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Determination of Heat Susceptibility Indices for Some Quantitative Traits in Bread Wheat (*Triticum aestivum* L. em. Thell.)

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ABSTRACT

The present investigation entitled "Determination of Heat Susceptibility Indices for Some Quantitative Traits in Bread Wheat (Triticum aestivum L. em. Thell.) was undertaken to understand the impact of higher temperature on yield attributing characters and to select higher heat stress tolerant parent and cross combinations for future breeding programme. To fulfill the requirement of this objective, the experiment was conducted in two environments i.e. normal (15th Nov.) and very late sown (15th Jan.) condition with 10 diverse genotypes, their 45 F_1's and F_2's. In the present study, the HSI value of parents and crosses for different quantitative characters was calculated and genotypes were classified in to four different categories i.e. highly heat tolerant (HSI < 0.50), heat tolerant (HSI: 0.51-0.75), moderately heat tolerant (HSI: 0.76 – 1.00) and heat susceptible (HSI > 1.00). The overall ranking of heat susceptibility index indicated that among the parents Raj 4083, Raj 4037 and Raj 3777 and among the crosses Raj 3765 × Raj 4037 followed by Raj 3777 × Raj 4037 and Raj 4037 × Raj 4083 were found to be desirable for most of the characters as they attained HSI value less than 1.

Key words: *Wheat, Heat Susceptibility Index, Quantitative Trait, Environment*

INTRODUCTION

Wheat is the primary crop because it is grown across an exceptionally diverse range of environments, from the arid plains of Africa to the humid valleys of Veitnam and from the cold of Nepal[9] to the heat of India/Pakistan[2]. Wheat is an important crop of India not only in terms of acreage, but also in terms of its versatility for adoption under wide range of agro climatic conditions and crop growing situations. Despite the wide adaptation of wheat (*Triticum aestivum* L.), which can be grown in many different environments ranging from temperate-irrigated to dry and high-rain-fall areas and from warm-humid to dry-cold conditions[1,7], drought and heat stresses are of common occurrence during grain filling in wheat growing areas with a Mediterranean climate[17].

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Blum (1988) stated that there are limited studies on the genetics of heat tolerance. Genetic information regarding yield and various yield components contribute significantly in the selection of desirable parents and resulting progenies to develop and execute effective breeding program to evolve high yielding and stress tolerant varieties. Lawlor[6] reported that specific responses of a plant to environmental factor (heat) are similar but differ quantitatively depending on genotype and are of great importance in plant breeding and crop adaptation to stress conditions. Breeding of thermo-tolerance forms is an integral component of wheat breeding programmes at both national and international level. Realization of potential wheat yield in hot irrigated climate is enshrined goal of our breeding program.

By keeping the above facts in view, there is a need to develop new genotypes having genetic structure to tolerate thermal stress to sustain and enhance productivity of wheat under warmer areas of India.

MATERIAL AND METHOD

In the Present investigation ten bread wheat (*Triticum aestivum* L. em. Thell.) varieties/ strains namely: Raj 3765, WH 1021, Raj 3777, Raj 4037, Raj 4120, PBW 343, Raj 4083, Raj 4238, DBW 17 and PBW 550 were crossed in half diallel fashion during *Rabi* 2013-14. Half of the F_1's seed was use to advance the generation in *Rabi* 2014-15. Finally, the whole experimental material (Ten genotypes along with their 45 F_1's and 45 F_2's progenies) was evaluated in Randomized Block Design with 3 replications in 2 environments (two different dates of sowing 15 Nov. and 15 Dec.) timely sown and very late sown, at Agricultural Research Farm of RARI Durgapura. Row length was 3 meter. Row to row and plant to plant distance was kept 30 cm and 10 cm, respectively. Observations were recorded for days to heading (75%), days to maturity (75%), grain filling period (days), plant height (cm), flag leaf area (cm^2), peduncle area (cm^2), number of tillers per plant, spike area(cm^2), number of grains per spike, grain yield per spike (g), 1000-grain weight (g), harvest index (%) and grain yield per plant (g) on 10 randomly selected plants in each of the F_1's progenies along with each parent while 30 plants were selected in F_2's population from each replication. Mean values over selected plants was used for analysis of heat susceptibility index.

