 30% of the leaf surface senesced (Table 1). Leaf senescence on the resistant check Stephens was just 60% after 21 days with no observable stripe rust symptoms. Although both fungicide treatments alone and in combination with both senescence retardants controlled contaminant fungal growth, they also inhibited stripe rust development on the susceptible wheat genotype (Table 1). Senescence retardance was effective when kinetin and benzimidazole were combined; however, this combination also inhibited stripe rust development. The benzimidazole treatment provided effective senescence retardation allowing the detached leaves to stay green for up to 27 days after plating and inoculation; however, benzimidazole also delayed the development of stripe rust by 5-6 days compared with the kinetin treatment. The combination of kinetin and Maneb treatments retarded senescence the longest, however, this treatment also inhibited the pathogen growth.

Experiment 3: Comparison of Detached Leaf Assay and Whole Seedling Assay

In the whole seedling assay, Lemhi was rated as susceptible with infection type (IT) 9 on the 0 to 9 scale, whereas Yr5 was resistant to all three isolates (Table 2). Druchamp was susceptible to PST-23 with IT equal to 8, but resistant to the other two isolates. Stephens was resistant to PST-45 with IT equal to 2, but susceptible to the other two isolates with IT scores of 7 and 8. Fielder was resistant to PST-23 with IT equal to 1, but susceptible to the other two isolates with IT equal to 9. Tyee was susceptible to PST-45 with IT equal to 8, but resistant to the other two isolates with IT equal to1. Express was susceptible to PST-100 with IT equal to 8, but resistant to the other two isolates with IT equal to 1. The data analysis by ANOVA showed that standard errors for the detached leaf and whole seedling assays were 0.07 and 0.08, respectively. The high IT scores of the detached leaf assay matched those of whole seedling assay (Table 2) although the high infection types (e.g.

susceptible reaction) observed in the detached leaves were slightly lower than those of the whole seedling assay. The adjustment of the pH of the media to 7 decreased the contamination of the media with non-target fungi (Fig. 1); however, the degree of contamination was not quantified.

DISCUSSION

We have developed an efficient and repeatable detached leaf screening method for stripe rust resistance in wheat. Disease ratings from the detached leaf and whole seedling assays were similar, validating the utility of the detached leaf assay developed here for assessing the diseases response of wheat genotypes to stripe rust. Low standard errors for each evaluation method (Table 2) further confirm the consistency of the disease response ratings between the detached leaf and the whole seedling assays. Slight variation between the infection types from the detached leaf and the intact seedling assays was due to the senescence of the detached leaves, which was observed as chlorotic and necrotic spots. The pathogen, being an obligate parasite, could not develop successfully on necrotic cells of detached leaves and consequently, could not produce large quantities of uredia resulting in lower infection types in susceptible cultivars. On the contrary, the infections types were slightly increased in the resistant cultivars, since more chlorotic flecks were observed on detached leaves. Nevertheless, the disease reaction (susceptible *vs*. resistant) on detached leaves was always detectable regardless of the degree of leaf senescence: in case of susceptible reaction, the uredia were observed clearly and in case of resistant reaction, IT 1 to 2 was distinctly detectable (Fig. 1).

The detached leaf assay is non-destructive (i.e. it does not require the whole plants to be sacrificed for the evaluation) and the testing conditions are highly controllable. The method also can be used for evaluating resistance to several stripe rust isolates on detached leaves from a single plant (on different Petri dishes) when plant material is limited. In addition the assay is efficient because it required considerably less space than the whole seedling assay (approximately 60 Petri dishes per shelve in one layer). Dew formation after inoculation occurs simply by placing the dishes with inoculated leaves into the growth chamber at a temperature (10 ^{o}C), which promotes condensation droplets to form on the detached leaf segments so that additional dew formation or spore hydration are not needed for the germination of the urediniospores to occur. Another benefit of the assay was that once the segments were plated and inoculated, and the temperature and photoperiod settings were established, the leaves did not require additional watering or maintenance prior to the disease evaluation. Growth chamber environments are subject to temperature variation due to the location of cooling units and airflow in the chamber. Therefore, placing the replications on one shelf is preferable to avoid observing variation in IT scores between the shelves.

Disadvantages of the method include contamination of the growth media with other saprophytic or facultative parasite fungi, even though they usually do not inhibit stripe rust growth. The source of fungal contamination (other then stripe rust) on the Petri dishes mainly comes from the stripe rust spores since there is no feasible approach to purify the spores without decreasing their viability. Contamination can be limited by avoiding dispersing spores of stripe rust on the media surface, adjusting the pH of the media to 7, and keeping temperatures in the growth chamber below 16 ^{o}C. Higher temperatures promote the growth of contaminant fungi, and reduces the viability of stripe rust (Roelfs et al., 1992). Lower temperature delays leaf senescence as well.

Further enhancement of the detached leaf assay will focus on testing different fungicides and antibiotics with the goal of selectively inhibiting development of other microorganisms while enhancing stripe rust development. In addition, our comparisons of whole seedlings and detached leave methods included wheat stripe rust differentials with extreme disease reactions (infection type scores 0 to2 or 7 to 9) and no intermediate types. Additional research is required to determine if the detached leaf assay accurately classifies intermediate infection types, and also to determine whether this approach is suitable for evaluating quantitative adult plant resistance.

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Table1. Treatments added to 0.5% water agar media that included two senescence retardants (kinetin and benzimidazole), two fungicides (Maneb and PCNB) and their combinations, and a control where no treatment was added, and observed results for each treatment on the percentage of leaf affected by leaf senescence and appearance of rust postules at 15th, 20th and 27th day after inoculation of the susceptible cultivar Fielder with race PST-45 of *Puccinia striiformis* f. sp. *tritici.*

Treatments	Day 15		Day 20		Day 27	
	Senescence %	Rust	Senescence %	Rust	Senescence %	Rust
Kinetine[1] + Maneb[2]	5	-	5	-	50	-
Kinetin + PCNB[3]	5	-	30	-	100	-
Kinetin	30	+	70	+	100	+
Benzimidazole [4]+ Maneb	15	-	25	-	100	-
Benzimidazole + PCNB	15	-	30	-	100	-
Benzimidazole	15	-	30	+	95	+
Kinetin + Benzimidazole + Maneb	10	-	15	-	100	-
Kinetin + Benzimidazole + PCNB	30	-	45	-	100	-
Kinetin + Benzimidazole	20	-	30	-	95	+
Maneb	90	-	100	-	100	-
PCNB	95	-	100	-	100	-
None[5]	100	-	100	-	100	-

('-'= no appearance of rust; '+'= stripe rust uredia were observed).

[1]Kinetin (N6-furfuryladenine) 10mg l^{-1}

[2]Maneb (Dithiocarbamate) 0.1mg l^{-1}

[3]PCNB (Pentachloronitrobenzene) 0.33g l^{-1}

[4]Benzimidazole (Benzoglyoxaline) 100mg l^{-1}

[5]0.5% water-agar media only

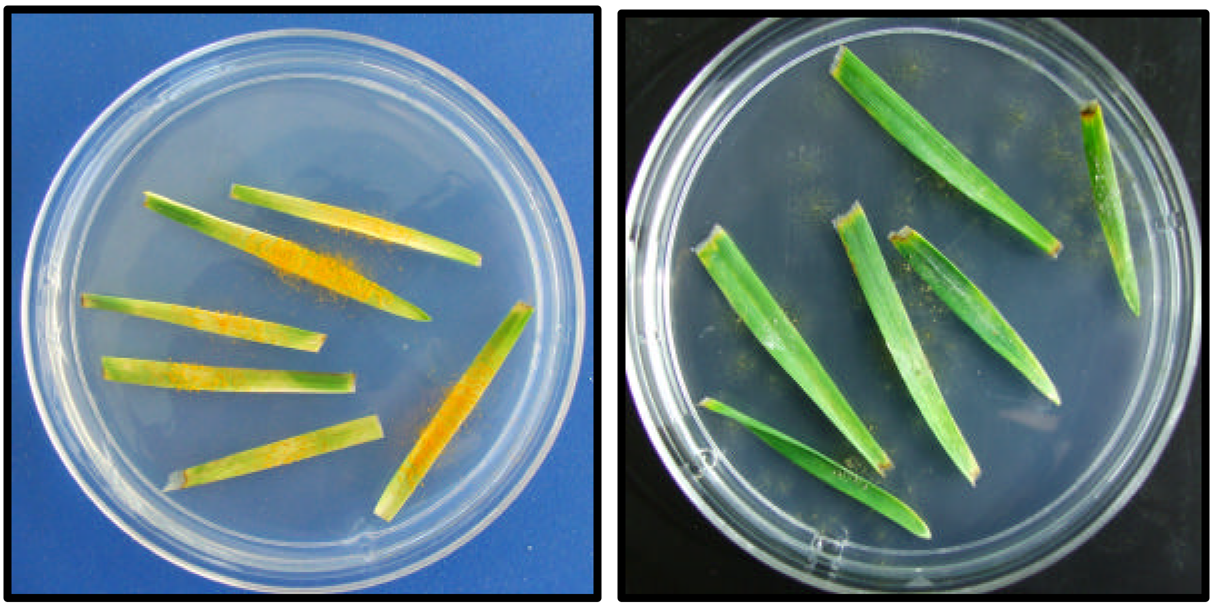
Table 2. Wheat stripe rust differentials with their resistance gene designations and their infection types to races PST-23, PST-45 and PST-100 of *Puccinia striiformis* f. sp. *tritici* observed in detached leaf and whole seedling assays. Infection types scored on 0 (no infection) to 9 (completely susceptible) scale.

			Infection Types to Different Races*					
			Detached Leaf Assay			Whole Seedling Assay		
Name	Accession	Genes	PST-23	PST-45	PST-100	PST-23	PST-45	PST-100
Lemhi	CI 011415	*Yr21*	8	8	8	9	9	9
Druchamp	CI 013723	*Yr3a, YrD, YrDru*	7	1	1	8	1	1
Stephens	CI 017596	*Yr3a, Yr22, Yr23*	8	2	8	7	2	8
Fielder	CI 017268	*Yr6, Yr20*	2	8	8	1	9	9
Tyee	CI 017773	*YrTye*	2	8	2	1	9	1
Express	DA 984034	Unknown	2	2	8	2	2	9
Yr5	PI 221419	*Yr5*	2	2	2	2	2	2

*Standard errors for detached leaf and whole seedling assays were 0.07 and 0.08 respectively.

Figure 1.

Infection types (IT) for stripe rust differential cultivars of wheat Lemhi (a) and Yr5 (b) to stripe rust race PST-100 race using detached leaf assay. The IT of Lemhi is equal to 8 (susceptible) and the IT of Yr5 is equal to 2 (resistant).



CHAPTER 3

IDENTIFICATION OF STRIPE RUST RESISTANCE IN WHEAT RELATIVES AND LANDRACES FROM GEORGIA

A. Loladze, Dept. of Crop and Soil Sciences, Washington State University, 201 Johnson Hall, WSU, Pullman, WA, 99164-6420,

K. Garland Campbell, Wheat Genetics, Quality, Physiology and Disease Research Unit, USDA-ARS, 209 Johnson Hall, WSU, Pullman, WA 99164

X. M. Chen, Wheat Genetics, Quality, Physiology and Disease Research Unit, USDA-ARS, 209 Johnson Hall, WSU, Pullman, WA 99164-6420

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ABSTRACT

Stripe rust or yellow rust, caused by *Puccinia striiformis* Westend. f. sp. *tritici* Eriks., is a major disease of wheat (*Triticum aestivum* L. em Thell.) in regions with temperate climates. Genetic resistance of wheat to stripe rust is the most effective and economic approach for controlling the disease. New virulent races of the pathogen frequently circumvent all-stage resistance genes, which are race specific and non-durable. Adult plant resistance is usually non-race specific and remains effective in cultivars that are widely grown for a long period of time. High-temperature adult-plant resistance (HTAP) is one

type of adult plant resistance, which is expressed in the adult stage at higher temperatures and also provides durable resistance to the pathogen. The number of adult plant resistance genes that has been identified in wheat is limited and HTAP resistance is not effective in all geographic regions; therefore, additional sources of durable resistance are needed. We hypothesized that durable stripe rust resistance could be identified among wild relatives and landraces of wheat collected from Georgia, since the region is considered a center of origin of the disease. The objective of the study was to evaluate 164 accessions of wheat relatives and landraces from Georgia from U.S. National Small Grains Germplasm Collection (Aberdeen, Idaho), which included the following species: *Triticum carthlicum*, *T. dicoccum*, *T. paleocolchicum*, *T. macha*, *T. timopheevii*, and *T. zhukovskyi* as well as a number of landraces of *T. durum* and *T. aestivum*. Resistance to stripe rust in adult plants was evaluated in 2005 in field trials in four locations in Washington State, each with two replications under natural stripe rust infections. Evaluation of all-stage resistance was conducted using detached leaves of 12-14 day-old seedlings placed on artificial media, in three replications. Five stripe rust races, the two most virulent of which (PST-100 and PST-116) also were present in the field trials under natural infections, were used for the all-stage resistance evaluation. In the field trials the disease was scored based on infection type on a 0 (no infection) to 9 (very susceptible) scale, as well as disease severity, which is the percent of the flag leaf infected with stripe rust, scored on a 1 to 100 scale. Disease scoring for all-stage resistance was based on infection types only. Seventy-four of the164 accessions tested were resistant to stripe rust in the adult stage across all field trials. Fifty-nine of those had adult plant resistance, since they were susceptible in the seedling stage, but resistant in the field; fifteen accessions had all-stage resistance, since they were resistant in both adult and seedling stages. The adult plant resistance reaction from eight accessions of the species *T. dicoccum* and four accessions of *T. timopheevii* was similar to HTAP resistance, since infection types were high (8 or 9) early in the growing season and low (1 or 2) later in the growing season when plants had reached advanced stages of development. Results indicate that the majority of the resistant genotypes had adult plant resistance and the percentage of resistant genotypes was high (45%) among this germplasm. These accessions may be useful for introgressing novel stripe rust resistance genes into adapted wheat cultivars.

INTRODUCTION

Stripe rust, also known as yellow rust, caused by *Puccinia striiformis* Westend. f. sp. *tritici* Eriks., is a major disease of wheat (*Triticum aestivum* L. em Thell.), causing significant yield and quality losses in regions with temperate climates (Line and Qayoum, 1992; Roelfs et al., 1992; Chen, 2005,). Although the center of origin of stripe rust is not known precisely, the pathogen is considered to have originated from the Caucasus (Georgia, Armenia, and Azerbaijan) followed by dispersal into Western Europe and Asia (Zhukovsky, 1965; Stubbs, 1985).

The use of genetic resistance in wheat is the most economic way of controlling the disease (Röbbelen and Sharp, 1978; Line and Chen, 1995). There are two mechanisms of resistance to stripe rust: seedling resistance, which can be expressed in all stages of plant development, and adult plant resistance, which expresses in adult stages (Chen, 2005). Chen (2005) suggested that the term seedling resistance could be misinterpreted and proposed to refer to it as all-stage resistance. All-stage resistance, and some types of adult plant resistance, are race specific (Chen and Line, 1992; Chen, 2005). Genotypes possessing only race specific resistance in most cases lose their resistance over time due to changes in virulence of stripe rust races (Line and Qayoum, 1992). In contrast, the majority of genes for adult plant resistance provide durable, non-race specific resistance. One type of adult plant resistance, referred to as high-temperature adult-plant resistance (HTAP), also known as temperature sensitive resistance (Roelfs et al., 1992), has been one of the most effective types of resistance for regions with certain climatic patterns where the disease develops early in the growing season (e.g. Western Oregon, Western Washington, California) (Chen, 2005). Wheat genotypes possessing only HTAP resistance are susceptible to all races of stripe rust in seedling and early stages of plant development. The HTAP resistance mechanism, which is non-race-specific, becomes effective as the plants develop and the temperature increases, lowering infection types and severity of disease (Line and Qayoum, 1992; Chen, 2005).

According to Chen (2005), seventy-eight genes for resistance to stripe rust have been identified in wheat. The large majority of them are all-stage resistance genes, which have been defeated by known races of stripe rust. Only four of the identified genes provide non-race-specific adult-plant resistance, and ten genes provide HTAP resistance. In some geographic regions stripe rust occurs early in the season when the temperatures are still low; therefore, the HTAP resistance is not effective (Chen, 2005). The combination of non-race specific HTAP and race-specific all-stage resistances is the most effective approach for controlling the disease, since all-stage resistance provides high levels of resistance until new virulent races circumvent deployed genes and HTAP resistance provides protection against the pathogen in advanced stages of plant development (Chen, 2005).

Eight genes for stripe rust resistance have been derived from various relatives of *T. aestivum* from the primary, secondary, or tertiary gene pools (Macer, 1966; Law, 1976; Gerechter-Amitai et al., 1989; Peng et al., 1999, 2000; McIntosh, 1998;.McIntosh et al., 2005; Uauy et al., 2005). All of those genes provide all-stage resistance except *Yr36* (6BS), derived from wild emmer, *Triticum turgidum* L. subsp. *dicoccoides* (Körn. ex Asch. & Graebn.) Thell. (2n=28, AABB), which provides HTAP resistance (Uauy et al., 2005). Wild relatives of wheat, and landraces, may provide novel stripe rust resistance genes for assuring the long term viability of wheat production.

The diverse altitudes, high rainfalls and lower temperatures during summer nights that are typical throughout the growing season in Georgia are favorable for the pathogen survival and development, and the disease epidemics are frequent. Wheat relatives and landraces historically have been present in the region (Zhukovsky, 1965) and have been subjected to high levels of stripe rust pressure. The coexistence of the pathogen and its host may have lead to the evolution of high, durable levels of resistance in the host species (Leppik, 1970; Swiezynski et al., 1991), and we hypothesized that novel resistance genes to stripe rust may be present among wheat relatives and landraces originating from the region.

The U.S. National Plant Germplasm System has approximately 200 accessions of wheat relatives and landraces collected from Georgia, which are stored in the national Small

Grains Germplasm Collection at Aberdeen, ID. The objective of the study was to evaluate 164 of those accessions from eight *Triritcum* species, for resistance to stripe rust. Some of those wild relatives have been investigated intensively for resistance to various pathogens and pest insects (Table 1). Despite their importance as a source of resistance to other pathogens, the accessions evaluated in this study have not been previously evaluated for resistance to stripe rust.

MATERIALS AND METHODS

In total, 164 accessions of eight species of the genus *Triticum* were received from the U.S. National Small Grains Germplasm Collection in Aberdeen, Idaho in spring 2004. The germplasm included the following species: *Triticum aestivum* L. subsp. *aestivum* em Thell., *T. aestivum* L*. subsp. macha* (Dekapr. & A. M. Menabde) Mackey, *T. turgidum* L. subsp. *durum* (Desf.) Husn., *T. turgidum* L. subsp. *turgidum*, *T. turgidum* L. s*ubsp. carthlicum* (Nevski) Á. Löve & D. Löve, *T. turgidum* L. subsp. *dicoccum* (Schrank ex Schübl.) Thell., *T. turgidum* L. subsp. *paleocolchicum* Á. Löve and D. Löve, *T. timopheevii* (Zhuk.) Zhuk. subsp. *timopheevii* and *T. zhukovskyi* A. M. Menabde & Eritzjan (USDA-ARS, 2006). The accession numbers and the genome composition of each species are summarized in Table 2. In total, 97 genotypes had spring growth habit and 67 had winter habit. Seed of each accession was increased at the Washington State University Plant Growth Facility (Pullman, WA) by growing six plants per accession and bulking resulting seed. All accessions regardless of growth habit were planted in the field in October 2004 at four locations in Washington State (Whitlow and Spillman farms near Pullman, WA, Central Ferry, WA and Mt. Vernon, WA) with two replications per location, and in addition, 97 accessions with spring growth habit were planted again in spring (April) 2005 at the same locations. Two grams of seed were planted per 1m plot, with 0.3 m spacing and resistant (R) and susceptible (S) commercial check cultivars were included at 40 plot intervals. Check cultivars included WA 7437 (PI 561033) (R), Stephens (CI 017596) (R), Madsen (PI 511673) (R), Eltan (PI 536994) (R), Coda (PI 594372) (R), Lambert (PI 583372) (R), Moro (CItr 13740) (S), Lemhi (CI 011415) (S), and WA7821 (S). Replications were not randomized in order to facilitate plot management.

Field evaluation for resistance to stripe rust was conducted under natural infections in May-June of 2005. Infection types (IT), assigned based on a 0 (no infection) to 9 (completely susceptible) scale, and the severity of infection on a 0-100 scale, based on the percentage of flag leaves covered with stripe rust uredia, were recorded (Line and Qayoum, 1992). The most prevalent races of stripe rust present in the field under natural infections were PST-100 and PST-116 (Chen, X. M., unpublished data), which are virulent on a broad spectrum of stripe rust resistance genes in wheat (Table 3). In Spillman Farm (Pullman, WA) and Central Ferry, WA, IT scores were recorded in boot, flowering and grain development stages (dough stage), which correspond to the 45, 58 and 75 stages of Zadoks' scale of plant development, respectively (Zadoks et al, 1974); At Whitlow farm (Pullman, WA), the IT scores were recorded only at flowering stage; at Mt. Vernon the IT scores were recorded at boot, flowering and grain developing stages in winter genotypes, and in flowering and grain development stages in the genotypes with spring growth habit. IT and severity means and standard errors were calculated for each accession for each disease scoring date at each location (see appendixes).

Those accessions with IT scores below 4 at the final scoring date at every location were selected as resistant and all others were considered to be susceptible. Seventy-four accessions were identified as resistant in the field and were tested for presence of all-stage resistance using detached leaves of 10-14 day-old seedlings in three replications(Loladze et al., unpublished). Five races of stripe rust including PST-17, PST-37; PST-45, PST-100 and PST-116, that together are virulent on most deployed all-stage resistance genes, were used in this assays (Chen, 2005, Chen and Penman, unpublished data) (Table 3). PST-17, PST-37 and PST-45 represented "old" races, since they were collected and identified before 2000, and PST-100 and PST-116 represented "new" races, since they were collected and identified after 2000 (Table 3) (Chen, 2005). The urediniospores of the races were obtained from our stock collections for evaluation of all-stage resistance. As described above PST-100 and PST-116, the most virulent races, also were present in the field trials under natural infections.

RESULTS

Seventy-four accessions had IT scores ranging from 1 to 4 at the last disease scoring date at every location, and therefore were considered to be resistant in adult stages of plant development (Table 2). The list of accessions with identified resistance in the field, their growth habits (spring and winter), plant introduction (PI) numbers, and all-stage infection types to the five stripe rust races are summarized in Table 4.

Among the eighty-eight accessions from the species *T. aestivum subs. aestivum* tested, seventeen were resistant in the field (Fig. 1, A). The number of accessions from this species with all-stage resistance against old races (PST-17, PST-37 and PST-45) was higher than those resistance to the new races (PST-100 and PST-116). For instance, seven accessions of this species were resistant to PST-17, the least virulent race, and only one accession was resistant to PST-116, the most virulent race. Among the ten accessions from the species *T. aestivum subs. macha* tested, five were identified as resistant in the field and none of those accessions were resistant to any race of the pathogen in the seedling stage (Fig. 1, B). Among the eleven accessions of *T. turgidum. subsp. durum* tested, nine were resistant in the field in the adult stage, and only one accession was resistant to PST-17 in the seedling stage (Fig. 1, C). Both of the two accessions from the species *T. turgidum. subsp. turgidum* tested, were resistant in the field in the adult stage and only one of them was resistant to PST-117 in the seedling stage (Fig. 1, D). Among the eighteen accessions from the species *T. turgidum. subsp. carthlicum* tested, sixteen were resistant in the field in the adult stage and only one accession was resistant to PST-17 in seedling stage (Fig. 1, E). Among the fifteen accessions from the species *T. turgidum* subsp. *dicoccum*, thirteen were resistant in the field in the adult stage and two accessions had all-stage resistance to the races PST-17, PST-37 and PST-45 in seedling stage (Fig. 1, F). Eight accessions from this species were highly susceptible with IT equal to 8 when plants were at the boot stage in the field (see appendixes). Later, in the flowering stage, when temperatures increased, the IT score was recorded as 2, which is an indicator of possible presence of HTAP resistance. Among two accessions of *T. turgidum subsp. paleocolchicum* one accession was resistant in the field and none were resistant in the seedling stage (Fig. 1, G). Among the fifteen accessions of the species *T. timopheevii subsp. timopheevii* tested, ten accessions were resistant in the field, three accessions were resistance to PST-17 and two accessions were resistant to PST-37 and PST-45 in the seedling stage (Fig. 1, H). In this species, four of the ten accessions identified as resistant in the field also had a reaction to the pathogen analogous to HTAP resistance (see appendixes). Among the three accessions from the species *T. zhukovsky* tested, one was resistant in the field and none were resistant to any of the races in the seedling stage (Fig. 1, I).

The evaluation of all-stage resistance indicated that the majority of accessions that were resistant in the field were susceptible to the five races of stripe rust tested in the seedling stage, and therefore had only adult plant resistance (Table 2). In total, 15, 10, 7, 2 and 1 accessions were resistant to PST-17, PST-37, PST-45, PST-100 and PST-116, respectively (Table 2; Fig.1, J). The majority of the genotypes that had all-stage resistance expressed in the seedling stage were represented by the landraces of *T. aestivum subsp. aestivum* and only one of those accession was resistant to PST-116 in seedling stage.

DISCUSSION

We identified germplasm sources of adult and all-stage resistances to stripe rust among several species of wheat relatives originating from Georgia. In total, 74 accessions across all species had resistance to stripe rust in adult stage of plant development (45% of the germplasm tested). The evaluation of all-stage resistance using 5 races of stripe rust also indicates that the majority of those accessions resistant in the field had only adult plant resistance, since they were susceptible to stripe rust in the seedling stage. The number of accessions with seedling resistance was different for each stripe rust race (Table 2). For instance, PST-17, representing the old races, was avirulent on 15 accessions across all species, whereas the race PST-116 representing the new races was virulent on all accessions except the *T. aestivum subsp. aestivum* accession PI57145 CItr7092.

The resistance identified in the field in adult stage of plant development in eight and four accessions of the species *T. turgidum subsp. dicoccum* and *T. timopheevii subsp. timopheevii*, respectively, may be HTAP resistance. The species *T. turgidum subsp. dicoccum* is a domesticated relative of *T. turgidum subsp. dicoccoides*, from which the stripe rust HTAP resistance gene, *Yr36*, was introgressed into bread wheat (Uauy et al., 2005). Since those two species share the genome constitution (AABB) and are closely related and provide analogous types of resistance (HTAP), they might be carrying the same genes for resistance. Further investigation is required to confirm the presence of HTAP resistance in both of these species. Currently, molecular markers (*Xucw69* and *Xbarc101*), which were linked to the *Yr36* gene (Uauy et al., 2005), are being used to screen DNA of *T. turgidum subsp. dicoccum* accessions and a genetic complementation test will be conducted as well to determine if the same alleles for stripe rust resistance are involved in both species. In addition, the introgression of stripe rust resistance from *T. timopheevi* and *T. dicoccum* into commercial cultivars of *T. aestivum* through interspecific hybridization and backcrossing is underway.

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Table 1. Summary of the genes for resistance to various diseases and pest insects of wheat previously identified by various authors in the species *Triticum aestivum L. subsp. macha* (Dekapr. & A. M. Menabde) Mackey, *T. turgidum L. subsp. dicoccum* (Schrank ex Schübl.) Thell., *T. turgidum* L. *subsp. carthlicum* (Nevski) Á. Löve & D. Löve and *T. timopheevii* (Zhuk.) Zhuk. *subsp. timopheevii*

Species	Genome	Disease	Genes and chromosome location	Reference
Triticum aestivum L. *subsp. macha* (Dekapr. & A. M. Menabde) Mackey	2n=42 AABBDD	1. *Fusarium graminearum,* 2. *Mycosphaerella graminicola*	1. Undesignated (4A) 2. Undesignated	Grausgruber et al. 1998; Mentewab et al. 2000; Arraiano et al., 2001.
Emmer, *Triticum turgidum* L. subsp. *dicoccum* (Schrank ex Schübl.) Thell.	2n=28 AABB	1. Powdery mildew 2. Stem rust 3. Leaf rust 4. Hessian fly	1. *Pm5a* (7BL); *Pm4a* (2AL); *MlRE* (6AL); 2. *Sr17*(5BL); *Sr2* (3BS); *Sr9e* (2BS) 3. *Lr14a* (5BL); *Lrac104* (4A) 4. Undesignated (1AS)	Law and Wolfe, 1966; The et al., 1979; Chantret et al., 2000; Hsam et al., 2001; McIntosh, 1998; Spielmeyer et al., 2003; Singh et al., 1992; McIntosh et al., 1998; McIntosh et al.,1967; Park et al., 2001; Hussein et al., 2005; Brown-Guedira et al., 2005.
Triticum turgidum L. subsp. *carthlicum* (Nevski) Á. Löve & D. Löve	2n=28 AABB	1. Powdery mildew 2. Hessian fly	1. *Pm4b* (2AL); *PmPs5A* (2AL); *Pm33* (2BL); 2. Undesignated	The et al, 1979; McIntosh and Arts, 1996; Jørgensen and Jensen, 1972; Zhou et al., 2005; Zhu et al., 2005; Nsarellah et all., 2004.
T. timopheevii (Zhuk.) Zhuk. *subsp. timopheevii*	2n=28 A^tA^tGG	1. Powdery mildew 2. Leaf rust 3. Stem rust 4. Septoria nodorum blotch	1. Pm2 (2BL); Pm27 (6B); 2. Lr18 (5BL); LrTt1 (2A); 3. Sr36 (2BS); 4. SnbTM (3A)	Jørgensen and Jensen 1972; Tao et al., 2000; Järve et al., 2000; Dyck and Samborski, 1968; McIntosh et al. 1995; Yamamori, 1994; Kolmer, 2003; Leonova et al., 2004; Allard and Shands, 1954; Jørgensen and Jensen, 1973; Gyarfas, 1978, McIntosh et al., 1998, Tao et al., 1999; Ma and Hughes, 1995; Cao et al., 2001

Table 2. Number of accessions from nine Triticum species with identified resistance in the adult stage of plant development in the field across four locations in Washington State under natural infections, and the number of accessions with identified all-stage resistance to five stripe rust races (PST-17, PST-37, PST-45, PST-100 and PST-116) in 12-14 day-old seedlings.

