An-Najah National University

Faculty of Graduate Studies

Morphological and Agronomic Traits Characterization of Local Durum Wheat *(Triticum turgadum var. durum)* Varieties Under Different Environmental Conditions in Palestine

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This Thesis is Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Plant Production, Faculty of Graduate Studies, An-Najah National University, Nablus, Palestine.

2015

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Dedication

This thesis is dedicated to:

The sake of Allah, my Creator and my Master.

My great teacher and messenger, Mohammed (May Allah bless and grant him), who taught us the purpose of life.

My homeland Palestine, the warmest womb; the great martyrs and prisoners.

The souls of my great parents, "Lord, be merciful to them just as they brought me up with kindness and affection."

My beloved brothers and sister; who stands by me when things look bleak.

My dearest wife, who leads me through the valley of darkness with light of hope and support.

My beloved kids: Ahmad, Aya and Mohammed, the flowers of my life and hope.

My friends who encourage and support me.

All the people in my life who touch my heart.

I dedicate this research.

Acknowledgments

✓ Praise and thanks to the Almighty Allah for conciliation, and providing patience.

✓ Financial support by **ICARDA** and **AFESD** is greatly acknowledged.

✓ I owe a great deal of thanks to my supervisor **Dr. Hassan Abu- Qaoud** for his generous advice, excellent suggestions, kindness, and allowing me allot of his time.

✓ Sincere thanks go to my second supervisor **Dr. Aziz Salameh** head of plant production and protection research department- NARC who helped me to do the field work and thesis preparation.

✓ All appreciation and thanks to **Dr. Mohammad Abu- Eid**, director general of NARC for his technical and administrative support through time of research.

✓ Sincere thanks are extended to **Dr. Rula Sameer** who had put her nice input in formatting parts of the thesis, **Eng. Sameh Jarrar** for his friendly help and technical support, Alot of thanks goes to all my colleagues in Plant production and protection department, other departments and agricultural stations of NARC.

✓ Special appreciation to **Dr. Abdullah Alomari**, ICARDA coordinator in Palestine for his constructive criticism, invaluable assistance and guidance.

✓ My appreciation is also extending to **Dr. Jehad Abbadi**, the head of Biology department at Al-Quds University for his scientific support during my study.

الإقرار

إنا الموقع أدناه مقدم الرسالة التي تحمل عنوان

Morphological and Agronomic Traits Characterization of Local Durum Wheat *(Triticum turgadum var. durum)* Varieties Under Different Environmental Conditions in Palestine

اقر بان ما اشتملت عليه هذه الرسالة إنما هو نتاج جهدي الخاص، باستثناء ما تمت الإشارة إليه حيثما ورد، وان هذه الرسالة ككل من أو جزء منها لم يقدم من قبل لنيل أية درجة أو بحث علمي أو بحثي لدى أية مؤسسة تعليمية أو بحثية أخرى.

Declaration

The work provided in this thesis, unless otherwise referenced, is the researcher's own work, and has not been submitted elsewhere for any other degree or qualification.

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Signature: **التوقيع:**

Date: **التاريخ:** ٢١/٥/٢٠١٥

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List of Abbreviations

Abbreviation	**Full Name**
2, 4- D	2,4-Dichlorophenoxyacetic acid
AFESD	Arab Fund for Economic and Social Development
DUS	Distinctness, uniformity and stability
FAO	Food and Agriculture Organization
GENSTAT	General Statistics Analysis Program
ICARDA	International Center for Agricultural Research in Dry Areas
MoA	Ministry of Agriculture
NARC	National Agricultural Research Center
RAPD	Random amplified polymorphic DNA
RCBD	Randomized Complete Block Design
UNDP	United Nations Development Program
UPOV	Union for the Protection of new Varieties of Plants

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Abstract

Wheat *(Triticum turgadum var. durum*) is one of the most important field crops in Palestine with an area exceeds 220000 dunum and an average productivity of 136 kg/dunum that represents less than 45% of average world productivity. This shortage is due to the effect of unfavorable local environmental conditions for used cultivars. The introduction of high yielding and well adapted cultivars could be one of the best resolutions. The establishment of national breeding program will fascilate this task through the collection and evaluation available of genetic resources. Palestine is rich with wild relatives of durum wheat and many landraces are still grown in different regions in Palestine that could be considered as a genetic resurve. Little information is available about the phenotypic description and agronomic performance of these landraces. Moreover, synonyms and antinomy are existed among farmers, agronomists and scientists when dealing with wheat landraces. The need to identify landraces and common varieties is a priority. The published data on morphological and agronomic identification for genetic resources of durum wheat landraces in Palestine are very scarce and not sufficient.