Heat susceptibility index (HSI) was calculated for grain yield and other quantitative traits over high temperature stress (very late sown) and non-stress environment (normal sown) by using the formula as suggested by Fisher and Maurer[5].

HSI = [l-YD/YP]/D

Where,

YD = mean of the genotypes in stress environment.

YP = mean of the genotypes under non-stress environment.

D = 1-[mean YD of all genotypes/mean YP of all genotypes].

RESULTS AND DISCUSSION

The impact of climate change is clearly evident from recent vagaries across regions in India. Ferrara *et. al.*[4], concluded that terminal heat stress is a common abiotic factor responsible for reducing yield. The results of present investigation demonstrated that the mean performance of parents, F_1's and F_2's under E_2 (very late sown) environment reduced in comparison to E_1 environment (normal sown) [Table 1] [3, 8, 10, 11, 12, 13, 14,15,16].

On the basis of HSI, the parents, F_1's and F_2's were classified as highly tolerant, tolerant, moderately tolerant, and susceptible to heat stress. As evident from Table 2, parent DBW 17, Raj 4238 and Raj 4083 for days to heading; Raj 4037, Raj 4120, Raj 4083 and

Raj 3765 for days to maturity; Raj 4037, Raj 3777 and Raj 4120 for grain filling period, DBW 17, Raj 4037 and PBW 550 for plant height; DBW17, WH 1021 and Raj 4120 for flag leaf area; Raj 4083, Raj 3765 and Raj 4037 for peduncle area; PBW 550, DBW 17 and WH 1021 for tillers per plant; Raj 3777, Raj 4083 and Raj 4120 for spike area; Raj 4037, Raj 3777 and Raj 3765 for number of grains per spike; Raj 3765, Raj 4083 and Raj 4120 for grain yield per spike; Raj 4083, Raj 3765 and Raj 3777 for 1000-grain weight; Raj 4083 and Raj 3777 for harvest index and Raj 4037, Raj 3777 and Raj 4083 for grain yield per plant were least affected under very late sown conditions (E_2). An overall assessment of parents for all the studied characters indicated that Raj 4083, Raj 4037, and Raj 3777 were found to be desirable for most of the characters on the basis of HSI.