	Species	Ploidy/Genome	Total number of accessions	Number of accessions with adult plant resistance	Number of accessions with all-stage resistance				
					Races of Stripe Rust				
					PST - 17	PST - 37	PST - 45	PST - 100	PST - 116
1.	*T. aestivum subsp. aestivum*	2n=42/AABBDD	88	17	7	6	3	2	1
2.	*T. aestivum subsp. macha*	2n=42/AABBDD	10	5	0	0	0	0	0
3.	*T. turgidum subsp. durum*	2n=28/AABB	11	9	1	0	0	0	0
4.	*T. turgidum subsp. turgidum*	2n=28/AABB	2	2	1	0	0	0	0
5.	*T. turgidum subsp. carthlicum*	2n=28/AABB	18	16	1	0	0	0	0
6.	T. turgidum subsp. dicoccum	2n=28/AABB	15	13	2	2	2	0	0
7.	*T. turgidum subsp. paleocolchicum*	2n=28/AABB	2	1	0	0	0	0	0
8.	*T. timopheevii subsp. timopheevii*	2n=28/AAGG	15	10	3	2	2	0	0
9.	*T. zhukovskyi*	2n=42/AAGGGG	3	1	0	0	0	0	0
		Total	164	74	15	10	7	2	1

Table 3. Races of stripe rust (PST-17, PST-37, PST-45, PST-100 and PST-116) used for evaluation of all-stage resistance in 74 accessions of 12-14 day-old seedlings of wheat relatives and landraces from Georgia, which were identified as resistant to stripe rust in the field in the adult stage of plant development under natural infections.

Races (year of release)	**Virulence Formula (*Yr* genes)**
PST-17 (1977)	Lemhi (*Yr21*), Chinese 166 (*Yr1*), Heines VII (*Yr2, YrHVII*), Yamhill (*Yr2,* Yr4a, *YrYam*), Lee (*Yr7, Yr22, Yr23*)
PST-37 (1987)	Lemhi (*Yr21*), Heines VII (*Yr2, YrHVII*), Druchamp (*Yr3a, YrD, YrDru*), Produra (*YrPr1, YrPr2*), Yamhill (*Yr2, Yr4a, YrYam*), Stephens (*Yr3a,YrS, YrSte*), Lee (*Yr7, Yr22, Yr23*), Fielder (*Yr6, Yr20*)
PST-45 (1990)	Lemhi (*Yr21*), Heines VII (*Yr2, YrHVII*), Fielder (*Yr6, Yr20*), Tyee (*YrTye*), Hyak (*Yr17*)
PST 100 (2003)	Lemhi (*Yr21*), Heines VII (*Yr2, YrHVII*), Produra (*YrPr1, YrPr2*), Yamhill (*Yr2, Yr4a, YrYam*), Stephens (*Yr3a, YrS, YrSte*), Lee (*Yr7, Yr22, Yr23*), Fielder (*Yr6, Yr20*), Express (*Yr?*), Yr8 (*Yr8*), Yr9 (*Yr9*), Clement (*Yr9*, YrCle), Compair (*Yr8, Yr19*)
PST-116 (2005)	Lemhi (*Yr21*), Heines VII (*Yr2, YrHVII*), Moro (*Yr10, YrMor*), Paha (*YrPa1, YrPa2, YrPa3*) Produra (*YrPr1, YrPr2*), Yamhill (*Yr2, Yr4a, YrYam*), Stephens (*Yr3a, YrS, YrSte*), Lee (*Yr7, Yr22, Yr23*), Fielder (*Yr6, Yr20*), Tres (*YrTr1, YrTr2*), Express (*Yr?*), Yr8 (*Yr8*), Yr9 (*Yr9*), Clement (*Yr9*, YrCle), Compair (*Yr8, Yr19*)

The years (given in parenthesis) represent the time of the collection and identification of the races. Virulence formula represents the names of wheat stripe rust differential cultivars with their genes for resistance to stripe rust, which have been defeated by the corresponding races of the pathogen. Races PST-17, PST-37 and PST-45 have been designated as old races, since they were collected and identified before 2000, whereas PST-100 and PST-116 have been designated as new races, since they were collected and identified after 2000.

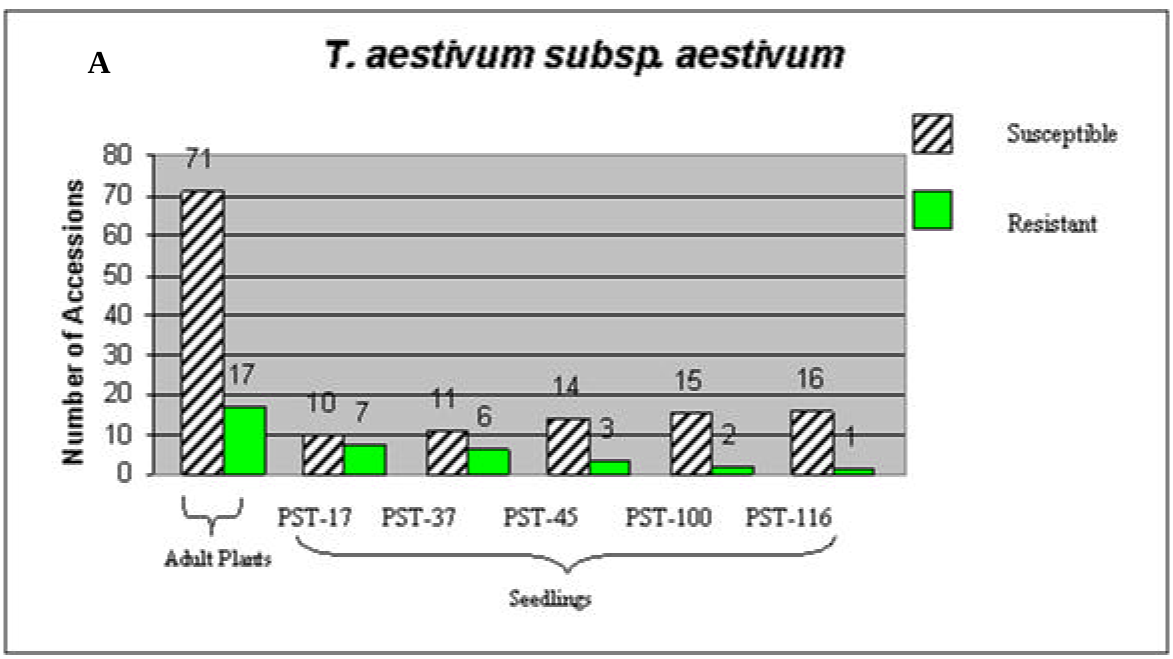
Table 4. Winter and spring genotypes of wheat relatives and landraces from Georgia identified as resistant to stripe rust in the field* in the adult stage of plant development under natural infections, and their all-stage resistance infections types (IT) to five races of stripe rust (PST-17, PST-37, PST-45, PST-100 and PST-116) scored on 0 (no infection) to 9 (completely susceptible) scale on 12-14 day-old seedlings.

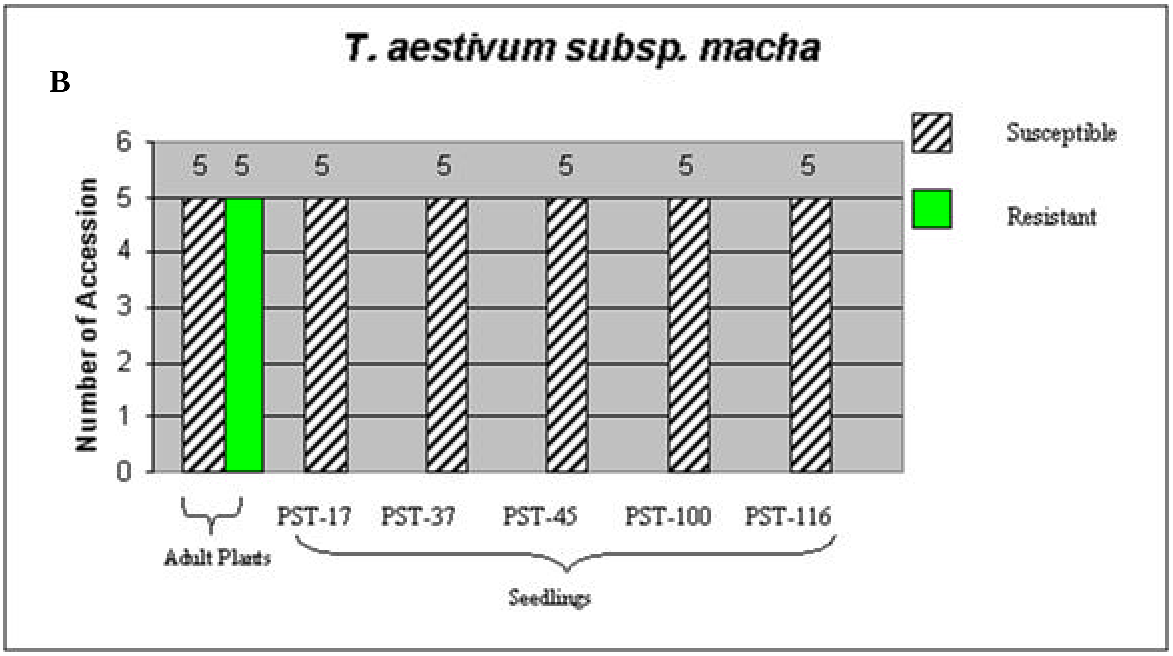
Number of accessions	**Plant ID**	**Habit****	**Species**	**PST-17**	**PST-37**	**PST-45**	**PST 100**	**PST-116**
				IT	IT	IT	IT	IT
1	PI 57142 CItr 7089	S	***T. aestivum subsp. aestivum***	8	8	8	8	8
2	PI 57143 CItr 7090	S	***T. aestivum subsp. aestivum***	8	8	8	8	8
3	PI 57145 CItr 7092	W	***T. aestivum subsp. aestivum***	2	2	2	2	2
4	PI 57147 CItr 7094	S	***T. aestivum subsp. aestivum***	2	8	8	8	8
5	PI 57148 CItr 7095	S	***T. aestivum subsp. aestivum***	7	8	8	8	8
6	PI 57150 CItr 7097	W	***T. aestivum subsp. aestivum***	2	2	8	8	8
7	PI 57183 CItr 7130	W	***T. aestivum subsp. aestivum***	2	2	2	5	8
8	PI 351501 T 3184	S	***T. aestivum subsp. aestivum***	2	2	2	8	8
9	PI 565393 Hozo Mestnaja	W	***T. aestivum subsp. aestivum***	7	8	8	8	8
10	PI 262619 Upkli	W	***T. aestivum subsp. aestivum***	8	8	8	8	8
11	PI 262678 Dika Dzhavakhetskaya	S	***T. aestivum subsp. aestivum***	2	2	8	6	8
12	PI 499971 KU 1806	S	***T. aestivum subsp. aestivum***	8	8	8	8	8
13	PI 57140 CItr 7087	W	***T. aestivum subsp. aestivum***	2	2	7	8	8
14	PI 57157 CItr 7104	W	***T. aestivum subsp. aestivum***	2	6	5	8	8
15	PI 57158 CItr 7105	W	***T. aestivum subsp. aestivum***	5	8	8	8	8
16	PI 57159 CItr 7106	W	***T. aestivum subsp. aestivum***	7	8	8	8	8
17	PI 499970 KU 1720	W	***T. aestivum subsp. aestivum***	8	8	8	8	8
18	PI 61102 Rusak	S	***T. turgidum subsp. carthlicum***	8	8	2	8	8
19	PI 94748 349	S	***T. turgidum subsp. carthlicum***	8	8	7	7	8
20	PI 94749 350	S	***T. turgidum subsp. carthlicum***	5	8	7	7	8
21	PI 94750 351	S	***T. turgidum subsp. carthlicum***	7	8	8	5	8
22	PI 94751 352	S	***T. turgidum subsp. carthlicum***	5	8	8	8	8
23	PI 94753 354	S	***T. turgidum subsp. carthlicum***	7	8	8	8	8
24	PI 94754 355	S	***T. turgidum subsp. carthlicum***	7	8	8	6	8
25	PI 94755 356	S	***T. turgidum subsp. carthlicum***	7	8	8	7	8
26	PI 115816 7106	S	***T. turgidum subsp. carthlicum***	8	8	8	8	8
27	PI 115817 11891	S	***T. turgidum subsp. carthlicum***	8	8	8	5	8
28	PI 352278 T-1300	S	***T. turgidum subsp. carthlicum***	8	8	8	6	8
29	PI 352282 T-2117	S	***T. turgidum subsp. carthlicum***	8	8	8	5	8
30	PI 585017 AW 6629/85	S	***T. turgidum subsp. carthlicum***	7	8	8	8	7
31	PI 585018 AW 6630/85	S	***T. turgidum subsp. carthlicum***	8	8	7	7	8
32	PI 78812 CItr 10110	S	***T. turgidum subsp. carthlicum***	7	8	8	7	8
33	PI 251914 WIR 25170	S	***T. turgidum subsp. carthlicum***	2	6	8	7	8

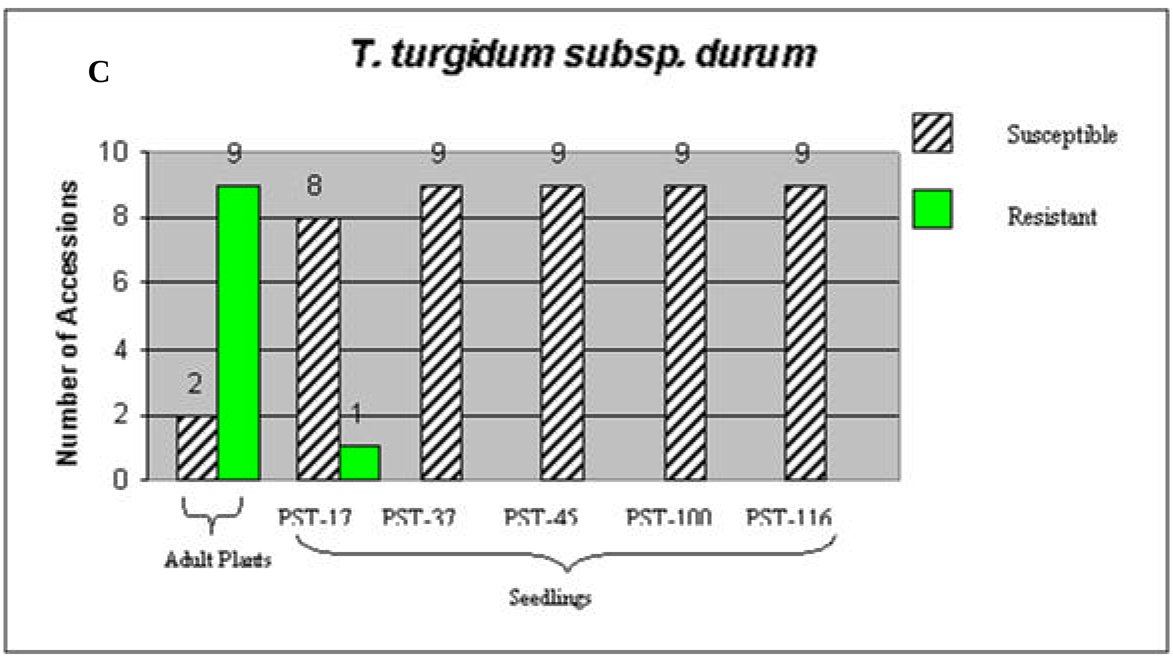
34	PI 572910 H Tri 13603/89	W	***T. aestivum subsp. macha***	8	8	8	8	8
35	PI 572911 H Tri 13613/87	W	***T. aestivum subsp. macha***	8	8	2	8	8
36	PI 572907 WIR 28214	W	***T. aestivum subsp. macha***	8	8	5	7	8
37	PI 572908 H Tri 13595/89	W	***T. aestivum subsp. macha***	7	8	8	6	8
38	PI 572913 H Tri 13614/89	W	***T. aestivum subsp. macha***	8	8	8	8	8
39	PI 94761 357	S	***T. timopheevii subsp. timopheevii***	2	2	2	7	7
40	PI 352506 Typicum	W	***T. timopheevii subsp. timopheevii***	8	8	8	8	8
41	PI 352508 Typicum	S	***T. timopheevii subsp. timopheevii***	2	1	2	8	8
42	PI 326318 WIR 29538	S	***T. timopheevii subsp. timopheevii***	9	4	2	8	8
43	PI 343447 WIR 29566	S	***T. timopheevii subsp. timopheevii***	7	8	2	8	8
44	PI 349054 WIR 46587	S	***T. timopheevii subsp. timopheevii***	8	8	8	8	8
45	PI 418584 WIR 38555	S	***T. timopheevii subsp. timopheevii***	7	8	8	8	8
46	PI 572917 H Tri 13606/89	S	***T. timopheevii subsp. timopheevii***	8	8	8	8	8
47	PI 94760 303	S	***T. timopheevii subsp. timopheevii***	2	6	8	8	8
48	PI 572916 H Tri 13604/87	S	***T. timopheevii subsp. timopheevii***	-	-	-	-	-
49	PI 94674 301	S	***T. turgidum subsp. dicoccum***	8	8	8	8	8
50	PI 94675 302	S	***T. turgidum subsp. dicoccum***	8	8	8	7	8
51	PI 113961 28170	S	***T. turgidum subsp. dicoccum***	8	8	6	8	7
52	PI 113963 28177	S	***T. turgidum subsp. dicoccum***	8	8	8	8	8
53	PI 591868 AW 6627/85	S	***T. turgidum subsp. dicoccum***	2	2	2	8	8
54	PI 74108 35900	S	***T. turgidum subsp. dicoccum***	2	2	2	7	8
55	PI 254150 28170	S	***T. turgidum subsp. dicoccum***	8	8	2	8	8
56	PI 254216 28177	S	***T. turgidum subsp. dicoccum***	8	8	2	8	8
57	PI 349043 WIR 6388	S	***T. turgidum subsp. dicoccum***	8	8	8	8	8
58	PI 349046 WIR 43848	S	***T. turgidum subsp. dicoccum***	7	8	8	7	8
59	PI 94747 301	S	***T. turgidum subsp. dicoccum***	8	8	8	8	8
60	PI 74104 35894	S	***T. turgidum subsp. dicoccum***	8	8	8	8	8
61	PI 254189 35900	S	***T. turgidum subsp. dicoccum***	8	8	5	8	8
62	PI 57194 CItr 7141	S	***T. turgidum subsp. durum***	8	8	8	8	8
63	PI 57195 CItr 7142	W	***T. turgidum subsp. durum***	2	8	8	8	7
64	PI 57200 CItr 7147	W	***T. turgidum subsp. durum***	8	8	8	8	8
65	PI 57210 CItr 7157	W	***T. turgidum subsp. durum***	8	8	8	8	8
66	PI 61111 999	S	***T. turgidum subsp. durum***	8	8	8	8	8
67	PI 27514 Kriek Bogda	W	***T. turgidum subsp. durum***	7	8	8	8	8
68	PI 78810 CItr 10108	W	***T. turgidum subsp. durum***	8	8	8	8	8
69	PI 262677 SHAUPKHA	S	***T. turgidum subsp. durum***	8	8	8	8	8
70	PI 349042 DIKA 9/14 S	S	***T. turgidum subsp. durum***	7	6	8	8	8
71	PI 349050 WIR 28162	W	***T. turgidum subsp. paleocolchicum***	8	8	8	8	8
72	PI 41029 533	S	***T. turgidum subsp. turgidum***	8	8	8	8	8
73	PI 349057 WIR 13448	W	***T. turgidum subsp. turgidum***	2	8	8	8	8
74	PI 355707 69Z5.72	W	***T. zhukovskyi***	8	8	8	7	8

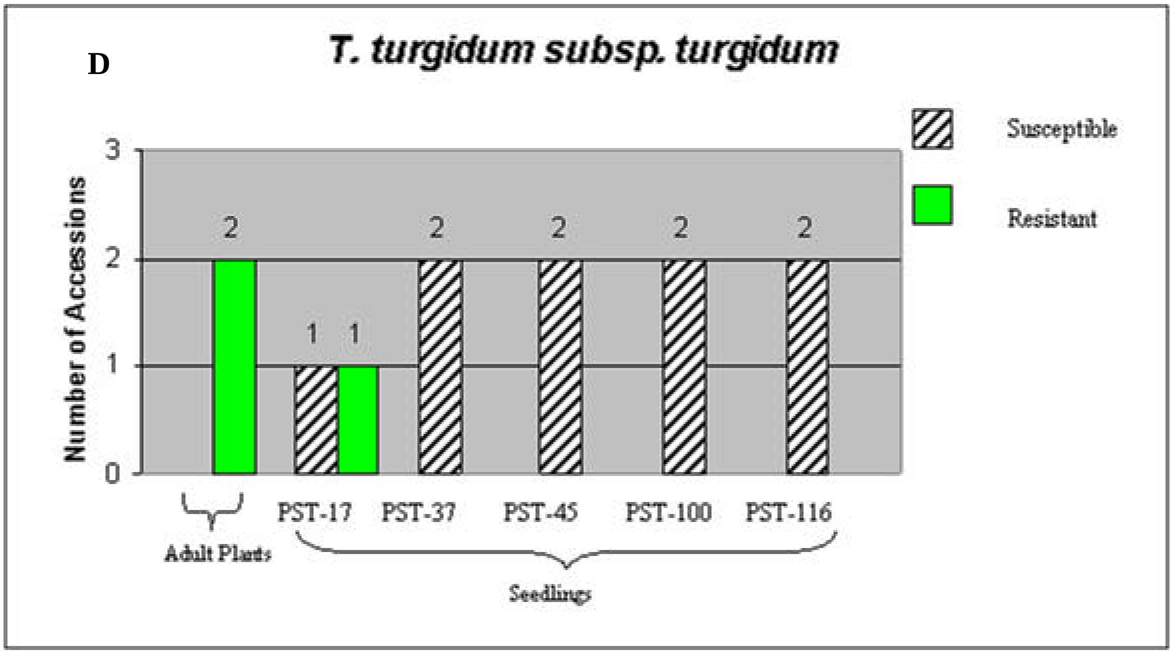
*Field resistance scores are listed in the appendix; **S=spring, W=winter

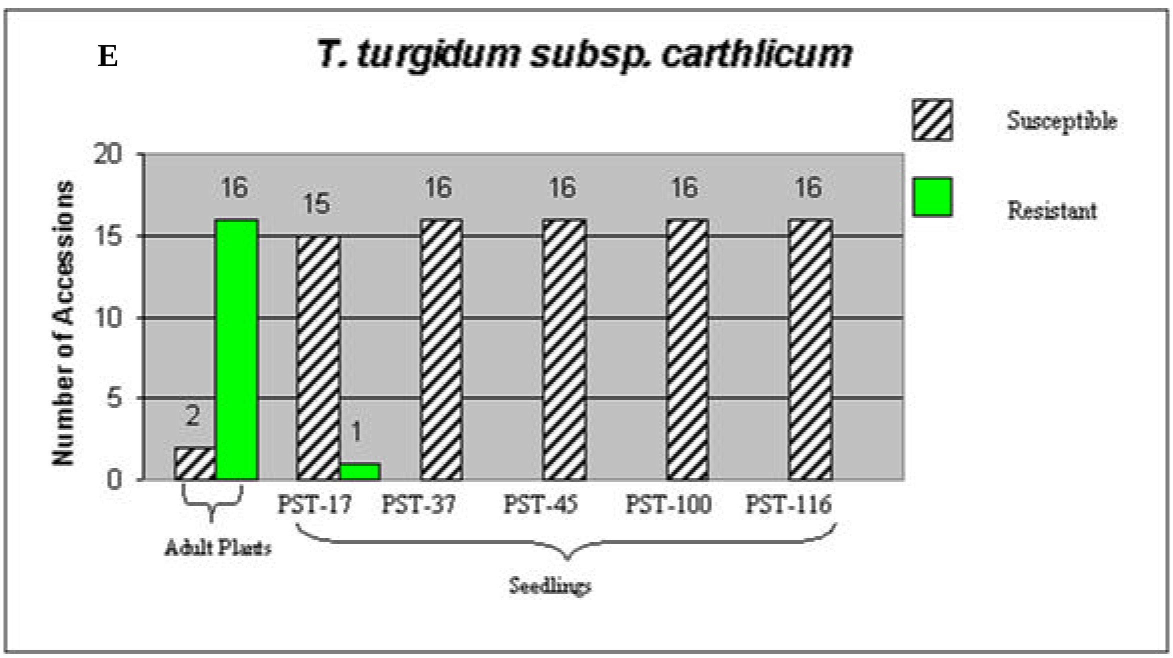
Figure 1. Number of genotypes with susceptible and resistant reactions to stripe rust among the 88 accessions evaluated from the species *T. aestivum subsp. aestivum* (A), ten accessions of *T. aestivum subsp. macha* (B), eleven accessions of *T. turgidum subsp. durum* (C), two accessions of *T. turgidum subsp. turgidum* (D), eighteen accessions of *T. turgidum subsp. carthlicum* (E), fifteen accessions of *T. turgidum subsp. dicoccum* (F), two accessions of *T. turgidum subsp. paleocolchicum* (G), fifteen accessions of *T. timopheevii subsp. timopheevii* (H), three accessions of *T. zhukovsky* (I), and all 164 genotypes from nine *Triticum* species from Georgia (J). The accessions were tested in the field in the adult stage of plant development under natural infections of stripe rust (noted in the figure as Adult Plants). Those identified as resistant in the field were later tested against stripe rust races PST-17, PST-37, PST-45, PST-100 and PST-116 for all-stage resistance in seedlings (noted in the figure as Seedlings). Susceptible and resistant accessions are represented by striped and blank bars, respectively, and the figures above each bar represent the number of accessions in each category.

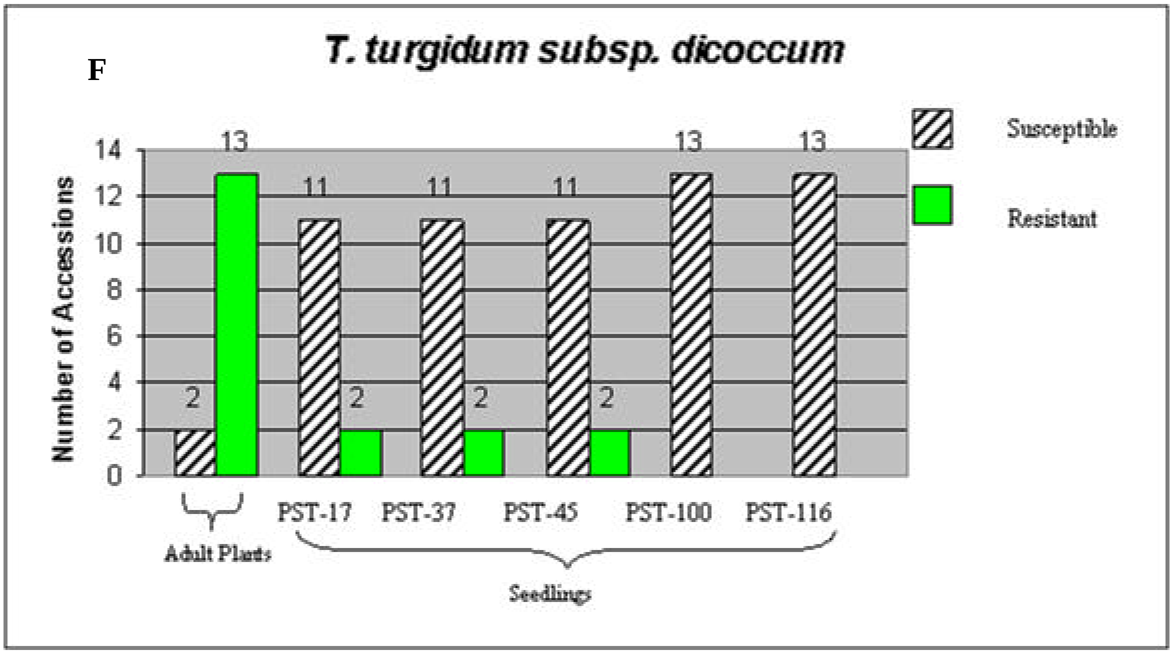


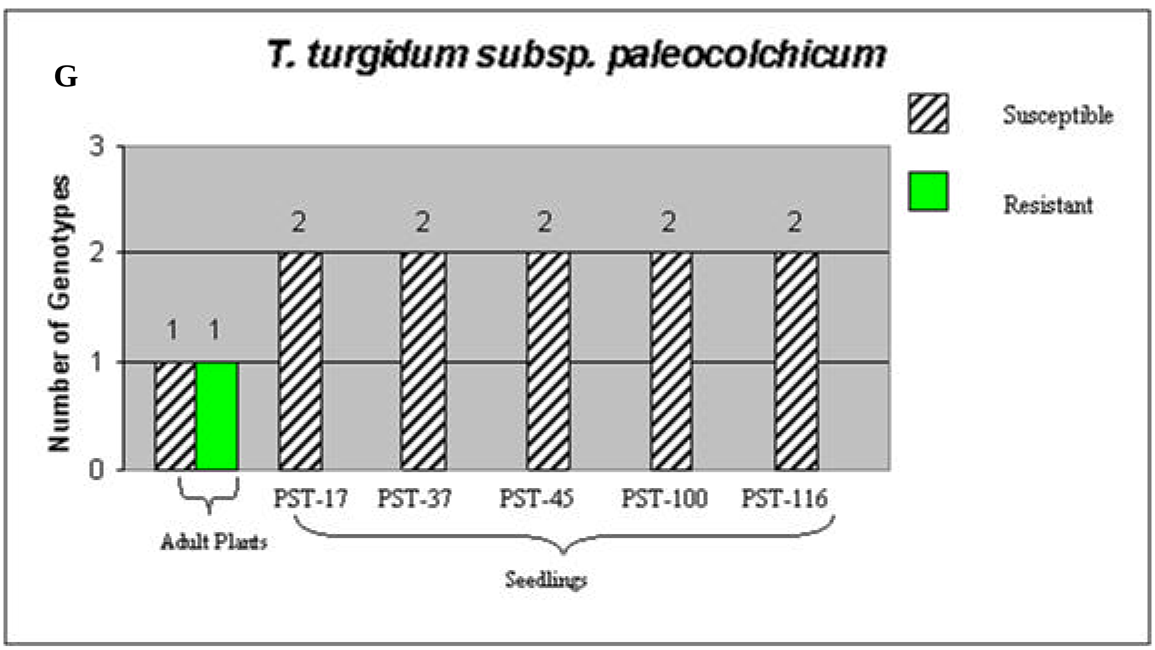

B
T. aestivum subsp. macha
Number of Accession
Susceptible
Resistant
Adult Plants
PST-17
PST-37
PST-45
PST-100
PST-116
Seedlings

