Asian Journal of Plant Sciences

ISSN 1682-3974

Asian Journal of Plant Sciences 5 (3): 553-558, 2006
ISSN 1682-3974

Agronomical and Adaptation Characters of Tritipyrum Lines in Comparison with Triticale and Iranian Wheat

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Abstract: In this study a Completely Randomized Design was conducted to evaluate the agronomical potential and adaptability behavior of tritipyrum lines in comparison with some triticale and local Iranian wheat varieties. The field trial was sown in October 2000 in research field of agricultural college of Bahonar University of Kerman, Iran and harvested in June 2001. All the conditions during the course of experiment were the same as for wheat in Kerman region. Nine tritipyrum lines, five triticale lines and four improved local wheat varieties were used in this study. The following traits were measured or counted on each plot, survival of plants per plot, height at maturity, tiller number, number of spikelets per spike, heading date, fertility, 1000 grain weight, biological yield, economical grain yield and harvest index. The results showed the apparent uniform growth and wheat-like morphology of tritipyrum lines in comparing with triticales and local wheat cultivars. The analysis of variance for characters studied showed a large variation between genotypes for the most traits in Kerman conditions. The mean yield in all tritipyrum lines (387 kg ha^{-1}), in spite of having severe brittle rachis, in comparison with triticales (815 kg ha^{-1}) and the improved local Iranian wheat cultivars (1988 kg ha^{-1}) showed a considerable adaptability of tritipyrum lines in this first ever trail in Iran.

Key words: Tritipyrum, triticale, Iranian bread wheat, agronimical and morphological traits

INTRODUCTION

Small grain production in southern Iran is limited by unfavourable environment such as saline soil and drought, particularly, in Kerman province. There is also an increased demand for feed grain in this area. In Iran, cereals are grown on 6.2% of the total cultivated area with a yield of 9.7 million tons and provide 5% of the gross national income because of their adaptability to the arid, semiarid, hilly and highland areas better than other crops (Keshavarz, 2002). Despite low and erratic rainfall, cereals have been cultivated in Iran for centuries, but triticale and tritipyrum, are the recently introduced cereal crops have not been studied for their potential and adaptation in arid and semi arid areas of Iran. Severe drought that have plagued most countrys regions during the past ten cropping seasons has focused attention on the drought and salt tolerance and genetic diversity in cereals. Triticale is a promising crop in many countries with specific adverse growing conditions for wheat and rye. It is replacing wheat in regions with highly acid soils where aluminium and copper toxicities are common, such as Mexico, northern India and Brazil (Bushak and Larter, 1980). Triticale (*Triticosecale wittmack* L.), a first man-made cereal, is an inter-generic hybrid between Triticum and Secale. It has come a long way from being an experimental hybrid and is likely to assume an important role in mankind nutrition (Dhindsa and Singh, 1996). Similar improvement in tritipyrum has considerable potential. The development of a forage/grain dual-purpose tritipyrum could lead to a new complete crop and livestock cycle in developing countries. A major breeding objective in wheat is the improvement of grain yield. This is often difficult because of the great number of genes involved and low heritability (Khalifa *et al.*, 1996). The novel concept of using forage cereals first for grazing or harvesting as green fodder, then allowing regeneration for grain production has been in circulation for some time (Brignall *et al.*, 1988; Brown and Almodares, 1976; Poysa, 1985). It is also hoped that tritipyrum could have an effect on the stability and sustainability of the agro-ecosystem. This study represents a firs attempt to

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compare tritipyrum with triticales and local Iranian bread wheats. The objectives were to obtain some information of adaptation performance, agronomic and morphological characteristics and the heritability of some yield components of this new salt tolerant cereal under field conditions for the first time in Iran.

MATERIALS AND METHODS

Plant materials: Nine tritipyrum lines (Az/b, Ka/b, La/b, La(4B/4D)/b, Ka/bxCr/b, F_3, Ka/bxCr/b, F_5, Ka/bxCr/b, F_6, Ma/bxCr/b,F_4, St/bxCr/b,F_4) five triticale lines (4103, 4108, 4115, 4116, M45/beta54) and four local wheat varieties (Omid, Alvand, Kavir, Bahara Baft) were used in this study (Table 1).