Considering heat susceptibility index (HSI) in F_1's (Table 2), the crosses WH 1021 × Raj 4120, WH 1021 × Raj 3777, Raj 3765 × DBW 17, Raj 4083 × PBW 550 and Raj 3765 × Raj 4238 for days to heading; Raj 3765 × Raj 4037, Raj 3777 × Raj 4037, PBW 343 × Raj 4083, Raj 3765 × Raj 4083 and Raj 3765 × Raj 4120 for days to maturity; PBW 343 × PBW 550, Raj 4037 × Raj 4120, Raj 3777 × Raj 4083, PBW 343 × DBW 17 and Raj 3777 × Raj 4037 for grain filling period; Raj 3765 × Raj 4037, Raj 3765 × Raj 3777, Raj 3765 × PBW 550, Raj 4120 × Raj 4238 and Raj 3765 × WH 1021 for plant height; WH 1021 × Raj 4037, Raj 4037 × PBW 343, Raj 4120 × PBW 550, Raj 4037 × Raj 4083 and WH 1021 × Raj 3777 for flag leaf area; Raj 3765 × DBW 17, WH 1021 × Raj 4037, WH 1021 × Raj 4083, WH 1021 × PBW 550 and Raj 4037 × Raj 4083 for peduncle area; PBW 343 × PBW 550, Raj 3765 × DBW 17, WH 1021 × DBW 17, Raj 3765 × PBW 550 and WH 1021 × Raj 3777 for number of tillers per plant; DBW 17 × PBW 550, Raj 4083 × PBW 550, Raj 4037 × Raj 4083, Raj 3777 × PBW 550 and Raj 4120 × PBW 550 for spike area; Raj 4037 × Raj 4120, Raj 3765 × PBW 343, Raj 4120 × Raj 4083, Raj 4037 × Raj 4238 and Raj 3777 × Raj 4120 for number of grains per spike; Raj 4037 × DBW 17, Raj 4037 × Raj 4083, Raj 3777 × DBW 17, Raj 3765 × Raj 4037 and WH 1021 × DBW 17 for grain yield per spike; Raj 4037 × Raj 4238, Raj 4037 × Raj 4083, Raj 3777 × Raj 4120, Raj 3777 × Raj 4238 and Raj 4083 × Raj 4238 for 1000-grain weight; Raj 3777 × Raj 4037, Raj 4120 × Raj 4238, Raj 3765 × Raj 4238, Raj 3777 × Raj 4120 and Raj 4120 × Raj 4083 for harvest index and Raj 4037 × DBW 17, Raj 4037 × Raj 4238, Raj 3777 × PBW 343, Raj 3765 × Raj 4037 and Raj 3777 × Raj 4120 for grain yield per plant exhibited comparatively more tolerance under very late sown conditions (E_2). It is well known that grain yield is prime concern of any breeding programme, therefore F_1 crosses Raj 4037 × DBW 17, Raj 4037 × Raj 4238, Raj 3777 × PBW 343, Raj 3765 × Raj 4037 and Raj 3777 × Raj 4120 which exhibited comparatively more tolerance among 45 F_1's for grain yield per plant were considered as desirable for heat stress tolerance in E_2.

Perusal of Table 2 in F_2's, the crosses, WH 1021 × Raj 4120, PBW 343 × Raj 4083, Raj 3765 × Raj 4083, WH 1021 × Raj 3777 and Raj 3765 × PBW 343 for days to heading; Raj 3765 × Raj 4083, Raj 3765 × Raj 4037, WH 1021 × Raj 4083, Raj 4037 × Raj 4083 and Raj 4037 Raj 4120 for days to maturity; PBW 343 × PBW 550, PBW 343 × DBW 17, Raj 4120 × Raj 4083, Raj 4037 × Raj 4120 and Raj 3765 × Raj 4037 for grain filling period; Raj 3765 × Raj 3777, Raj 3765 × WH 1021, Raj 3765 × Raj 4037, Raj 4120 × Raj 4238 and Raj 3765 × PBW 550 for plant height; Raj 3765 × DBW 17, Raj 3765 × PBW 550, Raj 3777 × Raj 4037, Raj 4238 ×