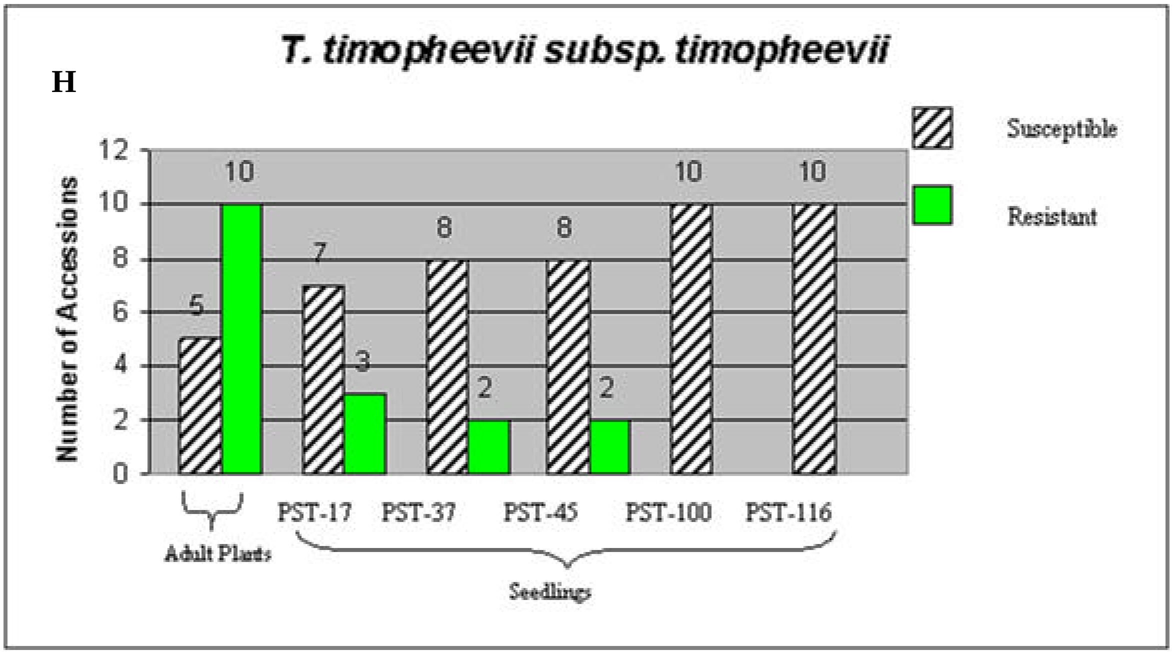

C
T. turgidum subsp. durum
Number of Accessions
Susceptible
Resistant
Adult Plants
PST-17
PST-37
PST-45
PST-100
PST-116
Seedlings

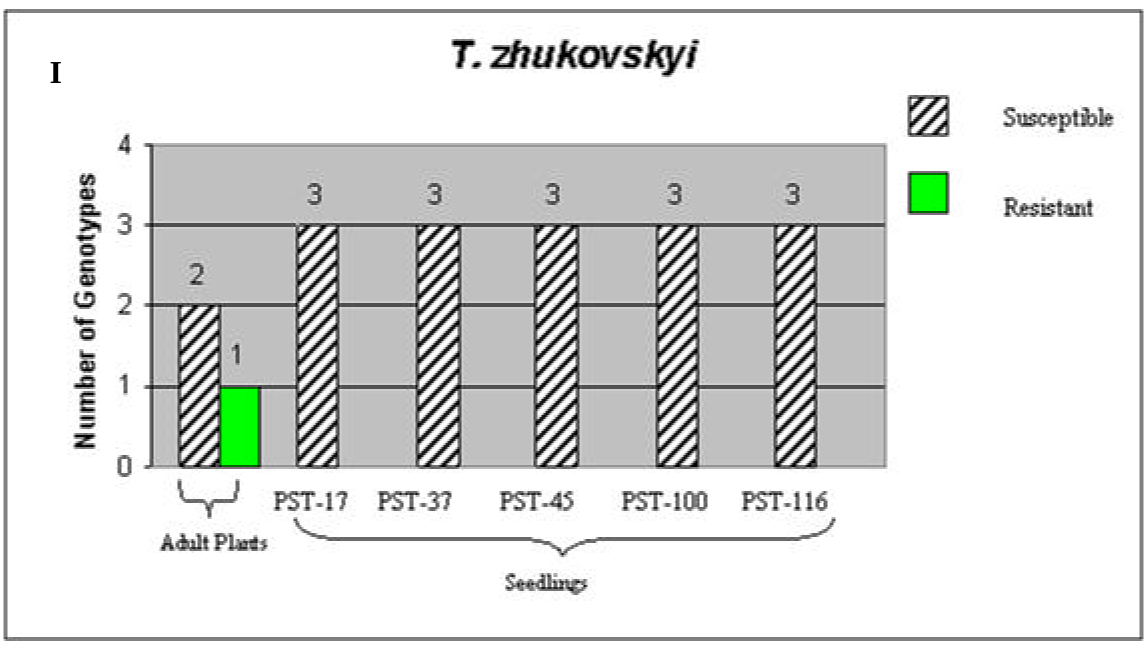

D
T. turgidum subsp. turgidum
Susceptible
Resistant
Number of Accessions
0
1
2
3
2
1 1
2
2
2
2
Adult Plants
PST-17
PST-37
PST-45
PST-100
PST-116
Seedlings

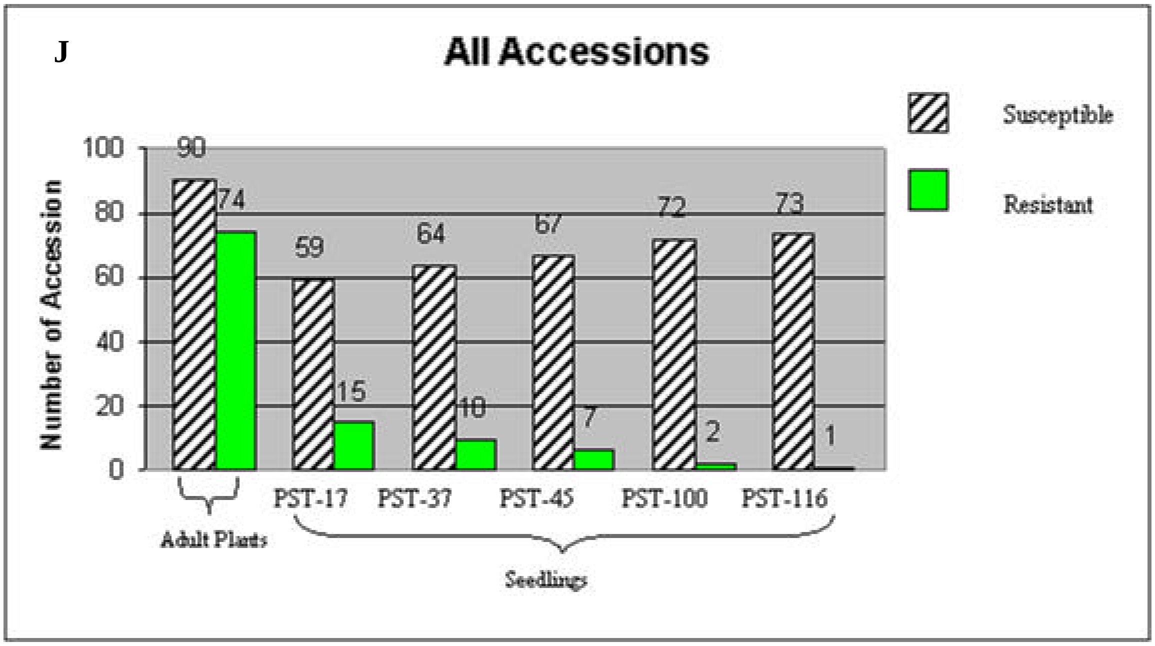

E
T. turgidum subsp. carthlicum
Susceptible
Resistant
Number of Accessions
0
5
10
15
20
2
16
15
1
16
16
16
16
Adult Plants
PST-17
PST-37
PST-45
PST-100
PST-116
Seedlings


F
T. turgidum subsp. dicoccum
Susceptible
Resistant
Number of Accessions
0
2
4
6
8
10
12
14
2
13
11
2
11
2
11
2
13
13
Adult Plants
PST-17
PST-37
PST-45
PST-100
PST-116
Seedlings


G
T. turgidum subsp. paleocolchicum
Susceptible
Resistant
Number of Genotypes
0
1
2
3
1
1
2
2
2
2
2
Adult Plants
PST-17
PST-37
PST-45
PST-100
PST-116
Seedlings


H
T. timopheevii subsp. timopheevii
Susceptible
Resistant
Number of Accessions
12
10
8
6
4
2
0
5
10
7
3
8
2
8
2
10
10
PST-17
PST-37
PST-45
PST-100
PST-116
Adult Plants
Seedlings


I
T. zhukovskyi
Susceptible
Resistant
Number of Genotypes
4
3
2
1
0
2
1
3
3
3
3
3
PST-17
PST-37
PST-45
PST-100
PST-116
Adult Plants
Seedlings


J
All Accessions
Susceptible
Resistant
Number of Accession
100
80
60
40
20
0
90
74
59
15
64
10
67
7
72
2
73
1
PST-17
PST-37
PST-45
PST-100
PST-116
Adult Plants
Seedlings

CHAPTER 4

APPENDIX

APPENDIX A-1

Comparison of infection types (IT) of stripe rust on intact seedling with IT of detached seedling leaves of seven wheat stripe rust differential cultivars inoculated with three different stripe rust races (PST) in three replications.

			Intact seedlings	Detached leaves
Cultivar	PST	Replication	IT	IT
Lemhi	23	1	9	8
Lemhi	23	2	9	8
Lemhi	23	3	9	8
Lemhi	45	1	9	8
Lemhi	45	2	9	8
Lemhi	45	3	9	9
Lemhi	100	1	9	8
Lemhi	100	2	9	8
Lemhi	100	3	9	8
Druchamp	23	1	8	7
Druchamp	23	2	8	8
Druchamp	23	3	8	8
Druchamp	45	1	1	1
Druchamp	45	2	1	1
Druchamp	45	3	1	1
Druchamp	100	1	1	1
Druchamp	100	2	1	1
Druchamp	100	3	1	1
Yr5	23	1	2	2
Yr5	23	2	2	2
Yr5	23	3	2	2
Yr5	45	1	2	2
Yr5	45	2	2	2
Yr5	45	3	2	2
Yr5	100	1	2	2
Yr5	100	2	2	1
Yr5	100	3	2	2
Stephens	23	1	8	8
Stephens	23	2	7	8
Stephens	23	3	7	8
Stephens	45	1	2	2
Stephens	45	2	2	2
Stephens	45	3	2	2
Stephens	100	1	8	8
Stephens	100	2	8	8
Stephens	100	3	8	8
Fielder	23	1	1	2

Fielder	23	2	1	2
Fielder	23	3	1	2
Fielder	45	1	9	8
Fielder	45	2	8	8
Fielder	45	3	9	8
Fielder	100	1	9	8
Fielder	100	2	9	8
Fielder	100	3	8	8
Tyee	23	1	1	2
Tyee	23	2	1	2
Tyee	23	3	1	2
Tyee	45	1	9	8
Tyee	45	2	9	8
Tyee	45	3	9	8
Tyee	100	1	1	2
Tyee	100	2	1	2
Tyee	100	3	1	2
Express	23	1	2	2
Express	23	2	2	2
Express	23	3	2	2
Express	45	1	2	2
Express	45	2	2	2
Express	45	3	2	2
Express	100	1	9	8
Express	100	2	9	8
Express	100	3	8	8
Standard error			0.07	0.08

APPENDIX B-1

Stripe rust infection types (IT) and severity (%) of winter and spring wheat landraces and relatives from Georgia recorded at Spillman farm near Pullman, WA in 2005 growing season. * S=spring, W=winter

plot #	Rep	Plant ID	Habit	*Species*	24-May		30-May		6-Jun	
					IT	%	IT	%	IT	%
Moro		check		*T. aestivum*	5	2	5	10	5	30
WA7437		check		*T. aestivum*	0	0	2	5	2	10
Stephens		check		*T. aestivum*	0	0	2	5	2	20
Madsen		check		*T. aestivum*	0	0	2	5	2	20
15001	1	CItr 14143 17425	S	*T. aestivum subsp. aestivum*	8	5	9	80	7	90
15002	1	PI 57140 CItr 7087	W	*T. aestivum subsp. aestivum*	0	0	3	5	2	10
15003	1	PI 57142 CItr 7089	S	*T. aestivum subsp. aestivum*	0	0	2	5	2	10
15004	1	PI 57143 CItr 7090	S	*T. aestivum subsp. aestivum*	0	0	3	5	2	20
15005	1	PI 57144 CItr 7091	S	*T. aestivum subsp. aestivum*	4	5	7	60	7	90
15006	1	PI 57145 CItr 7092	W	*T. aestivum subsp. aestivum*	0	0	2	5	2	20
15007	1	PI 57147 CItr 7094	S	*T. aestivum subsp. aestivum*	0	0	3	5	2	20
15008	1	PI 57148 CItr 7095	S	*T. aestivum subsp. aestivum*	0	0	2	5	3	20
15009	1	PI 57150 CItr 7097	W	*T. aestivum subsp. aestivum*	0	0	2	5	3	20
15010	1	PI 57151 CItr 7098	W	*T. aestivum subsp. aestivum*	0	0	3	10	3	20
15011	1	PI 57152 CItr 7099	W	*T. aestivum subsp. aestivum*	6	2	5	10	5	40
15012	1	PI 57153 CItr 7100	W	*T. aestivum subsp. aestivum*	6	5	8	70	7	70
15013	1	PI 57155 CItr 7102	W	*T. aestivum subsp. aestivum*	0	0	5	20	4	50
15014	1	PI 57156 CItr 7103	W	*T. aestivum subsp. aestivum*	3	2	2	5	4	50
15015	1	PI 57157 CItr 7104	W	*T. aestivum subsp. aestivum*	0	0	2	5	4	60
15016	1	PI 57158 CItr 7105	W	*T. aestivum subsp. aestivum*	0	0	2	5	2	30
15017	1	PI 57159 CItr 7106	W	*T. aestivum subsp. aestivum*	0	0	2	5	2	10
15018	1	PI 57160 CItr 7107	W	*T. aestivum subsp. aestivum*	5	2	4	20	8	70
15019	1	PI 57161 CItr 7108	S	*T. aestivum subsp. aestivum*	8	10	7	50	7	90
15020	1	PI 57162 CItr 7109	W	*T. aestivum subsp. aestivum*	6	10	8	40	7	70
15021	1	PI 57163 CItr 7110	W	*T. aestivum subsp. aestivum*	0	0	2	2	2	10
15022	1	PI 57164 CItr 7111	W	*T. aestivum subsp. aestivum*	5	5	4	5	5	60
15023	1	PI 57165 CItr 7112	W	*T. aestivum subsp. aestivum*	6	10	7	50	7	60
15024	1	PI 57166 CItr 7113	S	*T. aestivum subsp. aestivum*	6	5	5	40	8	70
15025	1	PI 57167 CItr 7114	W	*T. aestivum subsp. aestivum*	0	0	2	5	2	10
15026	1	PI 57168 CItr 7115	W	*T. aestivum subsp. aestivum*	3	5	3	5	2	10
15027	1	PI 57171 CItr 7118	W	*T. aestivum subsp. aestivum*	4	5	3	5	3	30
15028	1	PI 57172 CItr 7119	W	*T. aestivum subsp. aestivum*	4	5	3	20	3	40
15029	1	PI 57175 CItr 7122	S	*T. aestivum subsp. aestivum*	4	5	4	15	4	30
15030	1	PI 57177 CItr 7124	W	*T. aestivum subsp. aestivum*	6	10	4	50	7	70
15031	1	PI 57178 CItr 7125	W	*T. aestivum subsp. aestivum*	6	10	4	30	6	70
15032	1	PI 57179 CItr 7126	W	*T. aestivum subsp. aestivum*	8	20	8	70	9	90
15033	1	PI 57181 CItr 7128	W	*T. aestivum subsp. aestivum*	5	5	2	15	3	20

plot #	Rep	Plant ID	Habit	*Species*	IT	%	IT	%	IT	%
15034	1	PI 57182 CItr 7129	S	*T. aestivum subsp. aestivum*	8	5	3	10	2	20
15035	1	PI 57183 CItr 7130	W	*T. aestivum subsp. aestivum*	0	0	3	10	2	10
15036	1	PI 57184 CItr 7131	S	*T. aestivum subsp. aestivum*	8	10	9	60	7	60
WA7821		check		*T. aestivum*	7	40	8	70	7	90
WA7821		check		*T. aestivum*	7	40	8	70	7	90
WA7821		check		*T. aestivum*	7	40	8	70	7	90
WA7821		check		*T. aestivum*	7	40	8	70	7	90
15037	1	PI 57185 CItr 7132	W	*T. aestivum subsp. aestivum*	4	5	7	20	5	40
15038	1	PI 94476 156	W	*T. aestivum subsp. aestivum*	8	25	9	70	8	70
15039	1	PI 94478 158	W	*T. aestivum subsp. aestivum*	8	20	7	60	7	70
15040	1	PI 94521 201	W	*T. aestivum subsp. aestivum*	7	10	6	50	5	60
15041	1	PI 94522 202	W	*T. aestivum subsp. aestivum*	8	15	8	80	7	70
15042	1	PI 113962 28175	S	*T. aestivum subsp. aestivum*	8	15	9	80	9	90
15043	1	PI 351501 T 3184	S	*T. aestivum subsp. aestivum*	0	0	3	30	5	40
15044	1	PI 427146 ARAGVI	W	*T. aestivum subsp. aestivum*	3	5	7	30	4	60
15045	1	PI 565389 Hulugo	W	*T. aestivum subsp. aestivum*	8	30	9	90	9	90
15046	1	PI 565393 Hozo Mestnaja	W	*T. aestivum subsp. aestivum*	0	0	1	2	2	10
15047	1	PI 565421 BAGRATIONI	W	*T. aestivum subsp. aestivum*	4	5	5	20	2	60
15048	1	PI 591867 AW 6637C/86	S	*T. aestivum subsp. aestivum*	9	15	8	90	9	90
15049	1	PI 585016 AW 6626/88	S	*T. aestivum subsp. aestivum*	5	10	4	40	4	50
15050	1	PI 591869 AW 6634A/86	S	*T. aestivum subsp. aestivum*	8	20	5	60	9	80
15051	1	PI 74110 35919	S	*T. aestivum subsp. aestivum*	8	20	9	90	9	90
15052	1	PI 78814 CItr 10112	S	*T. aestivum subsp. aestivum*	7	20	5	20	9	80
15053	1	PI 254219 349	S	*T. aestivum subsp. aestivum*	8	15	9	20	9	70
15054	1	PI 262619 Upkli	W	*T. aestivum subsp. aestivum*	5	10	3	15	2	30
15055	1	PI 262628 Akhaltsikhis Tsiteli Doli	S	*T. aestivum subsp. aestivum*	8	15	9	60	9	90
15056	1	PI 262638 Lagodekhis Grdzeltavtava	S	*T. aestivum subsp. aestivum*	7	20	8	50	4	50
15057	1	PI 262639 Hulugo	W	*T. aestivum subsp. aestivum*	7	10	3	20	4	40
15058	1	PI 262640 Gomborka	S	*T. aestivum subsp. aestivum*	4	5	3	30	5	60
15059	1	PI 262678 Dika Dzhavakhetskaya	S	*T. aestivum subsp. aestivum*	0	0	1	10	2	20
15060	1	PI 499969 KU 1668	W	*T. aestivum subsp. aestivum*	6	5	4	15	8	90
15061	1	PI 499970 KU 1720	W	*T. aestivum subsp. aestivum*	5	5	4	30	4	30
15062	1	PI 499971 KU 1806	S	*T. aestivum subsp. aestivum*	4	2	3	10	2	20
15063	1	PI 572655 H Tri 13353/83	S	*T. aestivum subsp. aestivum*	8	15	7	70	9	90
15064	1	PI 572657 A Tri 13356/83	W	*T. aestivum subsp. aestivum*	6	15	7	50	8	50
15065	1	PI 572658 A Tri 13357/84	W	*T. aestivum subsp. aestivum*	6	10	5	30	8	70
15066	1	PI 572659 H Tri 13358/83		*T. aestivum subsp. aestivum*	4	5	4	30	4	60
15067	1	PI 572660 H Tri 13359/87	S	*T. aestivum subsp. aestivum*	8	10	6	60	8	60
15068	1	PI 572661 AW 6637A/87	S	*T. aestivum subsp. aestivum*	8	15	5	20	9	50
15069	1	PI 572662 AW 6637B/88	S	*T. aestivum subsp. aestivum*	8	15	7	60	8	70
15070	1	PI 572663 HW 6638/87	W	*T. aestivum subsp. aestivum*	4	10	3	30	8	60
15071	1	PI 572664 HW 6638B/87	S	*T. aestivum subsp. aestivum*	5	5	3	30	4	40
15072	1	PI 572665 AW 6631/85	S	*T. aestivum subsp. aestivum*	5	10	6	80	5	70
Eltan		check		*T. aestivum*	0	0	3	10	2	30
Su/O		check		*T. aestivum*	7	15	7	70	8	80
Coda		check		*T. aestivum*	0	0	2	10	2	20
Lambert		check		*T. aestivum*	2	5	3	20	3	30

plot #	Rep	Plant ID	Habit	*Species*	IT	%	IT	%	IT	%
15073	1	PI 572666 AW 6632/85	S	*T. aestivum subsp. aestivum*	5	10	5	40	5	70
15074	1	PI 572667 AW 6633A/85	S	*T. aestivum subsp. aestivum*	5	5	7	40	8	60
15075	1	PI 572668 AW 6633B/85	S	*T. aestivum subsp. aestivum*	7	10	6	40	8	70
15076	1	PI 572669 HW 6553/85	S	*T. aestivum subsp. aestivum*	7	20	7	90	7	90
15077	1	PI 572670 AW 6634B/86	S	*T. aestivum subsp. aestivum*	5	25	7	80	8	90
15078	1	PI 572671 AW 6635B/86	S	*T. aestivum subsp. aestivum*	7	10	7	70	8	90
15079	1	PI 572672 AW 6636A/85	S	*T. aestivum subsp. aestivum*	8	20	8	80	9	90
15080	1	PI 572673 AW 6636B/85	S	*T. aestivum subsp. aestivum*	6	15	8	80	9	90
15081	1	PI 572674 HW 6555/86	S	*T. aestivum subsp. aestivum*	5	15	6	70	7	70
15082	1	PI 572679 HW 7032/88	W	*T. aestivum subsp. aestivum*	0	0	0	0	3	30
15083	1	PI 572680 HW 7033/88	W	*T. aestivum subsp. aestivum*	6	5	3	20	5	50
15084	1	PI 572687 HW 7042/88	W	*T. aestivum subsp. aestivum*	4	5	4	20	7	60
15085	1	PI 572689 HW 7045/88	W	*T. aestivum subsp. aestivum*	0	0	2	20	2	20
15086	1	PI 572690 AW 7198/90	W	*T. aestivum subsp. aestivum*	3	2	2	20	3	30
15087	1	PI 572691 HW 7199/90	W	*T. aestivum subsp. aestivum*	Missing					
15088	1	PI 572693 AW 6635A/86	S	*T. aestivum subsp. aestivum*	6	5	7	50	7	80
15089	1	PI 61102 Rusak	S	*T. turgidum subsp. carthlicum*	3	5	3	15	2	20
15090	1	PI 94748 349	S	*T. turgidum subsp. carthlicum*	5	2	3	10	2	20
15091	1	PI 94749 350	S	*T. turgidum subsp. carthlicum*	6	5	4	5	2	2
15092	1	PI 94750 351	S	*T. turgidum subsp. carthlicum*	3	2	2	5	2	2
15093	1	PI 94751 352	S	*T. turgidum subsp. carthlicum*	5	5	2	5	2	10
15094	1	PI 94752 353	S	*T. turgidum subsp. carthlicum*	5	5	5	5	7	60
15095	1	PI 94753 354	S	*T. turgidum subsp. carthlicum*	3	2	2	5	2	10
15096	1	PI 94754 355	S	*T. turgidum subsp. carthlicum*	4	2	2	5	2	20
15097	1	PI 94755 356	S	*T. turgidum subsp. carthlicum*	5	5	3	5	3	30
15098	1	PI 115816 7106	S	*T. turgidum subsp. carthlicum*	4	2	2	5	2	20
15099	1	PI 115817 11891	S	*T. turgidum subsp. carthlicum*	4	5	2	5	2	10
15100	1	PI 352278 T-1300	S	*T. turgidum subsp. carthlicum*	5	5	2	5	2	20
15101	1	PI 352282 T-2117	S	*T. turgidum subsp. carthlicum*	4	2	2	5	2	20
15102	1	PI 585017 AW 6629/85	S	*T. turgidum subsp. carthlicum*	1	2	2	5	2	10
15103	1	PI 585018 AW 6630/85	S	*T. turgidum subsp. carthlicum*	3	2	2	5	2	10
15104	1	PI 78812 CItr 10110	S	*T. turgidum subsp. carthlicum*	1	2	2	5	2	20
15105	1	PI 251914 WIR 25170	S	*T. turgidum subsp. carthlicum*	1	2	2	5	2	20
15106	1	PI 499972 KU 1800	S	*T. turgidum subsp. carthlicum*	1	2	3	5	2	10
15107	1	PI 611470 H Tri 13601/87	W	*T. aestivum subsp. macha*	3	2	3	20	3	10
WA7821		check		*T. aestivum*	7	30	7	80	7	80
WA7821		check		*T. aestivum*	7	30	7	80	7	80
WA7821		check		*T. aestivum*	7	30	7	80	7	80
WA7821		check		*T. aestivum*	7	30	7	80	7	80
15108	1	PI 572905 WIR 29576	W	*T. aestivum subsp. macha*	5	2	4	20	5	40
15109	1	PI 572906 WIR 28168	W	*T. aestivum subsp. macha*	3	2	3	30	4	30
15110	1	PI 572907 WIR 28214	W	*T. aestivum subsp. macha*	5	5	5	50	5	50
15111	1	PI 572908 H Tri 13595/89	W	*T. aestivum subsp. macha*	5	5	4	20	4	30
15112	1	PI 572909 H Tri 13602/83	W	*T. aestivum subsp. macha*	3	2	3	15	3	30
15113	1	PI 572910 H Tri 13603/89	W	*T. aestivum subsp. macha*	4	5	4	15	3	20
15114	1	PI 572911 H Tri 13613/87	W	*T. aestivum subsp. macha*	5	5	3	10	2	20
15115	1	PI 572912 H Tri 13615/87	W	*T. aestivum subsp. macha*	4	10	3	10	3	20

plot #	Rep	Plant ID	Habit	*Species*	IT	%	IT	%	IT	%
15116	1	PI 572913 H Tri 13614/89	W	*T. aestivum subsp. macha*	5	5	3	5	3	10
15119	1	PI 94760 303	S	*T. timopheevii subsp. timopheevii*	0	0	2	2	0	0
15120	1	PI 94761 357	S	*T. timopheevii subsp. timopheevii*	0	0	0	0	0	0
15121	1	PI 352506 Typicum	W	*T. timopheevii subsp. timopheevii*	6	2	0	0	0	0
15122	1	PI 352508 Typicum	S	*T. timopheevii subsp. timopheevii*	0	0	0	0	0	0
15123	1	PI 352510 Viticulosum	S	*T. timopheevii subsp. timopheevii*	missing					
15124	1	PI 542472 M82-6267	W	*T. timopheevii subsp. timopheevii*	0	0	0	0	2	5
15125	1	PI 326318 WIR 29538	S	*T. timopheevii subsp. timopheevii*	0	0	0	0	0	0
15126	1	PI 341802 WIR 29548	S	*T. timopheevii subsp. timopheevii*	6	2	3	2	0	0
15127	1	PI 343447 WIR 29566	S	*T. timopheevii subsp. timopheevii*	6	2	3	2	0	0
15128	1	PI 349053 WIR 29548	S	*T. timopheevii subsp. timopheevii*	missing					
15129	1	PI 349054 WIR 46587	S	*T. timopheevii subsp. timopheevii*	missing					
15130	1	PI 418584 WIR 38555	S	*T. timopheevii subsp. timopheevii*	0	0	0	0	0	0
15131	1	PI 418585 WIR 46956	S	*T. timopheevii subsp. timopheevii*	0	0	0	0	0	0
15132	1	PI 572916 H Tri 13604/87	S	*T. timopheevii subsp. timopheevii*	0	0	0	0	0	0
15133	1	PI 572917 H Tri 13606/89	S	*T. timopheevii subsp. timopheevii*	6	2	0	0	0	0
15134	1	PI 94674 301	S	*T. turgidum subsp. Dicoccum*	8	10	0	0	2	5
15135	1	PI 94675 302	S	*T. turgidum subsp. Dicoccum*	5	10	0	0	2	2
15136	1	PI 94747 301	S	*T. turgidum subsp. Dicoccum*	8	10	2	2	2	10
15137	1	PI 113961 28170	S	*T. turgidum subsp. Dicoccum*	6	10	2	2	2	10
15138	1	PI 113963 28177	S	*T. turgidum subsp. Dicoccum*	8	10	0	0	3	20
15139	1	PI 591868 AW 6627/85	S	*T. turgidum subsp. Dicoccum*	8	10	0	0	0	0
15140	1	PI 74104 35894	S	*T. turgidum subsp. Dicoccum*	8	10	0	0	0	0
15141	1	PI 74108 35900	S	*T. turgidum subsp. Dicoccum*	6	5	0	0	0	0
15142	1	PI 254150 28170	S	*T. turgidum subsp. Dicoccum*	8	5	2	2	0	0
Moro		check		*T. aestivum*	6	2	2	5	4	30
WA7437		check		*T. aestivum*	0	0	2	5	2	10
Stephens		check		*T. aestivum*	0	0	2	5	2	20
Madsen		check		*T. aestivum*	0	0	2	5	2	20
15143	1	PI 254189 35900	S	*T. turgidum subsp. Dicoccum*	0	0	0	0	2	10
15144	1	PI 254216 28177	S	*T. turgidum subsp. Dicoccum*	6	20	0	0	2	10
15145	1	PI 326312 WIR 43843	S	*T. turgidum subsp. Dicoccum*	0	0	0	0	0	0
15146	1	PI 341801 WIR 35916	S	*T. turgidum subsp. Dicoccum*	7	5	0	0	0	0
15147	1	PI 349043 WIR 6388	S	*T. turgidum subsp. Dicoccum*	0	0	2	5	2	20
15148	1	PI 349046 WIR 43848	S	*T. turgidum subsp. Dicoccum*	8	10	0	0	2	20
15149	1	PI 57194 CItr 7141	S	*T. turgidum subsp. durum*	6	2	0	0	3	10
15150	1	PI 57195 CItr 7142	W	*T. turgidum subsp. durum*	0	0	0	0	2	5
15151	1	PI 57200 CItr 7147	W	*T. turgidum subsp. durum*	6	2	4	10	7	40
15152	1	PI 57210 CItr 7157	W	*T. turgidum subsp. durum*	7	5	2	10	2	20
15153	1	PI 61111 999	S	*T. turgidum subsp. durum*	5	5	4	10	2	20
15154	1	PI 27514 Kriek Bogda	W	*T. turgidum subsp. durum*	6	2	2	10	2	10
15155	1	PI 78809 CItr 10107	S	*T. turgidum subsp. durum*	7	10	6	70	8	9
15156	1	PI 78810 CItr 10108	W	*T. turgidum subsp . durum*	missing					
15157	1	PI 262677 SHAUPKHA	S	*T. turgidum subsp. durum*	Missing					
15158	1	PI 349042 DIKA 9/14 S	S	*T. turgidum subsp. durum*	3	2	0	0	2	20
15159	1	PI 572900 AW 6628/85	S	*T. turgidum subsp. durum*	5	5	6	20	8	70
15160	1	PI 349050 WIR 28162	W	*T. turgidum subsp. paleocolchicum*	4	2	2	10	5	40

