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COMPARATIVE PERFORMANCE OF BREAD WHEAT CULTIVARS IN PURE AND MIXED STANDS: RESPONSE OF YIELD COMPONENTS AND STRIPE RUST SEVERITY

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ABSTRACT

To examine the potential of wheat (*Triticum aestivum* L.) cultivar mixtures in stabilizing yield and reducing stripe rust (*Puccinia striiformis* West) severity, five Egyptian wheat cultivars (Sakha 69, Sakha 8, Sids 7, Sids 1 and Giza 164) were planted in pure stands and in 1:1 mixtures at Sakha Agricultural Experimental Station in two successive seasons 1997/1998 and 1998/1999. Stripe rust severity and yield contributing traits, i.e. stem length, spike length, number of spikelets/spike, weight of kernels/spike, 1000-kernel weight and grain yield were measured. Yielding ability of mixtures relative to highest and mid components and competitive ability of the cultivars in the mixtures were estimated. Generally yield components were higher in the second season compared to the first one due to absence of stripe rust in the 2nd season. The mixture (Sakha 69 + Sids 7) improved grain yield obtained by 71.7% and 54.8% relative to the high components and 31.5% and 88.4% relative to mid components in the 1st and 2nd seasons, respectively. This mixture had relatively lower stripe rust severity rating compared to other mixtures, but not significantly lower than its components. In both seasons Sakha 69 was the best competitor for number of heads and grain yield. A negative correlation (both phenotypic and genotypic) was found between both number of heads and grain yield with spike length, number of kernels per spike and 1000 kernel weight in both seasons. During the 1st season, stripe rust severity was negatively correlated with number of spikelets/spike, number of kernels/spike and number of heads. In general, the results of this study show the importance of prior testing for cultivar potential for blending and the advantages that can be gained from mixtures in stabilizing yield and reducing stripe rust severity.

Keywords: Mixtures, rust, wheat, yield components

INTRODUCTION

Wheat (*Triticum aestivum* L.) is a major cereal food crop in Egypt. Wheat occupied 2.4 million acres in Egypt during the winter of 2001 (Statistical book 2001) which yielded about 6.3 million tons. Large acreage and continuous monoculture of genetically uniform crops not only provide a pathogen with a substrate in both area and time, but also result in rapid selection for virulent races of the pathogen. It is a major challenge to wheat [illegible] cultivar for a given location is often becomes susceptible to an important production hazard such as disease or insect. Releasing wheat cultivars with single, race –specific resistance genes have proved to be short-lived in many host pathogen systems (Mundt and Browning, 1985). Several strategies were suggested to prolong the live time of newly released cultivars with race specific resistance. Among these strategies are the use of durable resistance (Xianming, 2002), multilines or cultivar mixture (Mundt and Browning, 1985 and Wolfe, 1985). Multilines cultivars have had significant commercial success (Browning and Frey, 1969 and Mundt and Browning, 1985), however, cultivar mixtures are more easily deployed. Cultivar mixtures can be prepared from existing, agronomically superior cultivars and require no additional breeding (Dileone and Mundt, 1994). In addition the diversity present in cultivars in the mixture can provide additional protection against primary and secondary diseases. Several studies on different crops also recommend blending or mixing cultivars within or among species to stabilize and to maximize production (Kannenberg and Hunter, 1972, Fehr and ..., 1974 and Rajeswara Rao and Prasad 1984).

Many epidemiological studies with cultivar mixtures have demonstrated reduction in disease severity of some pathogens below the mean of their component cultivars (Mcdonald et al., 1988 Brophy and ..., 1991) and increases in yield (Finchk and Mundt, 1992). Previous ... on mixing of wheat cultivars in Egypt also showed significant increase ... compared to the mixture components (Sallam 1995). Mixtures may increase yield in the absence of disease (Khalifa and Qualset, 1974) and contribute to yield stability (Akanda and Mundt, 1997). In addition, ... competition in mixed stands of wheat genotypes is ... production and reducing genotype-environment interactions. Such ... important to the agronomists as genotypes with high competitive ability ... be useful to combat the weed problem. They also important to ... breeders for predicting the fate of genotypes with low competitive ability ... heterogeneous populations (Rajeswara Rao and Prasad, 1984).