DBW 17 and Raj 4037 × DBW 17 for flag leaf area; WH 1021 × Raj 4083, Raj 4083 × DBW 17, Raj 3765 × DBW 17, Raj 3777 × Raj 4083 and WH 1021 × Raj 4037 for peduncle area; Raj 3765 × PBW 550, PBW 343 × PBW 550, Raj 3765 × Raj 4238, Raj 3765 × PBW 343 and PBW 343 × Raj 4083 for number of tillers per plant; Raj 4083 × PBW 550, Raj 3777 × PBW 343, Raj 3777 × DBW 17, Raj 4120 × PBW 343 and DBW 17 × PBW 550 for spike area; Raj 4037 × Raj 4083, Raj 4083 × Raj 4238, Raj 4037 × Raj 4120, Raj 4120 × Raj 4083 and Raj 4037 × Raj 4238 for number of grains per spike; Raj 4037 × DBW 17, DBW 17 × PBW 550, Raj 3765 × Raj 4238, Raj 4037 × Raj 4083 and Raj 3777 × Raj 4037 for grain yield per spike; Raj 4083 × Raj 4238, DBW 17 × PBW 550, Raj 3777 × PBW 550, Raj 3777 × Raj 4120 and Raj 3777 × DBW 17 for 1000-grain weight; Raj 3777 × Raj 4037, Raj 4120 × Raj 4083, Raj 4120 × Raj 4238, Raj 3765 × Raj 4238 and Raj 4083 × Raj 4238 for harvest index and Raj 3765 × Raj 4037, Raj 3777 × Raj 4037, Raj 4083 × Raj 4238, Raj 3765 × Raj 3777 and Raj 3765 × WH 1021 for grain yield per plant showed high heat tolerance under very late sown conditions (E_2). On the basis of HSI for grain yield in F_2 generation Raj 3765 × Raj 4037, Raj 3777 × Raj 4037, Raj 4083 × Raj 4238, Raj 3765 × Raj 3777 and Raj 3765 × WH 1021 were considered as desirable for thermal stress tolerance in E_2. Resemblance across the generations indicated the superiority of the crosses Raj 3777 × Raj 4037, Raj 3765 × Raj 4083, Raj 3777 × Raj 4037, Raj 4037 × Raj 3777, Raj 4037 × Raj 4238 and Raj 4120 × PBW 550 under vey late sown condition (E_2). Low value of heat stress intensity (D- value) indicated that parameters *viz.*, days to heading, harvest index, days to maturity, grain filling period, tillers per plant and 1000-grain weight were less affected while gain yield per plant, grain yield per spike, number of grains per spike, flag leaf area, spike area, plant height and peduncle area with high heat stress intensity (D- value) suffered more under E_2 environment.

Perusal of Table 2 manifested that the parents Raj 4083, Raj 3777 and PBW 550; in F_1 crosses Raj 4037 × DBW 17, Raj 4037 × Raj 4238, Raj 3777 × PBW 343, Raj 3765 × Raj 4037 and Raj 3777 × Raj 4120 and in F_2 Raj 3765 × Raj 4037, Raj 3777 × Raj 4037, Raj 4083 × Raj 4238, Raj 3765 × Raj 3777 and Raj 3765 × WH 1021 exhibited comparatively more tolerance for grain yield per plant under very late sown conditions (E_2).

The characters *viz*., gain yield per plant, grain yield per spike, number of grains per spike, flag leaf area, spike area, plant height and peduncle area with high heat stress intensity (D- value) suffered more under very late sown condition while. low value of heat stress intensity (D-value) indicated that parameters *viz.*, days to heading, harvest index, days to maturity, grain filling period, tillers per plant and 1000-grain weight showed more tolerance to heat stress. Similar findings were also observed for days to heading, days to maturity, spike length, plant height and harvest index by Singh *et. al*.[12]. Prakash Ved *et. al.*[15], also reported higher D-value for grain yield/m^2.

On the basis of heat susceptibility index, the parents Raj 3777, Raj 4037 and Raj 4083 were most desirable parents in E_2. As a consequence, it is recommended that these genotypes may perform as potential donor for heat tolerance. These parents should be further exploited for improvement of grain yield under late sown conditions. The HSI should be taken as important criteria for breeding wheat genotypes suitable for heat stress.

Table 1: Mean of parents, their F_1's sand F_2's for various characters in normal (E_1) and very late sown condition (E_2) in bread wheat

Character	Environment	Parents	F_1's	F_2's
Days to heading	E_1	79.10	77.21	78.59
	E_2	60.70	60.13	59.99
Days to maturity	E_1	125.66	126.29	126.64
	E_2	95.00	94.09	93.31
Grain filling period	E_1	46.56	49.07	48.06
	E_2	34.30	33.96	33.33
Plant height	E_1	90.25	92.60	90.63
	E_3	59.54	54.99	54.84
Flag leaf area	E_1	24.76	23.65	24.16
	E_2	12.79	11.94	11.82
Peduncle area	E_1	30.73	32.36	31.48
	E_2	17.78	19.73	19.17
Number of tillers per plant	E_1	7.00	7.39	6.75
	E_2	4.67	4.43	4.32
Spike area	E_1	39.33	41.78	39.23
	E_2	20.79	22.65	22.35
Number of grains per spike	E_1	49.34	52.85	51.59
	E_2	23.31	25.77	25.17
Grain yield per spike	E_1	1.87	2.11	1.90
	E_2	0.68	0.80	0.74
1000-grain weight	E_1	38.77	38.83	37.05
	E_2	24.16	23.60	23.06
Harvest index	E_1	40.31	40.71	40.16
	E_2	27.93	30.51	29.71
Grain yield per plant	E_1	18.68	21.55	21.00
	E_2	8.37	9.91	8.65