plot #	Rep	Plant ID	Habit	*Species*	IT	%	IT	%	IT	%
15161	1	PI 418586 WIR 28162	W	*T. turgidum subsp. paleocolchicum*	4	5	3	10	3	10
15162	1	PI 41029 533	S	*T. turgidum subsp. turgidum*	1	2	2	10	2	10
15163	1	PI 349057 WIR 13448	W	*T. turgidum subsp. turgidum*	1	2	2	10	2	20
15164	1	PI 352552 T-2299	W	*T. zhukovskyi*	3	2	2	10	2	20
15166	1	PI 355707 69Z5.72	W	*T. zhukovskyi*	3	10	3	5	3	20
WA7821		check		*T. aestivum*	8	35	7	80	7	80
WA7821		check		*T. aestivum*	8	35	7	80	7	80
WA7821		check		*T. aestivum*	8	40	7	80	7	80
WA7821		check		*T. aestivum*	8	35	7	80	7	80
15201	2	CItr 14143 17425	S	*T. aestivum subsp. aestivum*	9	35	9	80	9	100
15202	2	PI 57140 CItr 7087	W	*T. aestivum subsp. aestivum*	7	15	3	10	2	10
15203	2	PI 57142 CItr 7089	S	*T. aestivum subsp. aestivum*	4	10	4	20	2	20
15204	2	PI 57143 CItr 7090	S	*T. aestivum subsp. aestivum*	4	5	5	15	2	20
15205	2	PI 57144 CItr 7091	S	*T. aestivum subsp. aestivum*	4	10	6	60	8	80
15206	2	PI 57145 CItr 7092	W	*T. aestivum subsp. aestivum*	0	0	2	10	2	20
15207	2	PI 57147 CItr 7094	S	*T. aestivum subsp. aestivum*	0	0	2	10	2	30
15208	2	PI 57148 CItr 7095	S	*T. aestivum subsp. aestivum*	2	2	2	10	2	20
15209	2	PI 57150 CItr 7097	W	*T. aestivum subsp. aestivum*	0	0	2	10	2	10
15210	2	PI 57151 CItr 7098	W	*T. aestivum subsp. aestivum*	3	2	4	20	2	20
15211	2	PI 57152 CItr 7099	W	*T. aestivum subsp. aestivum*	5	10	3	20	2	30
15212	2	PI 57153 CItr 7100	W	*T. aestivum subsp. aestivum*	7	10	9	80	9	80
15213	2	PI 57155 CItr 7102	W	*T. aestivum subsp. aestivum*	5	5	5	30	8	80
15214	2	PI 57156 CItr 7103	W	*T. aestivum subsp. aestivum*	2	2	2	10	5	40
15215	2	PI 57157 CItr 7104	W	*T. aestivum subsp. aestivum*	4	5	3	10	4	30
15216	2	PI 57158 CItr 7105	W	*T. aestivum subsp. aestivum*	3	2	3	5	3	10
15217	2	PI 57159 CItr 7106	W	*T. aestivum subsp. aestivum*	1	2	3	10	2	20
15218	2	PI 57160 CItr 7107	W	*T. aestivum subsp. aestivum*	5	5	3	10	8	80
15219	2	PI 57161 CItr 7108	S	*T. aestivum subsp. aestivum*	6	10	4	30	7	70
15220	2	PI 57162 CItr 7109	W	*T. aestivum subsp. aestivum*	Missing					
15221	2	PI 57163 CItr 7110	W	*T. aestivum subsp. aestivum*	0	0	3	10	2	10
15222	2	PI 57164 CItr 7111	W	*T. aestivum subsp. aestivum*	4	5	6	30	8	70
15223	2	PI 57165 CItr 7112	W	*T. aestivum subsp. aestivum*	5	10	7	40	7	90
15224	2	PI 57166 CItr 7113	S	*T. aestivum subsp. aestivum*	5	10	4	30	3	30
15225	2	PI 57167 CItr 7114	W	*T. aestivum subsp. aestivum*	4	10	3	10	2	10
15226	2	PI 57168 CItr 7115	W	*T. aestivum subsp. aestivum*	6	5	2	10	2	20
15227	2	PI 57171 CItr 7118	W	*T. aestivum subsp. aestivum*	4	5	2	10	2	30
15228	2	PI 57172 CItr 7119	W	*T. aestivum subsp. aestivum*	4	15	4	30	7	50
15229	2	PI 57175 CItr 7122	S	*T. aestivum subsp. aestivum*	3	10	3	20	5	60
15230	2	PI 57177 CItr 7124	W	*T. aestivum subsp. aestivum*	4	10	4	40	8	90
15231	2	PI 57178 CItr 7125	W	*T. aestivum subsp. aestivum*	5	10	4	20	3	60
15232	2	PI 57179 CItr 7126	W	*T. aestivum subsp. aestivum*	7	25	7	80	9	90
15233	2	PI 57181 CItr 7128	W	*T. aestivum subsp. aestivum*	5	10	7	60	7	80
15234	2	PI 57182 CItr 7129	S	*T. aestivum subsp. aestivum*	3	15	4	50	2	50
15235	2	PI 57183 CItr 7130	W	*T. aestivum subsp. aestivum*	0	0	2	5	2	20
15236	2	PI 57184 CItr 7131	S	*T. aestivum subsp. aestivum*	7	15	8	60	7	90
15237	2	PI 57185 CItr 7132	W	*T. aestivum subsp. aestivum*	5	10	4	60	5	80
15238	2	PI 94476 156	W	*T. aestivum subsp. aestivum*	6	20	8	80	8	90

plot #	Rep	Plant ID	Habit	*Species*	IT	%	IT	%	IT	%
15239	2	PI 94478 158	W	*T. aestivum subsp. aestivum*	Missing					
15240	2	PI 94521 201	W	*T. aestivum subsp. aestivum*	4	10	5	50	9	70
15241	2	PI 94522 202	W	*T. aestivum subsp. aestivum*	5	15	8	60	7	90
15242	2	PI 113962 28175	S	*T. aestivum subsp. aestivum*	7	40	8	90	9	100
15243	2	PI 351501 T 3184	S	*T. aestivum subsp. aestivum*	7	10	2	15	2	30
15244	2	PI 427146 ARAGVI	W	*T. aestivum subsp. aestivum*	3	5	4	30	8	90
15245	2	PI 565389 Hulugo	W	*T. aestivum subsp. aestivum*	9	30	8	90	9	100
15246	2	PI 565393 Hozo Mestnaja	W	*T. aestivum subsp. aestivum*	0	0	1	2	2	10
15247	2	PI 565421 BAGRATIONI	W	*T. aestivum subsp. aestivum*	4	10	3	40	5	60
15248	2	PI 591867 AW 6637C/86	S	*T. aestivum subsp. aestivum*	8	20	4	40	9	90
15249	2	PI 585016 AW 6626/88	S	*T. aestivum subsp. aestivum*	4	15	3	50	8	70
15250	2	PI 591869 AW 6634A/86	S	*T. aestivum subsp. aestivum*	7	15	6	70	8	90
15251	2	PI 74110 35919	S	*T. aestivum subsp. aestivum*	9	50	8	90	9	100
15252	2	PI 78814 CItr 10112	S	*T. aestivum subsp. aestivum*	5	20	4	20	8	90
15253	2	PI 254219 349	S	*T. aestivum subsp. aestivum*	5	20	8	80	9	100
15254	2	PI 262619 Upkli	W	*T. aestivum subsp. aestivum*	3	10	2	30	2	30
15255	2	PI 262628 Akhaltsikhis Tsiteli Doli	S	*T. aestivum subsp. aestivum*	9	45	9	90	9	100
15256	2	PI 262638 Lagodekhis Grdzeltavtava	S	*T. aestivum subsp. aestivum*	4	10	4	30	5	40
15257	2	PI 262639 Hulugo	W	*T. aestivum subsp. aestivum*	3	5	3	20	4	30
15258	2	PI 262640 Gomborka	S	*T. aestivum subsp. aestivum*	3	10	2	15	2	30
15259	2	PI 262678 Dika Dzhavakhetskaya	S	*T. aestivum subsp. aestivum*	0	0	2	10	2	20
15260	2	PI 499969 KU 1668	W	*T. aestivum subsp. aestivum*	Missing					
15261	2	PI 499970 KU 1720	W	*T. aestivum subsp. aestivum*	5	10	2	10	2	30
15262	2	PI 499971 KU 1806	S	*T. aestivum subsp. aestivum*	3	5	2	10	2	20
15263	2	PI 572655 H Tri 13353/83	S	*T. aestivum subsp. aestivum*	6	10	7	60	9	80
15264	2	PI 572657 A Tri 13356/83	W	*T. aestivum subsp. aestivum*	4	5	3	40	8	70
15265	2	PI 572658 A Tri 13357/84	W	*T. aestivum subsp. aestivum*	3	5	3	30	3	40
15266	2	PI 572659 H Tri 13358/83		*T. aestivum subsp. aestivum*	4	5	3	20	2	30
15267	2	PI 572660 H Tri 13359/87	S	*T. aestivum subsp. aestivum*	8	20	8	80	8	90
15268	2	PI 572661 AW 6637A/87	S	*T. aestivum subsp. aestivum*	4	15	4	50	2	40
15269	2	PI 572662 AW 6637B/88	S	*T. aestivum subsp. aestivum*	7	25	6	70	3	50
15270	2	PI 572663 HW 6638/87	W	*T. aestivum subsp. aestivum*	4	20	4	30	4	50
15271	2	PI 572664 HW 6638B/87	S	*T. aestivum subsp. aestivum*	6	30	3	30	5	70
15272	2	PI 572665 AW 6631/85	S	*T. aestivum subsp. aestivum*	5	35	4	60	2	30
WA7821	2	check		*T. aestivum*	8	60	7	80	8	90
WA7821	2	check		*T. aestivum*	8	60	7	80	8	90
WA7821	2	check		*T. aestivum*	8	60	7	80	8	90
WA7821	2	check		*T. aestivum*	8	60	7	80	8	90
15273	2	PI 572666 AW 6632/85	S	*T. aestivum subsp. aestivum*	5	40	5	80	3	90
15274	2	PI 572667 AW 6633A/85	S	*T. aestivum subsp. aestivum*	5	25	6	70	8	70
15275	2	PI 572668 AW 6633B/85	S	*T. aestivum subsp. aestivum*	7	30	6	60	8	70
15276	2	PI 572669 HW 6553/85	S	*T. aestivum subsp. aestivum*	7	20	5	70	9	90
15277	2	PI 572670 AW 6634B/86	S	*T. aestivum subsp. aestivum*	8	30	5	80	8	90
15278	2	PI 572671 AW 6635B/86	S	*T. aestivum subsp. aestivum*	6	35	7	80	8	90
15279	2	PI 572672 AW 6636A/85	S	*T. aestivum subsp. aestivum*	7	30	8	70	8	80
15280	2	PI 572673 AW 6636B/85	S	*T. aestivum subsp. aestivum*	8	40	7	80	9	90
15281	2	PI 572674 HW 6555/86	S	*T. aestivum subsp. aestivum*	5	25	5	60	7	70

plot #	Rep	Plant ID	Habit	*Species*	IT	%	IT	%	IT	%
15282	2	PI 572679 HW 7032/88	W	*T. aestivum subsp. aestivum*	3	5	2	20	4	30
15283	2	PI 572680 HW 7033/88	W	*T. aestivum subsp. aestivum*	5	10	7	70	7	80
15284	2	PI 572687 HW 7042/88	W	*T. aestivum subsp. aestivum*	5	5	5	50	7	80
15285	2	PI 572689 HW 7045/88	W	*T. aestivum subsp. aestivum*	4	5	2	20	4	50
15286	2	PI 572690 AW 7198/90	W	*T. aestivum subsp. aestivum*	4	5	2	20	4	40
15287	2	PI 572691 HW 7199/90	W	*T. aestivum subsp. aestivum*	Missing					
15288	2	PI 572693 AW 6635A/86	S	*T. aestivum subsp. aestivum*	4	15	7	80	7	80
15289	2	PI 61102 Rusak	S	*T. turgidum subsp. carthlicum*	4	10	2	20	2	30
15290	2	PI 94748 349	S	*T. turgidum subsp. carthlicum*	3	10	2	20	2	30
15291	2	PI 94749 350	S	*T. turgidum subsp. carthlicum*	5	5	3	10	2	30
15292	2	PI 94750 351	S	*T. turgidum subsp. carthlicum*	3	5	2	10	2	30
15293	2	PI 94751 352	S	*T. turgidum subsp. carthlicum*	3	5	2	10	2	20
15294	2	PI 94752 353	S	*T. turgidum subsp. carthlicum*	5	5	7	50	8	70
15295	2	PI 94753 354	S	*T. turgidum subsp. carthlicum*	0	0	2	20	2	10
15296	2	PI 94754 355	S	*T. turgidum subsp. carthlicum*	3	5	2	15	2	20
15297	2	PI 94755 356	S	*T. turgidum subsp. carthlicum*	3	5	3	10	2	20
15298	2	PI 115816 7106	S	*T. turgidum subsp. carthlicum*	2	2	2	10	2	20
15299	2	PI 115817 11891	S	*T. turgidum subsp. carthlicum*	3	2	2	10	2	10
15300	2	PI 352278 T-1300	S	*T. turgidum subsp. carthlicum*	3	2	2	10	2	20
15301	2	PI 352282 T-2117	S	*T. turgidum subsp. carthlicum*	3	2	2	10	2	20
15302	2	PI 585017 AW 6629/85	S	*T. turgidum subsp. carthlicum*	3	5	2	5	2	20
15303	2	PI 585018 AW 6630/85	S	*T. turgidum subsp. carthlicum*	3	2	2	10	2	20
15304	2	PI 78812 CItr 10110	S	*T. turgidum subsp. carthlicum*	3	2	3	5	2	10
15305	2	PI 251914 WIR 25170	S	*T. turgidum subsp. carthlicum*	3	2	2	10	2	5
15306	2	PI 499972 KU 1800	S	*T. turgidum subsp. carthlicum*	0	0	1	5	2	10
15307	2	PI 611470 H Tri 13601/87	W	*T. aestivum subsp. macha*	3	2	2	5	3	10
Moro	2	check		*T. aestivum*	3	2	2	10	4	30
WA7437	2	check		*T. aestivum*	0	0	2	10	3	10
Stephens	2	check		*T. aestivum*	0	0	2	20	2	20
Madsen	2	check		*T. aestivum*	0	0	3	15	2	20
15308	2	PI 572905 WIR 29576	W	*T. aestivum subsp. macha*	3	5	3	5	4	20
15309	2	PI 572906 WIR 28168	W	*T. aestivum subsp. macha*	4	5	3	2	2	10
15310	2	PI 572907 WIR 28214	W	*T. aestivum subsp. macha*	5	10	3	10	4	20
15311	2	PI 572908 H Tri 13595/89	W	*T. aestivum subsp. macha*	5	10	3	5	5	20
15312	2	PI 572909 H Tri 13602/83	W	*T. aestivum subsp. macha*	8	15	3	10	5	20
15313	2	PI 572910 H Tri 13603/89	W	*T. aestivum subsp. macha*	4	10	3	10	2	30
15314	2	PI 572911 H Tri 13613/87	W	*T. aestivum subsp. macha*	4	5	3	10	2	30
15315	2	PI 572912 H Tri 13615/87	W	*T. aestivum subsp. macha*	4	5	3	5	5	20
15316	2	PI 572913 H Tri 13614/89	W	*T. aestivum subsp. macha*	4	5	2	5	3	20
15319	2	PI 94760 303	S	*T. timopheevii subsp. timopheevii*	0	0	2	5	0	0
15320	2	PI 94761 357	S	*T. timopheevii subsp. timopheevii*	0	0	3	5	0	0
15321	2	PI 352506 Typicum	W	*T. timopheevii subsp. timopheevii*	0	0	0	0	0	0
15322	2	PI 352508 Typicum	S	*T. timopheevii subsp. timopheevii*	0	0	0	0	0	0
15323	2	PI 352510 Viticulosum	S	*T. timopheevii subsp. timopheevii*	3	2	5	10	5	30
15324	2	PI 542472 M82-6267	W	*T. timopheevii subsp. timopheevii*	Missing					
15325	2	PI 326318 WIR 29538	S	*T. timopheevii subsp. timopheevii*	0	0	0	0	2	10
15326	2	PI 341802 WIR 29548	S	*T. timopheevii subsp. timopheevii*	0	0	0	0	0	0

plot #	Rep	Plant ID	Habit	*Species*	IT	%	IT	%	IT	%
15327	2	PI 343447 WIR 29566	S	*T. timopheevii subsp. timopheevii*	6	25	4	5	0	0
15328	2	PI 349053 WIR 29548	S	*T. timopheevii subsp. timopheevii*	Missing					
15329	2	PI 349054 WIR 46587	S	*T. timopheevii subsp. timopheevii*	3	5	3	5	5	5
15330	2	PI 418584 WIR 38555	S	*T. timopheevii subsp. timopheevii*	3	2	3	5	0	0
15331	2	PI 418585 WIR 46956	S	*T. timopheevii subsp. timopheevii*	5	2	3	5	0	0
15332	2	PI 572916 H Tri 13604/87	S	*T. timopheevii subsp. timopheevii*	3	2	3	5	0,8	5
15333	2	PI 572917 H Tri 13606/89	S	*T. timopheevii subsp. timopheevii*	3	2	3	5	0	0
15334	2	PI 94674 301	S	*T. turgidum subsp. Dicoccum*	8	5	0	0	2	10
15335	2	PI 94675 302	S	*T. turgidum subsp. Dicoccum*	8	5	0	0	2	10
15336	2	PI 94747 301	S	*T. turgidum subsp. Dicoccum*	8	10	0	0	0	0
15337	2	PI 113961 28170	S	*T. turgidum subsp. Dicoccum*	8	10	2	5	2	10
15338	2	PI 113963 28177	S	*T. turgidum subsp. Dicoccum*	4	2	4	5	2	30
15339	2	PI 591868 AW 6627/85	S	*T. turgidum subsp. Dicoccum*	8	10	2	5	2	10
15340	2	PI 74104 35894	S	*T. turgidum subsp. Dicoccum*	8	10	2	5	2	10
15341	2	PI 74108 35900	S	*T. turgidum subsp. Dicoccum*	8	10	0	0	2	20
15342	2	PI 254150 28170	S	*T. turgidum subsp. Dicoccum*	2	5	2	10	2	20
WA7821	2	check			7	45	7	80	7	80
WA7821	2	check			7	45	7	80	7	80
WA7821	2	check			7	45	7	80	7	80
WA7821	2	check			7	45	7	80	7	80
15343	2	PI 254189 35900	S	*T. turgidum subsp. Dicoccum*	2	2	3	10	3	20
15344	2	PI 254216 28177	S	*T. turgidum subsp. Dicoccum*	4	5	3	15	3	20
15345	2	PI 326312 WIR 43843	S	*T. turgidum subsp. Dicoccum*	Missing					
15346	2	PI 341801 WIR 35916	S	*T. turgidum subsp. Dicoccum*	Missing					
15347	2	PI 349043 WIR 6388	S	*T. turgidum subsp. Dicoccum*	0	0	2	5	2	5
15348	2	PI 349046 WIR 43848	S	*T. turgidum subsp. Dicoccum*	8	10	2	5	2	10
15349	2	PI 57194 CItr 7141	S	*T. turgidum subsp. durum*	3	5	2	5	2	20
15350	2	PI 57195 CItr 7142	W	*T. turgidum subsp. durum*	0	0	0	0	2	5
15351	2	PI 57200 CItr 7147	W	*T. turgidum subsp. durum*	6	15	2	5	2	30
15352	2	PI 57210 CItr 7157	W	*T. turgidum subsp. durum*	1	5	2	10	2	30
15353	2	PI 61111 999	S	*T. turgidum subsp. durum*	6	20	3	5	3	20
15354	2	PI 27514 Kriek Bogda	W	*T. turgidum subsp. durum*	Missing					
15355	2	PI 78809 CItr 10107	S	*T. turgidum subsp. durum*	7	30	7	80	8	90
15356	2	PI 78810 CItr 10108	W	*T. turgidum subsp. durum*	4	15	2	20	2	30
15357	2	PI 262677 SHAUPKHA	S	*T. turgidum subsp. durum*	Missing					
15358	2	PI 349042 DIKA 9/14 S	S	*T. turgidum subsp. durum*	1	2	2	5	2	20
15359	2	PI 572900 AW 6628/85	S	*T. turgidum subsp. durum*	4	2	3	5	3	20
15360	2	PI 349050 WIR 28162	W	*T. turgidum subsp. paleocolchicum*	2	2	3	5	3	20
15361	2	PI 418586 WIR 28162	W	*T. turgidum subsp. paleocolchicum*	5	5	2	10	2	10
15362	2	PI 41029 533	S	*T. turgidum subsp. Turgidum*	0	0	2	5	2	20
15363	2	PI 349057 WIR 13448	W	*T. turgidum subsp. turgidum*	1	2	2	10	2	20
15364	2	PI 352552 T-2299	W	*T. zhukovskyi*	5	2	3	20	6	50
15366	2	PI 355707 69Z5.72	W	*T. zhukovskyi*	3	2	2	20	4	10

* S=spring, W=winter

APPENDIX B-2

Stripe rust infection types (IT) and severity (%), plant height (cm) and heading dates of winter and spring wheat landraces and relatives from Georgia recorded at Central Ferry, WA in 2005 growing season

Plot #	Rep	Plant ID	Habit*	Species	Plant Height	Heading	Rust 17/05/05		Rust 23/05/05		Rust 30/05/05	
					PH	HEAD	IT	%	IT	%	IT	%
Moro		check		*T. aestivum*	92	18-May	1	2	4	20	4	30
WA7437		check		*T. aestivum*	78	24-May	1	2	1	2	1	2
Stephens		check		*T. aestivum*	90	20-May	1	2	1	10	2	20
Madsen		check		*T. aestivum*	91	23-May	1	2	1	5	1	10
15001	1	CItr 14143 17425	S	*T. aestivum subsp. aestivum*	100	13-May	8	60	9	80	9	90
15002	1	PI 57140 CItr 7087	W	*T. aestivum subsp. aestivum*	126	21-May	0	0	4	10	4	30
15003	1	PI 57142 CItr 7089	S	*T. aestivum subsp. aestivum*	122	18-May	0	0	2	10	2	30
15004	1	PI 57143 CItr 7090	S	*T. aestivum subsp. aestivum*	111	19-May	0	0	1	10	2	20
15005	1	PI 57144 CItr 7091	S	*T. aestivum subsp. aestivum*	104	27-May	5	50	9	70	9	90
15006	1	PI 57145 CItr 7092	W	*T. aestivum subsp. aestivum*	120	17-May	0	0	1	5	2	15
15007	1	PI 57147 CItr 7094	S	*T. aestivum subsp. aestivum*	118	17-May	0	0	1	5	2	30
15008	1	PI 57148 CItr 7095	S	*T. aestivum subsp. aestivum*	120	16-May	0	0	1	5	2	25
15009	1	PI 57150 CItr 7097	W	*T. aestivum subsp. aestivum*	133	15-May	0	0	2	10	2	30
15010	1	PI 57151 CItr 7098	W	*T. aestivum subsp. aestivum*	129	27-May	0	0	4	20	4	40
15011	1	PI 57152 CItr 7099	W	*T. aestivum subsp. aestivum*	100	30-May	0	0	8	30	8	70
15012	1	PI 57153 CItr 7100	W	*T. aestivum subsp. aestivum*	118	24-May	7	40	9	70	9	90
15013	1	PI 57155 CItr 7102	W	*T. aestivum subsp. aestivum*	95	21-May	0	0	7	60	7	80
15014	1	PI 57156 CItr 7103	W	*T. aestivum subsp. aestivum*	141	21-May	0	0	6	70	6	80
15015	1	PI 57157 CItr 7104	W	*T. aestivum subsp. aestivum*	158	17-May	0	0	5	70	4	70
15016	1	PI 57158 CItr 7105	W	*T. aestivum subsp. aestivum*	154	17-May	0	0	4	20	4	30
15017	1	PI 57159 CItr 7106	W	*T. aestivum subsp. aestivum*	140	13-May	0	0	2	10	2	10
15018	1	PI 57160 CItr 7107	W	*T. aestivum subsp. aestivum*	138	24-May	0	0	8	70	8	70
15019	1	PI 57161 CItr 7108	S	*T. aestivum subsp. aestivum*	110	30-May	5	30	9	80	9	90
15020	1	PI 57162 CItr 7109	W	*T. aestivum subsp. aestivum*	147	29-May	5	20	5	50	5	50
					PH	HEAD	IT	%	IT	%	IT	%
15021	1	PI 57163 CItr 7110	W	*T. aestivum subsp. aestivum*	148	23-May	0		4	40	6	60
15022	1	PI 57164 CItr 7111	W	*T. aestivum subsp. aestivum*	120	24-May	3	40	7	60	7	70
15023	1	PI 57165 CItr 7112	W	*T. aestivum subsp. aestivum*	150	25-May	2	30	9	50	9	80
15024	1	PI 57166 CItr 7113	S	*T. aestivum subsp. aestivum*	122	29-May	3	20	8	50	9	80
15025	1	PI 57167 CItr 7114	W	*T. aestivum subsp. aestivum*	152	22-May	0	0	4	30	4	50
15026	1	PI 57168 CItr 7115	W	*T. aestivum subsp. aestivum*	154	23-May	0	0	4	30	4	50

15027	1	PI 57171 CItr 7118	W	*T. aestivum subsp. aestivum*	150	23-May	0	0	3	15	3	30
15028	1	PI 57172 CItr 7119	W	*T. aestivum subsp. aestivum*	152	24-May	0	0	3	20	4	50
15029	1	PI 57175 CItr 7122	S	*T. aestivum subsp. aestivum*	131	28-May	0	0	6	40	6	70
15030	1	PI 57177 CItr 7124	W	*T. aestivum subsp. aestivum*	110	24-May	3	40	8	60	8	80
15031	1	PI 57178 CItr 7125	W	*T. aestivum subsp. aestivum*	120	27-May	2	20	5	50	5	70
15032	1	PI 57179 CItr 7126	W	*T. aestivum subsp. aestivum*	115	22-May	4	30	9	80	9	10
15033	1	PI 57181 CItr 7128	W	*T. aestivum subsp. aestivum*	107	22-May	2	5	4	30	4	50
15034	1	PI 57182 CItr 7129	S	*T. aestivum subsp. aestivum*	125	24-May	0	0	4	30	4	50
15035	1	PI 57183 CItr 7130	W	*T. aestivum subsp. aestivum*	147	25-May	0	0	1	5	2	20
15036	1	PI 57184 CItr 7131	S	*T. aestivum subsp. aestivum*	143	27-May	5	20	8	50	8	70
WA7821		check		*T. aestivum*	100	26-May	8	30	8	80	8	90
WA7821		check		*T. aestivum*	100	26-May	8	20	8	80	8	90
WA7821		check		*T. aestivum*	100	26-May	8	30	8	80	8	90
WA7821		check		*T. aestivum*	100	26-May	8	30	8	80	8	90
15037	1	PI 57185 CItr 7132	W	*T. aestivum subsp. aestivum*	113	13-May	4	20	6	70	6	70
15038	1	PI 94476 156	W	*T. aestivum subsp. aestivum*	122	28-May	3	10	9	70	9	90
15039	1	PI 94478 158	W	*T. aestivum subsp. aestivum*	129	26-May	6	5	9	80	9	90
15040	1	PI 94521 201	W	*T. aestivum subsp. aestivum*	132	18-May	5	5	7	60	7	70
15041	1	PI 94522 202	W	*T. aestivum subsp. aestivum*	126	10-May	8	10	9	80	9	90
15042	1	PI 113962 28175	S	*T. aestivum subsp. aestivum*	115	18-May	7	30	7	80	7	80
15043	1	PI 351501 T 3184	S	*T. aestivum subsp. aestivum*	129	25-May	0	0	2	10	2	50
15044	1	PI 427146 ARAGVI	W	*T. aestivum subsp. aestivum*	104	22-May	5	15	5	40	5	70
15045	1	PI 565389 Hulugo	W	*T. aestivum subsp. aestivum*	114	23-May	9	40	9	90	9	100
15046	1	PI 565393 Hozo Mestnaja	W	*T. aestivum subsp. aestivum*	123	25-May	0	0	1	2	1	5
15047	1	PI 565421 BAGRATIONI	W	*T. aestivum subsp. aestivum*	106	12-May	4	15	3	5	3	20
15048	1	PI 591867 AW 6637C/86	S	*T. aestivum subsp. aestivum*	113	30-May	6	20	8	60	8	90
15049	1	PI 585016 AW 6626/88	S	*T. aestivum subsp. aestivum*	130	24-May	2	5	4	40	4	60
15050	1	PI 591869 AW 6634A/86	S	*T. aestivum subsp. aestivum*	123	?	5	10	6	50	6	80
15051	1	PI 74110 35919	S	*T. aestivum subsp. aestivum*	102	10-May	8	30	9	80	9	100
15052	1	PI 78814 CItr 10112	S	*T. aestivum subsp. aestivum*	145	14-May	8	10	9	80	9	100
15053	1	PI 254219 349	S	*T. aestivum subsp. aestivum*	92	30-May	9	60	9	80	9	90
15054	1	PI 262619 Upkli	W	*T. aestivum subsp. aestivum*	134	17-May	0	0	2	10	2	30
15055	1	PI 262628 Akhaltsikhis Tsiteli Doli	S	*T. aestivum subsp. aestivum*	129	27-May	9	70	9	90	9	100
15056	1	PI 262638 Lagodekhis Grdzeltavtava	S	*T. aestivum subsp. aestivum*	139	26-May	5	20	8	70	8	90
15057	1	PI 262639 Hulugo	W	*T. aestivum subsp. aestivum*	131	?	0	0	4	40	4	60
15058	1	PI 262640 Gomborka	S	*T. aestivum subsp. aestivum*	137	26-May	0	0	4	30	4	60
					PH	HEAD	IT	%	IT	%	IT	%
15059	1	PI 262678 Dika Dzhavakhetskaya	S	*T. aestivum subsp. aestivum*	122	26-May	0	0	2	15	2	20
15060	1	PI 499969 KU 1668	W	*T. aestivum subsp. aestivum*	121	23-May	4	10	9	60	9	90
15061	1	PI 499970 KU 1720	W	*T. aestivum subsp. aestivum*	104	21-May	5	25	5	20	4	40
15062	1	PI 499971 KU 1806	S	*T. aestivum subsp. aestivum*	129	21-May	0	0	2	10	2	20
15063	1	PI 572655 H Tri 13353/83	S	*T. aestivum subsp. aestivum*	128	21-May	4	20	7	60	7	90
15064	1	PI 572657 A Tri 13356/83	W	*T. aestivum subsp. aestivum*	113	28-May	4	20	8	60	8	70

