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Influence of Water Stress on Yield, Technological and Rheological Characteristics of Some New Wheat Lines.

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ABSTRACT

Moisture stress is an environmental factor that may influence yield and end-use quality of wheat (Triticum aestivum L.). Yield, chemical, and rheological characteristics of new bread wheat lines were evaluated across two different levels of moisture stress. Ten bread wheat genotypes were grown in 2011 /2012 at Shebin El-kom Egypt. Extraction rate, chemical composition, gluten content, and dough rheological properties of wheat grains were evaluated. Results of field evaluation indicated that highly significant genotype differences were recorded for all yield characters studied except number of spikes per plant. Our studies identified a more outstanding lines under each irrigation level i.e. genotypes no. 7, 9, 12 and 21 had the highest values of grain yield under normal conditions (N). On the other hand, under water stress conditions (D), genotypes no 17, 21 and 24 gave the highest values of grain yield. These lines need to more evaluate under the same conditions and more locations in the next year to confirm the superiority. Results of technological and rheological characteristics revealed that genotypes differed in magnitude of chemical, and rheological characteristics response to moisture stress applied through the growing season. Results show that moisture, protein, ether extract, fiber, and ash were significantly higher in whole meal wheat flour (100% extraction) than that found in wheat flour (72% extraction). The highest wet gluten content was significantly higher of whole meal wheat flour than that found in wheat flour (72% extraction). Falling number of 72% extraction wheat flour was significantly higher than that found in whole meal wheat flour. Water absorption and dough stability of whole meal wheat varieties are higher than that of wheat flours (72%) perhaps due to the presence of bran particles in whole meal wheat genotypes which may interfere in quick development of gluten. Whole meal dough were less extensible than wheat flour dough 72% (125-90 mm) and resistance to extension of the studied genotypes of whole meal dough ranged between 620–520 BU, while its wheat flour 72% decreased and ranged between (510-400 BU). Dough energy of the studied wheat genotypes 72% increased and ranged between (85-70 cm^2), while its whole meal decreased between (120-85 cm^2). Heat of transition, maximum viscosity, and temperature of maximum viscosity of whole meal wheat varieties are higher than that of wheat flours (72%). Results obtained from the farinograph and extensograph parameters indicated that there are no significant differences between wheat genotypes produced in normal and drought conditions for the two extraction rate (100% and 72%),. From the previous results of technological and rheological characteristics, it could be recommended to using line24 in pasta; line 10 in bread and line 18 in biscuit product.

Keywords: Bread wheat (Triticum aestivum L.) Moisture stress, Yield, chemical, rheological characteristics and genotype

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INTRODUCTION

Bread wheat (Triticum aestivum L.) is one of the mostimportant winter crops in Egypt, so it is cultivated in about 1.2 million hectares yearly. The production of wheat cultivated area is about 8.7 million tons and which can covers less than 60% of national consumption (FAO, 2012). Egyptian government is going gradually to reduce the dependence on imported wheat by increasing grain yield and productivity (Kherallah et al., 1989)

Drought stress is one of the most widespread environmental stresses, which affect growing and productivity; it induces many physiological, biochemical and molecular responses on plants, so that plants became able to develop tolerance mechanisms which will provide to be adapted to limited environmental conditions (Boyer, 1982; Ludlow and Muchow, 1990).

Due to the limited water resources and the occurrence of Egypt under the water poverty line (1000 cubic meters per person per year) , any expected increase in cultivated land and consequently agricultural production in Egypt is attributed to the improved efficiency of water use for agricultural purposes., the hope is vertical expansion by increasing the unit area productivity. Therefore, breeding programs must focus on to solve this problem. The plant breeder has the responsibility to develop and identify cultivars that will enhance commercial production of a crop. All plant breeding programs have the same ultimate objective to improve yield and quality characteristics in order to produce varieties attractive to farmers or other end users. Wheat breeders are continuously trying to improve the wheat yield under water stress conditions but less interest in improving quality properties.

It has long been recognized that wheat productivity and quality vary considerably as a result of genotype, environment and their interaction. Adverse environmental conditions such as extreme temperature and drought during the anthesis and grain filling period have been identified as major constraints to wheat protein content and composition (Triboï, et al., 2003; Jiang, et al., 2009).While wheat growers consider yield as a major issue, millers and bakers emphasize variability in the functional properties of flour as their biggest concern. Consistency in quality and performance of wheat grain and flour is critical for the output of high quality end products. For the wheat breeder, this means wheat genotypes with good end-use quality must be consistent across environments. Breadmaking quality is a “super trait” and it can be expressed over numerous single characters related to the protein complex, milling properties and baking performances. Finney (1965) provided a general definition for good quality wheat suitable for milling and bread production. In general, a large portion of variation observed in wheat flour quality may be attributed to variation in gluten protein content and composition. The genetics and influence of glutenins on breadmaking quality traits have been described by several researchers (Payne et al., 1987; Lafiandra et al., 1993; Luo et al., 2001).

The Farinograph is the most important and widely used instrument to evaluate the quality and strength of the flour By determining parameters such as water absorption, dough development time, dough stability and weakness. In most cases, attention has been given to evaluating the grain yield and its components rather than the quality of grains, flour and dough, in spite of the importance of these properties to obtain a good product (Mahrous and Abd-Elhady, 2006).

Guttieri, et al., (2000) reported that identification of cultivars with stable end-use quality requires evaluation across a range of protein contents, which are produced by differential soil moisture availability.

This study was designed to determine the effect of water stress on yield and quality characters response to water stress conditions and normal as well. The objective of this study are: field evaluation of nine selected wheat lines under normal (N) and water stress (D) conditions to identify high-yielding genotypes under each levels and to evaluate the effects of water stress on end-use quality to determine the best ones for chemical and rheological characteristics, according to the extraction rate (100% and 72%), to predicate its technological uses, and so as to use the best lines for development of new wheat varieties.

MATERIALS AND METHODS

Field experiment

The plant materials used in this investigation included nine bread wheat lines (which selected from 25 F6 lines evaluated in the former season) and one check cultivar Gemmeza 11 (Triticum aestivum, L.).These lines derived from three way crosses between Egyptian wheat cultivars with CYMMIT and ICARDA germ-plasm lines. These materials were evaluated in Shebin EL-Kom, Menofiya- Governorate, Egypt.) during 2011/2012 growing seasons , under two different irrigation regimes. The first one was normal irrigation (N), five irrigation through the whole season, the second one (water stress D) plants was received two irrigations through the whole season (sowing and first irrigation only). The number and dates of sowing and irrigations are presented in (Table 1).