Table 2: Heat susceptibility indices for yield and its contributing attributes in E_2 in comparison to E_1 environment

Parents	Days to heading	Days to maturity	Grain filling period	Plant height	Flag leaf area	Peduncle area	Tillers per plant	Spike area	No. of grains per spike	Grain yield per spike	1000-grain weight	Harvest index	grain yield per plant
Raj 3765	1.01	0.92	0.82	0.83	0.98	0.49	1.07	1.11	0.86	0.81	0.79	1.37	0.95
WH 1021	0.98	0.95	0.93	0.80	0.92	1.76	0.68	1.31	1.29	1.22	1.30	1.50	1.23
Raj 3777	1.20	0.96	0.62	0.85	1.00	0.75	0.82	0.53	0.83	0.94	0.87	0.96	0.76
Raj 4037	1.08	0.85	0.56	0.78	1.02	0.71	1.32	0.96	0.75	0.96	0.94	1.10	0.74
Raj 4120	1.08	0.88	0.63	0.92	0.92	0.92	1.29	0.93	0.88	0.91	1.00	1.40	1.01
PBW 343	1.02	0.95	0.87	1.02	1.09	1.56	0.72	1.44	1.14	1.09	1.04	1.11	1.38
Raj 4083	0.95	0.92	0.88	0.97	1.11	0.45	1.04	0.56	0.96	0.83	0.75	0.70	0.80
Raj 4238	0.89	0.99	1.11	0.92	0.93	0.99	0.72	1.08	0.87	0.97	1.05	1.07	0.92
DBW 17	0.82	1.02	1.27	0.74	0.50	1.67	0.66	1.33	1.30	1.26	0.99	1.36	1.08
PBW 550	1.11	1.02	0.91	0.78	1.07	1.20	0.34	1.12	1.25	1.16	1.03	1.19	0.90
F_1 crosses													
P1xP2	0.84	0.91	1.02	0.87	1.11	0.97	0.68	1.29	1.16	1.14	0.86	0.51	0.92
P1xP3	1.02	0.99	0.77	0.78	1.12	0.67	1.03	0.96	0.88	0.85	1.19	0.74	0.72
P1xP4	0.83	0.85	0.78	0.77	0.81	0.86	0.84	0.93	1.08	0.67	0.84	0.74	0.66
P1xP5	0.91	0.88	0.94	0.99	0.84	0.92	0.93	1.17	0.98	1.01	1.28	0.61	0.79
P1xP6	1.05	1.07	1.20	1.02	1.27	1.28	1.06	1.28	0.67	0.77	0.95	1.70	0.99
P1xP7	0.80	0.87	1.02	1.10	0.84	0.64	0.96	0.94	1.04	0.74	0.96	0.43	0.80
P1xP8	0.76	1.06	1.27	1.07	0.86	0.69	0.96	1.08	0.81	0.82	1.20	0.00	0.95
P1xP9	0.70	1.08	1.25	1.10	0.96	0.41	0.28	1.36	0.95	0.93	1.24	1.80	1.06
P1xP10	0.88	1.08	1.13	0.83	0.76	1.06	0.62	0.92	1.11	1.23	1.24	1.12	1.13
P2xP3	0.69	0.99	1.29	0.93	0.74	1.38	0.67	1.27	1.32	1.06	1.10	1.28	0.82
P2xP4	0.77	0.98	1.16	1.10	0.56	0.47	1.31	1.11	1.30	1.23	1.01	0.96	0.92
P2xP5	0.89	0.90	1.01	1.10	1.10	1.37	1.14	1.25	1.38	1.34	1.42	1.59	1.18
P2xP6	0.68	1.01	1.30	1.04	1.12	1.51	0.96	1.13	1.23	1.12	1.02	1.13	1.30
P2xP7	1.08	0.96	1.01	0.96	1.08	0.50	0.89	1.36	1.00	1.19	1.14	0.54	1.15
P2xP8	1.10	1.04	0.98	1.12	0.99	0.75	1.11	1.12	1.13	1.23	1.03	0.65	1.09