15065	1	PI 572658 A Tri 13357/84	W	*T. aestivum subsp. aestivum*	127	24-May	8	10	8	70	8	90
15066	1	PI 572659 H Tri 13358/83		*T. aestivum subsp. aestivum*	92	18-May	4	5	5	50	4	50
15067	1	PI 572660 H Tri 13359/87	S	*T. aestivum subsp. aestivum*	110	29-May	7	20	9	70	7	90
15068	1	PI 572661 AW 6637A/87	S	*T. aestivum subsp. aestivum*	136	30-May	5	5	9	70	9	80
15069	1	PI 572662 AW 6637B/88	S	*T. aestivum subsp. aestivum*	140	28-May	5	5	9	80	9	90
15070	1	PI 572663 HW 6638/87	W	*T. aestivum subsp. aestivum*	141	28-May	0	0	5	40	5	70
15071	1	PI 572664 HW 6638B/87	S	*T. aestivum subsp. aestivum*	134	27-May	0	0	5	30	5	50
15072	1	PI 572665 AW 6631/85	S	*T. aestivum subsp. aestivum*	124	12-May	5	25	8	60	8	80
Eltan		check		*T. aestivum*	96	28-May	0	0	4	20	4	30
Su/O		check		*T. aestivum*	95	25-May	8	30	8	70	8	80
Coda		check		*T. aestivum*	100	26-May	0	0	1	5	2	10
Lambert		check		*T. aestivum*	103	23-May	0	0	1	5	2	20
15073	1	PI 572666 AW 6632/85	S	*T. aestivum subsp. aestivum*	124	10-May	8	30	8	60	8	80
15074	1	PI 572667 AW 6633A/85	S	*T. aestivum subsp. aestivum*	130	10-May	4	5	8	60	8	80
15075	1	PI 572668 AW 6633B/85	S	*T. aestivum subsp. aestivum*	146	30-May	8	15	8	70	8	90
15076	1	PI 572669 HW 6553/85	S	*T. aestivum subsp. aestivum*	110	11-May	9	50	9	80	9	100
15077	1	PI 572670 AW 6634B/86	S	*T. aestivum subsp. aestivum*	90	10-May	9	60	9	80	9	100
15078	1	PI 572671 AW 6635B/86	S	*T. aestivum subsp. aestivum*	95	10-May	7	40	9	80	9	100
15079	1	PI 572672 AW 6636A/85	S	*T. aestivum subsp. aestivum*	133	26-May	8	40	9	70	9	90
15080	1	PI 572673 AW 6636B/85	S	*T. aestivum subsp. aestivum*	96	28-May	6	20	8	60	8	90
15081	1	PI 572674 HW 6555/86	S	*T. aestivum subsp. aestivum*	121	29-May	5	10	8	75	8	90
15082	1	PI 572679 HW 7032/88	W	*T. aestivum subsp. aestivum*	95	17-May	4	5	4	15	4	25
15083	1	PI 572680 HW 7033/88	W	*T. aestivum subsp. aestivum*	116	18-May	4	10	4	25	4	40
15084	1	PI 572687 HW 7042/88	W	*T. aestivum subsp. aestivum*	94	17-May	3	10	4	20	4	50
15085	1	PI 572689 HW 7045/88	W	*T. aestivum subsp. aestivum*	126	17-May	3	5	4	15	4	30
15086	1	PI 572690 AW 7198/90	W	*T. aestivum subsp. aestivum*	107	17-May	4	5	4	20	4	40
15087	1	PI 572691 HW 7199/90	W	*T. aestivum subsp. aestivum*	Missing							
15088	1	PI 572693 AW 6635A/86	S	*T. aestivum subsp. aestivum*	129	25-May	7	15	9	60	9	90
15089	1	PI 61102 Rusak	S	*T. turgidum subsp. carthlicum*	118	?	2	10	2	20	2	40
15090	1	PI 94748 349	S	*T. turgidum subsp. carthlicum*	129	?	1	10	1	10	2	25
15091	1	PI 94749 350	S	*T. turgidum subsp. carthlicum*	117	24-May	1	10	1	10	2	30
15092	1	PI 94750 351	S	*T. turgidum subsp. carthlicum*	126	?	0	0	1	15	2	25
15093	1	PI 94751 352	S	*T. turgidum subsp. carthlicum*	113	25-May	1	10	1	15	2	30
15094	1	PI 94752 353	S	*T. turgidum subsp. carthlicum*	124	?	5	50	8	70	8	80
15095	1	PI 94753 354	S	*T. turgidum subsp. carthlicum*	106	30-May	0	0	1	5	2	20
15096	1	PI 94754 355	S	*T. turgidum subsp. carthlicum*	73	3-Jun	0	0	1	10	2	30
15097	1	PI 94755 356	S	*T. turgidum subsp. carthlicum*	127	25-May	0	0	1	15	2	30
15098	1	PI 115816 7106	S	*T. turgidum subsp. carthlicum*	120	2-Jun	0	0	1	5	2	10
15099	1	PI 115817 11891	S	*T. turgidum subsp. carthlicum*	107	23-May	0	0	1	5	2	30
15100	1	PI 352278 T-1300	S	*T. turgidum subsp. carthlicum*	118	3-Jun	0	0	1	10	2	20
15101	1	PI 352282 T-2117	S	*T. turgidum subsp. carthlicum*	111	4-Jun	0	0	1	5	2	30
15102	1	PI 585017 AW 6629/85	S	*T. turgidum subsp. carthlicum*	111	29-May	0	0	1	5	2	30
15103	1	PI 585018 AW 6630/85	S	*T. turgidum subsp. carthlicum*	121	23-May	1	5	1	5	2	10

15104	1	PI 78812 CItr 10110	S	*T. turgidum subsp. carthlicum*	120	28-May	0	0	1	5	2	15
15105	1	PI 251914 WIR 25170	S	*T. turgidum subsp. carthlicum*	119	29-May	0	0	1	5	2	15
15106	1	PI 499972 KU 1800	S	*T. turgidum subsp. carthlicum*	128	24-May	0	0	1	10	2	20
15107	1	PI 611470 H Tri 13601/87	W	*T. aestivum subsp. macha*	138	25-May	0	0	3	10	4	20
WA7821		check		*T. aestivum*	92	25-May	9	60	8	80	8	90
WA7821		check		*T. aestivum*	92	25-May	9	60	8	80	8	90
WA7821		check		*T. aestivum*	92	25-May	9	60	8	80	8	90
WA7821		check		*T. aestivum*	92	25-May	9	60	8	80	8	90
15108	1	PI 572905 WIR 29576	W	*T. aestivum subsp. macha*	123	3-Jun	7	20	6	75	6	80
15109	1	PI 572906 WIR 28168	W	*T. aestivum subsp. macha*	116	4-Jun	4	10	6	50	6	70
15110	1	PI 572907 WIR 28214	W	*T. aestivum subsp. macha*	127	1-Jun	4	15	6	50	6	60
15111	1	PI 572908 H Tri 13595/89	W	*T. aestivum subsp. macha*	129	30-May	5	5	6	20	6	50
15112	1	PI 572909 H Tri 13602/83	W	*T. aestivum subsp. macha*	127	30-May	3	5	7	50	5	60
15113	1	PI 572910 H Tri 13603/89	W	*T. aestivum subsp. macha*	131	29-May	0	0	2	10	2	40
15114	1	PI 572911 H Tri 13613/87	W	*T. aestivum subsp. macha*	135	28-May	0	0	1	10	2	30
15115	1	PI 572912 H Tri 13615/87	W	*T. aestivum subsp. macha*	122	30-May	0	0	3	30	3	50
15116	1	PI 572913 H Tri 13614/89	W	*T. aestivum subsp. macha*	122	?	4	15	4	30	4	40
15119	1	PI 94760 303	S	*T. timopheevii subsp. timopheevii*	missing							
15120	1	PI 94761 357	S	*T. timopheevii subsp. timopheevii*	86	5-Jun	0	0	0	0	2	20
15121	1	PI 352506 Typicum	W	*T. timopheevii subsp. timopheevii*	120	5-Jun	0	0	0	0	2	20
15122	1	PI 352508 Typicum	S	*T. timopheevii subsp. timopheevii*	139	5-Jun	1	2	1	5	2	40
15123	1	PI 352510 Viticulosum	S	*T. timopheevii subsp. timopheevii*	missing							
15124	1	PI 542472 M82-6267	W	*T. timopheevii subsp. timopheevii*	missing							
15125	1	PI 326318 WIR 29538	S	*T. timopheevii subsp. timopheevii*	121	4-Jun	1	2	1	5	2	20
15126	1	PI 341802 WIR 29548	S	*T. timopheevii subsp. timopheevii*	missing					0		
15127	1	PI 343447 WIR 29566	S	*T. timopheevii subsp. timopheevii*	97	3-Jun	0	0	0	0	2	5
15128	1	PI 349053 WIR 29548	S	*T. timopheevii subsp. timopheevii*	missing							
15129	1	PI 349054 WIR 46587	S	*T. timopheevii subsp. timopheevii*	113	3-Jun	0	0	0	0	2	5
15130	1	PI 418584 WIR 38555	S	*T. timopheevii subsp. timopheevii*	93	3-Jun	0	0	0	0	2	5
15131	1	PI 418585 WIR 46956	S	*T. timopheevii subsp. timopheevii*	missing							
15132	1	PI 572916 H Tri 13604/87	S	*T. timopheevii subsp. timopheevii*	missing							
15133	1	PI 572917 H Tri 13606/89	S	*T. timopheevii subsp. timopheevii*	124	4-Jun	0	0	0	0	2	10
15134	1	PI 94674 301	S	*T. turgidum subsp. Dicoccum*	126	30-May	8	10	1	2	2	5
15135	1	PI 94675 302	S	*T. turgidum subsp. Dicoccum*	131	30-May	5	2	1	2	2	5
15136	1	PI 94747 301	S	*T. turgidum subsp. Dicoccum*	missing							
15137	1	PI 113961 28170	S	*T. turgidum subsp. Dicoccum*	121	28-May	8	10	1	2	2	10
					PH	HEAD	IT	%	IT	%	IT	%
15138	1	PI 113963 28177	S	*T. turgidum subsp. Dicoccum*	121	29-May	2	5	2	10	2	10
15139	1	PI 591868 AW 6627/85	S	*T. turgidum subsp. Dicoccum*	102	30-May	6	5	1	2	2	5
15140	1	PI 74104 35894	S	*T. turgidum subsp. Dicoccum*	missing							
15141	1	PI 74108 35900	S	*T. turgidum subsp. Dicoccum*	117	30-May	7	5	1	2	2	10
15142	1	PI 254150 28170	S	*T. turgidum subsp. Dicoccum*	125	25-May	5	5	1	2	2	15
Moro		check		*T. aestivum*	87	28-May	0	0	3	5	3	10

WA7437		check		*T. aestivum*	89	29-May	0	0	1	2	2	10
Stephens		check		*T. aestivum*	94	24-May	1	2	1	2	2	15
Madsen		check		*T. aestivum*	94	24-May	1	2	1	2	2	5
15143	1	PI 254189 35900	S	*T. turgidum subsp. Dicoccum*	missing							
15144	1	PI 254216 28177	S	*T. turgidum subsp. Dicoccum*	99		0	0	1	2	2	10
15145	1	PI 326312 WIR 43843	S	*T. turgidum subsp. Dicoccum*	missing							
15146	1	PI 341801 WIR 35916	S	*T. turgidum subsp. Dicoccum*	missing							
15147	1	PI 349043 WIR 6388	S	*T. turgidum subsp. Dicoccum*	110	30-May	8	10	1	5	2	5
15148	1	PI 349046 WIR 43848	S	*T. turgidum subsp. Dicoccum*	118	30-May	8	10	1	5	2	5
15149	1	PI 57194 CItr 7141	S	*T. turgidum subsp. durum*	131	24-May	0	0	1	2	2	5
15150	1	PI 57195 CItr 7142	W	*T. turgidum subsp. durum*	161	23-May	1	2	1	2	2	5
15151	1	PI 57200 CItr 7147	W	*T. turgidum subsp. durum*	130	24-May	0	0	1	2	2	15
15152	1	PI 57210 CItr 7157	W	*T. turgidum subsp. durum*	128	23-May	1	2	1	2	2	15
15153	1	PI 61111 999	S	*T. turgidum subsp. durum*	135	23-May	1	2	1	2	2	15
15154	1	PI 27514 Kriek Bogda	W	*T. turgidum subsp. durum*	147	24-May	1	2	1	2	2	15
15155	1	PI 78809 CItr 10107	S	*T. turgidum subsp. durum*	121	25-May	3	5	8	60	8	90
15156	1	PI 78810 CItr 10108	W	*T. turgidum subsp. durum*	140	23-May	1	2	1	2	2	15
15157	1	PI 262677 SHAUPKHA	S	*T. turgidum subsp. durum*	145	23-May	1	2	1	2	2	5
15158	1	PI 349042 DIKA 9/14 S	S	*T. turgidum subsp. durum*	129	23-May	1	2	1	2	2	5
15159	1	PI 572900 AW 6628/85	S	*T. turgidum subsp. durum*	128	21-May	3	15	5	70	5	90
15160	1	PI 349050 WIR 28162	W	*T. turgidum subsp. paleocolchicum*	109	2-Jun	0	0	2	20	2	30
15161	1	PI 418586 WIR 28162	W	*T. turgidum subsp. paleocolchicum*	Missing							
15162	1	PI 41029 533	S	*T. turgidum subsp. turgidum*	162	24-May	1	1	2	5	3	5
15163	1	PI 349057 WIR 13448	W	*T. turgidum subsp. turgidum*	177	24-May	1	1	2	40	3	40
15164	1	PI 352552 T-2299	W	*T. zhukovskyi*	Missing							
WA7821		check		*T. aestivum*	84	25-May	8	60	8	80	8	90
WA7821		check		*T. aestivum*	85	25-May	8	60	8	80	8	90
WA7821		check		*T. aestivum*	85	25-May	8	60	8	80	8	90
WA7821		check		*T. aestivum*	102	25-May	8	60	8	80	8	90
15201	2	CItr 14143 17425	S	*T. aestivum subsp. aestivum*	97	15-May	9	60	9	90	9	100
15202	2	PI 57140 CItr 7087	W	*T. aestivum subsp. aestivum*	152	26-May	0	0	2	5	2	20
15203	2	PI 57142 CItr 7089	S	*T. aestivum subsp. aestivum*	135	22-May	0	0	2	5	2	20
15204	2	PI 57143 CItr 7090	S	*T. aestivum subsp. aestivum*	121	22-May	0	0	2	5	2	20
15205	2	PI 57144 CItr 7091	S	*T. aestivum subsp. aestivum*	100	22-May	9	9	9	75	9	100
15206	2	PI 57145 CItr 7092	W	*T. aestivum subsp. aestivum*	151	25-May	0	0	1	2	2	10
15207	2	PI 57147 CItr 7094	S	*T. aestivum subsp. aestivum*	121	23-May	0	0	1	2	2	10
					PH	HEAD	IT	%	IT	%	IT	%
15208	2	PI 57148 CItr 7095	S	*T. aestivum subsp. aestivum*	117	22-May	0	0	1	2	2	10
15209	2	PI 57150 CItr 7097	W	*T. aestivum subsp. aestivum*	135	16-May	2	5	2	5	2	20
15210	2	PI 57151 CItr 7098	W	*T. aestivum subsp. aestivum*	131	17-May	0	0	3	5	3	30
15211	2	PI 57152 CItr 7099	W	*T. aestivum subsp. aestivum*	115	30-May	4	10	5	25	5	60
15212	2	PI 57153 CItr 7100	W	*T. aestivum subsp. aestivum*	115	30-May	7	25	9	70	9	90
15213	2	PI 57155 CItr 7102	W	*T. aestivum subsp. aestivum*	105	28-May	5	10	5	20	7	80

15214	2	PI 57156 CItr 7103	W	*T. aestivum subsp. aestivum*	156	23-May	5	15	5	30	5	60
15215	2	PI 57157 CItr 7104	W	*T. aestivum su bsp. aestivum*	156	22-May	2	5	2	5	2	20
15216	2	PI 57158 CItr 7105	W	*T. aestivum subsp. aestivum*	149	15-May	0	0	1	10	2	20
15217	2	PI 57159 CItr 7106	W	*T. aestivum subsp. aestivum*	142	17-May	0	0	1	5	2	20
15218	2	PI 57160 CItr 7107	W	*T. aestivum subsp . aestivum*	135	28-May	7	20	8	70	9	90
15219	2	PI 57161 CItr 7108	S	*T. aestivum subsp. aestivum*	137	27-May	8	25	8	75	8	90
15220	2	PI 57162 CItr 7109	W	*T. aestivum subsp. aestivum*	Missing							
15221	2	PI 57163 CItr 7110	W	*T. aestivum subsp. aestivum*	144	23-May	4	10	4	10	4	30
15222	2	PI 57164 CItr 7111	W	*T. aestivum subsp. aestivum*	147	25-May	6	5	8	60	8	90
15223	2	PI 57165 CItr 7112	W	*T. aestivum subsp. aestivum*	146	25-May	7	30	9	75	9	90
15224	2	PI 57166 CItr 7113	S	*T. aestivum subsp. aestivum*	132	28-May	5	5	5	25	6	60
15225	2	PI 57167 CItr 7114	W	*T. aestivum subsp. aestivum*	146	22-May	3	5	3	15	3	25
15226	2	PI 57168 CItr 7115	W	*T. aestivum subsp. aestivum*	155	23-May	0	0	3	10	3	30
15227	2	PI 57171 CItr 7118	W	*T. aestivum subsp. aestivum*	150	24-May	0	0	3	10	3	40
15228	2	PI 57172 CItr 7119	W	*T. aestivum subsp. aestivum*	132	26-May	0	0	3	20	4	50
15229	2	PI 57175 CItr 7122	S	*T. aestivum subsp. aestivum*	134	26-May	0	0	4	20	4	50
15230	2	PI 57177 CItr 7124	W	*T. aestivum subsp. aestivum*	125	23-May	4	5	8	65	8	90
15231	2	PI 57178 CItr 7125	W	*T. aestivum subsp. aestivum*	130	27-May	0	0	4	25	5	40
15232	2	PI 57179 CItr 7126	W	*T. aestivum subsp. aestivum*	129	24-May	7	30	9	75	9	90
15233	2	PI 57181 CItr 7128	W	*T. aestivum subsp. aestivum*	122	25-May	6	15	6	60	6	70
15234	2	PI 57182 CItr 7129	S	*T. aestivum subsp. aestivum*	152	24-May	1	10	4	25	5	70
Eltan		check		*T. aestivum*	105	?	3	5	3	15	3	30
Su/O		check		*T. aestivum*	90	25-May	8	50	8	80	8	95
Coda		check		*T. aestivum*	90	25-May	0	0	2	10	3	20
Lambert		check		*T. aestivum*	105	23-May	0	0	3	10	3	30
15235	2	PI 57183 CItr 7130	W	*T. aestivum subsp. aestivum*	159	28-May	0	0	3	5	3	20
15236	2	PI 57184 CItr 7131	S	*T. aestivum subsp. aestivum*	135	30-May	9	25	9	60	9	80
15237	2	PI 57185 CItr 7132	W	*T. aestivum subsp. aestivum*	135	12-May	4	20	4	60	4	80
15238	2	PI 94476 156	W	*T. aestivum subsp. aestivum*	115	30-May	7	15	9	75	9	90
15239	2	PI 94478 158	W	*T. aestivum subsp. aestivum*	Missing							
15240	2	PI 94521 201	W	*T. aestivum subsp. aestivum*	132	17-May	3	5	4	15	4	40
15241	2	PI 94522 202	W	*T. aestivum subsp. aestivum*	137	10-May	7	25	9	80	9	90
15242	2	PI 113962 28175	S	*T. aestivum subsp. aestivum*	135	13-May	8	30	9	85	9	100
15243	2	PI 351501 T 3184	S	*T. aestivum subsp. aestivum*	142	27-May	0	0	2	15	2	30
15244	2	PI 427146 ARAGVI	W	*T. aestivum subsp. aestivum*	101	18-May	5	15	5	35	5	60
15245	2	PI 565389 Hulugo	W	*T. aestivum subsp. aestivum*	105	22-May	6	20	9	75	9	100
15246	2	PI 565393 Hozo Mestnaja	W	*T. aestivum subsp. aestivum*	147	27-May	0	0	0	0	1	5
15247	2	PI 565421 BAGRATIONI	W	*T. aestivum subsp. aestivum*	94	13-May	2	5	3	15	3	30
15248	2	PI 591867 AW 6637C/86	S	*T. aestivum subsp. aestivum*	135	27-May	8	15	9	80	9	90
15249	2	PI 585016 AW 6626/88	S	*T. aestivum subsp. aestivum*	137	27-May	8	15	9	45	9	90
15250	2	PI 591869 AW 6634A/86	S	*T. aestivum subsp. aestivum*	122	27-May	7	25	9	70	9	90
15251	2	PI 74110 35919	S	*T. aestivum subsp. aestivum*	108	13-May	9	70	9	80	9	95
15252	2	PI 78814 CItr 10112	S	*T. aestivum subsp. aestivum*	127	18-May	7	20	9	80	9	90

15253	2	PI 254219 349	S	*T. aestivum subsp. aestivum*	119	24-May	9	20	9	80	9	100
15254	2	PI 262619 Upkli	W	*T. aestivum subsp. aestivum*	146	18-May	1	2	1	10	2	20
15255	2	PI 262628 Akhaltsikhis Tsiteli Doli	S	*T. aestivum subsp. aestivum*	124	23-May	9	60	9	90	9	100
15256	2	PI 262638 Lagodekhis Grdzeltavtava	S	*T. aestivum subsp. aestivum*	150	27-May	6	25	6	60	6	80
15257	2	PI 262639 Hulugo	W	*T. aestivum subsp. aestivum*	135	28-May	4	15	4	40	4	50
15258	2	PI 262640 Gomborka	S	*T. aestivum subsp. aestivum*	142	28-May	5	10	6	40	5	70
15259	2	PI 262678 Dika Dzhavakhetskaya	S	*T. aestivum subsp. aestivum*	130	23-May	1	2	1	5	2	10
15260	2	PI 499969 KU 1668	W	*T. aestivum subsp. aestivum*	Missing							
15261	2	PI 499970 KU 1720	W	*T. aestivum subsp. aestivum*	105	18-May	0	0	2	5	2	30
15262	2	PI 499971 KU 1806	S	*T. aestivum subsp. aestivum*	135	23-May	1	5	1	5	2	10
15263	2	PI 572655 H Tri 13353/83	S	*T. aestivum subsp. aestivum*	133	523	5	25	8	55	8	90
15264	2	PI 572657 A Tri 13356/83	W	*T. aestivum subsp. aestivum*	131	24-May	6	15	7	40	8	80
15265	2	PI 572658 A Tri 13357/84	W	*T. aestivum subsp. aestivum*	135	24-May	5	10	5	25	8	70
15266	2	PI 572659 H Tri 13358/83		*T. aestivum subsp. aestivum*	105	19-May	4	10	6	10	5	30
15267	2	PI 572660 H Tri 13359/87	S	*T. aestivum subsp. aestivum*	117	28-May	6	25	6	30	6	40
15268	2	PI 572661 AW 6637A/87	S	*T. aestivum subsp. aestivum*	143	29-May	2	25	3	30	3	40
15269	2	PI 572662 AW 6637B/88	S	*T. aestivum subsp. aestivum*	Missing							
15270	2	PI 572663 HW 6638/87	W	*T. aestivum subsp. aestivum*	Missing							
WA7821		check		*T. aestivum*	85	28-May	7	50	8	80	8	90
WA7821		check		*T. aestivum*	85	28-May	7	50	8	80	8	90
WA7821		check		*T. aestivum*	85	28-May	7	50	8	80	8	90
WA7821		check		*T. aestivum*	85	28-May	7	50	8	80	8	90
15271	2	PI 572664 HW 6638B/87	S	*T. aestivum subsp. aestivum*	149	27-May	0	0	3	10	3	25
15272	2	PI 572665 AW 6631/85	S	*T. aestivum subsp. aestivum*	134	23-May	2	5	5	60	5	80
15273	2	PI 572666 AW 6632/85	S	*T. aestivum subsp. aestivum*	132	26-May	2	5	7	45	7	50
15274	2	PI 572667 AW 6633A/85	S	*T. aestivum subsp. aestivum*	137	25-May	9	10	6	45	6	60
15275	2	PI 572668 AW 6633B/85	S	*T. aestivum subsp. aestivum*	143	25-May	3	10	5	40	5	50
15276	2	PI 572669 HW 6553/85	S	*T. aestivum subsp. aestivum*	120	13-May	3	15	5	70	5	90
15277	2	PI 572670 AW 6634B/86	S	*T. aestivum subsp. aestivum*	95	13-May	0	0	3	25	4	70
15278	2	PI 572671 AW 6635B/86	S	*T. aestivum subsp. aestivum*	97	13-May	3	10	6	40	6	60
15279	2	PI 572672 AW 6636A/85	S	*T. aestivum subsp. aestivum*	123	22-May	4	20	4	60	4	70
15280	2	PI 572673 AW 6636B/85	S	*T. aestivum subsp. aestivum*	127	22-May	5	20	7	60	7	80
15281	2	PI 572674 HW 6555/86	S	*T. aestivum subsp. aestivum*	135	27-May	5	10	7	45	7	60
15282	2	PI 572679 HW 7032/88	W	*T. aestivum subsp. aestivum*	110	18-May	2	5	3	5	3	10
15283	2	PI 572680 HW 7033/88	W	*T. aestivum subsp. aestivum*	115	19-May	3	5	3	5	3	15
15284	2	PI 572687 HW 7042/88	W	*T. aestivum subsp. aestivum*	102	20-May	2	5	3	5	3	20
15285	2	PI 572689 HW 7045/88	W	*T. aestivum subsp. aestivum*	122	21-May	0	0	3	5	3	10
15286	2	PI 572690 AW 7198/90	W	*T. aestivum subsp. aestivum*	110	20-May	0	0	3	5	3	20
15287	2	PI 572691 HW 7199/90	W	*T. aestivum subsp. aestivum*	Missing					5		
15288	2	PI 572693 AW 6635A/86	S	*T. aestivum subsp. aestivum*	124	24-May	7	30	7	50	7	70
15289	2	PI 61102 Rusak	S	*T. turgidum subsp. carthlicum*	145	28-May	1	2	1	5	2	10
15290	2	PI 94748 349	S	*T. turgidum subsp. carthlicum*	129	27-May	1	2	1	2	2	10
15291	2	PI 94749 350	S	*T. turgidum subsp. carthlicum*	110	23-May	1	2	1	2	2	10

15292	2	PI 94750 351	S	*T. turgidum subsp. carthlicum*	110	23-May	1	2	1	2	2	10
15293	2	PI 94751 352	S	*T. turgidum subsp. carthlicum*	129	23-May	1	2	1	5	2	15
15294	2	PI 94752 353	S	*T. turgidum subsp. carthlicum*	125	23-May	3	2	5	15	8	30
15295	2	PI 94753 354	S	*T. turgidum subsp. carthlicum*	115	20-May	1	2	1	5	2	20
15296	2	PI 94754 355	S	*T. turgidum subsp. carthlicum*	124	29-May	1	2	1	5	2	20
15297	2	PI 94755 356	S	*T. turgidum subsp. carthlicum*	149	22-May	1	2	1	5	2	15
15298	2	PI 115816 7106	S	*T. turgidum subsp. carthlicum*	156	29-May	1	2	1	2	2	15
15299	2	PI 115817 11891	S	*T. turgidum subsp. carthlicum*	124	23-May	1	2	1	5	2	20
15300	2	PI 352278 T-1300	S	*T. turgidum subsp. carthlicum*	124	29-May	1	2	1	5	2	20
15301	2	PI 352282 T-2117	S	*T. turgidum subsp. carthlicum*	139	29-May	1	2	1	5	2	20
15302	2	PI 585017 AW 6629/85	S	*T. turgidum subsp. carthlicum*	132	27-May	1	2	1	5	2	20
15303	2	PI 585018 AW 6630/85	S	*T. turgidum subsp. carthlicum*	139	23-May	1	2	1	5	2	30
15304	2	PI 78812 CItr 10110	S	*T. turgidum subsp. carthlicum*	134	30-May	1	2	1	2	2	10
15305	2	PI 251914 WIR 25170	S	*T. turgidum subsp. carthlicum*	115	27-May	1	2	4	5	2	10
Moro		check		*T. aestivum*	122	25-May	1	2	3	5	3	30
WA7437		check		*T. aestivum*	95	?	0	0	0	0	2	5
Stephens		check		*T. aestivum*	101	24-May	1	2	1	2	2	5
Madsen		check		*T. aestivum*	95	24-May	1	2	1	2	2	5
15306	2	PI 499972 KU 1800	S	*T. turgidum subsp. carthlicum*	129	23-May	1	2	1	5	2	30
15307	2	PI 611470 H Tri 13601/87	W	*T. aestivum subsp. macha*	137	29-May	0	0	4	30	3	40
15308	2	PI 572905 WIR 29576	W	*T. aestivum subsp. macha*	129	30-May	0	0	6	25	7	50
15309	2	PI 572906 WIR 28168	W	*T. aestivum subsp. macha*	125	30-May	0	0	7	30	7	40
15310	2	PI 572907 WIR 28214	W	*T. aestivum subsp. macha*	110	30-May	1	2	2	5	2	20
15311	2	PI 572908 H Tri 13595/89	W	*T. aestivum subsp. macha*	100	30-May	1	2	1	5	2	20
15312	2	PI 572909 H Tri 13602/83	W	*T. aestivum subsp. macha*	122	29-May	1	2	3	20	3	40
15313	2	PI 572910 H Tri 13603/89	W	*T. aestivum subsp. macha*	115	27-May	2	10	2	15	2	40
15314	2	PI 572911 H Tri 13613/87	W	*T. aestivum subsp. macha*	119	27-May	1	2	1	2	2	10
15315	2	PI 572912 H Tri 13615/87	W	*T. aestivum subsp. macha*	134	28-May	1	2	3	15	3	30
15316	2	PI 572913 H Tri 13614/89	W	*T. aestivum subsp. macha*	129	29-May	1	2	3	10	2	10
15319	2	PI 94760 303	S	*T. timopheevii subsp. timopheevii*	140	3-Jun	1	2	1	2	1	5
15320	2	PI 94761 357	S	*T. timopheevii subsp. timopheevii*	132	5-Jun	1	2	1	2	1	5
15321	2	PI 352506 Typicum	W	*T. timopheevii subsp. timopheevii*	130	5-Jun	0	0	1	2	1	5
15322	2	PI 352508 Typicum	S	*T. timopheevii subsp. timopheevii*	Missing							
15323	2	PI 352510 Viticulosum	S	*T. timopheevii subsp. timopheevii*	Missing							
15324	2	PI 542472 M82-6267	W	*T. timopheevii subsp. timopheevii*	Missing							
15325	2	PI 326318 WIR 29538	S	*T. timopheevii subsp. timopheevii*	140	3-Jun	1	2	1	2	2	5
15326	2	PI 341802 WIR 29548	S	*T. timopheevii subsp. timopheevii*	Missing							
15327	2	PI 343447 WIR 29566	S	*T. timopheevii subsp. timopheevii*	115	5-Jun	1	2	1	2	2	5
15328	2	PI 349053 WIR 29548	S	*T. timopheevii subsp. timopheevii*	Missing							
15329	2	PI 349054 WIR 46587	S	*T. timopheevii subsp. timopheevii*	Missing							
15330	2	PI 418584 WIR 38555	S	*T. timopheevii subsp. timopheevii*	100	7-Jun	0	0	0	0	1	5
15331	2	PI 418585 WIR 46956	S	*T. timopheevii subsp. timopheevii*	Missing							
15332	2	PI 572916 H Tri 13604/87	S	*T. timopheevii subsp. timopheevii*	100	5-Jun	0	0	0	0	1	5