Stripe rust (*Puccinia striiformis* West) is a major disease of wheat in cool humid climates. Frequent epidemics of stripe rust have been reported in many countries (Ma, et al., 1997) and specifically in Egypt (El-Dawoudy, 1997). Infrequent attacks of stripe rust make the incorporation of resistance genes for this pathogen a difficult task in wheat breeding programs. However, it is more likely for a cultivar to stand the attack of a given race of the pathogen when it is in a mixture than when in pure stand.

The relationship between yield and its components and both incidence and severity of stripe rust has been reported (King, 1976; Sharma et al., 1985 and Yang and Zeng, 1989). But such relationship was mainly investigated under monoculture of wheat and it requires further investigation under mixtures.

The objectives of this study were to (1) estimate the yielding competitive ability of wheat cultivars in pure and mixed stands, (2) examine the role of some potential wheat mixtures in stabilizing yield and reducing disease and (3) estimate the simple genotypic and phenotypic correlations between yield components under disease stress.

MATERIALS AND METHODS

Wheat cultivars

Five Egyptian wheat cultivars, representing different regions and growth patterns (Sakha 69, Sakha 8, Sids 7, Sids 1 and Giza 164) were planted in pure stands and in 1:1 mixtures in Sakha Agricultural

Experimental Station (Kafr El-Sheik governorate) in two successive seasons 1997/1998 and 1998/1999.

Experimental design and treatments

Experiments were laid out in a randomized complete block design with three replications. Each plot consisted of three rows, 3 meters long and 25 cm apart. Single vacant row separated adjacent plots. Recommended practices for wheat production regarding fertilization and weed control were applied Planting dates for the two seasons were on 29^{th} and 30^{th} of November in 1997/1998 and 1998/1999 seasons, respectively.

Disease inoculation

All plots were uniformly dusted with a mixture* of urediospores of *P. striiformis* by beginning of March. Spores were mixed in talc powder in a ratio of approximately 1:25 (v:v). This procedure was done to get uniform infestation, though natural infection later in the season was abundant. Spreader rows of susceptible wheat cultivar Sids 7 were randomly distributed around the experiment borders to encourage natural disease spread.

Data on stripe rust severity were recorded on 10 random tillers in middle rows on mid April Disease severity was assessed by visually estimating the percent of leaf area covered with stripe rust lesions on the leaf below the flag leaf using a scale of 0,1, 5, 10, 20, 30, 40, 50, 60, 70, 80, 90, and 100% (Schultz and Line, 1992). Artificial infestations were attempted during 1998/1999, but environmental conditions were not conducive and only weak disease symptoms were obtained. At end of every season, 10 random tillers in the middle row were harvested to be used in the measurement of yield contributing traits, i.e. stem length, spike length, number of spikelets/spike, weight of kernels/spike and 1000-kernels weight. Number of spikes per one meter and their grain yield were also measured.

Data analyses

Collected data were statistically analyzed by analysis of variance (ANOVA) using PROC GLM (SAS Institute Inc, 1996). Means of cultivars were separated using Duncan's Multiple Range Test. Homogeneity test of data variance at both years was performed showing significant differences between years. Accordingly, combined analyses of variance was not used and each year was presented separately.

Phenotypic and genotypic correlation analysis among studied traits were also performed over pure and mixed stands. The covariance analysis (Singh and Chaudhary, 1985) was performed for each pair of traits of yield components in each year separately. Phenotypic correlation (r_p), and genotypic correlation (r_g) among yield attributes and stripe rust severity were calculated from variance and covariance components following Miller et al. (1958) as:

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*The mixture of spores was kindly provided by Dr. Yousef El-Dawoudy, Dept, of Cereal Pathology, ARC, Giza.

$$\text{Phenotypic correlation} = r_p = \frac{\sigma^2 p_{1,2}}{\sqrt{\sigma^2 p_1 \cdot \sigma^2 p_2}}$$

where $\sigma^2 p_{1,2}$ is the phenotypic covariance between trait 1 and 2, $\sigma^2 p_1$ and $\sigma^2 p_2$ are the phenotypic variances of traits 1 and 2, respectively. The genotypic (r_g) correlation was similarly estimated using the genotypic covariance between traits 1 and 2 ($\sigma^2 g_{1,2}$) and their respective genotypic variances ($\sigma^2 g_1$, $\sigma^2 g_2$).

In addition, percent of the yielding ability of mixtures relative to the highest component and the mid component were calculated (Rajeswara Rao and Rajendra Prasad, 1984) using the formulae:

Yield ability relative to highest component (%)= (Y mix / Y mono) x 100

Yield ability relative to mid component (%) = (Y mix / Y mid- mono) x 100

Where Y mix = Mean performance of mixed stand

Y mono = Mean performance of highest component when grown in a pure stand

Y mid-mono = Mid-mono culture performance = (Ya mono + Y b mono)/ 2

Where Ya and Yb = pure stand performance of cultivar a and b, respectively.