P2xP9	0.88	1.05	1.23	1.15	0.87	1.15	0.48	1.41	0.99	0.69	1.14	1.20	1.16
P2xP10	1.09	1.16	1.21	1.23	1.13	0.57	0.88	0.94	1.04	1.11	1.08	1.02	1.13
P3xP4	0.99	0.86	0.70	1.13	0.76	0.92	1.40	0.89	0.78	0.80	0.68	-0.56	0.72
P3xP5	0.94	0.91	0.91	1.18	1.08	0.72	1.07	1.12	0.75	0.94	0.61	0.01	0.70
P3xP6	0.92	1.08	1.34	1.27	1.09	0.79	1.19	0.76	0.88	0.99	0.72	0.86	0.60
P3xP7	1.29	0.95	0.42	1.00	0.86	0.66	1.21	0.93	0.77	0.77	0.85	0.50	1.02
P3xP8	1.11	1.04	0.95	1.10	1.14	1.13	0.87	0.88	0.94	0.88	0.67	0.85	0.77
P3xP9	0.92	0.99	1.08	1.13	1.09	1.40	1.21	0.76	1.06	0.63	0.97	1.43	0.72
P3xP10	0.91	1.07	1.33	0.97	0.87	1.10	1.39	0.73	1.05	0.96	0.94	1.67	0.91
P4xP5	1.26	0.90	0.30	0.89	1.39	1.07	0.95	1.02	0.57	0.98	0.68	0.57	0.77
P4xP6	1.02	0.92	0.80	1.13	0.59	0.76	1.09	0.87	1.21	1.03	0.84	1.06	0.97
P4xP7	0.82	0.95	1.13	0.98	0.70	0.62	1.21	0.52	1.02	0.60	0.56	0.70	0.91
P4xP8	0.83	0.93	1.08	0.94	0.92	1.20	1.56	0.87	0.70	0.80	0.45	0.68	0.55
P4xP9	1.08	1.03	0.92	0.91	0.74	0.78	0.83	1.29	0.90	0.60	1.35	0.89	0.48
P4xP10	0.80	0.99	1.12	1.10	1.17	0.73	1.03	0.78	1.12	0.80	0.85	1.41	0.87
P5xP6	0.89	0.94	1.10	1.11	0.90	1.13	1.17	1.14	1.04	1.20	1.39	1.73	1.21
P5xP7	1.16	0.98	0.70	0.96	1.20	1.18	1.20	0.95	0.76	1.29	1.24	0.27	1.21
P5xP8	1.04	1.13	1.06	0.84	1.03	1.00	1.59	0.86	0.70	1.01	1.30	-0.32	0.97
P5xP9	0.87	0.90	0.92	0.90	0.95	1.30	0.94	1.14	1.13	0.90	0.87	1.10	1.28
P5xP10	0.80	0.88	0.95	1.09	0.64	0.93	0.77	0.73	0.94	1.06	1.17	0.81	0.88
P6xP7	0.98	0.87	0.90	1.12	0.77	0.83	0.68	0.92	1.13	1.30	0.93	1.20	1.13
P6xP8	0.91	0.88	0.86	1.13	1.25	1.24	1.54	1.22	0.91	1.15	0.88	1.23	1.18
P6xP9	1.35	0.94	0.43	1.01	1.39	1.27	1.35	1.30	1.15	0.95	0.85	1.35	1.14
P6xP10	1.48	0.94	0.23	1.04	0.97	1.45	0.17	1.10	1.03	1.01	1.29	1.36	1.07
P7xP8	1.04	1.03	0.85	1.15	0.97	1.10	1.65	1.30	0.78	1.27	0.67	0.56	0.80
P7xP9	0.84	1.08	1.32	1.14	1.09	0.79	0.89	1.19	1.03	1.11	1.08	0.97	1.17
P7xP10	0.75	1.10	1.47	0.93	1.04	1.35	1.50	0.60	1.08	1.22	1.27	1.76	0.82
P8xP9	0.88	1.07	1.24	0.96	0.96	1.08	1.60	1.00	1.05	0.94	0.72	0.82	1.16
P8xP10	1.25	1.09	0.89	1.01	1.25	0.86	1.05	0.88	1.07	1.26	1.49	1.37	1.13
P9xP10	1.08	1.10	1.11	0.93	0.97	1.39	1.09	0.52	0.98	1.00	1.28	1.02	1.09
F_2 crosses													