Methods: The experiment was conducted at the Research field of the agricultural college, Bahonar university, Kerman, Iran. A field trial was sown on 2nd October 2000 and harvested on 3rd June 2001. It was sown as two rows of 25 seeds (10 cm apart) per genotype with 50 cm between rows. The trial was sown as a Randomized Block Design with four replications. For preventing the border effect three rows of the Iranian wheat cultivar Navid were sown as a guard around the trial. The following traits were measured or counted on each plot, survival of plants per plot, height at maturity (cm), tiller number, number of spikelets per spike, heading date (number of days from October second until the day when 50% of the spikes of leading tillers had emerged from the flag leaf), fertility (%), 1000-grain weight (estimated by weighing 250 grain), biological yield, economical grain yield and harvest index. All traits, except survival, were measured on the basis of ten plants of each plot and their average was considered as a replication of each genotype. Analysis of variance (balanced designs), in which the block and genotype were fixed factors, was calculated for the 72 plots of the experiment to determine the significant differences among the different tritipyrums, triticales and local Iranian bread wheat varieties for the various above mentioned traits (Table 3). The $LSD_{(\alpha = 5\%, df = 51)}$ for genotypes and blocks comparisons, Standard Deviation (STD) and Standard Error of Mean (SEM) for the mean of all characters were calculated (Table 2). The coefficient variation (CV = Mse/GMx100) for each character was calculated, GM (grand mean) and MSes were also calculated for each affiliated trait (Table 2).

RESULTS AND DISCUSSION

Triticale has shown a high yield in many European countries. Improved knowledge of this new species and also of tritiprum when cultivated in Iran would be considerable value. In some triticales, the leaf appearance is quicker that of wheat cultivars and tritipyrum lines. Consequently, it presents a shorter stem elongation period than wheat and tritipyrum. Tritipyrum reaches physiological maturity far later than wheat and triticales, a characteristic resulting from its prenial coach grass parent. The late maturity of tritipyrum, which can be a handicap, is compensated by a better adaptation to the high temperature in spring and summer in Iran. The uniform growth and wheat-like morphology of all tritipyrums (Fig. 1d and e) in the field study and the occurrence of the distinct staged production of tillers characteristic of tritipyrum lines were also apparent.

The analysis of variance for survival of plants (Table 3) showed no difference between genotypes and also for the blocks of the trial. This results shows that the tritipyrum lines have the same germination power as triticale and the local wheat, which is a key factor for adaptation to the conditions in Iran. The average number

Table 1: The various lines of three different amphiploid

Amphiploids	The complete and abbreviation of lines or varieties	Seed sown number
Tritipyrums	Aziziah/*Thinopyrum bessarabicum* (Az/b)	200
	Karim/ *Thinopyrum bessarabicum* (Ka/b)	200
	Langdon/ *Thinopyrum bessarabicum* (La/b)	200
	Langdon (4B/4D)/ *Thinopyrum bessarabicum* (La(4B/4D)/b	200
	Ka/b x Cr/b, F_3	200
	Ka/b x Cr/b, F_5	200
	Ka/b x Cr/b, F_6	200
	Ma/b x Cr/b, F_4	200
	St/b x Cr/b, F_4	200
Triticales	Triticale 4103	200
	Triticale 4108	200
	Triticale 4115	200
	Triticale 4116	200
	Triticale M45/Be95	200
Local Iranian	Omid	200
Wheat varieties	Alvand	200
	Kavir	200
	Bahare baft	200
Total		3600