Competitive ability of each cultivar in the mixture was also measured by its performance in competition compared with its performance in pure stand. Competitive ability was estimated (Fehr 1973) from the equation:

Competitive ability = (mean performance of cultivar in mixture - mean performance of cultivar in mono)/ mean performance of cultivar in mono) x 100

RESULTS AND DISCCUSION

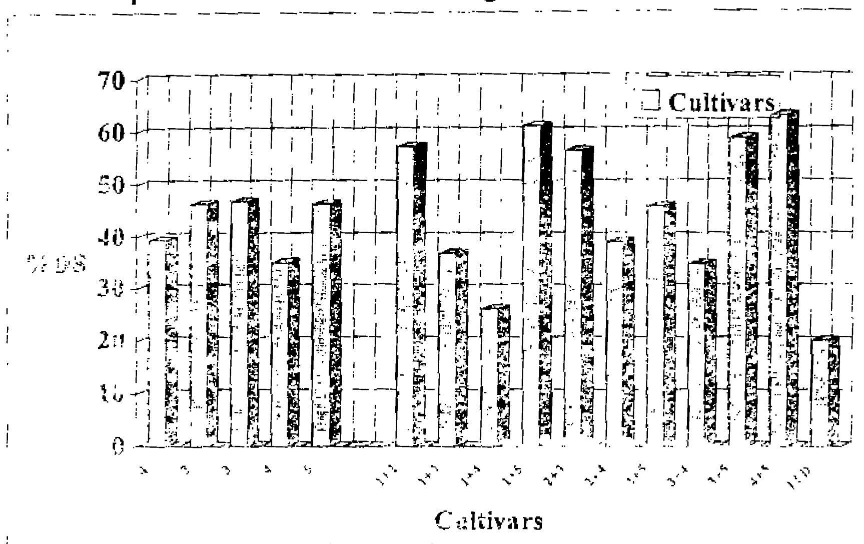
Yield components were significantly different (P<0.001) between the two seasons. This variation between the seasons is probably due to the abundance of stripe rust in the first season and not in the second one

Mean performance of yield components and stripe rust severity in two seasons are presented in Table (1) and Fig (1), respectively. Significant differences among genotypes were detected in all plant characteristics in both seasons except number of spikelets/spikes. Generally yield components were higher in the second season compared to the first one, except for number of heads. This is probably due to absence of stripe rust in the 2nd season. In pure stands, Sids 7 was the shortest cultivar in both seasons, while Sakha 8 and Giza 164 were the tallest. No significant differences were found in number of spikelets per spike in both seasons. During the 1st season, Sids 7 in pure stand, scored the highest in spike length, number and weight of kernels per spike, and 1000 kernel weight. However, it had the lowest number of heads and grain yield compared to the other cultivars in pure stands. These results are expected for Sids 7 as is known to have a single large spike and it is very susceptible to stripe rust. Giza 164 scored highest yield during 1st season, while Sids 1 was the highest in the 2nd season. No significant differences were detected in stripe rust severity in Pure stands (Fig 1).

Table (1): Mean performance for plant characteristics of 5 Egyptian wheat cultivars and their 1:1 mixtures in 1997/1998 (S1) and 1998/1999 (S2).