P1xP2	0.93	0.98	1.04	0.78	1.15	1.04	1.07	1.17	1.32	1.11	1.19	0.68	0.79
P1xP3	1.06	1.05	1.04	0.70	1.20	0.72	0.75	1.11	0.87	1.27	1.36	0.44	0.73
P1xP4	1.01	0.82	0.59	0.80	0.93	0.74	0.66	0.87	1.10	1.15	0.80	0.83	0.53
P1xP5	0.96	1.00	1.05	1.03	0.91	0.94	0.56	1.00	1.18	1.18	1.25	0.71	0.97
P1xP6	0.80	1.16	1.49	1.04	1.24	1.14	1.00	1.03	1.00	0.76	1.00	1.28	1.09
P1xP7	0.79	0.82	0.88	1.09	0.95	0.89	0.46	0.92	0.95	0.99	0.73	0.54	0.91
P1xP8	0.86	1.13	1.37	1.02	0.90	0.68	1.29	0.88	0.97	0.58	1.29	0.07	0.99
P1xP9	0.99	1.04	1.10	0.92	0.69	0.54	0.03	1.36	1.15	0.90	0.91	1.51	1.20
P1xP10	1.18	1.22	1.21	0.87	0.78	0.80	0.78	1.08	1.28	0.89	1.60	1.35	1.23
P2xP3	0.79	1.08	1.40	0.90	1.07	1.36	1.05	1.17	1.13	1.02	0.99	1.33	0.85
P2xP4	1.01	1.09	1.15	1.03	0.88	0.56	0.86	1.23	1.10	1.29	0.83	0.99	1.23
P2xP5	0.64	1.05	1.54	1.08	1.02	1.19	1.07	1.08	1.25	1.22	1.10	1.66	1.28
P2xP6	0.94	1.05	1.15	0.91	1.24	1.37	0.78	0.99	1.13	1.32	0.80	1.62	1.36
P2xP7	0.94	0.87	0.80	0.96	1.24	0.48	0.91	1.34	1.05	1.15	0.98	0.39	1.04
P2xP8	1.24	1.01	0.74	1.06	1.06	0.67	0.77	0.97	1.00	1.15	1.19	1.02	1.00
P2xP9	1.09	0.98	0.85	1.07	0.91	1.18	0.96	1.37	0.93	0.68	1.24	1.38	1.19
P2xP10	1.19	0.97	0.72	1.15	0.95	0.63	0.77	0.84	0.97	1.13	1.06	1.27	1.12
P3xP4	1.05	0.96	0.87	1.04	0.78	0.88	1.31	0.84	0.89	0.59	0.60	-0.38	0.54
P3xP5	0.95	0.97	1.02	1.11	1.08	0.73	0.94	0.99	0.75	0.69	0.51	0.30	0.80
P3xP6	0.84	1.06	1.32	1.19	1.13	1.03	1.09	0.59	0.86	0.96	0.90	0.98	1.17
P3xP7	1.15	0.91	0.59	0.98	1.18	0.55	1.04	0.85	0.99	1.10	0.77	0.96	1.14
P3xP8	1.13	1.07	1.00	1.15	1.14	1.21	1.19	0.84	0.80	0.86	1.16	1.07	0.83
P3xP9	1.08	1.09	1.11	1.07	1.09	1.47	0.70	0.64	0.94	0.73	0.56	1.46	1.18
P3xP10	1.04	1.14	1.25	0.99	1.01	1.00	1.27	0.69	1.30	1.08	0.49	1.55	1.03
P4xP5	1.12	0.89	0.58	1.03	1.11	1.06	0.89	0.78	0.62	0.79	0.70	0.28	0.84
P4xP6	1.14	1.02	0.87	1.10	0.88	0.88	0.97	0.81	0.96	0.96	0.60	1.02	1.16
P4xP7	1.04	0.88	0.67	0.88	0.91	0.67	0.97	0.77	0.37	0.58	1.05	0.62	1.06
P4xP8	1.01	0.99	1.00	0.98	0.88	1.38	1.21	0.72	0.74	0.95	0.91	0.63	0.80
P4xP9	1.03	1.04	1.09	0.90	0.81	0.73	1.28	1.19	0.89	0.29	1.28	1.10	1.06