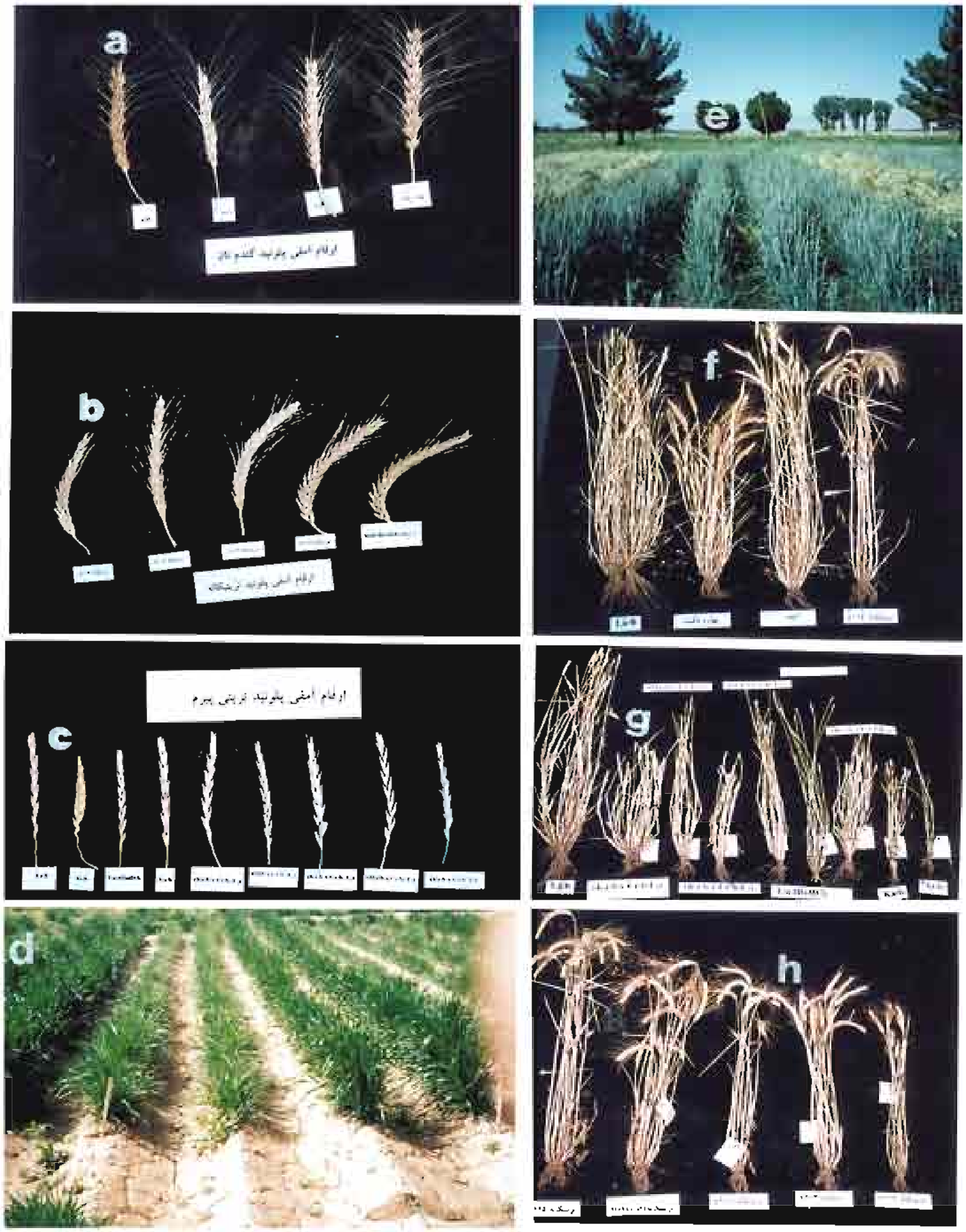

Fig. 1: The morphology plants growth, spikes and late maturity of tritipyrum lines in comparision with triticale and wheat varieties in field condition. a) Left to right: the spike morphology of local iranian wheat varieties kavir, omid alvand and bahare baft. b) Left to right: the spike morophology of five triticales breeding lines: 4103, 4116 and M45/ß54. C) Left to right: the spike morphology of tritpyrum lines: La/b, Az/b, La(4B/4D)/b, Ka/b, (Ka/b)x(Cr/b),F_2, (St/b)x(Cr/b),F_2, (Ka/b)x(Cr/b),F_3, (Ma/b)x(Cr/b),F_3 and (Ka/b)x(Cr/b),F_4. d) Vegetative growth of tritpyrum (middle) with wheat (left) and triticale (right). e) The late maturity of tritipyrum (middle: green) with wheat (left: yellow). f) Left to right: the morphology of whole plantys of tritipyrum(La/b: one plant) in comparision with wheat (bahare baft and omid: one plant of each) and triticale (4115: one plant). g) Left to right: the morphology of tritpyrum: La/b(one plant), (Ka/b)x(Cr/b)F_2(one plant), (Ka/b)x(Cr/b)F_3(two plant), La(a/B/4D)(three plant), Ka/b(one plant) and Az/b(one plant). h) Left to right: the morphology of triticALES (4108, 4108, 41115, 4116 and M45/ß54: one plant each)