The two experiments were lay out in a randomized complete block design with three replications. Each plot had six rows, 5 m long with row spacing of 20 cm. The seeds were planted at a seed rate of approximately 500 seeds m-2. The seeds were planted at 21 November. All the normal agronomic practices were followed as usual in the ordinary wheat field in the areas of study. All field trials received water irrigation other than rainfall.

Data on days to heading, plant height (cm), number of spikes/plant, spike length (cm), number of spikelets/spike, 100-kernel weight (gm), grain yield/plant (gm) were recorded.

Table (1): Numbers and dates of irrigations for normal and water stress conditions applied to 10 wheat genotypes in 2011/2012season at Shebin El-Kom region.

Normal irrigation regime (N) (Shebin El-Kom).	Water stress conditions (D (Shebin El-Kom).
First Irri.- November,21(sowing irrigation)	First- Irri.- November,21(sowing irrigation)
Second- Irri.- December, 15	
Third- Irri.- January,23	
Fourth- Irri.- February, 24	Second- Irri.- December, 15
Fifth - Irri.- March, 10	
Sixth- Irri.- March, 25	

Wheat flour quality experiment:

Milling

Wheat grains varieties were manually cleaned, tempered to 14% moisture content, then milled using Quadrumat Junior flour mill. The obtained flour represent whole flour mill (100% extraction), then sieved to obtain flours of 72% extraction.

Rheological properties

Dough characteristics (water absorption, dough development time, dough stability, weakening and mixing tolerance index) were evaluated according to AACC (2000) using Farinograph (model No: 81010, Duisburg, Germany). Dough elastic properties (resistance to extension, extensibility, proportional number and energy) were measured according to AACC (2000) by using Extensograph (Model No: 81010, ©Brabender, Duisburg, Germany). Falling number was determined according to AACC (2000). Viscoamylograph test was carried out according to Kim and D'Appolonia (1977). Wet and dry gluten contents of flour were estimated by following the method No. 38-10 as described in AACC, 2000.

Chemical Analysis

Wheat varieties were analyzed for moisture, crude protein (% N×5.71), ether extract, total ash and crude fiber according to methods described in A.O.A.C. (2000). Total carbohydrates were calculated by the difference (100- (fat+ protein+ ash+ fibers) on dry weight basis.

Statistical Analysis

All data obtained were statistically calculations according to Gomez and Gomez (1984) for yield characters and McClave and Benson (1991) for technological traits and using SPSS computer software, in order to assort genotypes according to their agronomic and rheological characters. Differences between means were compared using LSD test at 5% of probability.

RESULTS AND DISCUSSION

The analysis of variance of all traits studied is presented in Tables (2). Highly significant genotype differences were recorded for all characters except number of spikes per plant indicating the presence of considerable variability between the tested new wheat lines also, these variations among genotypes might partially reflect their different genetic backgrounds. Sultana et al., (2007), Esmail et al,(2008), Abdel-Moneam & Sultan(2009) ,Talebi et al,(2009) ,Ahmadizadeh et al., (2011), Abd El-Ghany et al,(2012) found significant variation in yield and yield component among wheat genotypes under favorable and unfavorable conditions.

Table (2): Mean square values for all studied characters among the ten wheat genotypes evaluated under normal (N) and water stress conditions (D) at (Shebin El-Kom) in 2011/2012 winter growing season.

S.O.V	D.F	Days to heading	Plant height(cm)	Spike no.	Spike length(cm)	Spikelets no./spike	100 Grain weight (g)	Grain yield /plant (g)
Normal irrigation (N)								
Reps	2	1.18	0.64	4.93	0.122	3.91	0.001	0.365
Lines	9	45.96**	603.49**	4.81	7.79**	4.47**	2.9**	26.21**
error	18	2.38	0.84	1.77	0.032	0.51	0.003	4.3.9
Water stress (D)								
Reps	2	0.64	0.273	0.76	0.18	0.031	0.0002	0.121
Lines	9	32.07**	609.25**	1.62	4.27**	3.988**	2.42**	11.12*
Error	18	1.70	0.873	1.69	0.14	0.596	0.006	3.52

The genotypes mean performance for all studied traits are presented in **Table (3)**. Generally, results revealed that the rank of genotypes (perse) relative to its mean performance was differed from one irrigation regime to another indicated that the studied genotypes responded differently to the environmental conditions which suggesting the importance of testing our genotypes under different environments in order to identify the best genetic make up for a particular environment. Genotypes no.7-10 and 24 exhibited more early flowering lines under normal and water stress conditions.

Results obtained here demonstrated that the performance of all genotypes was increased under water stress condition relative to overall mean (average) except spike length (Table 3). This may be attributed to potentials of some genotypes to tolerate water deficit or due disability of some genotypes to produce high grain yield since new tillers death after irrigated (visual remarks), this illustrate decrease of spike number / plant under normal conditions. This result harmony with the previous results obtained in the first season. Water deficits have little impact on the rate of kernel growth, but often shorten the duration of filling. Also, water stress during flowering causes pollen sterility and failure of pollination. Drought during endosperm cell division decreases sink potential by inhibiting cell division and DNA Endo reduplication , and stress later during grain filling shortens the duration of filling by causing premature desiccation of the endosperm and by limiting embryo volume (Saini & Westgate, 2000).

Results with respect to plant height, low value is preferred from the wheat breeder of view, lines (no., 18 and 20) were superior for breeding to dwarf and semi-dwarf cultivars, where their plant height less than 100 cm. i.e., no.6 (98.33cm and 7 (77.66cm) (Table 3). Gupta et al. (2001) and Muzammil (2003) observed substantial decline in plant height when irrigation was withheld at booting stage however, tolerant genotypes attained more plant height.

Concerning number of spikes/plant, 100-kernel weight, grain yield/plant, means performance were increased in water stress condition relative to overall mean performance (average). Spike length as the yield parameters was decreased in water stress condition (**Table 3**).

Concerning no. of spikes per plant, insignificant between genotypes was found also, means ranged from (4.61 to 8.66) and from (5.66 to 8.0) spikes/ plant in normal and water stress levels, respectively, low variability of this trait may be due to the selection practice in the former season. The number of tillers per plant has got direct contribution towards grain yield. It means that, as the number of productive tillers increase, there will be simultaneous increase in yield. Ehadaie et al. (1988) found that the number of spikes per plant was the least affected trait by drought stress and the number of grains per spike was the most affected. Khavarinejad and Babajanov (2011) stated that, to estimate genetic traits for drought tolerance in wheat genotypes, it is necessary that researchers test genotypes for high yield potential in different drought levels. This research has identified genotypes that had both tolerance to drought and high yield potential in a normal environment.