15333	2	PI 572917 H Tri 13606/89	S	*T. timopheevii subsp. timopheevii*	90	5-Jun	1	2	1	2	1	2
15334	2	PI 94674 301	S	*T. turgidum subsp. Dicoccum*	115	5-Jun	1	2	1	5	2	20
15335	2	PI 94675 302	S	*T. turgidum subsp. Dicoccum*	120	6-Jun	1	2	1	2	2	5
15336	2	PI 94747 301	S	*T. turgidum subsp. Dicoccum*	65	23-May	0	0	3	10	3	15
15337	2	PI 113961 28170	S	*T. turgidum subsp. Dicoccum*	140	23-May	0	0	2	5	2	10
15338	2	PI 113963 28177	S	*T. turgidum subsp. Dicoccum*	110	2-Jun	3	5	4	40	3	40
15339	2	PI 591868 AW 6627/85	S	*T. turgidum subsp. Dicoccum*	Missing							
15340	2	PI 74104 35894	S	*T. turgidum subsp. Dicoccum*	130	2-Jun	1	2	1	5	2	10
15341	2	PI 74108 35900	S	*T. turgidum subsp. Dicoccum*	Missing							
WA7821		check			95	?	9	60	8	80	8	90
WA7821		check			95		9	60	8	80	8	90
WA7821		check			95		9	60	8	80	8	90
WA7821		check			95		9	60	8	80	8	90
15342	2	PI 254150 28170	S	*T. turgidum subsp. Dicoccum*	135	24-May	1	2	2	20	2	30
15343	2	PI 254189 35900	S	*T. turgidum subsp. Dicoccum*	130	29-May	1	2	1	2	2	10
15344	2	PI 254216 28177	S	*T. turgidum subsp. Dicoccum*	120	27-May	3	2	5	40	5	60
15345	2	PI 326312 WIR 43843	S	*T. turgidum subsp. Dicoccum*	Missing							
15346	2	PI 341801 WIR 35916	S	*T. turgidum subsp. Dicoccum*	Missing							
15347	2	PI 349043 WIR 6388	S	*T. turgidum subsp. Dicoccum*	129	5-Jun	1	2	1	2	2	5
15348	2	PI 349046 WIR 43848	S	*T. turgidum subsp. Dicoccum*	115	3-Jun	1	2	1	2	1	5
15349	2	PI 57194 CItr 7141	S	*T. turgidum subsp. durum*	155	24-May	3	5	3	15	3	30
15350	2	PI 57195 CItr 7142	W	*T. turgidum subsp. durum*	158	25-May	1	2	1	2	2	10
15351	2	PI 57200 CItr 7147	W	*T. turgidum subsp. durum*	155	25-May	2	10	3	25	3	40
15352	2	PI 57210 CItr 7157	W	*T. turgidum subsp. durum*	145	25-May	1	2	1	2	2	10
15353	2	PI 61111 999	S	*T. turgidum subsp. durum*	150	27-May	2	10	3	15	3	30
15354	2	PI 27514 Kriek Bogda	W	*T. turgidum subsp. durum*	Missing							
15355	2	PI 78809 CItr 10107	S	*T. turgidum subsp. durum*	115	24-May	8	35	9	70	90	90
15356	2	PI 78810 CItr 10108	W	*T. turgidum subsp. durum*	150	19-May	3	5	3	15	5	60
15357	2	PI 262677 SHAUPKHA	S	*T. turgidum subsp. durum*	Missing							
15358	2	PI 349042 DIKA 9/14 S	S	*T. turgidum subsp. durum*	135	23-May	0	0	3	10	3	20
15359	2	PI 572900 AW 6628/85	S	*T. turgidum subsp. durum*	145	16-May	5	10	8	65	8	80
15360	2	PI 349050 WIR 28162	W	*T. turgidum subsp. paleocolchicum*	135	3-Jun	3	15	3	25	2	40
15361	2	PI 418586 WIR 28162	W	*T. turgidum subsp. paleocolchicum*	135	4-Jun	1	2	1	5	2	10
15362	2	PI 41029 533	S	*T. turgidum subsp. Turgidum*	149	25-May	1	2	1	5	1	5
15363	2	PI 349057 WIR 13448	W	*T. turgidum subsp. turgidum*	160	25-May	1	2	1	5	1	5
15366	2	PI 355707 69Z5.72	W	*T. zhukovskyi*	130	?	1	2	3	25	2	30

* S=spring, W=winter

APPENDIX B-3

Stripe rust infection types (IT) and severity (%) of winter wheat landraces and relatives from Georgia recorded at flowering stage at Whitlow farm (Pullman, WA) and at stem elongation, heading and dough stages at Mt. Vernon, WA in 2005 growing season under natural infection.

			STRIPE RUST							
			Whitlow		Mt. Vernon					
			6/20/05		4/29/05		5/25/05		6/28/05	
			Flowering		Stem elong.		Heading		Dough	
ACC #	PLANT ID	SPECIES	IT	%	IT	%	IT	%	IT	%
2	PI 57140 CItr 7087	*Triticum aestivum subsp. aestivum*	5	10	2	10	2	2	2	2
6	PI 57145 CItr 7092	*Triticum aestivum subsp. aestivum*	5	10	2	5	2	2	2	2
9	PI 57150 CItr 7097	*Triticum aestivum subsp. aestivum*	5	20	2	5	2	2	2	30
10	PI 57151 CItr 7098	*Triticum aestivum subsp. aestivum*	8	40	2	10	2	2	5	60
11	PI 57152 CItr 7099	*Triticum aestivum subsp. aestivum*	8	90	2	10	8	30	8	80
12	PI 57153 CItr 7100	*Triticum aestivum subsp. aestivum*	8	100	-	-	-	-	-	-
13	PI 57155 CItr 7102	*Triticum aestivum subsp. aestivum*	8	100	8	40	8	50	8	100
14	PI 57156 CItr 7103	*Triticum aestivum subsp. aestivum*	5	80	2	10	2	2	2	30
15	PI 57157 CItr 7104	*Triticum aestivum subsp. aestivum*	8	80	2	5	2	2	2	20
16	PI 57158 CItr 7105	*Triticum aestivum subsp. aestivum*	5	50	2	10	2	2	2	10
17	PI 57159 CItr 7106	*Triticum aestivum subsp. aestivum*	5	10	2	10	2	2	2	2
18	PI 57160 CItr 7107	*Triticum aestivum subsp. aestivum*	8	100	8	40	8	50	8	80
20	PI 57162 CItr 7109	*Triticum aestivum subsp. aestivum*	8	100	8	60	8	70	8	90
21	PI 57163 CItr 7110	*Triticum aestivum subsp. aestivum*	8	20	2	5	2	2	2	2
22	PI 57164 CItr 7111	*Triticum aestivum subsp. aestivum*	8	100	3	10	8	50	8	80
23	PI 57165 CItr 7112	*Triticum aestivum subsp. aestivum*	8	80	2	10	8	30	8	80
25	PI 57167 CItr 7114	*Triticum aestivum subsp. aestivum*	8	40	2	5	2	10	2	30
26	PI 57168 CItr 7115	*Triticum aestivum subsp. aestivum*	8	80	2	10	8	30	8	70
27	PI 57171 CItr 7118	*Triticum aestivum subsp. aestivum*	8	50	2	10	0	0		dry
28	PI 57172 CItr 7119	*Triticum aestivum subsp. aestivum*	8	80	3	10	0	0	3	5
30	PI 57177 CItr 7124	*Triticum aestivum subsp. aestivum*	8	100	3	10	2	2	5,2	50
31	PI 57178 CItr 7125	*Triticum aestivum subsp. aestivum*	8	80	5	40	8	50	8	70
32	PI 57179 CItr 7126	*Triticum aestivum subsp. aestivum*	8	100	8	60	8	100	8	100
33	PI 57181 CItr 7128	*Triticum aestivum subsp. aestivum*	8	60	2	10	0	0	dry	dry
35	PI 57183 CItr 7130	*Triticum aestivum subsp. aestivum*	5	60	2	10	0	0	0	0
37	PI 57185 CItr 7132	*Triticum aestivum subsp. aestivum*	8	80	8	40	8	50	8	80
38	PI 94476 156	*Triticum aestivum subsp. aestivum*	8	100	8	80	8	50	8	90
39	PI 94478 158	*Triticum aestivum subsp. aestivum*	8	90	3	10	2	2	2	15
40	PI 94521 201	*Triticum aestivum subsp. aestivum*	8	100	3	10	2	2	2,5	10
41	PI 94522 202	*Triticum aestivum subsp. aestivum*	8	100	8	60	8	50	8	80
44	PI 427146 ARAGVI	*Triticum aestivum subsp. aestivum*	8	90	5	40	8	50	8	80
45	PI 565389 Hulugo	*Triticum aestivum subsp. aestivum*	8	100	8	100	8	100	8	100

46	PI 565393 Hozo Mestnaja	*Triticum aestivum subsp. aestivum*	0	0	2	10	0	0	0	0
47	PI 565421 BAGRATIONI	*Triticum aestivum subsp. aestivum*	8	90	8	20	8	90	8	100
54	PI 262619 Upkli	*Triticum aestivum subsp. aestivum*	8	80	8	40	8	60	8	80
ACC #	PLANT ID	SPECIES	IT	%	IT	%	IT	%	IT	%
57	PI 262639 Hulugo	*Triticum aestivum subsp. aestivum*	8	70	5	40	8	40	8	70
60	PI 499969 KU 1668	*Triticum aestivum subsp. aestivum*	8	100	8	60	5	50	8	100
61	PI 499970 KU 1720	*Triticum aestivum subsp. aestivum*	5	40	5	40	5	30	5	30
64	PI 572657 A Tri 13356/83	*Triticum aestivum subsp. aestivum*	8	100	8	40	8	10	8	100
65	PI 572658 A Tri 13357/84	*Triticum aestivum subsp. aestivum*	8	100	8	40	8	50	8	100
66	PI 572659 H Tri 13358/83	*Triticum aestivum subsp. aestivum*	8	60	3	10	2	10	2	20
70	PI 572663 HW 6638/87	*Triticum aestivum subsp. aestivum*	8	100	8	40	8	30	8	100
82	PI 572679 HW 7032/88	*Triticum aestivum subsp. aestivum*	8	90	3	10	2	10	2	20
83	PI 572680 HW 7033/88	*Triticum aestivum subsp. aestivum*	8	90	3	10	2	2	2	10
84	PI 572687 HW 7042/88	*Triticum aestivum subsp. aestivum*	8	60	3	10	2	2	2	30
85	PI 572689 HW 7045/88	*Triticum aestivum subsp. aestivum*	5	30	2,8	10	2	2	2	2
86	PI 572690 AW 7198/90	*Triticum aestivum subsp. aestivum*	5	70	3	10	2	2	2	2
107	PI 611470 H Tri 13601/87	*Triticum aestivum subsp. macha*	8	80	0	0	2	1	dry	dry
108	PI 572905 WIR 29576	*Triticum aestivum subsp. macha*	8	90	8	10	8	30	8	60
109	PI 572906 WIR 28168	*Triticum aestivum subsp. macha*	8	100	8	10	8	80	8	100
110	PI 572907 WIR 28214	*Triticum aestivum subsp. macha*	8	90	8	10	8	80	8	100
111	PI 572908 H Tri 13595/89	*Triticum aestivum subsp. macha*	8	90	2	10	8	50	8	100
112	PI 572909 H Tri 13602/83	*Triticum aestivum subsp. macha*	8	100	2,8	10	8	80	8	100
113	PI 572910 H Tri 13603/89	*Triticum aestivum subsp. macha*	8	70	2	10	8	30	8	60
114	PI 572911 H Tri 13613/87	*Triticum aestivum subsp. macha*	8	80	3	10	8	40	8	60
115	PI 572912 H Tri 13615/87	*Triticum aestivum subsp. macha*	8	90	2	10	8	30	8	80
116	PI 572913 H Tri 13614/89	*Triticum aestivum subsp. macha*	8	80	2	10	0	0	8	40
150	PI 57195 CItr 7142	*Triticum turgidum subsp. durum*	2	10	2	10	0	0	3	40
151	PI 57200 CItr 7147	*Triticum turgidum subsp. durum*	8	50	2,5	10	0	0	2	40
152	PI 57210 CItr 7157	*Triticum turgidum subsp. durum*	2	20	-	-	-	-	-	-
156	PI 78810 CItr 10108	*Triticum turgidum subsp. durum*	-	-	8	40	8	60	8	70
163	PI 349057 WIR 13448	*Triticum turgidum subsp. turgidum*	-	-	8	40	8	70	8	100
164	PI 352552 T-2299	*Triticum zhukovskyi*	-	-	8	40	8	50	dry	dry
166	PI 355707 69Z5.72	*Triticum zhukovskyi*	-	-	5	40	8	50	8	80
	PS 279		-	-	**8**	**60**	**8**	**90**	**8**	**100**

APPENDIX B-4

Stripe rust infection types (IT) and severity (%) of spring wheat landraces and relatives from Georgia recorded at heading stage at Whitlow farm (Pullman, WA) and at tillering and flowering stages at Mt. Vernon, WA during 2005 growing season under natural infection.

			STRIPE RUST					
			Whitlow		Mt. Vernon			
			7/6/2005		5/26/2005		6/29/2005	
			Headed		Tillering		Flowering	
ACC #	PLANT ID	SPECIES	IT	%	IT	%	IT	%
1	CItr 14143 17425	*Triticum aestivum subsp. aestivum*	8	90	8	40	8	100
3	PI 57142 CItr 7089	*Triticum aestivum subsp. aestivum*	5	50	8	30	2	30
4	PI 57143 CItr 7090	*Triticum aestivum subsp. aestivum*	5	30	8	40	2	10
5	PI 57144 CItr 7091	*Triticum aestivum subsp. aestivum*	8	30	8	40	8	70
7	PI 57147 CItr 7094	*Triticum aestivum subsp. aestivum*	8	20	2	2	2	5
8	PI 57148 CItr 7095	*Triticum aestivum subsp. aestivum*	5	20	5	10	2	5
19	PI 57161 CItr 7108	*Triticum aestivum subsp. aestivum*	8	90	8	20	2,8	10
24	PI 57166 CItr 7113	*Triticum aestivum subsp. aestivum*	8	70	8	30	2	5
29	PI 57175 CItr 7122	*Triticum aestivum subsp. aestivum*	2	10	8	30	2	10
34	PI 57182 CItr 7129	*Triticum aestivum subsp. aestivum*	5	40	8	30	2	10
36	PI 57184 CItr 7131	*Triticum aestivum subsp. aestivum*	8	90	8	30	8	80
42	PI 113962 28175	*Triticum aestivum subsp. aestivum*	8	100	8	40	8	100
43	PI 351501 T 3184	*Triticum aestivum subsp. aestivum*	5	70	0,8	30	2	5
48	PI 591867 AW 6637C/86	*Triticum aestivum subsp. aestivum*	8	100	8	30	8	100
49	PI 585016 AW 6626/88	*Triticum aestivum subsp. aestivum*	5-8	50	8	30	2	5
50	PI 591869 AW 6634A/86	*Triticum aestivum subsp. aestivum*	8	80	8	30	8	80
51	PI 74110 35919	*Triticum aestivum subsp. aestivum*	8	100	8	40	8	100
52	PI 78814 CItr 10112	*Triticum aestivum subsp. aestivum*	8	100	8	30	8	100
53	PI 254219 349	*Triticum aestivum subsp. aestivum*	2,8	90	2	2	2,8	10
55	PI 262628 Akhaltsikhis Tsiteli Doli	*Triticum aestivum subsp. aestivum*	8	100	8	30	8	100
56	PI 262638 Lagodekhis Grdzeltavtava	*Triticum aestivum subsp. aestivum*	2	2	8	30	2	10
58	PI 262640 Gomborka	*Triticum aestivum subsp. aestivum*	5	20	8	30	2	5
59	PI 262678 Dika Dzhavakhetskaya	*Triticum aestivum subsp. aestivum*	2	2	2	2	2	5
62	PI 499971 KU 1806	*Triticum aestivum subsp. aestivum*	2	10	2	2	2	10
63	PI 572655 H Tri 13353/83	*Triticum aestivum subsp. aestivum*	8	90	8	30	8	70
67	PI 572660 H Tri 13359/87	*Triticum aestivum subsp. aestivum*	8	90	8	30	8	70
68	PI 572661 AW 6637A/87	*Triticum aestivum subsp. aestivum*	8	100	8	30	8	90
69	PI 572662 AW 6637B/88	*Triticum aestivum subsp. aestivum*	8	100	8	40	8	100
71	PI 572664 HW 6638B/87	*Triticum aestivum subsp. aestivum*	2	5	8	20	2	10

72	PI 572665 AW 6631/85	*Triticum aestivum subsp. aestivum*	8	100	8	30	8	90
73	PI 572666 AW 6632/85	*Triticum aestivum subsp. aestivum*	8	100	8	20	8	70
ACC #	PLANT ID	SPECIES	IT	%	IT	%	IT	%
74	PI 572667 AW 6633A/85	*Triticum aestivum subsp. aestivum*	8	100	8	20	8	90
75	PI 572668 AW 6633B/85	*Triticum aestivum subsp. aestivum*	8	100	8	30	8	90
76	PI 572669 HW 6553/85	*Triticum aestivum subsp. aestivum*	8	100	8	30	8	90
77	PI 572670 AW 6634B/86	*Triticum aestivum subsp. aestivum*	2	10	8	30	2	10
78	PI 572671 AW 6635B/86	*Triticum aestivum subsp. aestivum*	8	2	8	40	2	10
79	PI 572672 AW 6636A/85	*Triticum aestivum subsp. aestivum*	8	100	8	30	8	90
80	PI 572673 AW 6636B/85	*Triticum aestivum subsp. aestivum*	8	100	8	30	8	90
81	PI 572674 HW 6555/86	*Triticum aestivum subsp. aestivum*	8	90	8	30	8	90
88	PI 572693 AW 6635A/86	*Triticum aestivum subsp. aestivum*	8	80	8	30	8	60
89	PI 61102 Rusak	*Triticum turgidum subsp. carthlicum*	2	10	8	30	2	10
90	PI 94748 349	*Triticum turgidum subsp. carthlicum*	2	2	2	2	2	5
91	PI 94749 350	*Triticum turgidum subsp. carthlicum*	2	2	8	20	2	5
92	PI 94750 351	*Triticum turgidum subsp. carthlicum*	2	2	0,8	20	2	5
93	PI 94751 352	*Triticum turgidum subsp. carthlicum*	2	2	8	20	2	1
94	PI 94752 353	*Triticum turgidum subsp. carthlicum*	8	20	8	20	2,8	10
95	PI 94753 354	*Triticum turgidum subsp. carthlicum*	2	5	0	0	2	1
96	PI 94754 355	*Triticum turgidum subsp. carthlicum*	2	2	8	30	2	5
97	PI 94755 356	*Triticum turgidum subsp. carthlicum*	3	10	0	0	2	10
98	PI 115816 7106	*Triticum turgidum subsp. carthlicum*	2	5	8	20	2	5
99	PI 115817 11891	*Triticum turgidum subsp. carthlicum*	2	10	8	10	2	1
100	PI 352278 T-1300	*Triticum turgidum subsp. carthlicum*	5	20	8	30	2	1
101	PI 352282 T-2117	*Triticum turgidum subsp. carthlicum*	3	20	8	30	2	10
102	PI 585017 AW 6629/85	*Triticum turgidum subsp. carthlicum*	2	10	5	30	2	10
103	PI 585018 AW 6630/85	*Triticum turgidum subsp. carthlicum*	2	10	8	30	2	10
104	PI 78812 CItr 10110	*Triticum turgidum subsp. carthlicum*	2	5	8	20	2	5
105	PI 251914 WIR 25170	*Triticum turgidum subsp. carthlicum*	2	10	5	30	2	5
106	PI 499972 KU 1800	*Triticum turgidum subsp. carthlicum*	2	5	5-8	20	2	10
117	PI 591871 H Tri 13605/87	*Triticum monococcum subsp. monococcum*	-	-	0	0	2	2
118	PI 418583 Iz Populyatcii Zanduri	*Triticum monococcum subsp. monococcum*	-	-	0	0	2	2
119	PI 94760 303	*Triticum timopheevii subsp. timopheevii*	-	-	0	0	2	2
120	PI 94761 357	*Triticum timopheevii subsp. timopheevii*	0	0	0	0	2	2
122	PI 352508 Typicum	*Triticum timopheevii subsp. timopheevii*	-	-	0	0	2	2
123	PI 352510 Viticulosum	*Triticum timopheevii subsp. timopheevii*	-	-	-	-	-	-
125	PI 326318 WIR 29538	*Triticum timopheevii subsp. timopheevii*	2	10	0	0	2	2
126	PI 341802 WIR 29548	*Triticum timopheevii subsp. timopheevii*	0	0	0	0	2	2
127	PI 343447 WIR 29566	*Triticum timopheevii subsp. timopheevii*	0	0	0	0	2	2
128	PI 349053 WIR 29548	*Triticum timopheevii subsp. timopheevii*	-	-	-	-	-	-
129	PI 349054 WIR 46587	*Triticum timopheevii subsp. timopheevii*	0	0	-	-	-	-
130	PI 418584 WIR 38555	*Triticum timopheevii subsp. timopheevii*	0	0	0	0	2	2
131	PI 418585 WIR 46956	*Triticum timopheevii subsp. timopheevii*	-	-	0	0	2	2
132	PI 572916 H Tri 13604/87	*Triticum timopheevii subsp. timopheevii*	0	0	0	0	2	2
133	PI 572917 H Tri 13606/89	*Triticum timopheevii subsp. timopheevii*	2	10	0	0	2	2

134	PI 94674 301	*Triticum turgidum subsp. Dicoccum*	2	5	0,8	20	2	2
135	PI 94675 302	*Triticum turgidum subsp. Dicoccum*	2	2	0	0	2	2
ACC #	PLANT ID	SPECIES	IT	%	IT	%	IT	%
136	PI 94747 301	*Triticum turgidum subsp. Dicoccum*	5	60	0	0	8	100
137	PI 113961 28170	*Triticum turgidum subsp. Dicoccum*	5	50	0,8	30	2	10
138	PI 113963 28177	*Triticum turgidum subsp. Dicoccum*	5-8	50	0,8	40	2,8	20
139	PI 591868 AW 6627/85	*Triticum turgidum subsp. Dicoccum*	2	2	0	0	2	2
140	PI 74104 35894	*Triticum turgidum subsp. Dicoccum*	2	20	0,8	20	2	2
141	PI 74108 35900	*Triticum turgidum subsp. Dicoccum*	-	-	0	0	2	2
142	PI 254150 28170	*Triticum turgidum subsp. Dicoccum*	5-8	60	8	30	8	50
143	PI 254189 35900	*Triticum turgidum subsp. Dicoccum*	-	-	0	0	2	2
144	PI 254216 28177	*Triticum turgidum subsp. Dicoccum*	5	30	8	30	2	10
145	PI 326312 WIR 43843	*Triticum turgidum subsp. Dicoccum*	2	10	-	-	-	-
146	PI 341801 WIR 35916	*Triticum turgidum subsp. Dicoccum*	2	5	5	5	2	2
147	PI 349043 WIR 6388	*Triticum turgidum subsp. Dicoccum*	2	10	5-8	10	2	2
148	PI 349046 WIR 43848	*Triticum turgidum subsp. Dicoccum*	2	5	0	0	2	2
149	PI 57194 CItr 7141	*Triticum turgidum subsp. durum*	2	5	8	30	2	2
153	PI 61111 999	*Triticum turgidum subsp. durum*	2	10	8	20	2	2
155	PI 78809 CItr 10107	*Triticum turgidum subsp. durum*	8	100	8	30	8	90
157	PI 262677 SHAUPKHA	*Triticum turgidum subsp. durum*	3	20	-	-	-	-
158	PI 349042 DIKA 9/14 S	*Triticum turgidum subsp. durum*	5	5	0	0	2	2
159	PI 572900 AW 6628/85	*Triticum turgidum subsp. durum*	8	90	8	30	8,2	20
162	PI 41029 533	*Triticum turgidum subsp. turgidum*	5	5 winter	8	30	2	20
	Lemhi	***(Susceptible check)***	**8**	**100**	**8**	**40**	**8**	**100**
	Lemhi	***(Susceptible check)***	**8**	**100**	**8**	**40**	**8**	**100**
	Barley Fill							

APPENDIX B-5

Identification of all-stage resistance using five races of stripe rust (PST-1, PST-37, PST-45, PST-100 and PST-116) using infection types (IT) in seedlings of winter and spring wheat relatives and landraces from Georgia.

	2004-05 plot #	Plant ID	Habit*	Species	PST-17	PST-37	PST-45	PST 100	PST-116
					IT	IT	IT	IT	IT
1	15003	PI 57142 CItr 7089	S	***T. aestivum subsp. aestivum***	8	8	8	8	8
2	15004	PI 57143 CItr 7090	S	***T. aestivum subsp. aestivum***	8	8	8	8	8
3	15006	PI 57145 CItr 7092	W	***T. aestivum subsp. aestivum***	2	2	2	2	2
4	15007	PI 57147 CItr 7094	S	***T. aestivum subsp. aestivum***	2	8	8	8	8
5	15008	PI 57148 CItr 7095	S	***T. aestivum subsp. aestivum***	7	8	8	8	8
6	15009	PI 57150 CItr 7097	W	***T. aestivum subsp. aestivum***	2	2	8	8	8
7	15035	PI 57183 CItr 7130	W	***T. aestivum subsp. aestivum***	2	2	2	5	8
8	15043	PI 351501 T 3184	S	***T. aestivum subsp. aestivum***	2	2	2	8	8
9	15046	PI 565393 Hozo Mestnaja	W	***T. aestivum subsp. aestivum***	7	8	8	8	8
10	15054	PI 262619 Upkli	W	***T. aestivum subsp. aestivum***	8	8	8	8	8
11	15059	PI 262678 Dika Dzhavakhetskaya	S	***T. aestivum subsp. aestivum***	2	2	8	6	8
12	15062	PI 499971 KU 1806	S	***T. aestivum subsp. aestivum***	8	8	8	8	8
13	15089	PI 61102 Rusak	S	***T. turgidum subsp. carthlicum***	8	8	2	8	8
14	15090	PI 94748 349	S	***T. turgidum subsp. carthlicum***	8	8	7	7	8
15	15091	PI 94749 350	S	***T. turgidum subsp . carthlicum***	5	8	7	7	8
16	15092	PI 94750 351	S	***T. turgidum subsp. carthlicum***	7	8	8	5	8
17	15093	PI 94751 352	S	***T. turgidum subsp. carthlicum***	5	8	8	8	8
18	15095	PI 94753 354	S	***T. turgidum subsp. carthlicum***	7	8	8	8	8
19	15096	PI 94754 355	S	***T. turgidum subsp. carthlicum***	7	8	8	6	8
20	15097	PI 94755 356	S	***T. turgidum subsp. carthlicum***	7	8	8	7	8
21	15098	PI 115816 7106	S	***T. turgidum subsp. carthlicum***	8	8	8	8	8
22	15099	PI 115817 11891	S	***T. turgidum subsp. carthlicum***	8	8	8	5	8
23	15100	PI 352278 T-1300	S	***T. turgidum subsp. carthlicum***	8	8	8	6	8
24	15101	PI 352282 T-2117	S	***T. turgidum subsp. carthlicum***	8	8	8	5	8
25	15102	PI 585017 AW 6629/85	S	***T. turgidum subsp. carthlicum***	7	8	8	8	7
26	15103	PI 585018 AW 6630/85	S	***T. turgidum subsp. carthlicum***	8	8	7	7	8
27	15104	PI 78812 CItr 10110	S	***T. turgidum subsp. carthlicum***	7	8	8	7	8
28	15105	PI 251914 WIR 25170	S	***T. turgidum subsp. carthlicum***	2	6	8	7	8

	2004-05 plot #	Plant ID	Habit*	Species	PST-17	PST-37	PST-45	PST 100	PST-116
					IT	IT	IT	IT	IT
29	15113	PI 572910 H Tri 13603/89	W	*T. aestivum subsp. macha*	8	8	8	8	8
30	15114	PI 572911 H Tri 13613/87	W	*T. aestivum subsp. macha*	8	8	2	8	8
31	15120	PI 94761 357	S	*T. timopheevii subsp. timopheevii*	2	2	2	7	7
32	15121	PI 352506 Typicum	W	*T. timopheevii subsp. timopheevii*	8	8	8	8	8
33	15122	PI 352508 Typicum	S	*T. timopheevii subsp. timopheevii*	2	1	2	8	8
34	15125	PI 326318 WIR 29538	S	*T. timopheevii subsp. timopheevii*	9	4	2	8	8
35	15127	PI 343447 WIR 29566	S	*T. timopheevii subsp. timopheevii*	7	8	2	8	8
36	15129	PI 349054 WIR 46587	S	*T. timopheevii subsp. timopheevii*	8	8	8	8	8
37	15130	PI 418584 WIR 38555	S	*T. timopheevii subsp. timopheevii*	7	8	8	8	8
38	15133	PI 572917 H Tri 13606/89	S	*T. timopheevii subsp. timopheevii*	8	8	8	8	8
39	15134	PI 94674 301	S	*T. turgidum subsp. dicoccum*	8	8	8	8	8
40	15135	PI 94675 302	S	*T. turgidum subsp. dicoccum*	8	8	8	7	8
41	15137	PI 113961 28170	S	*T. turgidum subsp. dicoccum*	8	8	6	8	7
42	15138	PI 113963 28177	S	*T. turgidum subsp. dicoccum*	8	8	8	8	8
43	15139	PI 591868 AW 6627/85	S	*T. turgidum subsp. dicoccum*	2	2	2	8	8
44	15141	PI 74108 35900	S	*T. turgidum subsp. dicoccum*	2	2	2	7	8
45	15142	PI 254150 28170	S	*T. turgidum subsp. dicoccum*	8	8	2	8	8
46	15144	PI 254216 28177	S	*T. turgidum subsp. dicoccum*	8	8	2	8	8
47	15147	PI 349043 WIR 6388	S	*T. turgidum subsp. dicoccum*	8	8	8	8	8
48	15148	PI 349046 WIR 43848	S	*T. turgidum subsp. dicoccum*	7	8	8	7	8
49	15149	PI 57194 CItr 7141	S	*T. turgidum subsp. durum*	8	8	8	8	8
50	15150	PI 57195 CItr 7142	W	*T. turgidum subsp. durum*	2	8	8	8	7
51	15151	PI 57200 CItr 7147	W	*T. turgidum subsp. durum*	8	8	8	8	8
52	15152	PI 57210 CItr 7157	W	*T. turgidum subsp. durum*	8	8	8	8	8
53	15153	PI 61111 999	S	*T. turgidum subsp. durum*	8	8	8	8	8
54	15154	PI 27514 Kriek Bogda	W	*T. turgidum subsp. durum*	7	8	8	8	8
55	15156	PI 78810 CItr 10108	W	*T. turgidum subsp. durum*	8	8	8	8	8
56	15157	PI 262677 SHAUPKHA	S	*T. turgidum subsp. durum*	8	8	8	8	8
57	15158	PI 349042 DIKA 9/14 S	S	*T. turgidum subsp. durum*	7	6	8	8	8
58	15160	PI 349050 WIR 28162	W	*T. turgidum subsp. paleocolchicum*	8	8	8	8	8
59	15162	PI 41029 533	S	*T. turgidum subsp. turgidum*	8	8	8	8	8
60	15163	PI 349057 WIR 13448	W	*T. turgidum subsp. turgidum*	2	8	8	8	8
61	15202	PI 57140 CItr 7087	W	*T. aestivum subsp. aestivum*	2	2	7	8	8
62	15215	PI 57157 CItr 7104	W	*T. aestivum subsp. aestivum*	2	6	5	8	8
63	15216	PI 57158 CItr 7105	W	*T. aestivum subsp. aestivum*	5	8	8	8	8
64	15217	PI 57159 CItr 7106	W	*T. aestivum subsp. aestivum*	7	8	8	8	8
65	15261	PI 499970 KU 1720	W	*T. aestivum subsp. aestivum*	8	8	8	8	8
66	15310	PI 572907 WIR 28214	W	*T. aestivum subsp. macha*	8	8	5	7	8
67	15311	PI 572908 H Tri 13595/89	W	*T. aestivum subsp. macha*	7	8	8	6	8
68	15316	PI 572913 H Tri 13614/89	W	*T. aestivum subsp. macha*	8	8	8	8	8
69	15319	PI 94760 303	S	*T. timopheevii subsp. timopheevii*	2	6	8	8	8