Table 2: The mean of morphological and agronomical characters of tritipyrum, triticale and local Iranian wheat cultivars

Genotype	Survival (%)	Tiller number	Height (cm)	Ear emerge (day)	Maturity (day)	Spikelet per spike
Az/b	18±8.7	1±0.58	46±13.1	162±1.8	212±61	13±3.6
Ka/b	21±6.4	6±1.7	44±2.4	165±2.6	209±1.2	12±0.3
La/b	29±3.8	12±1.9	74±8.9	169±1.1	218±1.3	13±0.3
La(4B/4D)/b	26±3.6	9±1.6	60±8.6	164±1.8	211±3.2	12±1.1
Ka/bxCr/b, F_3	29±3	12±2.1	57±4	162±0.58	212±0.5	13±0.3
Ka/bxCr/b, F_5	28±2	13±1.9	54±3.7	164±1.2	257±5.2	13±0.8
Ka/bxCr/b, F_6	23±4.9	10±1.3	52±2.1	164±1.7	204±8.3	12±0.5
Ma/bxCr/b, F_4	29±2.9	9±1.7	69±2.8	165±1.2	214±2.8	15±0.5
St/bxCr/b, F_4	27±3.1	9±1.6	68±2.5	160±0.8	213±3.2	13±0.6
Triticale 4103	24±6	7±0.7	70±4.7	170±6.3	188±1.5	24±0.9
Triticale 4108	25±1.8	6±1	74±1.7	162±8.1	197±6.4	28±0.4
Triticale 4115	28±1	7±1.5	82±4.1	160±6.7	195±7.1	27±1.2
Triticale 4116	24±6.6	5±0.9	73±5.7	150±0.4	190±1.4	28±1.5
TriticaleM45/Beta54	22±5	7±1.3	72±5.3	163±7	192±0	27±1.4
Omid	25±3.3	13±0.8	76±3.7	167±1.1	206±2.4	18±0.7
Alvand	29±7	9±2.3	53±2.9	156±1.2	197±0	19±0.3
Kavir	28±5.3	8±1.3	54±3	151±1.3	193±2.6	20±1.1
Bahare baft	21±4.6	10±2.6	54±7	160±7	191±1.8	19±1.2
Grand mean	25.33	8.5	62.89	161.33	194.56	18.0
CV %	39.13	31.13	16.83	14.71	15.16	13.61
LSD (Genotypes)	14.7	3.76	15.04	33.72	41.92	3.48