P4xP10	1.14	1.06	0.98	1.12	0.86	0.68	0.98	0.68	0.98	0.80	0.83	1.64	0.95
P5xP6	0.83	1.08	1.34	1.01	0.90	1.21	0.90	0.99	1.27	1.09	1.35	1.58	1.16
P5xP7	1.16	0.91	0.57	0.94	1.04	1.26	0.88	0.96	0.65	1.23	1.52	-0.17	1.10
P5xP8	0.98	1.10	1.28	0.85	1.06	0.90	1.17	0.88	1.08	1.35	1.57	-0.03	1.06
P5xP9	1.01	1.08	1.15	0.98	1.13	1.43	1.15	1.08	1.13	0.73	1.05	0.85	1.35
P5xP10	0.93	1.02	1.14	0.94	1.03	0.78	0.93	0.83	0.92	1.07	0.71	0.97	0.90
P6xP7	0.75	0.96	1.25	1.15	0.98	0.82	0.57	0.80	1.25	1.10	0.72	1.01	1.18
P6xP8	1.07	1.08	1.13	1.02	1.17	1.20	0.77	1.01	0.88	1.08	0.65	1.35	1.22
P6xP9	1.25	0.94	0.56	1.05	1.29	1.37	1.06	1.15	1.13	0.95	0.61	1.47	1.22
P6xP10	1.60	1.06	0.36	1.03	1.17	1.60	0.38	1.02	0.92	0.82	1.03	1.41	1.15
P7xP8	0.98	0.90	0.81	0.99	1.08	1.13	1.40	1.06	0.54	1.24	0.24	0.25	0.73
P7xP9	0.96	1.12	1.31	1.08	1.04	0.50	0.83	1.19	1.09	0.88	0.96	1.56	1.25
P7xP10	0.86	1.03	1.20	0.89	0.83	1.19	1.34	0.48	1.12	1.00	0.93	1.58	0.80
P8xP9	1.29	1.05	0.75	1.03	0.80	1.23	1.48	1.12	1.00	0.75	1.22	0.75	1.23
P8xP10	1.36	1.07	0.73	1.02	1.18	0.91	0.72	0.90	0.84	1.23	1.58	1.46	1.26
P9xP10	1.11	1.02	0.92	1.03	0.91	1.39	0.89	0.68	1.02	0.38	0.45	1.02	1.18
D-Vaue	**0.23**	**0.26**	**0.30**	**0.39**	**0.50**	**0.39**	**0.38**	**0.45**	**0.51**	**0.62**	**0.38**	**0.26**	**0.56**

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