70	15332	PI 572916 H Tri 13604/87	S	***T. timopheevii subsp. timopheevii***	-	-	-	-	-
71	15336	PI 94747 301	S	***T. turgidum subsp. dicoccum***	8	8	8	8	8
72	15340	PI 74104 35894	S	***T. turgidum subsp. dicoccum***	8	8	8	8	8
73	15343	PI 254189 35900	S	***T. turgidum subsp. dicoccum***	8	8	5	8	8
74	15366	PI 355707 69Z5.72	W	***T. zhukovskyi***	8	8	8	7	8

*** S=spring, W=winter**

APPENDIX B-6

Means and standard errors (SE) of stripe rust infection types (IT) and severity (%) for each scoring date over two replications for individual accessions of winter and spring wheat landraces and relatives from Georgia recorded at Spillman Farm, (Pullman, WA) in 2005 growing season.In cases when accessions were missing in both or in one of the replications, the means and standard errors could not be calculated and are represented in the table as "-". * S=spring, W=winter

				05/24/05				05/30/05				06/06/05			
plot #	Plant ID	Habit	Species	Mean IT	SE	Mean %	SE	Mean IT	SE	Mean %	SE	Mean IT	SE	Mean %	SE
Moro	check		*T. aestivum*	4	1.4	2	0	3.5	2.1	10	0	4.5	0.7	30	0
WA7437	check		*T. aestivum*	0	0	0	0	2	0	7.5	3.5	2.5	0.7	10	0
Stephens	check		*T. aestivum*	0	0	0	0	2	0	13	11	2	0	20	0
Madsen	check		*T. aestivum*	0	0	0	0	2.5	0.7	10	7.1	2	0	20	0
15001	CItr 14143 17425	S	*T. aestivum subsp. aestivum*	8.5	0.7	20	21	9	0	80	0	8	1.4	95	7.1
15002	PI 57140 CItr 7087	W	*T. aestivum subsp. aestivum*	3.5	4.9	7.5	11	3	0	7.5	3.5	2	0	10	0
15003	PI 57142 CItr 7089	S	*T. aestivum subsp. aestivum*	2	2.8	5	7.1	3	1.4	13	11	2	0	15	7.1
15004	PI 57143 CItr 7090	S	*T. aestivum subsp. aestivum*	2	2.8	2.5	3.5	4	1.4	10	7.1	2	0	20	0
15005	PI 57144 CItr 7091	S	*T. aestivum subsp. aestivum*	4	0	7.5	3.5	6.5	0.7	60	0	7.5	0.7	85	7.1
15006	PI 57145 CItr 7092	W	*T. aestivum subsp. aestivum*	0	0	0	0	2	0	7.5	3.5	2	0	20	0
15007	PI 57147 CItr 7094	S	*T. aestivum subsp. aestivum*	0	0	0	0	2.5	0.7	7.5	3.5	2	0	25	7.1
15008	PI 57148 CItr 7095	S	*T. aestivum subsp. aestivum*	1	1.4	1	1.4	2	0	7.5	3.5	2.5	0.7	20	0
15009	PI 57150 CItr 7097	W	*T. aestivum subsp. aestivum*	0	0	0	0	2	0	7.5	3.5	2.5	0.7	15	7.1
15010	PI 57151 CItr 7098	W	*T. aestivum subsp. aestivum*	1.5	2.1	1	1.4	3.5	0.7	15	7.1	2.5	0.7	20	0
15011	PI 57152 CItr 7099	W	*T. aestivum subsp. aestivum*	5.5	0.7	6	5.7	4	1.4	15	7.1	3.5	2.1	35	7.1
15012	PI 57153 CItr 7100	W	*T. aestivum subsp. aestivum*	6.5	0.7	7.5	3.5	8.5	0.7	75	7.1	8	1.4	75	7.1
15013	PI 57155 CItr 7102	W	*T. aestivum subsp. aestivum*	2.5	3.5	2.5	3.5	5	0	25	7.1	6	2.8	65	21
15014	PI 57156 CItr 7103	W	*T. aestivum subsp. aestivum*	2.5	0.7	2	0	2	0	7.5	3.5	4.5	0.7	45	7.1
15015	PI 57157 CItr 7104	W	*T. aestivum subsp. aestivum*	2	2.8	2.5	3.5	2.5	0.7	7.5	3.5	4	0	45	21
15016	PI 57158 CItr 7105	W	*T. aestivum subsp. aestivum*	1.5	2.1	1	1.4	2.5	0.7	5	0	2.5	0.7	20	14
15017	PI 57159 CItr 7106	W	*T. aestivum subsp. aestivum*	0.5	0.7	1	1.4	2.5	0.7	7.5	3.5	2	0	15	7.1
15018	PI 57160 CItr 7107	W	*T. aestivum subsp. aestivum*	5	0	3.5	2.1	3.5	0.7	15	7.1	8	0	75	7.1
15019	PI 57161 CItr 7108	S	*T. aestivum subsp. aestivum*	7	1.4	10	0	5.5	2.1	40	14	7	0	80	14
15020	PI 57162 CItr 7109	W	*T. aestivum subsp. aestivum*	6		10	-	8	-	40	-	7	-	70	-
15021	PI 57163 CItr 7110	W	*T. aestivum subsp. aestivum*	0	0	0	0	2.5	0.7	6	5.7	2	0	10	0
15022	PI 57164 CItr 7111	W	*T. aestivum subsp. aestivum*	4.5	0.7	5	0	5	1.4	18	18	6.5	2.1	65	7.1
15023	PI 57165 CItr 7112	W	*T. aestivum subsp. aestivum*	5.5	0.7	10	0	7	0	45	7.1	7	0	75	21
15024	PI 57166 CItr 7113	S	*T. aestivum subsp. aestivum*	5.5	0.7	7.5	3.5	4.5	0.7	35	7.1	5.5	3.5	50	28

plot #	Plant ID	Habit	Species	05/24/05				05/30/05				06/06/05			
				Mean IT	SE	Mean %	SE	Mean IT	SE	Mean %	SE	Mean IT	SE	Mean %	SE
15025	PI 57167 CItr 7114	W	*T. aestivum subsp. aestivum*	2	2.8	5	7.1	2.5	0.7	7.5	3.5	2	0	10	0
15026	PI 57168 CItr 7115	W	*T. aestivum subsp. aestivum*	4.5	2.1	5	0	2.5	0.7	7.5	3.5	2	0	15	7.1
15027	PI 57171 CItr 7118	W	*T. aestivum subsp. aestivum*	4	0	5	0	2.5	0.7	7.5	3.5	2.5	0.7	30	0
15028	PI 57172 CItr 7119	W	*T. aestivum subsp. aestivum*	4	0	10	7.1	3.5	0.7	25	7.1	5	2.8	45	7.1
15029	PI 57175 CItr 7122	S	*T. aestivum subsp. aestivum*	3.5	0.7	7.5	3.5	3.5	0.7	18	3.5	4.5	0.7	45	21
15030	PI 57177 CItr 7124	W	*T. aestivum subsp. aestivum*	5	1.4	10	0	4	0	45	7.1	7.5	0.7	80	14
15031	PI 57178 CItr 7125	W	*T. aestivum subsp. aestivum*	5.5	0.7	10	0	4	0	25	7.1	4.5	2.1	65	7.1
15032	PI 57179 CItr 7126	W	*T. aestivum subsp. aestivum*	7.5	0.7	23	3.5	7.5	0.7	75	7.1	9	0	90	0
15033	PI 57181 CItr 7128	W	*T. aestivum subsp. aestivum*	5	0	7.5	3.5	4.5	3.5	38	32	5	2.8	50	42
15034	PI 57182 CItr 7129	S	*T. aestivum subsp. aestivum*	5.5	3.5	10	7.1	3.5	0.7	30	28	2	0	35	21
15035	PI 57183 CItr 7130	W	*T. aestivum subsp. aestivum*	0	0	0	0	2.5	0.7	7.5	3.5	2	0	15	7.1
15036	PI 57184 CItr 7131	S	*T. aestivum subsp. aestivum*	7.5	0.7	13	3.5	8.5	0.7	60	0	7	0	75	21
15037	PI 57185 CItr 7132	W	*T. aestivum subsp. aestivum*	4.5	0.7	7.5	3.5	5.5	2.1	40	28	5	0	60	28
15038	PI 94476 156	W	*T. aestivum subsp. aestivum*	7	1.4	23	3.5	8.5	0.7	75	7.1	8	0	80	14
15039	PI 94478 158	W	*T. aestivum subsp. aestivum*	8		20	-	7	-	60	-	7	-	70	-
15040	PI 94521 201	W	*T. aestivum subsp. aestivum*	5.5	2.1	10	0	5.5	0.7	50	0	7	2.8	65	7.1
15041	PI 94522 202	W	*T. aestivum subsp. aestivum*	6.5	2.1	15	0	8	0	70	14	7	0	80	14
15042	PI 113962 28175	S	*T. aestivum subsp. aestivum*	7.5	0.7	28	18	8.5	0.7	85	7.1	9	0	95	7.1
15043	PI 351501 T 3184	S	*T. aestivum subsp. aestivum*	3.5	4.9	5	7.1	2.5	0.7	23	11	3.5	2.1	35	7.1
15044	PI 427146 ARAGVI	W	*T. aestivum subsp. aestivum*	3	0	5	0	5.5	2.1	30	0	6	2.8	75	21
15045	PI 565389 Hulugo	W	*T. aestivum subsp. aestivum*	8.5	0.7	30	0	8.5	0.7	90	0	9	0	95	7.1
15046	PI 565393 Hozo Mestnaja	W	*T. aestivum subsp. aestivum*	0	0	0	0	1	0	2	0	2	0	10	0
15047	PI 565421 BAGRATIONI	W	*T. aestivum subsp. aestivum*	4	0	7.5	3.5	4	1.4	30	14	3.5	2.1	60	0
15048	PI 591867 AW 6637C/86	S	*T. aestivum subsp. aestivum*	8.5	0.7	18	3.5	6	2.8	65	35	9	0	90	0
15049	PI 585016 AW 6626/88	S	*T. aestivum subsp. aestivum*	4.5	0.7	13	3.5	3.5	0.7	45	7.1	6	2.8	60	14
15050	PI 591869 AW 6634A/86	S	*T. aestivum subsp. aestivum*	7.5	0.7	18	3.5	5.5	0.7	65	7.1	8.5	0.7	85	7.1
15051	PI 74110 35919	S	*T. aestivum subsp. aestivum*	8.5	0.7	35	21	8.5	0.7	90	0	9	0	95	7.1
15052	PI 78814 CItr 10112	S	*T. aestivum subsp. aestivum*	6	1.4	20	0	4.5	0.7	20	0	8.5	0.7	85	7.1
15053	PI 254219 349	S	*T. aestivum subsp. aestivum*	6.5	2.1	18	3.5	8.5	0.7	50	42	9	0	85	21
15054	PI 262619 Upkli	W	*T. aestivum subsp. aestivum*	4	1.4	10	0	2.5	0.7	23	11	2	0	30	0

plot #	Plant ID	Habit	Species	05/24/05				05/30/05				06/06/05			
				Mean IT	SE	Mean %	SE	Mean IT	SE	Mean %	SE	Mean IT	SE	Mean %	SE
15055	PI 262628 Akhaltsikhis Tsiteli Doli	S	*T. aestivum subsp. aestivum*	8.5	0.7	30	21	9	0	75	21	9	0	95	7.1
15056	PI 262638 Lagodekhis Grdzeltavtava	S	*T. aestivum subsp. aestivum*	5.5	2.1	15	7.1	6	2.8	40	14	4.5	0.7	45	7.1
15057	PI 262639 Hulugo	W	*T. aestivum subsp. aestivum*	5	2.8	7.5	3.5	3	0	20	0	4	0	35	7.1
15058	PI 262640 Gomborka	S	*T. aestivum subsp. aestivum*	3.5	0.7	7.5	3.5	2.5	0.7	23	11	3.5	2.1	45	21
15059	PI 262678 Dika Dzhavakhetskaya	S	*T. aestivum subsp. aestivum*	0	0	0	0	1.5	0.7	10	0	2	0	20	0
15060	PI 499969 KU 1668	W	*T. aestivum subsp. aestivum*	6		5	-	4	-	15	-	8	-	90	-
15061	PI 499970 KU 1720	W	*T. aestivum subsp. aestivum*	5	0	7.5	3.5	3	1.4	20	14	3	1.4	30	0
15062	PI 499971 KU 1806	S	*T. aestivum subsp. aestivum*	3.5	0.7	3.5	2.1	2.5	0.7	10	0	2	0	20	0
15063	PI 572655 H Tri 13353/83	S	*T. aestivum subsp. aestivum*	7	1.4	13	3.5	7	0	65	7.1	9	0	85	7.1
15064	PI 572657 A Tri 13356/83	W	*T. aestivum subsp. aestivum*	5	1.4	10	7.1	5	2.8	45	7.1	8	0	60	14
15065	PI 572658 A Tri 13357/84	W	*T. aestivum subsp. aestivum*	4.5	2.1	7.5	3.5	4	1.4	30	0	5.5	3.5	55	21
15066	PI 572659 H Tri 13358/83		*T. aestivum subsp. aestivum*	4	0	5	0	3.5	0.7	25	7.1	3	1.4	45	21
15067	PI 572660 H Tri 13359/87	S	*T. aestivum subsp. aestivum*	8	0	15	7.1	7	1.4	70	14	8	0	75	21
15068	PI 572661 AW 6637A/87	S	*T. aestivum subsp. aestivum*	6	2.8	15	0	4.5	0.7	35	21	5.5	4.9	45	7.1
15069	PI 572662 AW 6637B/88	S	*T. aestivum subsp. aestivum*	7.5	0.7	20	7.1	6.5	0.7	65	7.1	5.5	3.5	60	14
15070	PI 572663 HW 6638/87	W	*T. aestivum subsp. aestivum*	4	0	15	7.1	3.5	0.7	30	0	6	2.8	55	7.1
15071	PI 572664 HW 6638B/87	S	*T. aestivum subsp. aestivum*	5.5	0.7	18	18	3	0	30	0	4.5	0.7	55	21
15072	PI 572665 AW 6631/85	S	*T. aestivum subsp. aestivum*	5	0	23	18	5	1.4	70	14	3.5	2.1	50	28
WA7821	check		*T. aestivum*	7.5	0.7	50	14	7.5	0.7	75	7.1	7.5	0.7	90	0
WA7821	check		*T. aestivum*	7.5	0.7	50	14	7.5	0.7	75	7.1	7.5	0.7	90	0
WA7821	check		*T. aestivum*	7.5	0.7	50	14	7.5	0.7	75	7.1	7.5	0.7	90	0
WA7821	check		*T. aestivum*	7.5	0.7	50	14	7.5	0.7	75	7.1	7.5	0.7	90	0
15073	PI 572666 AW 6632/85	S	*T. aestivum subsp. aestivum*	5	0	25	21	5	0	60	28	4	1.4	80	14
15074	PI 572667 AW 6633A/85	S	*T. aestivum subsp. aestivum*	5	0	15	14	6.5	0.7	55	21	8	0	65	7.1
15075	PI 572668 AW 6633B/85	S	*T. aestivum subsp. aestivum*	7	0	20	14	6	0	50	14	8	0	70	0
15076	PI 572669 HW 6553/85	S	*T. aestivum subsp. aestivum*	7	0	20	0	6	1.4	80	14	8	1.4	90	0
15077	PI 572670 AW 6634B/86	S	*T. aestivum subsp. aestivum*	6.5	2.1	28	3.5	6	1.4	80	0	8	0	90	0
15078	PI 572671 AW 6635B/86	S	*T. aestivum subsp. aestivum*	6.5	0.7	23	18	7	0	75	7.1	8	0	90	0
15079	PI 572672 AW 6636A/85	S	*T. aestivum subsp. aestivum*	7.5	0.7	25	7.1	8	0	75	7.1	8.5	0.7	85	7.1
15080	PI 572673 AW 6636B/85	S	*T. aestivum subsp. aestivum*	7	1.4	28	18	7.5	0.7	80	0	9	0	90	0

plot #	Plant ID	Habit	Species	05/24/05				05/30/05				06/06/05			
				Mean IT	SE	Mean %	SE	Mean IT	SE	Mean %	SE	Mean IT	SE	Mean %	SE
15081	PI 572674 HW 6555/86	S	*T. aestivum subsp. aestivum*	5	0	20	7.1	5.5	0.7	65	7.1	7	0	70	0
15082	PI 572679 HW 7032/88	W	*T. aestivum subsp. aestivum*	1.5	2.1	2.5	3.5	1	1.4	10	14	3.5	0.7	30	0
15083	PI 572680 HW 7033/88	W	*T. aestivum subsp. aestivum*	5.5	0.7	7.5	3.5	5	2.8	45	35	6	1.4	65	21
15084	PI 572687 HW 7042/88	W	*T. aestivum subsp. aestivum*	4.5	0.7	5	0	4.5	0.7	35	21	7	0	70	14
15085	PI 572689 HW 7045/88	W	*T. aestivum subsp. aestivum*	2	2.8	2.5	3.5	2	0	20	0	3	1.4	35	21
15086	PI 572690 AW 7198/90	W	*T. aestivum subsp. aestivum*	3.5	0.7	3.5	2.1	2	0	20	0	3.5	0.7	35	7.1
15087	PI 572691 HW 7199/90	W	*T. aestivum subsp. aestivum*		-	-	-	-	-	-	-	-	-	-	-
15088	PI 572693 AW 6635A/86	S	*T. aestivum subsp. aestivum*	5	1.4	10	7.1	7	0	65	21	7	0	80	0
15089	PI 61102 Rusak	S	*T. turgidum subsp. carthlicum*	3.5	0.7	7.5	3.5	2.5	0.7	18	3.5	2	0	25	7.1
15090	PI 94748 349	S	*T. turgidum subsp. carthlicum*	4	1.4	6	5.7	2.5	0.7	15	7.1	2	0	25	7.1
15091	PI 94749 350	S	*T. turgidum subsp. carthlicum*	5.5	0.7	5	0	3.5	0.7	7.5	3.5	2	0	16	20
15092	PI 94750 351	S	*T. turgidum subsp. carthlicum*	3	0	3.5	2.1	2	0	7.5	3.5	2	0	16	20
15093	PI 94751 352	S	*T. turgidum subsp. carthlicum*	4	1.4	5	0	2	0	7.5	3.5	2	0	15	7.1
15094	PI 94752 353	S	*T. turgidum subsp. carthlicum*	5	0	5	0	6	1.4	28	32	7.5	0.7	65	7.1
15095	PI 94753 354	S	*T. turgidum subsp. carthlicum*	1.5	2.1	1	1.4	2	0	13	11	2	0	10	0
15096	PI 94754 355	S	*T. turgidum subsp. carthlicum*	3.5	0.7	3.5	2.1	2	0	10	7.1	2	0	20	0
15097	PI 94755 356	S	*T. turgidum subsp. carthlicum*	4	1.4	5	0	3	0	7.5	3.5	2.5	0.7	25	7.1
15098	PI 115816 7106	S	*T. turgidum subsp. carthlicum*	3	1.4	2	0	2	0	7.5	3.5	2	0	20	0
15099	PI 115817 11891	S	*T. turgidum subsp. carthlicum*	3.5	0.7	3.5	2.1	2	0	7.5	3.5	2	0	10	0
15100	PI 352278 T-1300	S	*T. turgidum subsp. carthlicum*	4	1.4	3.5	2.1	2	0	7.5	3.5	2	0	20	0
15101	PI 352282 T-2117	S	*T. turgidum subsp. carthlicum*	3.5	0.7	2	0	2	0	7.5	3.5	2	0	20	0
15102	PI 585017 AW 6629/85	S	*T. turgidum subsp. carthlicum*	2	1.4	3.5	2.1	2	0	5	0	2	0	15	7.1
15103	PI 585018 AW 6630/85	S	*T. turgidum subsp. carthlicum*	3	0	2	0	2	0	7.5	3.5	2	0	15	7.1
15104	PI 78812 CItr 10110	S	*T. turgidum subsp. carthlicum*	2	1.4	2	0	2.5	0.7	5	0	2	0	15	7.1
15105	PI 251914 WIR 25170	S	*T. turgidum subsp. carthlicum*	2	1.4	2	0	2	0	7.5	3.5	2	0	13	11
15106	PI 499972 KU 1800	S	*T. turgidum subsp. carthlicum*	0.5	0.7	1	1.4	2	1.4	5	0	2	0	10	0
15107	PI 611470 H Tri 13601/87	W	*T. aestivum subsp. macha*	3	0	2	0	2.5	0.7	13	11	3	0	10	0
15108	PI 572905 WIR 29576	W	*T. aestivum subsp. macha*	4	1.4	3.5	2.1	3.5	0.7	13	11	4.5	0.7	30	14
15109	PI 572906 WIR 28168	W	*T. aestivum subsp. macha*	3.5	0.7	3.5	2.1	3	0	16	20	3	1.4	20	14
15110	PI 572907 WIR 28214	W	*T. aestivum subsp. macha*	5	0	7.5	3.5	4	1.4	30	28	4.5	0.7	35	21

plot #	Plant ID	Habit	Species	05/24/05				05/30/05				06/06/05			
				Mean IT	SE	Mean %	SE	Mean IT	SE	Mean %	SE	Mean IT	SE	Mean %	SE
15111	PI 572908 H Tri 13595/89	W	*T. aestivum subsp. macha*	5	0	7.5	3.5	3.5	0.7	13	11	4.5	0.7	25	7.1
15112	PI 572909 H Tri 13602/83	W	*T. aestivum subsp. macha*	5.5	3.5	8.5	9.2	3	0	13	3.5	4	1.4	25	7.1
15113	PI 572910 H Tri 13603/89	W	*T. aestivum subsp. macha*	4	0	7.5	3.5	3.5	0.7	13	3.5	2.5	0.7	25	7.1
15114	PI 572911 H Tri 13613/87	W	*T. aestivum subsp. macha*	4.5	0.7	5	0	3	0	10	0	2	0	25	7.1
15115	PI 572912 H Tri 13615/87	W	*T. aestivum subsp. macha*	4	0	7.5	3.5	3	0	7.5	3.5	4	1.4	20	0
15116	PI 572913 H Tri 13614/89	W	*T. aestivum subsp. macha*	4.5	0.7	5	0	2.5	0.7	5	0	3	0	15	7.1
15119	PI 94760 303	S	*T. timopheevii subsp. timopheevii*	0	0	0	0	2	0	3.5	2.1	0	0	0	0
15120	PI 94761 357	S	*T. timopheevii subsp. timopheevii*	0	0	0	0	1.5	2.1	2.5	3.5	0	0	0	0
15121	PI 352506 Typicum	W	*T. timopheevii subsp. timopheevii*	3	4.2	1	1.4	0	0	0	0	0	0	0	0
15122	PI 352508 Typicum	S	*T. timopheevii subsp. timopheevii*	0	0	0	0	0	0	0	0	0	0	0	0
15123	PI 352510 Viticulosum	S	*T. timopheevii subsp. timopheevii*	3		2	-	5	-	10	-	5	-	30	-
15124	PI 542472 M82-6267	W	*T. timopheevii subsp. timopheevii*	0		0	-	0	-	0	-	2	-	5	-
15125	PI 326318 WIR 29538	S	*T. timopheevii subsp. timopheevii*	0	0	0	0	0	0	0	0	1	1.4	5	7.1
15126	PI 341802 WIR 29548	S	*T. timopheevii subsp. timopheevii*	3	4.2	1	1.4	1.5	2.1	1	1.4	0	0	0	0
15127	PI 343447 WIR 29566	S	*T. timopheevii subsp. timopheevii*	6	0	14	16	3.5	0.7	3.5	2.1	0	0	0	0
15128	PI 349053 WIR 29548	S	*T. timopheevii subsp. timopheevii*			-	-	-	-	-	-	-	-	-	-
15129	PI 349054 WIR 46587	S	*T. timopheevii subsp. timopheevii*	3		5	-	3	-	5	-	5	-	5	-
15130	PI 418584 WIR 38555	S	*T. timopheevii subsp. timopheevii*	1.5	2.1	1	1.4	1.5	2.1	2.5	3.5	0	0	0	0
15131	PI 418585 WIR 46956	S	*T. timopheevii subsp. timopheevii*	2.5	3.5	1	1.4	1.5	2.1	2.5	3.5	0	0	0	0
15132	PI 572916 H Tri 13604/87	S	*T. timopheevii subsp. timopheevii*	1.5	2.1	1	1.4	1.5	2.1	2.5	3.5	4	5.7	2.5	3.5
15133	PI 572917 H Tri 13606/89	S	*T. timopheevii subsp. timopheevii*	4.5	2.1	2	0	1.5	2.1	2.5	3.5	0	0	0	0
15134	PI 94674 301	S	*T. turgidum subsp. dicoccum*	8	0	7.5	3.5	0	0	0	0	2	0	7.5	3.5
15135	PI 94675 302	S	*T. turgidum subsp. dicoccum*	6.5	2.1	7.5	3.5	0	0	0	0	2	0	6	5.7
15136	PI 94747 301	S	*T. turgidum subsp. dicoccum*	8	0	10	0	1	1.4	1	1.4	1	1.4	5	7.1
15137	PI 113961 28170	S	*T. turgidum subsp. dicoccum*	7	1.4	10	0	2	0	3.5	2.1	2	0	10	0
15138	PI 113963 28177	S	*T. turgidum subsp. dicoccum*	6	2.8	6	5.7	2	2.8	2.5	3.5	2.5	0.7	25	7.1
15139	PI 591868 AW 6627/85	S	*T. turgidum subsp. dicoccum*	8	0	10	0	1	1.4	2.5	3.5	1	1.4	5	7.1
15140	PI 74104 35894	S	*T. turgidum subsp. dicoccum*	8	0	10	0	1	1.4	2.5	3.5	1	1.4	5	7.1
15141	PI 74108 35900	S	*T. turgidum subsp. dicoccum*	7	1.4	7.5	3.5	0	0	0	0	1	1.4	10	14
15142	PI 254150 28170	S	*T. turgidum subsp. dicoccum*	5	4.2	5	0	2	0	6	5.7	1	1.4	10	14

plot #	Plant ID	Habit	Species	05/24/05				05/30/05				06/06/05			
				Mean IT	SE	Mean %	SE	Mean IT	SE	Mean %	SE	Mean IT	SE	Mean %	SE
Moro	check		*T. aestivum*	6.5	0.7	24	30	4.5	3.5	43	53	5.5	2.1	55	35
WA7437	check		*T. aestivum*	3.5	4.9	23	32	4.5	3.5	43	53	4.5	3.5	45	49
Stephens	check		*T. aestivum*	3.5	4.9	23	32	4.5	3.5	43	53	4.5	3.5	50	42
Madsen	check		*T. aestivum*	3.5	4.9	23	32	4.5	3.5	43	53	4.5	3.5	50	42
15143	PI 254189 35900	S	*T. turgidum subsp. dicoccum*	1	1.4	1	1.4	1.5	2.1	5	7.1	2.5	0.7	15	7.1
15144	PI 254216 28177	S	*T. turgidum subsp. dicoccum*	5	1.4	13	11	1.5	2.1	7.5	11	2.5	0.7	15	7.1
15145	PI 326312 WIR 43843	S	*T. turgidum subsp. dicoccum*	0		0	-	0	-	0	-	0	-	0	-
15146	PI 341801 WIR 35916	S	*T. turgidum subsp. dicoccum*	7		5	-	0	-	0	-	0	-	0	-
15147	PI 349043 WIR 6388	S	*T. turgidum subsp. dicoccum*	0	0	0	0	2	0	5	0	2	0	13	11
15148	PI 349046 WIR 43848	S	*T. turgidum subsp. dicoccum*	8	0	10	0	1	1.4	2.5	3.5	2	0	15	7.1
15149	PI 57194 CItr 7141	S	*T. turgidum subsp. durum*	4.5	2.1	3.5	2.1	1	1.4	2.5	3.5	2.5	0.7	15	7.1
15150	PI 57195 CItr 7142	W	*T. turgidum subsp. durum*	0	0	0	0	0	0	0	0	2	0	5	0
15151	PI 57200 CItr 7147	W	*T. turgidum subsp. durum*	6	0	8.5	9.2	3	1.4	7.5	3.5	4.5	3.5	35	7.1
15152	PI 57210 CItr 7157	W	*T. turgidum subsp. durum*	4	4.2	5	0	2	0	10	0	2	0	25	7.1
15153	PI 61111 999	S	*T. turgidum subsp. durum*	5.5	0.7	13	11	3.5	0.7	7.5	3.5	2.5	0.7	20	0
15154	PI 27514 Kriek Bogda	W	*T. turgidum subsp. durum*	6		2	-	2	-	10	-	2	-	10	-
15155	PI 78809 CItr 10107	S	*T. turgidum subsp. durum*	7	0	20	14	6.5	0.7	75	7.1	8	0	50	57
15156	PI 78810 CItr 10108	W	*T. turgidum subsp. durum*	4		15	-	2	-	20	-	2	-	30	-
15157	PI 262677 SHAUPKHA	S	*T. turgidum subsp. durum*			-	-	-	-	-	-	-	-	-	-
15158	PI 349042 DIKA 9/14 S	S	*T. turgidum subsp. durum*	2	1.4	2	0	1	1.4	2.5	3.5	2	0	20	0
15159	PI 572900 AW 6628/85	S	*T. turgidum subsp. durum*	4.5	0.7	3.5	2.1	4.5	2.1	13	11	5.5	3.5	45	35
15160	PI 349050 WIR 28162	W	*T. turgidum subsp. paleocolchicum*	3	1.4	2	0	2.5	0.7	7.5	3.5	4	1.4	30	14
15161	PI 418586 WIR 28162	W	*T. turgidum subsp. paleocolchicum*	4.5	0.7	5	0	2.5	0.7	10	0	2.5	0.7	10	0
15162	PI 41029 533	S	*T. turgidum subsp. turgidum*	0.5	0.7	1	1.4	2	0	7.5	3.5	2	0	15	7.1
15163	PI 349057 WIR 13448	W	*T. turgidum subsp. turgidum*	1	0	2	0	2	0	10	0	2	0	20	0
15164	PI 352552 T-2299	W	*T. zhukovskyi*	4	1.4	2	0	2.5	0.7	15	7.1	4	2.8	35	21
15166	PI 355707 69Z5.72	W	*T. zhukovskyi*	3	0	6	5.7	2.5	0.7	13	11	3.5	0.7	15	7.1
WA7821	check		*T. aestivum*	7.5	0.7	33	3.5	7	0	80	0	7	0	80	0
WA7821	check		*T. aestivum*	7.5	0.7	33	3.5	7	0	80	0	7	0	80	0
WA7821	check		*T. aestivum*	7.5		35	7.1	7	0	80	0	7	0	80	0
WA7821	check		*T. aestivum*	7.5	0.7	33	3.5	7	0	80	0	7	0	80	0