The main objective of this investigation was to make clear identification of fifteen durum wheat varieties grown in Palestine through the characterization of the phenotypic traits and agronomic performance under different environmental conditions.

The fifteen genotypes of durum wheat under the study included eleven local landraces (Kahatat, Heitia safra, Heitia beda 1, Heitia beda 2, Heitia soda, Heitia, Debbiya, Soori, Noorsi, Kahla and Nabeljamal), and four introduced varieties (Horani 27, Numra 8, Cham 5 and Anbar). All studied genotypes were grown in randomized complete block design (RCBD) trials at five different climatic locations (Beit- Qad station, Tubas, Tulkarm station, Za'tara and Arroub station) during two growing seasons (2012-2013 and 2013-2014). Forty morphological and agronomic traits were evaluated. Data were collected according to UPOV (Union for the Protection of new Varieties of Plants) guidelines and analyzed using GENSTAT statistical program.

The results revealed the presence of high variations among the genotypes in thirty eight traits. Cluster analysis grouped genotypes in five main clusters according to relatedness and variation for all studied trait. The performance of landraces was not stable under different environmental conditions as most of them showed high straw but low grain yield as Nabeljamal variety (922 Kg/du straw and 201 Kg/du grain yield).

The results obtained from this study led to a clear morphological identification of studied varieties, especially for local landraces at levels with synonyms and antinomy problem removed. Genetic variation revealed that, local landraces could be considered as a primary step to launch a national breeding program for the development of new wheat cultivars adapted to harsh climatic conditions.

Chapter One

Introduction

Wheat *(Triticum spp.*) is one of the most important stable and economic food crops for more than one third of the world population. It is widely cultivated in the world with total area of 218 million hectares that represents about 17% of total planted area and production of 713 million tons, and productivity of 3.3 tons per hectare (FAO, 2013). Wheat contributes more calories and proteins to the world diet than any other cereal crops (Nimbal et al., 2009). In addition, it provides nearly 55% of carbohydrate and 20% of the food calories. Wheat grains contains 78.10% carbohydrate, 14.70% protein, 2.10% fat, 2.10% minerals and considerable proportions of vitamins (thiamine and vitamin-B) and minerals mainly zinc and iron (Kumar et al., 2011).

Historically, it was documented that wheat was grown in the earliest sites of civilization and played a crucial role in humanity development by providing food to one third of people in those sites (Breiman and Graur, 1995). The origin of habitat for many crops including wheat was the region of Fertile Crescent which spread from Palestine and Jordan through Syria, Lebanon, south Turkey to north Iraq and Iran (Nevo, 1998). Wild wheat spread naturally in a broad spectrum of variability and many landraces are still grown and conserved in sito by local farmers. From this primary origin wheat was transmitted to new sites in the Mediterranean area and then to the rest of the world (Harlan, 1981).

Agriculture is an essential component of the Palestinian national, cultural and economic life. Palestinians have been pioneers in transmitting and disseminating agricultural techniques to several countries in the region and outside. In addition to its traditional significance for nations and states, agriculture is particularly important for Palestinians as it embodies their perseverance, confrontation and adherence to their land under the threat of confiscation and settlement activities. It also provides a refuge and a source of income and food supplies at times of crises (Agricultural Sector Strategy, MoA, Ramallah, Palestine, 2009).

In addition, Palestine lies within the Fertile Crescent Center of diversity where wheat, barley, lentil, and several food and feed legumes and fruit trees have originated over the last 10,000 years. Cereals, food legumes, and fruit trees are major crop commodities contributing to food security of the Palestinian people (UNDP, 1998).