No.	Cultivar/mixture	Plant height		Spike length		No. Spikelets/ spike		No. Kernels/ spike		Wt Kernels/ spike		Wt 1000 Kernels		No. heads/1m		Grain yield /1m	
		S1	S2	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
1	Sakha69	87.0	88.0	9.1	12.6	17.6	21.0	41.0	65.0	0.9	3.4	29.0	48.5	106.0	54.0	86.5	104.4
2	Sakha8	94.0	94 0	8.9	9.5	17.9	21.5	42.2	45.8	1.0	2.2	29.0	43.8	127.0	83.2	100.9	117.1
3	Sids7	79.0	77.0	12.6	10 5	18.9	20.8	57.8	46.6	1.9	2.3	45.7	43.9	47.3	99.5	53.7	162.3
4	Sids1	82.0	91 0	7.7	10 1	16 4	22.0	33.3	48.9	1.1	2.3	39.8	48.8	120 0	112.7	106.9	182.3
5	Giza164	92.0	107.0	9.6	11.2	20.6	22.9	46.7	54.7	1.1	2.7	30.5	48.0	136.0	92 4	127.5	124 1
1+2	Sakh69 +Sakha 8	81.0	91.0	8.5	13.4	19.0	23.0	37.9	66.9	0.9	3.6	38.2	55.0	122.7	61.8	96.5	104.2
1+3	Sakha69+Sids 7	77.0	75.0	8.0	11.0	17.2	22.7	41 0	52.0	0.8	2.6	42.7	49.8	124.0	124.0	92.2	251.2
1+4	Sakha69+Sids 1	97.0	107.0	9.4	13.0	23.6	21.8	47.3	56.3	0.9	3.1	42 2	54.5	114.0	52.6	86.4	101.3
1+5	Sakha69+Giza 164	98.0	102 0	7.7	10.0	16.6	20.4	35.5	43.8	0.9	2.0	37.2	42.9	106.7	97.5	78.5	144.1
2+3	Sakha8+Sids7	86.0	97.0	8.7	10.7	19.0	21 6	43.3	47.1	0.8	1.9	44.9	41.3	116.0	81.1	81.7	138.9
2+4	Sakha8+Sids1	85.0	85.0	8.3	11 9	17.9	20.9	40.8	65.5	0.8	3.4	45 4	56.1	105.3	83.2	67.6	144.9
2+5	Sakha8+Giza164	93.0	108.0	9 4	11 7	17.0	21 8	41.4	64 3	0.9	3 3	35.5	50.7	124.0	83.2	93.7	127.7
3+4	Sids7+Sids1	83.0	90.0	7.3	10.7	14.7	21.8	34.7	56.6	0.9	2.6	31.3	39.3	161.3	91.3	123.7	163.3
3+5	Sids7+Giza 164	82.0	92.0	8.1	10.5	14.7	21 7	32.3	50 8	1.1	2 5	38.0	51.9	116.0	92 4	102.1	161.1
4+5	Sids1+Giza164	98.0	105.0	8 4	11 2	18 0	21.5	34.5	57 6	1.1	2.7	41.2	46.1	102.7	77.1	92.3	119.2
	LSD (0.05)	11.9	9.9	2.0	1.3	NS	NS	13.5	10.0	0.3	0.6	6.9	6.1	33 3	18.8	44.6	42.7

Figure (1): Percent stripe rust severity (% DS) of five wheat cultivars in pure and mixed stands during 1997/1998 season.



(1) Sakha69, (2) Sakha 8, (3) Sids7, (4) Sids1 and (5) Giza164.

In mixtures, Sakha 69 + Sids 7 and Sids7 + Sids1 scored relatively higher grain yield in both seasons. The grain yield of Sakha 69 + Sids 7 surpassed both its single components in both years and specially during the 2nd season. This finding points to the advantage tnat can be gained from mixtures in yield gains. Similar results were found by Rajeswara Rao and Rajendra Prasad, 1984; Sallam, 1995 and Akanda and Mundt, 1996. It is worth noting that during the 1st season, these two mixtures had relatively lower stripe rust severity rating compared to other mixtures (Fig. 1). Therefore, the utilization of such mixture can be a good means to stabilize and improve yield of wheat over years. Sakha 69 + Sids 1 also scored significantly lower disease severity rating compared to many other mixtures (Fig. 1). Finchk and Mundt, 1992, reported similar reductions in stripe rust in some wheat mixtures. However, the grain yield of this specific mixture did not surpass its single components (Table 1). On the other hand, several other mixtures were not compatible and resulted in a higher disease severity (Fig. 1).

Relative yielding ability percent for each wheat cultivars mixture relative to high and mid component are presented in Table (2). Results of the 1st season showed that the blend (Sakha 69 + Sids1) had the highest number of kernels per spike relative to high and mid component, while (Sakha 8 + Sids1), (Sakha 8 + Giza 164) and (Sids 7 + Sids 1) were higher during the 2nd season. In the 1st season, performance of the mixtures relative to high and mid component in weight of kernel per spike was decreased in all mixtures except for (Sids1 + Giza 164), where it was the same. However, during the 2nd season, the mixtures (Sakha 8 +Sids1), (Sakha 8 + Giza 164) and (Sids 7

+ Sids 1) showed an increase in weight of kernel per spike relative to both high and mid components. That increase ranged from 13 to 47.8 % relative to the highest component and 13 to 51.1% relative to the mid component. For 1000 kernel weight, noticeable increase in performance was found in the majority of mixtures in both seasons. For number of heads, the mixture (Sakha 69 + Sids7) showed a major increase relative to high component and mid component (162.2% and 61.8%. respectively) during the 1st season. This increase in number of heads is probably attributed to the compensation of Sakha 69 to the lower number of tillers contributed by Sids 7 in the mixture.