Table (3): Mean performance of nine selected lines and check cultivar evaluated under normal irrigation (N) and water stress (D) at (Shebin EL-Kom) in 2011/2012 winter growing season.

lines	Days to heading		Plant height(cm)		Spike no.		Spike length(cm)		Spikelets no		100 grain weight (g)		Grain yield /plant (g)	
	N	D	N	D	N	D	N	D	N	D	N	D	N	D
1-Line 7	97.31	97.66	121.60	124.0	6.0	5.66	13.13	14.1	24.3	24.66	3.66	4.58	12.6	13.3
2-Line 9	101.5	96.0	122.68	114.0	8.66	7.66	13.06	12.5	23.0	22.66	3.69	5.09	16.6	17.3
3-Line 10	98.66	99.33	101.0	98.0	5.66	7.33	12.5	13.6	22.66	25.0	3.33	3.67	16.0	14.6
4-Line 12	100.6	97.32	115.3	111.0	6.66	6.67	14.96	12.0	26.0	24.0	3.2	4.03	14.0	15.3
5-Line 17	100.0	98.0	120.33	117.0	7.33	7.0	12.3	12.5	23.0	24.66	4.73	5.43	14.6	14.0
6-Line 18	101.6	101.0	98.33	96.33	4.61	7.31	14.5	13.1	24.33	22.66	4.76	3.80	12.6	12.6
7-Line 20	105.3	104.3	77.66	69.64	6.0	6.31	12.1	12.6	22.66	24.66	3.41	3.70	14.6	12.0
8-Line 21	109.3	105.0	106.33	98.23	5.0	8.0	13.16	12.1	24.33	22.67	3.61	3.45	12.0	16.0
9-Line 24	95.71	94.36	117.33	107.6	7.32	6.0	11.53	11.3	23.0	22.31	6.35	6.03	21.3	14.0
Gemeza 11	100.3	98.0	124.0	106.3	4.66	6.33	17.06	15.0	26.0	24.33	5.27	5.42	18.o	16.6
Average	**101.0**	**99.09**	**110.4**	**104.2**	**6.19**	**6.82**	**13.43**	**12.8**	**23.92**	**23.76**	**4.201**	**4.52**	**14.9**	**14.57**
L.S.D.	2.63	1.61	1.56	0.831	2.27	1.16	0.26	0.34	1.22	1.32	0.53	0.44	3.57	3.52

Chemical composition of whole meal wheat flour(100% extraction) and wheat flour (72%extraction):

Data presented in Table (4) shows that moisture, protein, ether extract, fiber, and ash were significantly higher in whole meal wheat flour (100% extraction) than that found in wheat flour (72% extraction). The results of present study are agreed with findings of Butt et al, (1997), Azizi et al. (2006), Dewettinck et al., 2008 and Kamil et al., (2011). It could be regarded to the presence of higher amounts of bran layer and germ which possessed such components with higher amounts than the other layers, in the wholemeal than the 72% extraction one. Several investigators (Kent-Jons & Amos,1967 and Niewczas et al., 1994) stated that germ and bran were higher than endosperm in protein, fat, ash and fiber content, and lower in starch and total carbohydrate. On contrary, total carbohydrates were significantly lower in the former than the latter.

From the results in Table (4), we find that there is no significant differences between wheat genotypes produced in normal and drought conditions for the contents of protein, ash, fat and fibre but in case of comparing different investigated wheat lines, line no.24 produced higher content of protein (13.12%) and fat (2.65%) in drought conditions .

An evaluation of drought and heat effects on wheat in a Mediterranean climate showed the highest grain protein content under warm dry rain-fed conditions and the lowest in the irrigated environment (García Del Moral et al., 2007).

Effect of wheat varieties, extraction rate and producing conditions on falling number and gluten content

The flour gluten content is one of the most important factors responsible for quality and baking strength of wheat flour (Maleki and Parchami, 1976). Gluten and falling number were determined to identify the technological quality of wheat genotypes. Data presented in Table (5) showed that, the highest wet gluten content were significantly higher of whole meal wheat flour than that found in wheat flour (72% extraction). The results of present studies indicated significant differences among wheat lines that might be due to difference in their protein contents. The protein content has been found to be correlated with the gluten content (Anjum and Walker, 2000). The differences in wet and dry gluten contents of different wheat varieties are reflected by the variation in moisture and protein contents (Corbellini et al., 1999). The highest wet and gluten content was found in wheat flour of line 24 (34.02 % and 20.52%), respectively while line 10 in normal and drought reached to 33.52 and 33 %; and the lowest gluten content was found in line 18 produced in drought (26.13%). This result indicated that line 24, line 10 in normal & line 10 in drought condition and line 18 varieties could be used as a durum, hard and soft wheat, respectively. So, it could be recommended to line 24 in pasta; line 10 in normal & line 10 in drought in bread and line 18 in biscuit product. The difference in gluten contents of different wheat varieties may be due to the environmental conditions like temperature, rainfall and their genotypic difference (Ahmad,2001). Falling number (FN) was determined also to evaluate α amylase activity of wheat flour varieties; high the FN value, lower will be enzyme activity. Falling number of 72%extraction wheat flour was significantly higher than that found in whole meal wheat flour. Table (5) showed that, falling number of wheat varieties ranked as follows: gemmeza 11 produced in drought condition (520 sec.), line 9 normal condition (487 sec.), line 10 drought (484 sec.), and the lowest value in line 21 normal (302 sec.). These results are also supported by the study of Anjum & Walker (1991) who reported low alpha amylase activity in Pakistani wheat. Zahoor (2003) analyzed 44 Pakistani wheat varieties and reported FN in the range of 277.83-1065 sec. Moreover, the differences in FN values in different wheat varieties are reflected by the variation in moisture and protein contents (Corbellini et al., 1999).

Rheological properties of wholemeal and wheat flour doughs

Rheological methods are useful in the study of dough properties. Rheometery evaluates important functional properties of flour including viscosity, elasticity and plasticity which can be related with dough behavior during processing and end product quality (Bloksma and Bushuk, 1988).