Wheat is the major cultivated field crop in Palestine with more than 22000 hectares. The majority of wheat produced in West Bank was in Jenin, Tubas, and Ramallah districts. Durum wheat is the predominant type of wheat and met more than 70% of the total planted areas with wheat in West Bank, with about 96% is cultivated under rain fed system (PCBS, 2008).

It was documented that, average productivity of wheat in West Bank was 1360 kg/ha (PCBS, 2008). This productivity is very low as compared to the world productivity which exceeded 3000 kg/he (FAO, 2008). This large difference in average production may be due to many determinant effects of biotic and abiotic conditions (Salimia and Atawnah, 2014). The well known two ways to increase production are to increase the cultivated area which is very limited in the Occupied Palestinian areas or to increase the production per unit area which may be achieved by introducing high yielding varieties. One strategic approach towards the second goal might be through the establishment of a national breeding program that depends primarily on evaluating available genetic resources of wild relatives of wheat, cultivated landraces or local varieties, introducing lines and cultivars in order to domesticate high yielding and/ or stress tolerant cultivars (Gepts, 2006).

The Palestinian farmers still grow old local durum wheat varieties (landraces) for several reasons. First, political situation, the accessibility to obtain new improved durum varieties with high yielding potential and good level of resistance to biotic and abiotic stress from regional and international research institutes is very difficult. Second, there is no active national breeding program for producing improved lines of durum wheat. Moreover, the landraces of durum wheat are common to farmer and adapted to local environmental harsh conditions (Jaradat, 2013). Therefore, the intensive use of introduced cultivars of durum wheat with high productivity and well agronomic performance threaten local varieties by losing and disappearing from the agricultural map by the Palestinian farmers. Consequently, many useful genes may disappear forever (Jaradat, 2013). The performance of cultivated landraces of wheat against biotic and abiotic stress conditions is not evaluated yet.

Pre-breeding activities such durum wheat landraces collection, characterization and agronomic performance evaluation are the first steps in the long way to establish a sufficient national wheat breeding program in Palestine. Several national institutes in Palestine already have collected various landraces of durum wheat from farmers and started either to conserve it in germplasm units or distribute these seeds to neighboring farmers without sufficient agronomic data. This situation lead to what called “synonyms phenomena”. Consequently, losses of many landraces of wheat could be form a solid genetic basis for future national breeding program. On other side, conserving the durum wheat without characterization is useless since many agronomic traits and a pool of useful genetic variation could be lost without any evaluation.

Therefore, the characterization of the collected landraces of durum wheat and the evaluation of its agronomic performance under different climate conditions are necessary steps in Palestine and should be implemented prior to any breeding program.

Characterization and identification of local varieties could be done using morphological, chemical or molecular methods (Salimia and Atawnah, 2014). Morphological methods are classical approaches that have been used since many years in the world by using various traits side by side with chemical and molecular methods which had been widely used in last decades. Few researches were conducted in Palestine on identification of local wheat varieties, and most of them based on molecular characterization, while there is a big gap in using precious morphological traits.

Objective

The main objective of this investigation is to characterize the phenotypic and agronomic traits of fifteen durum wheat varieties (eleven landraces and four introduced) grown in different climatic conditions in Palestine.

Study Significance and Justifications

In spite of the importance of wheat landraces in Palestine as a genetic recourse for wheat improvement, little information is available about their description and field performance. Moreover, synonyms and antinomy are existed among farmers, agronomists and scientists when dealing with landraces. This situation may confuse and mislead scientists or agronomists and farmers. Therefore, the need to identify local landraces and varieties through clarification and discrimination work is urgent. The published data on previous identification for genetic resources of durum wheat in Palestine are very rare and this study could be a comprehensive work on the characterization of available landraces in terms of morphology and yield components. The study doesn't stand at agronomic traits evaluation but covers the morphological characterization as well. Using UPOV guidelines as international standards in morphological description of varieties will uniform the language of scientists, agronomists and genetic diversity specialists. This research is considered the first step in the long way to launch a national breeding program for durum wheat in Palestine.