Table (2): Percent yielding ability of yield components and stripe rust severity relative to the high and mid components for 1:1 cultivar mixtures of wheat in two seasons 1997/98 (S1) and 1998/99 (S2).

Cultivar Mixture	No. Kernels/ spike		Wt kernels/ spike		Wt 1000 Kernels		No. heads/1m		Grain yield/1m		Disease
	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2	S1
Yielding ability relative to the high component											
1+2	89.8	102.9	90.0	105.9	131.7	113 4	96.6	74.3	95.6	89.0	123.8
1+3	70.9	80.0	42 1	76 5	93.4	102.7	262.2	124.6	171 7	154.8	78.8
1+4	115.4	86.6	81 8	91.2	106.0	111.7	95.0	46.7	80.8	55.6	66.7
1+5	76.0	67.4	81.8	58.8	122.0	88.5	78.5	105.5	61.6	116.1	132.5
2+3	74.9	86.1	42.1	82.6	98.2	94.1	91.3	81.5	81.0	85.6	120.8
2+4	96.7	133.9	72.7	147.8	114.1	115.0	82.9	73.8	63.2	79.5	84.2
2+5	101.0	117.6	81.8	122.2	116.4	115.8	91.2	90.0	73.5	102.9	98.9
3+4	60.0	108.8	47.4	113.0	68.5	89.5	134.4	81.0	115.7	89.6	74.3
3+5	91.0	92.9	57.9	92.6	83.2	108.1	85.3	92.9	80.1	99.3	125.9
4+5	73.9	105.3	100.0	100.0	103.5	94.5	75.5	68.4	72.4	65.4	136.4
Yielding ability relative to the mid component											
1+2	91.1	120.8	94.7	128.6	131.7	119.2	105.3	90 1	103.0	94.1	133.9
1+3	83.0	93.2	57.1	91.2	114.3	107 8	161.8	161.6	131.5	188.4	85.6
1+4	127.3	98.9	90.0	108.8	122.7	112.0	100.9	63.1	89.3	70.7	70.5
1+5	81.0	73.2	90.0	65.6	125.0	88.9	88.2	133.2	73.4	126.1	143.2
2+3	86.6	101.9	55.2	84.4	120.2	94.2	133 1	88.8	105 7	99.4	121.3
2+4	108.1	138.3	76.2	151.1	132.0	121.2	85.3	84.9	65.1	96.8	95.9
2+5	93.1	128.0	85.7	134.7	119.3	110.5	94.3	94.8	82.0	105.9	99.0
3+4	76.2	118.5	60.0	113.0	73.2	84.8	192.8	86.1	154.0	94.8	84.9
3+5	61.8	100.3	73.3	100.0	99.7	112.9	126.6	96.3	112.7	112.5	126.6
4+5	86.3	111.2	100.0	108.0	117.2	95.2	80.2	75.2	78.8	77.8	155.2

(1) Sakha69, (2) Sakha 8, (3) Sids7, (4) Sids1 and (5) Giza164.
Note: For disease severity lower values means better performance

During the 2nd season, only the mixtures (Sakha 69 + Sids 7) and (Sakha 69 + Giza 164) maintained an increase in the number of heads. The mixture (Sakha 69 + Sids 7) also improved grain yield obtained by 71.7% and 54.8% during 1st and 2nd seasons, respectively, relative to the high component and 31.5% and 88.4% in the 1st and 2nd seasons, respectively, relative to the mid component. Also the mixture (Sids 7+ Sids1) showed better performance relative to high and mid component during 1st season. For stripe rust severity, the lower severity means better performance and consequently, *the mixtures (Sakha 69 + Sids 7)*, (Sakha 69 + Sids 1) and (Sids7 + Sids1) were the best with reduced disease severity relative to both *the high and the mid component*. These results confirm the value that mixture can add either in yield improvement or stripe rust reduction. It can be seen *that during the* 2nd *season* (when stripe rust was absent), different mixtures from those of the 1st season were superior in grain yield (particularly relative *to the mid component*). This indicates that certain combinations of wheat cultivars can perform better than others when its inoculum of stripe rust is *abundant*.