Farinograph Parameters

Farinograph was used to evaluate rheological properties of ten wheat genotypes. Data presented in Table (6) showed that, water absorption and dough stability of whole meal wheat varieties are higher than that of wheat flours (72%) perhaps due to the presence of bran particles in whole meal wheat varieties which may interfere in quick development of gluten. The results of the dough stability are in line with the findings of Corbellini et al. (1999). Arrival time of whole meal varieties characterized with its highest values in case of line 17 (2.6 min). In addition, wheat flour 72% of line 17 characterized with its higher arrival time (2.1 min) if compared with wheat flour 72% of other varieties. The same trend observed in dough stability time of both whole meal and wheat flour 72% of the twenty investigated varieties. Dough development time and mixing tolerance index of whole meal decreased if compared with wheat flour 72% as affected by bran that contains high fiber. The previous results agreed with Rao et al, 1985 and Shouk, 1996, where they stated that, as flour extraction increase water absorption and dough stability time increased but dough stability decreased. From the results Table (6), we find that there is no significant differences between wheat varieties produced in normal and drought conditions that in farinograph parameters. In general, the flours which have low softening (weakening) values are strong and the ones having high softening values are weak. Similarly, flours which have good tolerance to mixing have low tolerance index and the higher are the tolerance index value; the weaker would be the flour (Farooq et al., 2001). Developing and stability time of the Farinograph mainly due to differences in protein quality. These parameters positively correlated with bread baking quality. These data are in line with those obtained by Uhlen et al., (2004) and Cunibert et al., (2003). Who reported that, development time and stability time of frinogram depend on polymeric protein and not on total protein amount in wheat flour. These parameters are therefore principally depended on genotype. Also Faridi and Faubion (1990) stated that, the dough development time (peak time) is an indicator of protein quality; stronger flour normally require a longer development time than do weaker flour therefore a comparison of peak time indicate the relative strength of different flour.

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Table (4): Chemical composition of whole meal (100%) and 72%extraction wheat flour (on dry wet basis).

Genotypes	Line-7	Line-9	Line-10	Line-12	Line-17	Line-18	Line-20	Line-21	Line-24	Gimmeza 11
Moisture										
Normal (100%)	11.90^{b}±0.35	12.54^{ab}±0.28	11.95^{b}±0.37	12.59^{ab}±0.21	13.24^{a}±0.42	12.23^{ab}±0.15	11.92^{b}±0.36	12.56^{ab}±0.29	12.19^{ab}±0.13	12.22^{ab}±0.15
Drought(100%)	12.29^{ab}±0.12	10.43^{bc}±0.25	12.34^{ab}±0.15	13.30^{a}±0.40	11.90^{b} ±0.36	11.94^{b} ±0.17	12.31^{ab}±0.13	13.26^{a}±0.43	11.92^{b} ±0.32	12.19^{ab}±0.16
Normal (72%)	11.25^{b} ±0.18	11.37^{b}±0.36	11.31^{b} ±0.12	11.33^{b}±0.32	12.30^{ab}±0.34	11.35^{b}±0.11	11.27^{b} ±0.2	11.39^{b}±0.37	11.32^{b}±0.24	11.36^{b}±0.42
Drought(72%)	11.42^{b}±0.22	9.98^{c}±0.32	11.47^{b}±0.23	12.36^{ab}±0.30	11.25^{b} ±0.19	11.29^{b} ±0.29	11.44^{b}±0.25	12.32^{ab}±0.35	11.27^{b} ±0.21	11.34^{b}±0.26
Protein										
Normal (100%)	12.35^{a} ±0.31	11.60^{b}±0.41	12.52^{a}±0.12	13.06^{a} ±0.22	12.15^{ab}±0.15	12.33^{a}±0.05	12.32^{a} ±0.21	11.63^{b}±0.41	11.72^{b}±0.36	12.25^{ab}±0.17
Drought(100%)	11.50^{b}±0.269	12.52^{a}±0.52	12.15^{ab}±0.17	12.00^{ab} 0.25	13.06^{a} ±0.30	11.55^{b}±0.41	12.38^{a}±0.25	12.15^{ab}±0.15	13.12^{a} ±0.25	11.50^{b}±0.33
Normal (72%)	10.48^{c} ±0.46	10.52^{c}±0.18	11.48^{b}±0.15	12.18^{ab} ±0.15	11.25^{b}±0.60	9.71^{c}±0.03	11.28^{a} ±0.42	10.45^{c}±0.18	10.90^{c}±0.22	11.40^{b}±0.35
Drought(72%)	10.25^{c}±0.07	11.48^{b}±0.35	11.22^{b}±0.50	11.13^{b} ±0.30	12.18^{ab}±0.32	10.48^{c}±0.27	9.82^{c}±0.08	11.20^{b}±0.32	12.18^{ab}±0.41	10.82^{c}±0.21
Ether extract										
Normal (100%)	2.60^{a} ±0.07	1.80$^{a\ b}$±0.01	1.75^{ab}±0.03	2.25^{a}±0.07	2.30^{a}±0.02	2.43^{a}±0.01	2.52^{a} ±0.09	1.81^{ab}±0.05	2.36^{a}±0.01	2.31^{a}±0.10
Drought(100%)	2.50^{a}±0.01	2.40^{a}±0.07	2.35^{a}±0.07	2.58^{a} ±0.06	2.63^{a} ±0.09	2.26^{a}±0.03	2.48^{a}0.01	2.32^{a}±0.02	2.65^{a} ±0.07	2.62^{a} ±0.08
Normal (72%)	1.40^{b}±0.05	1.30^{b} ±0.03	1.25^{b} ±0.05	1.33^{b}±0.04	1.40^{b}±0.05	1.38^{b}±0.09	1.33^{b}±0.06	1.30^{b}±0.08	1.35^{b}±0.03	1.32^{b}±0.04
Drought(72%)	1.40^{b}±0.03	1.50^{ab}±0.01	1.82^{ab}±0.02	1.43^{b}±0.05	1.45^{b}±0.06	1.37^{b}±0.07	1.40^{b}±0.03	1.43^{b}±0.05	1.41^{b}±0.06	1.38^{b}±0.05
Fiber										
Normal (100%)	2.10^{a} ±0.01	1.46^{b} ±0.06	1.52^{b} ±0.06	2.25^{a}±0.06	2.18^{a}±0.07	2.23^{a} ±0.09	2.19^{a} ±0.01	1.45^{b} ±0.06	2.32^{a}±0.07	2.37^{a}±0.06
Drought(100%)	2.31^{a}±0.09	1.58^{b}±0.05	1.62^{b}±0.10	2.17^{a} ±0.07	2.10^{a} ±0.01	1.46^{b} ±0.04	2.30^{a}±0.09	2.20^{a}±0.06	2.17^{a} ±0.09	2.44^{a} ±0.07
Normal (72%)	0.44^{c}±0.04	0.43^{c}±0.04	0.28^{c}±0.01	0.38^{c}±0.05	0.42^{c}±0.09	0.49^{c}±0.02	0.45^{c}±0.04	0.28^{c}±0.01	0.48^{c}±0.02	0.45^{c}±0.01
Drought(72%)	0.49^{c}±0.02	0.52^{c}±0.07	0.57^{c}±0.08	0.41^{c}±0.03	0.36^{c}±0.02	0.32^{c}±0.01	0.41^{c}±0.02	0.43^{c}±0.05	0.43^{c}±0.04	0.52^{c}±0.03
Ash										
Normal (100%)	1.52^{a} ±0.01	1.85^{a}±0.01	1.75^{a}±0.06	1.26^{a}±0.06	1.65^{a}±0.06	1.56^{a} ±0.03	1.53^{a} ±0.07	1.81^{a}±0.01	1.79^{a}±0.09	1.52^{a} ±0.10
Drought(100%)	1.80^{a}±0.09	1.26^{a}±0.09	1.81^{a}±0.01	1.62^{a}±0.08	1.52^{a} ±0.04	1.56^{a}±0.09	1.73^{a} ±0.01	1.61^{a}±0.05	1.26 ^{a} ±0.02	1.69^{a}±0.10
Normal (72%)	0.53^{b}±0.03	0.75^{b}±0.05	0.61^{b}±0.03	0.62^{b} ±0.03	0.70^{b}±0.02	0.51^{b} ±0.05	0.52^{b}±0.03	0.79^{b}±0.03	0.72^{b}±0.03	0.65^{b}±0.06
Drought(72%)	0.72^{b}±0.06	0.80^{b} ±0.04	0.67^{b}±0.03	0.63^{b}±0.02	0.53^{b} ±0.05	0.62^{b}±0.05	0.70^{b} ±0.02	0.60^{b}±0.07	0.50^{b}±0.01	0.72^{b}±0.03
Total carbohydrate										
Normal (100%)	81.43^{c}±0.86	83.89^{b}±1.09	82.46^{b}±0.82	81.18 ^{b}± 0.87	81.72^{c}±0.70	81.45^{b}±0.80	81.44^{c}±0.90	83.30^{b}±1.00	81.81^{c}±1.12	81.55^{b}±0.1.01
Drought(100%)	81.89^{c}±1.00	82.24^{c}±0.72	82.07 ^{b}±0.85	81.63^{b}±0.72	80.69^{c}±0.90	83.17 ^{b}±0.96	81.11^{c}±1.01	81.72^{c}±0.78	80.80^{c}±0.92	81.75^{b}±0.72
Normal (72%)	87.15^{a}±0.86	87.00^{a}±0.82	86.38^{a}±0.78	85.5 a ±0.75	86.23^{a}±0.74	87.91^{a}±0.69	81.11^{a}±0.85	87.18^{a}±0.65	86.61^{a}±1.26	86.2 ^{a} ±0.92
Drought(72%)	87.14^{a}±1.18	85.70^{b}±0.63	85.72 ^{a} ±0.72	86.4 ^{a} ±0.92	85.48^{a}±0.84	87.21^{a}±0.89	87.67^{a}±1.10	86.34^{a}±0.73	85.48^{a}±0.86	86.56^{a}±0.87