Study outputs and applications:

The expected specific outputs from this study include:

- Create a clear morphological characterization for wheat landraces in Palestine with releasing a descriptive identification in the shape of a guide manual for the benefit of farmers, agronomists and researchers.
- Evaluate the agronomic traits of wheat particularly the yield components under different climatic conditions as part of variety characteristics.
- Study the genetic variation and relatedness between genotypes of durum wheat in Palestine in comparison with some improved or introduced genotypes based on morphological and agronomic characteristics and make it available for researchers to be used in future improving programs.

Chapter Two

Literature Review

2.1 Taxonomy and Classification of wheat

Wheat is an annual cereal grass belongs to the family Graminae (Poaceae) and to genus *Triticum*. This genus includes many wild and cultivated species that could be classified into four main groups according to the number of chromosomes, morphological and botanical characteristics (Chapman and Carter, 1976)

These main wheat groups are:

1) Diploid group (1n= 7, 2n= 14): this group includes *T. aegilepoids* (wild single grain wheat), *T. urothum* (wild wheat), *T. monococcum* L. (single grain cultivated wheat in limited areas).
2) Tetraploid group (1n= 14, 2n= 28): includes Emmer (two grain wild wheat) and the cultivated species *T. dicoccum* SHS, *T. durum* Desf., *T. turgidum* L., *T. polonicum* L., *T. tauranicum* Jak., *T. persicum* L., *T. peramidale* (Perc), *T. timo pheevi* Zhukov, *T. palaeq cal chicum* Men and *T. carthicum* Nev.
3) Hexaploid group (1n= 21, 2n= 42): Includes *T. spelta* L., *T. macha* Dek, *T. compactum* Host, *T. sphaerococcum* Pere, *T. vavilovi* Jacobs, *T. aestivum* and *T. amplissifolium* Zhuk.
4) Octaploid group (1n= 28, 2n= 56): this group includes only one species of wheat; *T. fungicidum* Zhuk.

2.2 Origin, domestication and distribution of wheat

The domestication of wild wheat dates back to about 10000 years in the Near East. It is documented that wild einkorn (*T. monococcum* sp. *aegilopoides*) may have been domesticated to einkorn wheat (*T. monococcum*) in Karacadag Mountains region in southeast Turkey (Heun et al., 1997), where the wild form was cultivated also in parallel. Also the cultivated emmer (*T. dicoccon*) was registered in several regions in Syria dating back to 7500 BC. By the Bronze Age, These wild forms of wheat had been replaced by higher yielding and free threshing tetraploid and hexaploid wheats in cultivation, (Zohary and Hopf 1993). Currently, einkorn is only cultivated in small areas in the Mediterranean region (Perrino et al., 1996), while its wild form is spread naturally in some locations of that region (Zohary and Hopf 1993).

Bread wheat *(T. aestivum*) appspikeed first in Transcaucasia, Southwest of Iran in the time that *Aegilops tauschii* ssp. *strangulate*, was predominant in the region and hybridized with cultivated emmer (*T. dicoccon*) to produce *T. aestivum* (Dvorak, 1998).

The domesticated wheats as a result of man selection since 10000 years or more, have acquired a stockpile of genes for high productivity but with a narrow genetic base. In the time that wild relatives have acquired a larger reservoir of genes due to natural adaptation to a great diversity of environments during the evolutionary time. This wide pool in the wild populations has remained largely unavailable, or at least unused by wheat breeders (Johnson and Walnes, 1977).

At the time when domestication has occurred in the Karadagh Mountains, Turkey. Following a cross between tetraploid *T. turgidum* and diploid goat grass *(Aegilops cylindrica* Host), the resultant hexaploid (6x) bread wheat was disseminated around the Caucasian region, then around the Old World. These events, although resulted in wheat domestication, created genetic bottlenecks (Hammer et al., 1996), which excluded potentially adaptive alleles. More recently, the development of high yielding wheat varieties which caused a loss of much of the diversity in wheat landraces and old cultivars. A significant decrease of genetic diversity has been observed related to the replacement of bread wheat landraces by high yielding cultivars which appear to be associated with the loss of some quality traits such as protein content and glutenine quality (Distefeld et al., 2007).

In general, domestication of wheat resulted in the enhancement changes in some of important traits of wheat such as:

1. An increase in grain size, associated with better germination and growth of seedlings in cultivated fields.
2. The development of non-shattering seed, which decreased natural seed dispersal and allowed humans to harvest and collect the seed with optimal timing (Willcox, 1998).