Table 2: Continued

Genotypes	Side florets	Seed/side florets	Fertility (%)	Biological yield (g)	Grain yield (g)	1000-grain weight (g)	Harvest
indexAz/b	25±7.2	20±5.8	80±23.1	183±54.6	20±5.7	28±8.2	0.11
Ka/b	23±0.6	20±0.9	86±2.3	362±172.7	303±202	25±6.4	0.41
La/b	27±1	22±1.4	84±4.9	1091±233	104±22.1	26±0.6	0.10
La(4B/4D)/b	24±2.2	19±2.5	80±4.7	208±182.7	71±35.5	27±0.6	0.70
Ka/bxCr/b, F_3	26±0.5	23±0.3	89±1.4	996±189.3	129±30.5	33±1.6	0.13
Ka/bxCr/b, F_5	27±1.5	24±2	90±3.4	1023±185	135±42.5	34±1	0.13
Ka/bxCr/b, F_6	23±1	18±1.3	77±3.7	649±156.9	87±35.2	33±0.4	0.13
Ma/bxCr/b, F_4	29±1	23±1.7	81±1.9	857±248.9	115±39.9	31±3.2	0.13
St/bxCr/b, F_4	27±1.3	23±1.1	88±1.5	766±281.1	81±32.1	24±0.7	0.11
Triticale 4103	48±1.7	42±3	87±4	1005±314	251±94.5	31±1.6	0.23
Triticale 4108	56±0.8	52±0.9	93±1.2	875±107.3	254±47.8	30±1.2	0.29
Triticale 4115	53±2.4	49±1.7	92±1.5	1126±259	292±42.3	35±2.2	0.26
Triticale 4116	56±3	50±3.5	90±1.9	769±386	199±108	35±2.3	0.23
Triticale M45/Beta54	54±2.9	47±2.5	88±0.9	949±337	227±93.5	34±1.3	0.21
Omid	36±1.4	28±2.5	79±6.4	999±162.1	155±49.3	34±1.5	0.14
Alvand	39±0.5	32±1.7	83±3.3	840±237.2	184±73.4	31±0.09	0.20
Kavir	40±2.2	33±0.7	83±4.2	739±169.9	194±69.7	37±0.7	0.24
Bahare baft	39±2.4	31±3.9	78±6.8	1039±221	262±94.1	35±1.7	0.22
Grand Mean	36.22	31.89	84.89	804.22	153.33	31.83	0.22
CV %	13.24	15.4	5.7	47.36	91.19	17.21	32.14
LSD (Genotypes)	6.82	6.82	19.33	321.14	198.73	7.79	0.1005

Table 3: The analysis of variance for various traits of nine tritipyrum lines, five promising triticale lines and four local Iranian wheat varieties

Source of variation	Survival (%)	Tiller number	Height (cm)	Ear emergence (day)	Maturity (day)	Spikelet per spike	Side florets	Grain per side florets	Fertility (%)	Biological yield (g)	Grain yield (g)	1000-grain weight (g)	Harvest index
Genotypes	47^{ns}	38^{**}	825^{**}	1568^{**}	2414^{**}	177^{**}	634^{**}	634^{**}	544^{**}	315977^{*}	24888^{*}	151^{**}	0.018^{**}
Blocks	6^{ns}	63^{**}	353^{*}	202^{ns}	1154^{ns}	11^{ns}	49^{ns}	49^{ns}	8^{ns}	1380537^{**}	98365^{**}	28^{ns}	0.008^{ns}
Errors	98	7	112	563	870	6	23	23	185	145055	19551	30	0.005

** Significant at 1% level, * Significant at %5 level, ^{NS}: non-significant

of surviving plants of the tritipyrum lines was higher than the varieties (Table 2). The number of survival plants (Table 2) in tritipyrum lines was higher than the survival in the first trail in UK (Hassani, 1998) indicating that although the wheat and triticales are winter sown crops, the tritipyrums also have a good survival potential.

The analysis of variance for tiller number (Table 3) showed a highly significant difference for this trait among all genotypes. They range from 1±0.58 (Az/b) to 13±1.9 (Ka/bxCr/b, F_4 and Omid) tillers per plants (Table 2). The analysis of variance for height (Table 3) showed a significant difference between tritipyrum genotypes, with a range of 44±2.4-74±8.9 cm in comparison with triticles (70±4.7-82±4.1 cm) and the wheats (54±3-76±3.7 cm). The height variation (Table 2) showed similar differences between tritipyrum lines and the triticale lines and local wheat varieties. These results are in agreement with King *et al.* (1997) and Hassani *et al.* (1998, 2000).

The analysis of ear emergence (Table 3) showed meaningful differences between all genotypes, with the range of 160±0.8 to 169±1.1 days (tritipyrums), 150±0.4 to 170±6.3 days (triticales) and 151±1.3 to 167±1.1 (wheat varieties) but there was no difference between the blocks of the experiment. This character can be used as an indicator of the maturity behaviour of tritipyrum in comparison to the triticale and wheat varieties. All tritipyrum lines had later ear emergence than wheat and triticale lines (Fig. 1e). The analysis of grain maturity (Table 3) showed meaningful differences between all genotypes, with the mean ranging (Table 2) from 204±8.3 to 257±5.2 days (tritipyrums), 188±1.5 to 197±6.4 days (triticales) and 191±1.8 to 206±2.4 days (wheats).