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Table (5): Falling number and percentage of wet and dry gluten content of whole meal and 72%extraction wheat flour of the ten wheat genotypes studied.

Genotypes	Falling number (Sec.)				Wet Gluten (%)				Dry Gluten (%)			
	100%		72%		100%		72%		100%		72%	
	Normal	Drought	Normal	Drought	Normal	Drought	Normal	Drought	Normal	Drought	Normal	Drought
Line-7	302±2.5	287±3.2	320±3.3	318±3.4	32.00±0.17	28.0±0.19	30.0±0.13	26.0±0.28	20.32±0.46	18.0±0.11	19.05±0.32	16.50±0.17
Line-9	473±2.5	438±2.8	487±2.6	458±2.5	31.0±0.21	33.0±0.32	28.0±0.26	31.0±0.35	18.5±0.18	19.5±0.21	17.8±0.14	18.3±0.15
Line-10	390±3.5	462±1.9	410±2.0	484±3.6	33.52±0.33	33.0±0.18	32.0±0.25	31.0±0.22	19.12±0.22	19.45±0.22	19.0±0.09	18.59±0.31
Line-12	360±2.5	290±3.5	386±3.2	330±3.6	32.24±0.16	28.5±0.35	30.06±0.13	26.18±0.42	19.09±0.12	18.0±0.15	18.5±0.16	17.18±0.26
Line-17	450±2.3	265±2.3	480±2.4	316±3.6	30.0±0.41	29.08±0.19	28.06±0.39	27.05±0.28	18.55±0.13	18.0±0.16	18.0±0.16	17.5±0.22
Line-18	420±2.5	380±3.6	455±3.0	410±3.0	29.8±0.15	26.13±0.29	27.5±0.18	24.25±0.25	17.8±0.15	17.15±0.29	17.7±0.17	16.35±0.16
Line-20	450±3.0	330±3.1	472±3.2	442±2.5	29.5±0.33	29.7±0.12	27.19±0.28	27.28±0.16	18.16±0.32	18.35±0.13	17.56±0.42	17.62±0.19
Line-21	285±2.0	360±2.5	302±2.3	380±3.0	29.02±0.36	31.22±0.18	27.51±0.17	29.16±0.22	17.95±0.17	18.6±0.18	17.56±0.25	17.83±0.17
Line-24	338±3.2	345±3.0	346±3.1	375±3.0	30.38±0.22	34.02±0.32	28.22±0.26	32.12±0.26	19.25±0.22	21.52±0.28	18.36±0.12	19.03±0.52
Gimmeza 11	434±3.4	500±3.7	483±3.2	520±3.2	31.5±0.16	29.32±0.19	28.12±0.13	27.22±0.21	18.75±0.12	18.05±0.13	17.84±0.19	17.5±0.25

Table (6): Farinograph parameters of whole meal and 72%extraction wheat flour of the ten wheat genotypes studied.