Wheat Distribution

After domestication, wheat cultivation was reported about 6000 years ago in the Mesopotamian Fertile Crescent. From that region it spread to the

Middle East, North Africa, Asia and Europe. Wheat spread to the Americans and Southern Africa around 1500 AD, and was introduced into Australia in 1790. Recently, wheat is the most widely and diversely cultivated food crop in the world. It is grown under different altitudes, from the sea level up to 4500m, which reflects its wide cultivability and adaptability (Harlan, 1981).

2.3 Wheat landraces or local varieties

2.3.1 Definition and synonyms

Since 1890, tens of definitions had been proposed to describe the term "landrace" and its relative synonyms (Zeven, 1998). Teshome et al. (1997) defined landraces as "variable plant populations adapted to local agro climatic conditions, which are named, selected and maintained by the traditional farmers to meet their social economic, cultural and ecological needs. While Zeven (1998) proposed that landrace could be defined as "a variety with a high capacity to tolerate biotic and abiotic stress, resulting in a high yield stability and an intermediate yield level under a low input agricultural system".

A number of synonyms for the term "landrace" have been used in literature. Zeven (1998) reported a number of synonyms for landrace as used in the literature, and their mutual relationship according to each author:

- Race (Leng et al., 1962)
- Local variety (Brandolini, 1969, Bellon & Brush, 1994)

- Ecotype (Brandolini, 1969)
- Landrace population (Harlan, 1975)
- Local population (Camussi, 1979)
- Landrace (Zeven, 1986)
- Traditional cultivar (Old field & Alcon, 1987)
- Farmer variety (Bellon & Brush, 1994)
- Farmer population (Cleveland et al., 1994)

2.3.2 General characteristics of landraces

Thousands of years of cultivation combined with natural and human selection have resulted in the development of a wide diversity of genotypes in wheat species. Traditional management of wheat landraces by farmer contributed to the conservation of a considerable level of diversity. Therefore, a wheat landrace is not a genetically and phenotypically stable, distinct, and uniform unit (Morris and Heisey, 1998).

The complexity genetic structure of wheat landraces populations may arise from the number of different homozygotes and the occurrence and frequency of heterozygotes in these populations. Therefore, characterization of the population structure of wheat landraces is critical to identify and interpret correctly the correlation between their functional and molecular diversity (Brown, 2000).

Wheat landraces as compared to modern cultivars, with relatively higher biomass, may don't develop larger root dry mass, but in increased ratio of root mass to penetrates deeper in soil profiles, increased ability to obtain moisture from those depths, and higher water use efficiency. In addition, their higher concentration of soluble carbohydrates in the stem shortly after anthesis ensures adequate translocation of photo assimilates to the developing grains. These properties enable wheat landraces to face harsh conditions especially season- late drought by early maturation (Ayed et al., 2010). Some wheat landraces have a unique characteristic of facultative growth habit which provides flexibility of sowing either in the fall as a winter crop or, after the failure of the crop in winter, again in the spring. Under limited nitrogen availability in soil, wheat landraces with a taller growth habit and lower harvest index have the ability to absorb and translocate more nitrogen into the grain than modern varieties (Geneç et al., 2005). Because wheat landraces have been developed mostly in low available nutrient environments, they represent a source of genetic variation for selection of varieties adapted to low fertilizer input cropping systems (Distefeld et al., 2007; Koshgoftarmanesh et al., 2010).