All tritipyrum lines showed a brittle rachis. There was a clear variation in the number of spikelets per ear ranging (Table 2) from 12±0.3(Ka/b) to 28±1.5 (Triticale 4116). The results of the analysis of variance for spikelet per leading spike of each genotype (Table 3) showed a huge difference between genotypes for this character. In all lines of tritipyrum, triticale and wheat, the number of spikelets and seed number per side florets of all spikelets in each leading spikes were counted and then the fertility (%) was calculated for each lines. The analysis of variance for fertility (Table 3) showed a considerable difference between lines of tritipyrum, triticale and wheat. The mean fertility in the leading tiller of the tritipyrum lines ranged from 77±3.7 (ka/bxCr/b, F5) to 90±3.4 (Ka/bxCr/b, F4), for the triticales from 87±4 (triticale 4103) to 93±1.2 (triticale 4108) and for the wheats from 78±6.8 (Bahare baft) to 83±3.75 (Alvand and Kavir). The average fertility of the open-pollinated tritipyrums in the field study in Iran was higher than both the field [(35.3±2.4% (St/*Th. junceiforme*) to 75.3±4.7% (La/b)] and the greenhouse [13.5±13.5% (St/*Th. junceiforme*) to 67.0±5.2% (Né/b)] in the UK (Hassani *et al*., 1998). All tritipyrum lines studied here showed relatively moderate levels of fertility in comparison to triticale lines and the local Iranian wheat cultivars (Table 2). This may be due to increased chromosome stability at meiosis, resulting from further self-pollination generations since the UK studies (Hassani *et al*., 1998).

The analysis of variance for biological yield (Table 3) showed a difference between genotypes with the mean variation (Table 2) ranging from 183±54.6 g (Az/b) to 1126±259.2 g (triticale 41115) per plot. The analysis of variance for grain yield (Table 3) showed a considerable difference between genotypes means with the variation (Table 2) ranging from 20±5.7g (Az/b) to 292±42.3 g per plot (triticale 41115). The analysis of variance for 1000 grain weight (Table 3) also showed a high difference between genotypes for this character with the mean variation (Table 2) ranging from 24±0.7 g (St/bxCr/b, F3) to 37±0.7 g (Kavir). The analysis of variance for harvest index (Table 3) demonstrated a high difference between genotypes for this character with the average variation (Table 2) ranging from 0.07 (La(4B/4D)/b) to 0.41 (Ka/b).

The overall results in the current evaluation of tritipyrum lines with triticale and Iranian local wheat varieties in first trial in kerman province demonstrated that the tritipyrums have a reasonable agronomical performance potential which are in agree with the results of Hassani *et al*. (2000), King *et al*. (1997) and Hassani (1998). They had the average survival of over 50% average of nine tillers per plant and fertility of 83.89%. Their mean for the biological yield, grain yield, 1000-grain weight and the harvest index were 681.67, 116.11g, 29 and 0.15%, respectively (Table 2). The large variation for all the characters studied shows there is considerable potential for the improvement of tritipyrum as a new cereal in comparison with commercial varieties of local Iranian wheat and promising triticale lines. In this respect the development of tritipyrum has parallel aspects with the development of triticale, which in early stages, also showed similar variation, but breeding and continuing selection especially within the wheat components produced a successful new cereal to the world farming system. In spite of involving meiotically unstable lines of tritipyrum in the field study, the reasonable low CV compared to the triticale lines and wheat cultivars (Table 2) indicates the accuracy and reliability of this field trail results. Normally the CV varies greatly with the type of experiment, the crop grown and the character measured (Gomez and Gomez, 1984). These preliminary results shows the potential of tritipyrum as a new cereal crop and indicated the further need of its development and farming in Iran, particularly in Kerman province.

ACKNOWLEDGEMENT

The authors are grateful to the college of agriculture for supporting the budget of the project. Thanks are also due to Mr. Marefat from salinity research station for providing the seeds of triticale lines and Engineer Amiri from the Kerman Research Center for providing the seeds of the local Iranian wheat varieties.

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