Table (3) represents percent competitive ability for five wheat *cultivars in* 1:1 mixture relative to the high and mid components for some yield components in two seasons 1997/98 and 1998/99. A good competitor *cultivar* is the one that have greater yield in a competitive situation than it does in pure stand. During the 1st season, mixtures (Sakha 69 + Sids7) and (Sids 7 + Sids 1) had the highest competitive ability in the number of heads and grain yield, which coincided also with relatively low stripe rust severity. In the 2nd season only the mixture (Sakha 69 + Sids7) maintained the highest competitive ability in number of heads and grain yield The components of this mixture Sakha 69 and Sids 7 were the only cultivars with positive values in the general mean of grain yield in both seasons, referring to their high competitive ability. These results mean that the mixture of (Sakha 69 + Sids7) was more stable over the two years and under different environmental conditions. These results show the ability of some wheat mixtures in stabilizing yield over different environments or when stripe rust was present or absent.

During the 2nd season (with stripe rust absent), although *cultivars* Sakha 8, Sids 7 and Sids 1were more competitive in number of kernels per spike, weight of kernels per spike and 1000 kernel weight. *Sakha 69 and Sids* 7 were still the best competitors for grain yield.

In addition, during 1st season, with stripe rust stress. the *average* performance of cultivars showed that Sids 7 was the best competitor in number of heads, grain yield and reduction in stripe rust *severity This* means that the performance of Sids 7 was improved when mixed with other cultivars compared to its pure stand. It is known that *Sids 7 have single large* spike and is highly susceptible to stripe rust. Rust infestation decreases the performance of Sids 7 and limits the use of *this cultivar in several regions*. However, under blended situation, its performance is highly enhanced.

Table (3): Competitive ability (%) of yield components and stripe rust severity for five wheat cultivars in 1 : 1 mixture relative to the high and mid components in two seasons 1997/98 and 1998/99.

Cultivar ratio	No.Kernels/ Spike		Wt Kernels/ Spike		Wt. 1000 Kernels		No. heads/1m		Grain yield/1m		Stripe rust severity	
1997 / 1998												
1:2	-7.6	-10.2	0.0	-10.0	31.7	31.7	15.8	-3.4	11.6	-4.4	45.8	23.8
1:3	0.0	-20.1	-11.1	-57.9	47.2	-6.6	17.0	162.2	6.6	71.7	-6.4	-21.2
1:4	15.4	42.0	0.0	-18.2	45.5	6.0	7.5	-5.0	-0.1	-19.2	-33.3	-25.1
1:5	-13.4	-24.0	0.0	-18.2	28.3	22.0	0.7	-21.5	-9.2	-38.4	55.7	32.5
2:3	2.6	-25.1	-20.0	-57.9	54.8	-1.8	-8.7	145.2	-19.0	52.1	21.8	20.8
2:4	-3.3	22.5	-20.0	-27.3	56.6	14.1	-17.1	-12.3	-33.0	-36.8	-15.8	11.4
2:5	-1.9	-11.3	-10.0	-18.2	22.4	16.4	-2.4	-8.8	-7.1	-26.5	-1.1	-0.9
3:4	-40.0	4.2	-52.6	-18.2	-31.5	-21.4	241.0	34.4	130.4	15.7	-25.7	-0.9
3:5	-44.1	-30.8	-42.1	0.0	-16.8	24.6	145.2	-14.7	90.1	-19.9	25.9	27.3
4:5	3.6	-25.1	0.0	0.0	3.5	35.1	-14.4	-24.5	-13.7	-27.6	80.0	36.4
General mean												
1	-1.4		-2.5		38.2		10.2		2.2		15.5	
2	-0.2		-15.0		41.4		-7.9		-15.9		7.2	
3	-34.6		-52.6		-14.2		173.4		86.1		-0.1	
4	18.1		-15.9		0.6		0.7		-13.5		16.4	
5	23.1		-9.1		24.5		-17.4		-28.1		23.8	
1998 /1999												
1:2	2.9	46.1	5.9	63.6	13.4	25.6	14.4	-25.7	-0.2	-11.0		
1:3	-20.0	11.6	-23.5	13.0	2.7	13.4	129.6	24.6	140.6	54.8		
1:4	-13.4	15.1	-8.8	34.8	12.4	11.7	-2.6	-53.3	-3.0	-44.4		
1:5	-32.6	-19.9	-41.2	-25.9	-11.5	-10.6	80.6	5.5	36.0	16.1		
2:3	2.8	1.1	-13.6	-17.4	-5.7	-5.9	-2.5	-18.5	18.6	-14.4		
2:4	43.0	33.9	54.5	47.8	28.1	15.0	0.0	-26.2	23.7	-20.5		
2:5	40.4	17.6	50.0	22.2	15.8	5.6	0.0	-10.0	9.1	2.9		
3:4	21.5	15.7	13.0	13.0	-10.5	-19.5	-8.2	-19.0	0.6	-10.4		
3:5	9.0	-7.1	8.7	-7.4	18.2	8.1	-7.1	0.0	-0.7	29.8		
4:5	17.8	5.3	17.4	0.0	-5.5	-4.0	-31.6	-16.6	-34.6	-3.9		
General mean												
1	-15.8		-16.9		4.2		55.5		43.9			
2	33.1		38.6		15.9		-7.1		10.1			
3	10.8		4.3		3.8		-2.3		10.1			
4	20.7		28.3		0.4		-32.5		-27.5			
5	-1.1		-2.8		-0.2		-5.2		11.2			