2.3.3 Importance of wheat landraces in agro-systems

As long time of wheat history, farmers were behind the conservation and development of wheat genetic diversity (Zeven, 2000). The landraces and old cultivars they developed can be considered as evolutionary links between wild emmer wheat, the wild progenitor of all domesticated wheat, and advanced wheat cultivars. Often landraces have remained undisturbed over decades as they are well adapted to the selection pressure coming from specific eco-geographical structures (Nevo, 1998). Given their longstanding adaptation to specific environments, landraces may have developed a broad spectrum of resistance to various biotic and abiotic threats, which can make them a useful resource to breed new cultivars in which high yield is combined with stress resistance. Nowadays, many local landraces have been disappearing due to retreating of traditional farming systems, genetic erosion, or even the aging or exodus of rural population, and environmental degradation (Mercer and Peralis, 2010), that have led to the extinction of many local landraces. As a consequence, the disappearance of most of unique cereal biodiversity and the information about landraces and traditional cultivars are now very rare. Several reports estimated that about 75% of the genetic diversity of crop plants had been lost in the last century (Hammer et al., 1996; Witcombe et al., 1996). This dangerous disappearance of these valuable genetic resources results in a severe threat to the world's long-term food security. In this case, there is an urgent need to identify, preserve and utilize landrace genetic resources as a safeguard against an unpredictable future is evident.

2.3.4 Conservation and utilization of wheat landrace

Through the period 1970 -1990 much of landraces across the world has been collected and is being conserved in long-term national and international gene banks (Frizon et al., 2011).

In other side, a small portion of this diversity is being conserved and used on-farm where it continues to evolve (Brush and Meng, 1998). Both of these conservation methods have its advantages and limitations. On-farm conservation is considered as a sustainable management of genetic diversity of landraces and local varieties, it provides a natural approach for continuous development and helps accumulation of agronomic traits for adaptation of variety to specific eco-geographical and matching the requirements of farmers. On-farm conservation of landraces, as many reports indicated, is one of the most important recent issues in plant genetic resources management (Le Boulch et al., 1994; Kebebew et al., 2001).

Farmers continue to grow and conserve and develop a wheat landrace if it meets their production and consumption needs. That means their on-farm conservation and continued utilization of landraces is determined by the cost and benefits these landraces to farmer. They maintain crop landraces if these are of high economic, cultural, social value, or even ecological reasons (Brush and Meng, 1998).

2.3.5 Landraces and the Future of Wheat Diversity

Nowadays, due to modern revolution in agriculture, wheat landraces have been largely replaced, in their centers of diversity by monocultures of pure genotypes represents high yielding modern cultivars. This replacement resulted in significant loss of genetic diversity for quality traits and resistance or tolerance to biotic and abiotic stresses; whereas, the pure wheat genotypes lack the wide adaptation found in landraces. The heterogeneity provided by diversity of populations of wheat landraces will decrease abiotic and biotic stresses within cropping systems (Bonman et al., 2007).

One practical strategy to improve yield and yield stability is to develop new varieties from wheat landrace populations, especially under stress and climate change conditions. Or just enhancement of productivity and stability of deteriorated landraces which could be achieved through continuous selection within original landraces population under the harsh conditions, to exploit the constantly released useful adaptive variation (Ehdaie and Waines, 1989).

2.3.6 Characterization and evaluation of wheat landraces studies

Several studies were conducted to evaluate the performance of landrace of wheat or to determine the genetic diversity. Bechere et al. (1996) studied the variation among 27 Ethiopian populations of durum wheat using phenotypic characters and concluded the presence of wide variability in most studied traits. Similar results were discovered in twelve land races populations in Jordan conducted by Rawashdeh et al. (2007) using phenotypic characters. In Morocco agro- morphological variability in a set of durum wheat germplasm collection indicated that thousands kernel weight and plant height presented the highest coefficient of variation (Zarkti, 2012).

Elings and Nachit (1991) also studied 185 populations of durum wheat landraces collected from four different climatic zones in Syria by agronomic and morphological characterization and reported that these populations were categorized into clusters according to geographic distribution. Also, variation of phenotypic description in spikes of tetraploid durum wheat landraces in Oman using 14 qualitative and 17 quantitative traits revealed a high variability for quantitative traits more than qualitative traits (Alkhanajari et al., 2005).

2.3.7 Studying wheat landraces in Palestine

Similar studies in Palestine are limited especially for morphological characterization of durum wheat landraces, although some publications dealt with evaluation of few agronomic traits for some local landraces. Atawnah (2013) evaluated growth performance, yield components and genetic variation in six landraces genotypes and showed a significant variation in most of studied traits, thus the dindogram cleared the relations among genotypes. Some other studies used molecular tools for this purpose (Sawalha, et al., 2008) by studying genetic diversity in wheat landraces in Palestine using RAPD markers in comparison to phenotypic classification indicated a level of genetic diversity and similarities expressed in clusters of the landraces analyzed. In another study RAPD method was used to estimate genetic diversity in ten durum wheat genotypes cultivated in Palestine both landraces and commercial, although landraces were classified in one cluster there was a wide variation between them (Alfares and Abu- Qaoud, 2012).