APPENDIX B-7

Means and standard errors (SE) of stripe rust infection types (IT) and severity (%) for each scoring date over two replications for individual accessions of winter and spring wheat landraces and relatives from Georgia recorded at Central Ferry, WA in 2005 growing season.; In cases when accessions were missing in both or in one of the replications, the means and standard errors could not be calculated and are represented in the table as “-” . * S=spring, W=winter

Plot #	Plant ID	Habit*	Species	17/05/05				23/05/05				30/05/05			
				Mean IT	SE	Mean %	SE	Mean IT	SE	Mean %	SE	Mean IT	SE	Mean %	SE
15001	CItr 14143 17425	S	*T. aestivum subsp. aestivum*	8.5	0.7	60	0	9	0	85	7.1	9	0	95	7.1
15002	PI 57140 CItr 7087	W	*T. aestivum subsp. aestivum*	0	0	0	0	3	1.4	7.5	3.5	3	1.4	25	7.1
15003	PI 57142 CItr 7089	S	*T. aestivum subsp. aestivum*	0	0	0	0	2	0	7.5	3.5	2	0	25	7.1
15004	PI 57143 CItr 7090	S	*T. aestivum subsp. aestivum*	0	0	0	0	1.5	0.7	7.5	3.5	2	0	20	0
15005	PI 57144 CItr 7091	S	*T. aestivum subsp. aestivum*	7	2.8	30	29	9	0	73	3.5	9	0	95	7.1
15006	PI 57145 CItr 7092	W	*T. aestivum subsp. aestivum*	0	0	0	0	1	0	3.5	2.1	2	0	13	3.5
15007	PI 57147 CItr 7094	S	*T. aestivum subsp. aestivum*	0	0	0	0	1	0	3.5	2.1	2	0	20	14
15008	PI 57148 CItr 7095	S	*T. aestivum subsp. aestivum*	0	0	0	0	1	0	3.5	2.1	2	0	18	11
15009	PI 57150 CItr 7097	W	*T. aestivum subsp. aestivum*	1	1.4	2.5	3.5	2	0	7.5	3.5	2	0	25	7.1
15010	PI 57151 CItr 7098	W	*T. aestivum subsp. aestivum*	0	0	0	0	3.5	0.7	13	11	3.5	0.7	35	7.1
15011	PI 57152 CItr 7099	W	*T. aestivum subsp. aestivum*	2	2.8	5	7.1	6.5	2.1	28	3.5	6.5	2.1	65	7.1
15012	PI 57153 CItr 7100	W	*T. aestivum subsp. aestivum*	7	0	33	11	9	0	70	0	9	0	90	0
15013	PI 57155 CItr 7102	W	*T. aestivum subsp. aestivum*	2.5	3.5	5	7.1	6	1.4	40	28	7	0	80	0
15014	PI 57156 CItr 7103	W	*T. aestivum subsp. aestivum*	2.5	3.5	7.5	11	5.5	0.7	50	28	5.5	0.7	70	14
15015	PI 57157 CItr 7104	W	*T. aestivum subsp. aestivum*	1	1.4	2.5	3.5	3.5	2.1	38	46	3	1.4	45	35
15016	PI 57158 CItr 7105	W	*T. aestivum subsp. aestivum*	0	0	0	0	2.5	2.1	15	7.1	3	1.4	25	7.1
15017	PI 57159 CItr 7106	W	*T. aestivum subsp. aestivum*	0	0	0	0	1.5	0.7	7.5	3.5	2	0	15	7.1
15018	PI 57160 CItr 7107	W	*T. aestivum subsp. aestivum*	3.5	4.9	10	14	8	0	70	0	8.5	0.7	80	14
15019	PI 57161 CItr 7108	S	*T. aestivum subsp. aestivum*	6.5	2.1	28	3.5	8.5	0.7	78	3.5	8.5	0.7	90	0
15020	PI 57162 CItr 7109	W	*T. aestivum subsp. aestivum*	-	-	-	-	-	-	-	-	-	-	-	-
15021	PI 57163 CItr 7110	W	*T. aestivum subsp. aestivum*	2	2.8	10	-	4	0	25	21	5	1.4	45	21
15022	PI 57164 CItr 7111	W	*T. aestivum subsp. aestivum*	4.5	2.1	23	25	7.5	0.7	60	0	7.5	0.7	80	14
15023	PI 57165 CItr 7112	W	*T. aestivum subsp. aestivum*	4.5	3.5	30	0	9	0	63	18	9	0	85	7.1
15024	PI 57166 CItr 7113	S	*T. aestivum subsp. aestivum*	4	1.4	13	11	6.5	2.1	38	18	7.5	2.1	70	14
15025	PI 57167 CItr 7114	W	*T. aestivum subsp. aestivum*	1.5	2.1	2.5	3.5	3.5	0.7	23	11	3.5	0.7	38	18
15026	PI 57168 CItr 7115	W	*T. aestivum subsp. aestivum*	0	0	0	0	3.5	0.7	20	14	3.5	0.7	40	14
15027	PI 57171 CItr 7118	W	*T. aestivum subsp. aestivum*	0	0	0	0	3	0	13	3.5	3	0	35	7.1
15028	PI 57172 CItr 7119	W	*T. aestivum subsp. aestivum*	0	0	0	0	3	0	20	0	4	0	50	0
15029	PI 57175 CItr 7122	S	*T. aestivum subsp. aestivum*	0	0	0	0	5	1.4	30	14	5	1.4	60	14

				17/05/05				23/05/05				30/05/05			
Plot #	Plant ID	Habit*	Species	Mean IT	SE	Mean %	SE	Mean IT	SE	Mean %	SE	Mean IT	SE	Mean %	SE
15030	PI 57177 CItr 7124	W	*T. aestivum subsp. aestivum*	3.5	0.7	23	25	8	0	63	3.5	8	0	85	7.1
15031	PI 57178 CItr 7125	W	*T. aestivum subsp. aestivum*	1	1.4	10	14	4.5	0.7	38	18	5	0	55	21
15032	PI 57179 CItr 7126	W	*T. aestivum subsp. aestivum*	5.5	2.1	30	0	9	0	78	3.5	9	0	50	57
15033	PI 57181 CItr 7128	W	*T. aestivum subsp. aestivum*	4	2.8	10	7.1	5	1.4	45	21	5	1.4	60	14
15034	PI 57182 CItr 7129	S	*T. aestivum subsp. aestivum*	0.5	0.7	5	7.1	4	0	28	3.5	4.5	0.7	60	14
15035	PI 57183 CItr 7130	W	*T. aestivum subsp. aestivum*	0	0	0	0	2	1.4	5	0	2.5	0.7	20	0
15036	PI 57184 CItr 7131	S	*T. aestivum subsp. aestivum*	7	2.8	23	3.5	8.5	0.7	55	7.1	8.5	0.7	75	7.1
WA7821	check		*T. aestivum*	7.5	0.7	40	14	8	0	80	0	8	0	90	0
WA7821	check		*T. aestivum*	7.5	0.7	35	21	8	0	80	0	8	0	90	0
WA7821	check		*T. aestivum*	7.5	0.7	40	14	8	0	80	0	8	0	90	0
WA7821	check		*T. aestivum*	7.5	0.7	40	14	8	0	80	0	8	0	90	0
15037	PI 57185 CItr 7132	W	*T. aestivum subsp. aestivum*	4	0	20	0	5	1.4	65	7.1	5	1.4	75	7.1
15038	PI 94476 156	W	*T. aestivum subsp. aestivum*	5	2.8	13	3.5	9	0	73	3.5	9	0	90	0
15039	PI 94478 158	W	*T. aestivum subsp. aestivum*	-	-	-	-	-	-	-	-	-	-	-	-
15040	PI 94521 201	W	*T. aestivum subsp. aestivum*	4	1.4	5	0	5.5	2.1	38	32	5.5	2.1	55	21
15041	PI 94522 202	W	*T. aestivum subsp. aestivum*	7.5	0.7	18	11	9	0	80	0	9	0	90	0
15042	PI 113962 28175	S	*T. aestivum subsp. aestivum*	7.5	0.7	30	0	8	1.4	83	3.5	8	1.4	90	14
15043	PI 351501 T 3184	S	*T. aestivum subsp. aestivum*	0	0	0	0	2	0	13	3.5	2	0	40	14
15044	PI 427146 ARAGVI	W	*T. aestivum subsp. aestivum*	5	0	15	0	5	0	38	3.5	5	0	65	7.1
15045	PI 565389 Hulugo	W	*T. aestivum subsp. aestivum*	7.5	2.1	30	14	9	0	83	11	9	0	100	0
15046	PI 565393 Hozo Mestnaja	W	*T. aestivum subsp. aestivum*	0	0	0	0	0.5	0.7	1	1.4	1	0	5	0
15047	PI 565421 BAGRATIONI	W	*T. aestivum subsp. aestivum*	3	1.4	10	7.1	3	0	10	7.1	3	0	25	7.1
15048	PI 591867 AW 6637C/86	S	*T. aestivum subsp. aestivum*	7	1.4	18	3.5	8.5	0.7	70	14	8.5	0.7	90	0
15049	PI 585016 AW 6626/88	S	*T. aestivum subsp. aestivum*	5	4.2	10	7.1	6.5	3.5	43	3.5	6.5	3.5	75	21
15050	PI 591869 AW 6634A/86	S	*T. aestivum subsp. aestivum*	6	1.4	18	11	7.5	2.1	60	14	7.5	2.1	85	7.1
15051	PI 74110 35919	S	*T. aestivum subsp. aestivum*	8.5	0.7	50	28	9	0	80	0	9	0	98	3.5
15052	PI 78814 CItr 10112	S	*T. aestivum subsp. aestivum*	7.5	0.7	15	7.1	9	0	80	0	9	0	95	7.1
15053	PI 254219 349	S	*T. aestivum subsp. aestivum*	9	0	40	28	9	0	80	0	9	0	95	7.1
15054	PI 262619 Upkli	W	*T. aestivum subsp. aestivum*	0.5	0.7	1	1.4	1.5	0.7	10	0	2	0	25	7.1
15055	PI 262628 Akhaltsikhis Tsiteli Doli	S	*T. aestivum subsp. aestivum*	9	0	65	7.1	9	0	90	0	9	0	100	0
15056	PI 262638 Lagodekhis Grdzeltavtava	S	*T. aestivum subsp. aestivum*	5.5	0.7	23	3.5	7	1.4	65	7.1	7	1.4	85	7.1

				17/05/05				23/05/05				30/05/05			
Plot #	Plant ID	Habit*	Species	Mean IT	SE	Mean %	SE	Mean IT	SE	Mean %	SE	Mean IT	SE	Mean %	SE
15057	PI 262639 Hulugo	W	*T. aestivum subsp. aestivum*	2	2.8	7.5	11	4	0	40	0	4	0	55	7.1
15058	PI 262640 Gomborka	S	*T. aestivum su bsp. aestivum*	2.5	3.5	5	7.1	5	1.4	35	7.1	4.5	0.7	65	7.1
15059	PI 262678 Dika Dzhavakhetskaya	S	*T. aestivum subsp. aestivum*	0.5	0.7	1	1.4	1.5	0.7	10	7.1	2	0	15	7.1
15060	PI 499969 KU 1668	W	*T. aestivum subsp. aestivum*	-	-	-	-	-	-	-	-	-	-	-	-
15061	PI 499970 KU 1720	W	*T. aestivum subsp. aestivum*	2.5	3.5	13	18	3.5	2.1	13	11	3	1.4	35	7.1
15062	PI 499971 KU 1806	S	*T. aestivum subsp. aestivum*	0.5	0.7	2.5	3.5	1.5	0.7	7.5	3.5	2	0	15	7.1
15063	PI 572655 H Tri 13353/83	S	*T. aestivum subsp. aestivum*	4.5	0.7	23	3.5	7.5	0.7	58	3.5	7.5	0.7	90	0
15064	PI 572657 A Tri 13356/83	W	*T. aestivum subsp. aestivum*	5	1.4	18	3.5	7.5	0.7	50	14	8	0	75	7.1
15065	PI 572658 A Tri 13357/84	W	*T. aestivum subsp. aestivum*	6.5	2.1	10	0	6.5	2.1	48	32	8	0	80	14
15066	PI 572659 H Tri 13358/83		*T. aestivum subsp. aestivum*	4	0	7.5	3.5	5.5	0.7	30	28	4.5	0.7	40	14
15067	PI 572660 H Tri 13359/87	S	*T. aestivum subsp. aestivum*	6.5	0.7	23	3.5	7.5	2.1	50	28	6.5	0.7	65	35
15068	PI 572661 AW 6637A/87	S	*T. aestivum subsp. aestivum*	3.5	2.1	15	14	6	4.2	50	28	6	4.2	60	28
15069	PI 572662 AW 6637B/88	S	*T. aestivum subsp. aestivum*	-	-	-	-	-	-	-	-	-	-	-	-
15070	PI 572663 HW 6638/87	W	*T. aestivum subsp. aestivum*	-	-	-	-	-	-	-	-	-	-	-	-
15071	PI 572664 HW 6638B/87	S	*T. aestivum su bsp. aestivum*	0	0	0	0	4	1.4	20	14	4	1.4	38	18
15072	PI 572665 AW 6631/85	S	*T. aestivum subsp. aestivum*	3.5	2.1	15	14	6.5	2.1	60	0	6.5	2.1	80	0
Eltan	check		*T. aestivum*	1.5	2.1	2.5	3.5	3.5	0.7	18	3.5	3.5	0.7	30	0
Su/O	check		*T. aestivum*	8	0	40	14	8	0	75	7.1	8	0	88	11
Coda	check		*T. aestivum*	0	0	0	0	1.5	0.7	7.5	3.5	2.5	0.7	15	7.1
Lambert	check		*T. aestivum*	0	0	0	0	2	1.4	7.5	3.5	2.5	0.7	25	7.1
15073	PI 572666 AW 6632/85	S	*T. aestivum subsp. aestivum*	5	4.2	18	18	7.5	0.7	53	11	7.5	0.7	65	21
15074	PI 572667 AW 6633A/85	S	*T. aestivum subsp. aestivum*	6.5	3.5	7.5	3.5	7	1.4	53	11	7	1.4	70	14
15075	PI 572668 AW 6633B/85	S	*T. aestivum subsp. aestivum*	5.5	3.5	13	3.5	6.5	2.1	55	21	6.5	2.1	70	28
15076	PI 572669 HW 6553/85	S	*T. aestivum subsp. aestivum*	6	4.2	33	25	7	2.8	75	7.1	7	2.8	95	7.1
15077	PI 572670 AW 6634B/86	S	*T. aestivum subsp. aestivum*	4.5	6.4	30	42	6	4.2	53	39	6.5	3.5	85	21
15078	PI 572671 AW 6635B/86	S	*T. aestivum subsp. aestivum*	5	2.8	25	21	7.5	2.1	60	28	7.5	2.1	80	28
15079	PI 572672 AW 6636A/85	S	*T. aestivum subsp. aestivum*	6	2.8	30	14	6.5	3.5	65	7.1	6.5	3.5	80	14
15080	PI 572673 AW 6636B/85	S	*T. aestivum subsp. aestivum*	5.5	0.7	20	0	7.5	0.7	60	0	7.5	0.7	85	7.1
15081	PI 572674 HW 6555/86	S	*T. aestivum subsp. aestivum*	5	0	10	0	7.5	0.7	60	21	7.5	0.7	75	21
15082	PI 572679 HW 7032/88	W	*T. aestivum subsp. aestivum*	3	1.4	5	0	3.5	0.7	10	7.1	3.5	0.7	18	11
15083	PI 572680 HW 7033/88	W	*T. aestivum subsp. aestivum*	3.5	0.7	7.5	3.5	3.5	0.7	15	14	3.5	0.7	28	18

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Plot #	Plant ID	Habit*	Species	Mean IT	SE	Mean %	SE	Mean IT	SE	Mean %	SE	Mean IT	SE	Mean %	SE
15084	PI 572687 HW 7042/88	W	*T. aestivum subsp. aestivum*	2.5	0.7	7.5	3.5	3.5	0.7	13	11	3.5	0.7	35	21
15085	PI 572689 HW 7045/88	W	*T. aestivum subsp. aestivum*	1.5	2.1	2.5	3.5	3.5	0.7	10	7.1	3.5	0.7	20	14
15086	PI 572690 AW 7198/90	W	*T. aestivum subsp. aestivum*	2	2.8	2.5	3.5	3.5	0.7	13	11	3.5	0.7	30	14
15087	PI 572691 HW 7199/90	W	*T. aestivum subsp. aestivum*	-	-	-	-	-	-	-	-	-	-	-	-
15088	PI 572693 AW 6635A/86	S	*T. aestivum subsp. aestivum*	7	0	23	11	8	1.4	55	7.1	8	1.4	80	14
15089	PI 61102 Rusak	S	*T. turgidum subsp. carthlicum*	1.5	0.7	6	5.7	1.5	0.7	13	11	2	0	25	21
15090	PI 94748 349	S	*T. turgidum subsp. carthlicum*	1	0	6	5.7	1	0	6	5.7	2	0	18	11
15091	PI 94749 350	S	*T. turgidum subsp. carthlicum*	1	0	6	5.7	1	0	6	5.7	2	0	20	14
15092	PI 94750 351	S	*T. turgidum subsp. carthlicum*	0.5	0.7	1	1.4	1	0	8.5	9.2	2	0	18	11
15093	PI 94751 352	S	*T. turgidum subsp. carthlicum*	1	0	6	5.7	1	0	10	7.1	2	0	23	11
15094	PI 94752 353	S	*T. turgidum subsp. carthlicum*	4	1.4	26	34	6.5	2.1	43	39	8	0	55	35
15095	PI 94753 354	S	*T. turgidum subsp. carthlicum*	0.5	0.7	1	1.4	1	0	5	0	2	0	20	0
15096	PI 94754 355	S	*T. turgidum subsp. carthlicum*	0.5	0.7	1	1.4	1	0	7.5	3.5	2	0	25	7.1
15097	PI 94755 356	S	*T. turgidum subsp. carthlicum*	0.5	0.7	1	1.4	1	0	10	7.1	2	0	23	11
15098	PI 115816 7106	S	*T. turgidum subsp. carthlicum*	0.5	0.7	1	1.4	1	0	3.5	2.1	2	0	13	3.5
15099	PI 115817 11891	S	*T. turgidum subsp. carthlicum*	0.5	0.7	1	1.4	1	0	5	0	2	0	25	7.1
15100	PI 352278 T-1300	S	*T. turgidum subsp. carthlicum*	0.5	0.7	1	1.4	1	0	7.5	3.5	2	0	20	0
15101	PI 352282 T-2117	S	*T. turgidum subsp. carthlicum*	0.5	0.7	1	1.4	1	0	5	0	2	0	25	7.1
15102	PI 585017 AW 6629/85	S	*T. turgid um subsp. carthlicum*	0.5	0.7	1	1.4	1	0	5	0	2	0	25	7.1
15103	PI 585018 AW 6630/85	S	*T. turgidum subsp. carthlicum*	1	0	3.5	2.1	1	0	5	0	2	0	20	14
15104	PI 78812 CItr 10110	S	*T. turgidum subsp. carthlicum*	0.5	0.7	1	1.4	1	0	3.5	2.1	2	0	13	3.5
15105	PI 251914 WIR 25170	S	*T. turgidum subsp. carthlicum*	0.5	0.7	1	1.4	2.5	2.1	5	0	2	0	13	3.5
15106	PI 499972 KU 1800	S	*T. turgidum subsp. carthlicum*	0.5	0.7	1	1.4	1	0	7.5	3.5	2	0	25	7.1
15107	PI 611470 H Tri 13601/87	W	*T. aestivum subsp. macha*	0	0	0	0	3.5	0.7	20	14	3.5	0.7	30	14
WA7821	check		*T. aestivum*	9	0	60	0	8	0	80	0	8	0	90	0
WA7821	check		*T. aestivum*	9	0	60	0	8	0	80	0	8	0	90	0
WA7821	check		*T. aestivum*	9	0	60	0	8	0	80	0	8	0	90	0
WA7821	check		*T. aestivum*	9	0	60	0	8	0	80	0	8	0	90	0
15108	PI 572905 WIR 29576	W	*T. aestivum subsp. macha*	3.5	4.9	10	14	6	0	50	35	6.5	0.7	65	21

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Plot #	Plant ID	Habit*	Species	Mean IT	SE	Mean %	SE	Mean IT	SE	Mean %	SE	Mean IT	SE	Mean %	SE
15109	PI 572906 WIR 28168	W	*T. aestivum subsp. macha*	2	2.8	5	7.1	6.5	0.7	40	14	6.5	0.7	55	21
15110	PI 572907 WIR 28214	W	*T. aestivum subsp. macha*	2.5	2.1	8.5	9.2	4	2.8	28	32	4	2.8	40	28
15111	PI 572908 H Tri 13595/89	W	*T. aestivum subsp. macha*	3	2.8	3.5	2.1	3.5	3.5	13	11	4	2.8	35	21
15112	PI 572909 H Tri 13602/83	W	*T. aestivum subsp. macha*	2	1.4	3.5	2.1	5	2.8	35	21	4	1.4	50	14
15113	PI 572910 H Tri 13603/89	W	*T. aestivum subsp. macha*	1	1.4	5	7.1	2	0	13	3.5	2	0	40	0
15114	PI 572911 H Tri 13613/87	W	*T. aestivum subsp. macha*	0.5	0.7	1	1.4	1	0	6	5.7	2	0	20	14
15115	PI 572912 H Tri 13615/87	W	*T. aestivum subsp. macha*	0.5	0.7	1	1.4	3	0	23	11	3	0	40	14
15116	PI 572913 H Tri 13614/89	W	*T. aestivum subsp. macha*	2.5	2.1	8.5	9.2	3.5	0.7	20	14	3	1.4	25	21
15119	PI 94760 303	S	*T. timopheevii subsp. timopheevii*	-	-	-	-	-	-	-	-	-	-	-	-
15120	PI 94761 357	S	*T. timopheevii subsp. timopheevii*	0.5	0.7	1	1.4	0.5	0.7	1	1.4	1.5	0.7	13	11
15121	PI 352506 Typicum	W	*T. timopheevii subsp. timopheevii*	0	0	0	0	0.5	0.7	1	1.4	1.5	0.7	13	11
15122	PI 352508 Typicum	S	*T. timopheevii subsp. timopheevii*	-	-	-	-	-	-	-	-	-	-	-	-
15123	PI 352510 Viticulosum	S	*T. timopheevii subsp. timopheevii*	-	-	-	-	-	-	-	-	-	-	-	-
15124	PI 542472 M82-6267	W	*T. timopheevii subsp. timopheevii*	-	-	-	-	-	-	-	-	-	-	-	-
15125	PI 326318 WIR 29538	S	*T. timopheevii subsp. timopheevii*	1	0	2	0	1	0	3.5	2.1	2	0	13	11
15126	PI 341802 WIR 29548	S	*T. timopheevii subsp. timopheevii*	-	-	-	-	-	-	-	-	-	-	-	-
15127	PI 343447 WIR 29566	S	*T. timopheevii subsp. timopheevii*	0.5	0.7	1	1.4	0.5	0.7	1	1.4	2	0	5	0
15128	PI 349053 WIR 29548	S	*T. timopheevii subsp. timopheevii*	-	-	-	-	-	-	-	-	-	-	-	-
15129	PI 349054 WIR 46587	S	*T. timopheevii subsp. timopheevii*	-	-	-	-	-	-	-	-	-	-	-	-
15130	PI 418584 WIR 38555	S	*T. timopheevii subsp. timopheevii*	0	0	0	0	0	0	0	0	1.5	0.7	5	0
15131	PI 418585 WIR 46956	S	*T. timopheevii subsp. timopheevii*	-	-	-	-	-	-	-	-	-	-	-	-
15132	PI 572916 H Tri 13604/87	S	*T. timopheevii subsp. timopheevii*	-	-	-	-	-	-	-	-	-	-	-	-
15133	PI 572917 H Tri 13606/89	S	*T. timopheevii subsp. timopheevii*	0.5	0.7	1	1.4	0.5	0.7	1	1.4	1.5	0.7	6	5.7
15134	PI 94674 301	S	*T. turgidum subsp. dicoccum*	4.5	4.9	6	5.7	1	0	3.5	2.1	2	0	13	11
15135	PI 94675 302	S	*T. turgidum subsp. dicoccum*	3	2.8	2	0	1	0	2	0	2	0	5	0
15136	PI 94747 301	S	*T. turgidum subsp. dicoccum*	0	-	0	-	3	-	10	-	3	-	15	-
15137	PI 113961 28170	S	*T. turgidum subsp. dicoccum*	4	5.7	5	7.1	1.5	0.7	3.5	2.1	2	0	10	0
15138	PI 113963 28177	S	*T. turgidum subsp. dicoccum*	2.5	0.7	5	0	3	1.4	25	21	2.5	0.7	25	21
15139	PI 591868 AW 6627/85	S	*T. turgidum subsp. dicoccum*	-	-	-	-	-	-	-	-	-	-	-	-
15140	PI 74104 35894	S	*T. turgidum subsp. dicoccum*	-	-	-	-	-	-	-	-	-	-	-	-

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15141	PI 74108 35900	S	*T. turgidum subsp. dicoccum*	-	-	-	-	-	-	-	-	-	-	-	-
15142	PI 254150 28170	S	*T. turgidum subsp. dicoccum*	3	2.8	3.5	2.1	1.5	0.7	11	13	2	0	23	11
Moro	check		*T. aestivum*	0.5	0.7	1	1.4	3	0	5	0	3	0	20	14
WA7437	check		*T. aestivum*	0	0	0	0	0.5	0.7	1	1.4	2	0	7.5	3.5
Stephens	check		*T. aestivum*	1	0	2	0	1	0	2	0	2	0	10	7.1
Madsen	check		*T. aestivum*	1	0	2	0	1	0	2	0	2	0	5	0
15143	PI 254189 35900	S	*T. turgidum subsp. dicoccum*	-	-	-	-	-	-	-	-	-	-	-	-
15144	PI 254216 28177	S	*T. turgidum subsp. dicoccum*	1.5	2.1	1	1.4	3	2.8	21	27	3.5	2.1	35	35
15145	PI 326312 WIR 43843	S	*T. turgidum subsp. dicoccum*	-	-	-	-	-	-	-	-	-	-	-	-
15146	PI 341801 WIR 35916	S	*T. turgidum subsp. dicoccum*	-	-	-	-	-	-	-	-	-	-	-	-
15147	PI 349043 WIR 6388	S	*T. turgidum subsp. dicoccum*	4.5	4.9	6	5.7	1	0	3.5	2.1	2	0	5	0
15148	PI 349046 WIR 43848	S	*T. turgidum subsp. dicoccum*	4.5	4.9	6	5.7	1	0	3.5	2.1	1.5	0.7	5	0
15149	PI 57194 CItr 7141	S	*T. turgidum subsp. durum*	1.5	2.1	2.5	3.5	2	1.4	8.5	9.2	2.5	0.7	18	18
15150	PI 57195 CItr 7142	W	*T. turgidum subsp. durum*	1	0	2	0	1	0	2	0	2	0	7.5	3.5
15151	PI 57200 CItr 7147	W	*T. turgidum subsp. durum*	1	1.4	5	7.1	2	1.4	14	16	2.5	0.7	28	18
15152	PI 57210 CItr 7157	W	*T. turgidum subsp. durum*	1	0	2	0	1	0	2	0	2	0	13	3.5
15153	PI 61111 999	S	*T. turgidum subsp. durum*	1.5	0.7	6	5.7	2	1.4	8.5	9.2	2.5	0.7	23	11
15154	PI 27514 Kriek Bogda	W	*T. turgidum subsp. durum*	-	-	-	-	-	-	-	-	-	-	-	-
15155	PI 78809 CItr 10107	S	*T. turgidum subsp. durum*	5.5	3.5	20	21	8.5	0.7	65	7.1	49	58	90	0
15156	PI 78810 CItr 10108	W	*T. turgidum subsp. durum*	2	1.4	3.5	2.1	2	1.4	8.5	9.2	3.5	2.1	38	32
15157	PI 262677 SHAUPKHA	S	*T. turgidum subsp. durum*	-	-	-	-	-	-	-	-	-	-	-	-
15158	PI 349042 DIKA 9/14 S	S	*T. turgidum subsp. durum*	0.5	0.7	1	1.4	2	1.4	6	5.7	2.5	0.7	13	11
15159	PI 572900 AW 6628/85	S	*T. turgidum subsp. durum*	4	1.4	13	3.5	6.5	2.1	68	3.5	6.5	2.1	85	7.1
15160	PI 349050 WIR 28162	W	*T. turgidum subsp. paleocolchicum*	1.5	2.1	7.5	11	2.5	0.7	23	3.5	2	0	35	7.1
15161	PI 418586 WIR 28162	W	*T. turgidum subsp. paleocolchicum*	-	-	-	-	-	-	-	-	-	-	-	-
15162	PI 41029 533	S	*T. turgidum subsp. turgidum*	1	0	1.5	0.7	1.5	0.7	5	0	2	1.4	5	0
15163	PI 349057 WIR 13448	W	*T. turgidum subsp. turgidum*	1	0	1.5	0.7	1.5	0.7	23	25	2	1.4	23	25
15164	PI 352552 T-2299	W	*T. zhukovskyi*	-	-	-	-	-	-	-	-	-	-	-	-