(1) Sakha69, (2) Sakha 8, (3) Sids7, (4) Sids1 and (5) Giza164.

Table (4) represents the phenotypic and genotypic correlation among yield components and stripe rust severity in five wheat cultivars in pure and mixed stand during 1997/98 and 1998/99 seasons. Data reveal that during the 1st season, there was a significant negative correlation (both phenotypic and genotypic) between both number of heads and grain yield with spike length, number of kernels per spike and 1000 kernel weight. The same relationship was also found in the second season, but with less magnitude. This negative relationship is probably due to the inclusion of large spike and

highly susceptible cultivars in pure and mixed stands such as Sids 7. This may have resulted in a negative relationship between yield and spike attributes. Number of heads was highly positively correlated with grain yield (rp=0.886 and rg= 0.896).

Also, during the 1st season, stripe rust severity was negatively correlated with number of spikelets/spike, number of kernels/spike, and number of heads. The relationship between stripe rust and yield, thought was negative, it was not high in magnitude. This is probably because stripe rust was inconsistent among the mixtures (See Fig 1). As a result the general effect of stripe rust was correlated with yield.

In addition, during the 1st season, the values (and sometimes the signs) of both genotypic and phenotypic correlation of those related attributes were not matching. This indicates a higher environmental influence on these traits, which can be attributed to stripe rust stress during the 1st season. On the other hand, during the 2nd season, such disease stress was uncommon and the values for phenotypic and genotypic were matching. In several cases during the 1st season, the genotypic correlation coefficient exceeded the unity. These irregularities probably resulted from the differences in magnitude and signs of the environmental and cultivars phenotypic covariance which affected the estimation of genotypic covariance.

From this study, it was evident that some mixtures performed better than others, and one mixture component was influenced differentially by its companion cultivar. The blending of some cultivars resulted in a compatible response and a more stable performance over environments with and without stripe rust yield (such as Sakha 69 + Sids 7). However, some mixtures were incompatible and resulted in less yield or higher rust severity. Thus, the results of this study clearly reveal the importance of prior testing for cultivar potential for blending and selecting the compatible and competitive cultivars that can integrate with each other and produce the highest yield and express lowest disease incidence. Consequently, such mixtures can stabilize yield over environments and reduce the need for more breeding efforts. However, the use of mixtures to stabilize yield and /or control disease requires thorough studies on stability of the composition of the mixture over years of utilization. This is necessary to reduce the need for blending the desired mixture annually, specially under conditions where certified seed is not available every year.

Table (4): Phenotypic and genotypic correlation among yield components and stripe rust severity in 5 wheat cultivars in pure and mixed stand during 1997 / 98 (above diagonal) and 1998/99 (below diagonal).