Genotypes	Line-7	Line-9	Line10	Line12	Line17	Line18	Line20	Line 21	Line24	Gimmeza 11	Average
Water absorption (%)											
Normal	73.0	74.0	72.5	72.0	73.0	75.0	76.5	73.0	72.0	72.5	73.35
Drought(100%	77.0	73.5	71.5	76.0	73.0	73.0	73.5	72.5	75.5	72.0	73.75
Normal (72%)	68.5	67.0	65.5	67.5	68.0	68.0	69.5	66.0	67.5	65.5	67.3
Drought(72%)	70.0	66.5	66.5	79.0	68.5	68.5	66.5	67.5	68.5	67.0	68.85
Arrival time (min)											
Normal	1.9	2.3	2.0	1.8	2.6	1.6	1.7	1.9	1.6	1.8	1.92
Drought(100%	1.8	2.0	2.3	1.5	1.8	1.7	2.2	2.5	1.5	2.4	1.97
Normal (72%)	1.6	1.6	1.3	1.4	2.1	1.1	1.2	1.6	1.3	1.5	1.47
Drought(72%)	1.3	1.7	1.8	1.0	1.5	1.4	1.5	2.0	1.0	1.9	1.51
Dough development time (min)											
Normal	4.3	2.1	1.8	4.1	4.1	2.3	2.5	2.5	4.0	2.4	3.01
Drought(100%	2.6	2.6	3.8	2.4	4.2	4.0	2.0	4.0	2.3	3.9	3.18
Normal (72%)	6.1	3.6	3.3	5.8	6.1	4.2	4.5	4.0	5.8	3.8	4.72
Drought(72%)	4.6	4.1	5.8	4.4	6.0	5.7	3.5	6.0	4.3	5.8	5.02
Dough stability (min)											
Normal	16.0	10.0	12.0	15.0	13.5	14.5	14.0	12.0	1 5.5	12.5	13.27
Drought(100%	15.0	13.0	13.0	14.5	15.0	15.0	11.0	12.5	1 3 .0	13.0	13.55
Normal (72%)	13.0	7.5	9.5	12.5	10.0	11.5	12.0	9.0	1 2.5	8.5	10.38
Drought(72%)	12.0	9.0	11.5	11.5	12.0	12.0	8.5	11.0	11.5	9.5	10.85
Mixing tolerance index (BU)											
Normal	45.0	30.0	35.0	55.0	40.0	5.0.0	50.0	38.0	50.0	40.0	42.55
Drought(100%	55.0	35.0	50.0	50.0	40.0	55.0	25.0	42.0	60.0	45.0	45.7
Normal (72%)	55.0	35.0	45.0	65.0	55.0	65.0	65.0	50.0	60.0	50.0	54.5
Drought(72%)	70.0	50.0	60.0	65.0	50.0	60.0	30.0	52.0	70.0	60.0	56.7
Dough weakening (BU)											
Normal	75.0	60.0	50.0	70.0	95.0	95.0	90.0	75.0	75.0	80.0	76.5
Drought(100%	95.0	80.0	80.0	90.0	70.0	75.0	55.0	90.0	85.0	90.0	81
Normal (72%)	95.0	80.0	70.0	90.0	115.0	110.0	120.0	95.0	95.0	90.0	96
Drought(72%)	125.0	100.0	100.0	120.0	90.0	90.0	75.0	110.0	110.0	100.0	102

Extensograph Parameters

Extensibility and resistance to extension of studied wheat varieties evaluated using Extensograph, and presented in Table (7). The obtained data showed that, whole meal dough were less extensible (145-110 mm) than wheat flour dough 72% (125-90 mm). This trend observed in all types of wheat varieties. Table (7) showed also that, resistance to extension of the studied varieties of whole meal dough ranged between 620–520 BU, while its wheat flour 72% decreased and ranged between 510-400 BU. Similar results were obtained by Shouk (1996), Hussein, et al., 2010 and Kamil et al., 2011) who mentioned that, as flour extraction increased both extensibility and resistance to extension decreased. Moreover, Table (7) showed that, dough energy of the studied wheat varieties 72% increased and ranged between (85-70 cm^2), while its whole meal decreased between 120-85 cm2. This result could due to the higher content of fiber in whole meal than wheat flour 72%, or on other word, by dilution of gluten with fiber (Chen et al., 1988). These data are agreement with those obtained by Cuniberti et al., (2003) who reported that, dough extensibility and bake-test loaf volume in long fermentation process depend on total amount of polymeric protein in the grain or flour. Extensibility, loaf volume are in addition to genotype dependence, influence markedly by environmental effects such as N availability. Also, Uhlen et al., (2004) reported that, the composition of gluten subunits are indirectly relate to baking quality via the quantity or the size distribution of the glutenin polymer, which are essential for the mixing requirements and the resistance of the dough. Also, they mentioned that, increased protein content, however, generally increased dough extensibility. From the results Table (7), we find that there is no significant differences between wheat varieties produced in normal and drought conditions that in extensograph parameters ,

Table (7): Extensograph parameters of whole meal and 72% extraction wheat flour

Lines	Extensibility (E) (mm)				Resistance to extension (R) (BU)				Proportional number (R/E)				Dough energy (cm^2)			
	100%		72%		100%		72%		100%		72%		100%		72%	
	N	D	N	D	N	D	N	D	N	D	N	D	N	D	N	D
Line 7	125	120	115	105	550	540	490	410	4.4	4.5	4.26	3.90	110	90	80	75
Line 9	135	145	125	115	590	550	410	500	4.07	4..07	3.28	4.35	85	80	75	70
Line 10	135	120	115	110	610	570	460	510	4.52	4.75	4.0	4.64	85	90	70	75
Line 12	110	115	90	105	550	560	490	500	5.0	4.87	5.44	4.76	90	120	80	100
Line 17	115	120	95	110	540	550	480	500	5.7	4.58	5.05	4.55	100	110	90	80
Line 18	110	135	95	115	520	620	410	480	4.73	4.59	4.32	4.17	100	85	80	75
Line 20	115	140	100	120	550	590	420	450	4.78	4.21	4.20	3.75	100	80	80	70
Line 21	130	110	110	90	540	530	480	470	4.15	4.82	4.36	5.22	85	100	80	90
Line 24	115	110	105	95	560	550	500	430	4.87	5.0	4.76	4.52	110	100	90	80
Gemeza 11	135	110	115	90	570	520	430	460	4.6	4.73	3.73	5.11	90	90	75	80
Average	122.5	122.5	106.5	105.5	558	558	457	471	4.68	4.67	4.34	4.49	95.5	94.5	80	79.5

Viscoamylograph measurements

The amylograph measures the change in viscosity of a flour-water suspension as the temperature is raised at a uniform rate. The height of the amylogram peak is related to the gelatinization characteristics of the starch and the α-amylase activity (Shuey, 1975).