2.4 Growth stages of wheat

Growth is a complex process in which different organs developing, growing and dying in overlapping sequences and it is easier to think of it as a series of growth stages.

There are several scales or developmental codes that describe visible growth stages of wheat. Hauns’s scale can be used particularly for defining and description of vegetative growth stages (Haun, 1973). Feeke’s scale provides a good description for both vegetative and reproductive stages

(Large, 1954). However, Zadoks' scale is the most comprehensive and easiest to use in practice (Zadoks, 1974). It describes all stages of the cereal growth cycle, including characteristics not considered in other scales. This scale has 10 main growth stages, labeled 0 to 9, which describe the crop; and each main growth stage can be further subdivided and described using a second digit, labeled 0 to 9 too (Table 5.16).

2.5 Characterization and variety identification of wheat

Variety identification is a very important process used for purity assessment crop varieties which is a primary demand in seed multiplication, certification and it is a necessary tool for protection of new breeder lines and new varieties through the multiple stages. It is also of special importance when we deal with old deteriorated varieties and local land races that exposed to danger of extinction and genetic loss. In general, there are deferent methods for making characterization and variety identification, including morphological, chemical and molecular methods (Mansing, 2010).

2.5.1Morphological Characterization

A wide range of morphological distinctness between various genotypes was used in varietal identification which was observed in seed, seedling and plant (Mansing, 2010).

2.5.1.1 Seed characteristics

Many morphological traits of seeds as seed shape, size, color, seed weight, seed germ width, seed crease and brush hair length are useful characters for varietal identification of wheat (Mansing, 2010).

Paukens (1975) reported that the seed color (white, light yellow, bright yellow, dark yellow and red), length (short, medium and long), width (narrow, medium and wide) and thickness (thin, medium and thick) were used for determining the cultivar trueness and purity in maize, while Sivasubramanian and Ramakrishnan (1978) studied the distinctness in rice cultivars based on seed, seedlings and chemical tests and expressed the color of coleoptile, color and shape of the seed were found to be of considerable diagnostic value.

2.5.1.2 Seedling characteristics

Sivasubramanian and Ramakrishnan (1978) reported that seedling characters like coleoptile color (purple to colorless) and ratio of primary leaf to coleoptile length were used for identification of rice varieties. Hoson (1984) differentiated between dwarf and tall cultivars of rice and maize based on coleoptile length growth.

Mansing (2010) reported Wide variations in mesocotyl length and pigmentation of coleoptile among hill rice cultivars. Miyagawa (1984) classified 86 Japanese and 14 scented rice cultivars based on mesocotyl and coleoptile length.

Lirinde (1986) and Terao (1986) classified the rice genotypes based on seedling characters as seedling length, coleoptile, sheath color and mesocotyl length.

2.5.1.3 Morphological characters of plant

Mustafa *et al.* (1998) examined the seedling characteristics of nine different bread wheat (*Triticum aestivum* L.) varieties, several variables regarding seedling size and germination characteristics were analyzed using canonical correlation analysis. Significantly correlated first canonical variate pairs indicated that the variables within each set such as coleoptile length, shoot length and fresh weight within size set, and emergence rate index and germination percentage can be regarded as main factors for vigorous wheat seedlings.

Elzevir and Aluizio (1999) studied seven characters of six bread varieties as plant height, days to emerge of first spikelet, number of grain per spike, spike length, spike shape, spike waxiness and spike density for varietal characterization.

Karagoz et al. (2006) characterized 112 wild wheat (*Triticum aegilops* L.) and 12 population of cultivated wheat (*Triticum aestivum* L.) in order to study their agromorphological characteristics (plant height, days to heading, growth habit, plant foliage color, number of tillers, flag leaf waxiness of blade, flag leaf length, flag leaf width, awns attitude and spike length) and variation among the populations.