		Plht	Spklnth	NoSpklt	NoKrnl	WtKrnl	Wt1000	Noheads	Grnyield	Disease
Plant height	r p		-0.066	0.347	-0.070	-0.209	-0.291	0.111	0.092	0.188
(Plht), cm	r g		-0.086	0.586	-0.165	-0.361	-0.421	0.099	-0.101	0.315
Spike length	r p	0.119		0.488*	0.906**	0.763**	0.187	-0.721**	-0.786**	-0.043
(Spklnth), cm	r g	0.168		0.326	0.981	1.062	0.322	-0.932	-1.374	0.036
No. spikelets/spike	r p	0.077	0.300		0.647*	0.066	0.225	-0.229	-0.202	-0.248
(NoSpklt)	r g	0.120	0.185		0.572	0.170	0.446	0.340	-0.270	0.466
No kernels/spike	r p	0.066	0.837**	0.246		0.532*	0.233	[illegible]	-0.464	-0.261
(NoKrnl)	r g	0.106	0.841	0.137		0.626	0.479	0.807	-0.755	-0.355
Wt kernels/spike	r p	0.005	0.876**	0.253	0.968**		[illegible]	[illegible]	0.349	0.155
(WtKrnl), g	r g	0.019	0.872	0.129	0.984		[illegible]	[illegible]	[illegible]	0.206
1000 kernels wt	r p	0.007	0.677**	0.308	0.615*	0.740**		[illegible]	-0.664	0.062
(Wt1000), g	r g	-0.022	0.714	0.270	0.679	0.768		[illegible]	[illegible]	0.129
[illegible]	r p	[illegible]	[illegible]	0.056	-0.560	[illegible]	[illegible]		[illegible]	-0.210
(Noheads)	r g	[illegible]	-0.793	0.755	0.659	[illegible]	[illegible]			-0.152
Grain yield in 1 m	r p	-0.623*	0.452*	-0.151	-0.376	-0.350	[illegible]	0.686**		-0.119
Grnyield	r g	-0.704	-0.519	-0.139	-0.477	0.416	[illegible]	0.896		0.001

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الاداء المقارن لاصناف قمح الخبز فى الزراعة المنفـــردة والمخــاليط : اســتجابة مكونات المحصول و شدة الاصابة بالصدأ الاصفر

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لاختبار كفاءة مخاليط من القمح فى تحقيق ثبات المحصول و تقليل شدة الاصابــة بــالصدأ الاصفر، فقد تم زراعة خمسة اصناف من القمح المصري (سخا ٦٩ ، سخا ٨، سدس ٧ ، سدس ١ و جيزة ١٦٤) منفردة وفي مخاليط بنسبة ١:١ فى محطة البحوث الزراعية بسخا ، كفر الشيخ فى الموسمين ١٩٩٧/١٩٩٨ و ١٩٩٨/١٩٩٩. تم تقدير صفات مكونات المحصــول المختلفــة بالاضافة لشدة الاصابة بالصدأ الاصفرو كذلك تقدير قدرة المخاليط على زيــادة الانتاجيــة فــى المحصول وتقليل الاصابة بالصدأ. و ايضا دراسة القدرة التنافسية للأصناف عند الخلط مقارنـــة بالمكون الأعلى ومتوسط المكونين .وكذلك علاقات الارتباط الوراثي والمظهري بيــن مكونــات المحصول تحت ظروف الإجهاد المرضىّ للصدأ.

أظهرت النتائج ارتفاع قيم مكونات المحصول بشكل عام فى الموسم الثانى عن الاول نتيجة لغياب الصدأ الاصفر فى الموسم الثانى. ادي استخدام المخلوط (سخا ٦٩ + سدس ٧) الى زيــادة انتاج الغلة بنسبة ٧١,٧ % و٥٤,٨ % بالنسبة للاب الاعلـــى و ٣١.٥ % و ٨٨,٤ % مقارنــة بمتوسط المكونين فى حالة الزراعة المنفردة فى الموسم الاول والثانى على التوالى. كذلك سجل نفس المخلوط نسبة منخفضة للصدأ الاصفر مقارنة بالعديد من المخاليط الاخري ولكن ليس اقل من مكونات هذا المخلوط نفسه. كان الصنف سخا ٦٩ افضل الاصناف تنافسا فى صفات عـــدد السنابل و محصول الغلة. أظهرت النتائج وجود علاقة ارتباط سلبى (وراثى ومظهري) بين عدد السنابل والمحصول مع كل من صفات طول السنبلة و عدد حبوب السنبلة ووزن الالف حبة فــى كلا الموسمين. ايضا فى الموسم الاول كانت هناك علاقة ارتباط سلبى بين شدة الاصابة بــالصدأ الأصفر و كل من طول السنبلة و عدد السنيبلات و عدد السنابل. بصفة عامة تشير نتــائج هــذه الدراسة الي أهمية اختبار أصناف القمح قبل الخلط وكذلك تشير الى المزايا التى يمكن تحقيقها من المخاليط سواء فى زيادة المحصول و وتقليل شدة الإصابة بالإمراض.