Whole meal flour (100%) and flour (72% extraction) of different varieties were rheologically evaluated by Viscoamylograph for heat of transition, maximum viscosity, and temperature of maximum viscosity as presented in Table (8). Results in Table (8) showed that, heat of transition, maximum viscosity, and temperature of maximum viscosity of whole meal wheat varieties are higher than that of wheat flours (72%) perhaps due to the presence of bran particles in whole meal wheat varieties which may interfere in quick development of gluten. From the results table (8), we find that there is no significant differences between wheat varieties produced in normal and drought conditions that in viscoamylograph parameters

Table (8): Viscoamylograph parameters of whole meal (100%) and 72% extraction wheat flour at normal and water stress conditions of ten wheat genotypes.

Genotypes	**Transition temp. (°c)**				**Temp. at maximum viscosity (°c)**				**Maximum viscosity (BU)**			
	100%		72%		100%		72%		100%		72%	
	Normal	Drought	Normal	Drought	Normal	Drought	Normal	Drought	Normal	Drought	Normal	Drought
Line-7	60.5	57.5	66	60	89	93	85	90	650	850	450	600
Line-9	60	60	60	60	87	88.5	87	87	1520	1470	840	760
Line-10	55.5	55	60.0	60	78	63	85.0	67.5	120	105	100	80
Line-12	60	54	63	57	84	90	76.5	85.5	480	1350	240	1060
Line-17	57	57	60	54	87	93	87	76.5	1540	1200	1300	860
Line-18	57	60	60	57	88.5	87	87	91.5	800	900	650	720
Line-20	60	61	56	58	89	85	86	80	1000	1100	800	800
Line-21	58	63	55	60	86	78	82	75	900	800	630	560
Line-24	61.5	69	61.5	60	87	88.5	76.5	78.0	180	180	140	190
Gimmeza 11	58.5	62	69	67	88.5	80	90	86	1115	1060	560	780
Average	**58.8**	**59.85**	**61.05**	**59.3**	**86.4**	**84.6**	**84.2**	**81.7**	**830.5**	**901.5**	**571**	**641**

Cluster analysis

Cluster analysis approach which based on the principle of similarity and dissimilarity is helpful for parental selection in the breeding programme (**Souza and Sorrells, 1991).**

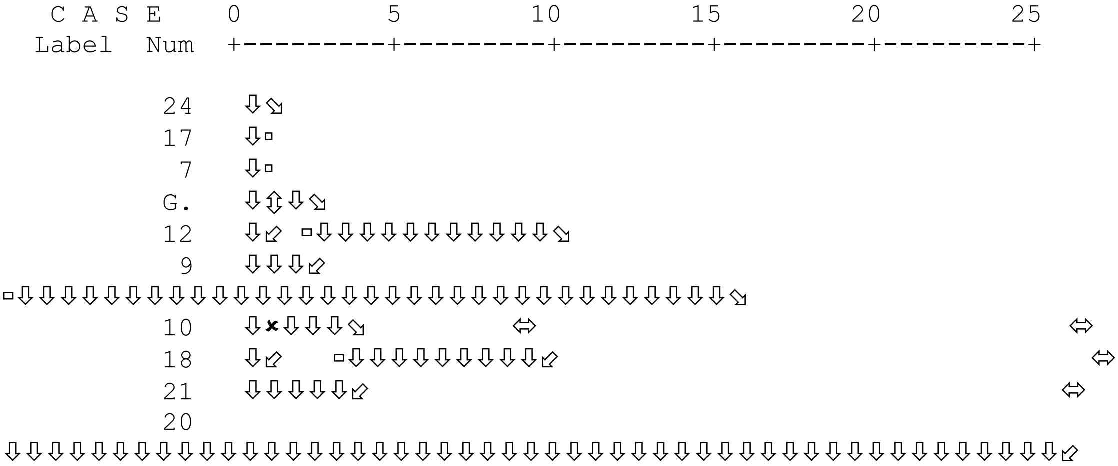

Fig.1: Cluster diagram for 10 wheat genotypes on basis of agronomic traits under normal conditions (N).

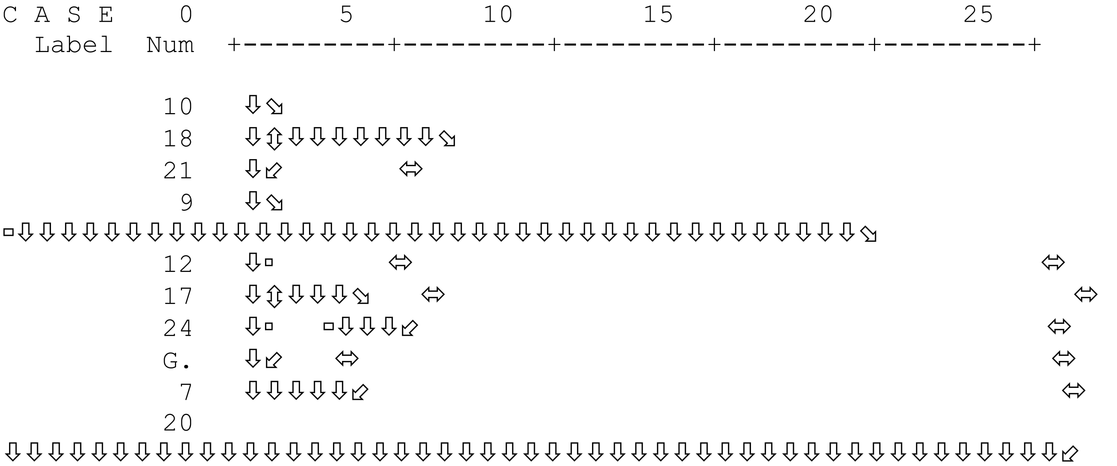

Fig.2: Cluster diagram for 10 wheat genotypes on basis of agronomic traits under drought conditions (D).

The cluster analysis among studied bread wheat genotypes based on Euclidean distance (tree diagram) using agronomic characters estimated under normal (N) and stress (D) levels illustrated in Fig.(1 & 2). Generally, a distribution pattern of 10 wheat genotypes into two clusters at each level indicated the presence of considerable genetic divergence among the genotypes for most of the studied traits.

Cluster one consisted of 9 genotypes, and separated into two sub-clusters, at normal condition (N) (Fig. 1) the first one included 6 genotypes i.e. (no. 24,17,7,12 ,9 and check variety Gimmeza 11) and the second contains 3 lines(no. 10,18 and 21). The first sub-group had the highest yield and yield component means at normal level especially lines no 24,9,10 and 12.

On the contrary, at stress level (D) (Fig.2) the first sub- group included 3 lines (no. 10, 18 and 21) and the second ones contains the other six genotypes which exhibited the best performance for yield characters and stress tolerant (Table 3).

Group two included only the same genotype (line no.20) under normal and stress conditions. This

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cluster was the lowest performance for grain yield and its components in stress and non-stress environments (Table 3).

The cluster analysis among studied bread wheat genotypes based on Euclidean distance (tree diagram) using Viscoamylograph parameters estimated under normal (N) and stress (D) conditions illustrated in Fig.(3 & 4). Generally, a distribution pattern of 10 wheat genotypes into two main clusters at each level indicated the presence of considerable genetic divergence among the genotypes for rheological studied characters.

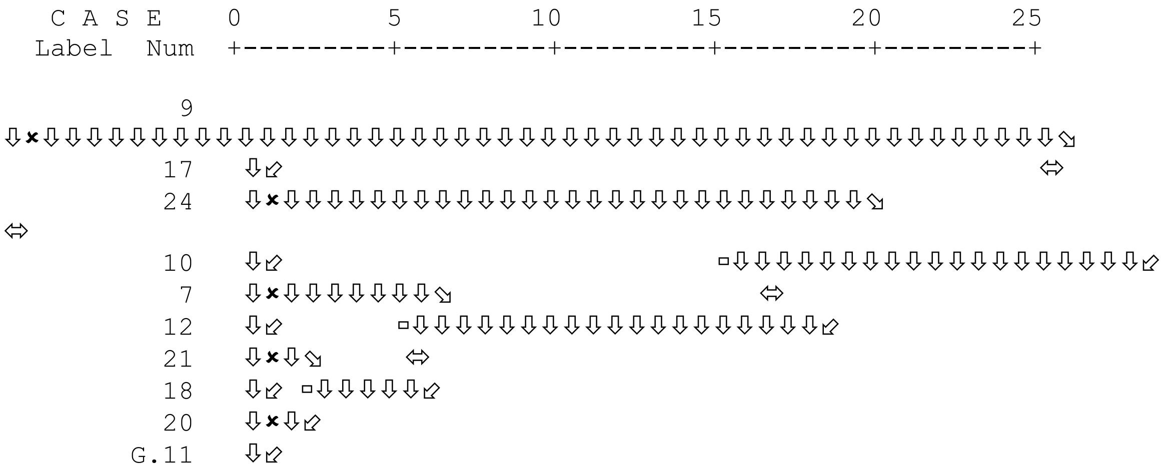

Fig.3: Cluster diagram for 10 wheat genotypes classified by Viscoamylograph parameters for whole meal (100%) extraction rate under normal conditions (N).

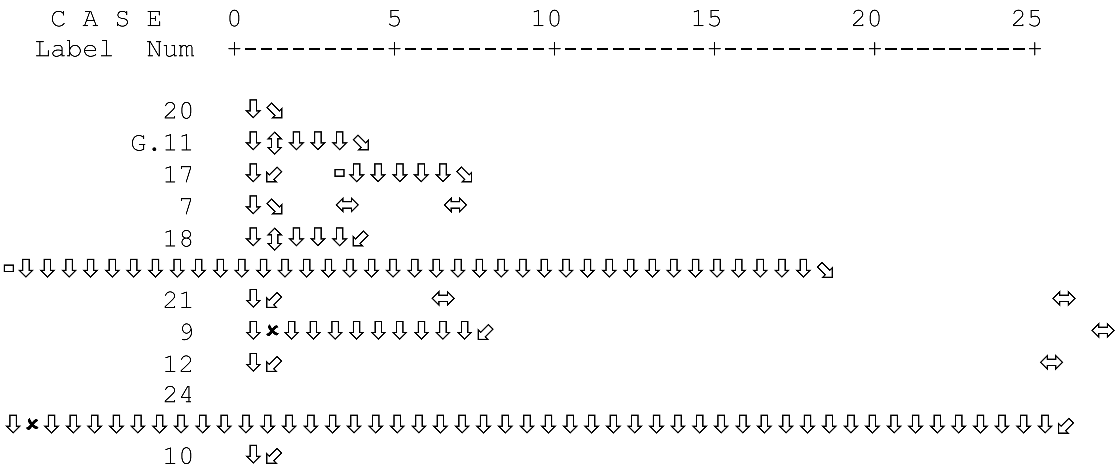

Fig.4: Cluster diagram for 10 wheat genotypes classified by Viscoamylograph parameters for whole meal (100%) extraction rate under drought conditions (D).

At normal condition (N), cluster one consisted of two genotypes lines no.9&17. This cluster was the highest reading for Viscoamylograph parameters in normal environments (Table 8). The second main cluster consists of 8 genotypes and separated into two sub-clusters, (Fig. 1).

On the other hand, at stress level (D) cluster one consisted of 8 genotypes and separated into two sub-clusters, (Fig. 2) the first sub- cluster included 5 lines (no. 17,20,7,18,21) and check variety Gimmeza 11 while, the second ones contains the two lines no 9 and 12(Fig. 2).

The second main cluster under stress conditions included two lines (no. 24&10). This cluster was the lowest Viscoamylograph reading in all environments (Table 8).

Distribution pattern of all the genotypes into various clusters showed the presence of considerable genetic divergence among the genotypes for most of the traits. All the five genotypes of China were grouped in cluster I. The mean number of productive tillers per plant, number of spikelets per spike, spike length, number of grains per spike and yield per plant were highest in this cluster, hence these genotypes may be exploited for their direct release or as parents in hybridization programmes to develop high-yielding wheat varieties. The genotypes in cluster II may be used for the improvement of plant height and 1000 grain weight in wheat.

CONCLUSION

It could be concluded that, the dependence of various quality parameters on protein composition can useful as a guide for manipulating specific character trait in wheat breeding programs. The reheological data showed to be relevant for many cereal laboratoties where these instruments are relied on for prediction of end-use quality. Results of r heological properties, gluten content and falling number (classified line24, line 10and line 18 as a durum , hard and soft wheat) respectively. Consequently, we recommend using the line No.24 in the pasta industry and line No.10 in bread while line No.18 in the manufacture of biscuits.

Results of yield evaluations identified a more outstanding lines under each irrigation level i.e. genotypes no. 7, 9, 12 and 21 had the highest values of grain yield under normal conditions (N). On the other hand, under water stress conditions (D), genotypes no 17, 21 and 24 gave the highest values of grain yield. These lines need to more evaluate under the same conditions and more locations in the next year to confirm the superiority.

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