Rehman et al. (2006) evaluated some plant morphological characters (plant height, flag leaf length, flag leaf width, flag leaf attitude, flag leaf hairs on auricle, flag leaf waxiness of blade, spikelet number, spike length, spike density, peduncle waxiness, peduncle length and awns presence) of four bread wheat varieties. Based on the results it was possible to identified varieties from each other.

Haljak *et al.* (2008) studied ten morphological characters (anthocyanin colouration of auricles of flag leaf, hairiness of auricles of flag leaf, flag leaf width, plants with recurved flag leaves, glaucosity of sheath of flag leaf, flag leaf waxiness of sheath, glaucosity of spike, peduncle waxiness, spike waxiness, spike density and peduncle length) of nine winter wheat (*Triticum aestivum* L.) and suggested that these morphological characters are best for distinctness of the varieties.

Naghavi et al. (2009) evaluated genetic variation of 96 durum wheat landraces and cultivars using morphological and protein markers. They studied plant morphological characters as days to heading, flag leaf waxiness of blade, flag leaf length, flag leaf width, spikelet per spike, test weight, plant height, peduncle waxiness, peduncle attitude, peduncle length and spike length.

2.5.2 Chemical characterization

The components of the seed react with the alkali to produce color which intensity could be used in characterization of wheat cultivars. Many chemicals tests were used in seed variety identification; NaOH test is useful in identification of yellow and red color seeds.

Studies on characterization of cultivars based on response of seed and seedling to various chemicals *as* phenol test, peroxidase enzyme activity, potassium hydroxide, sodium hydroxide test and GA3 *etc.,* offer wide variability and can be used in characterization of genotypes(Mansing, 2010)

2.5.2.1 Phenol test

A rapid chemical technique for identification of different seeds, it employs phenol to cause different color reaction in seeds, according to these test varieties can be classified. The test depends on the enzyme present in seed coat. Phenol color reaction was first reported for varietal classification in wheat by Chemelar and Mostovoj (1938) and has been accepted as a standard method for testing of wheat by International Seed testing Association ISTA (Mansing, 2010).

2.5.2.2 Peroxidase enzyme activity test

The presence of peroxidase enzyme in the seed coat of wheat genotypes was used as criteria for distinguishing the genotypes. The test is easy, but time consuming and tedious.

Mckee (1973) suggested that barley varieties can be separated into as high or low in peroxidase activity by soaking into 0.1 % solution of hydrogen peroxidase for ten minutes saturated with benzidine dihydrochloride as a technique to distinguish different seed varieties.

2.5.2.3 Potassium hydroxide test

Wheat genotypes can be differentiated based on the color pattern obtained by the reaction of chemical to seeds with the secondary metabolites. Test is simple, easy and reproducible.

Mckee (1973) suggested that 5 or 10 % potassium hydroxide solution could be useful for separating white grain wheat varieties from red grain wheat varieties.

2.5.2.4 Sodium hydroxide test

Simple, quick, and cheap test, based on the secondary metabolites present in the seed coat react and produce distinct colors (Vanderburg and Vanzwol, 1991).

2.5.2.5 Seedling growth response to GA3

Plant growth regulators influence plant growth by affecting the mobilization of food reserves to different plant parts. The effect of the growth regulators may vary in different cultivars which may be classified based on their response in terms of increase or decrease in growth of root, shoot and coleoptile length etc. The effect of growth regulators on seedling growth behavior has been used for characterization of cereals like wheat and rice (Laloriya and Naqvi, 1961; Gupta, 1985).

2.5.3 Molecular marker

Molecular methods were used for the assessment of genetic diversity within and between plant populations using various laboratory-based techniques such as allozyme or DNA analysis, which measure levels of variation directly. Molecular markers may or may not correlate with phenotypic expression of a genomic trait but, they offer a lot of advantages over conventional, phenotype-based methods as they are stable and detectable in all tissues regardless of growth, differentiation, development or defense status of the cell. Additionally, they are not affected by environmental conditions (Linda *et al.,* 2009).

Chapter Three

Materials and Methods

3.1 Plant Material

Fifteen genotypes of durum wheat were used in the trials (eleven local landraces and four introduced varieties). Local wheat landraces were obtained from Genetic Recourses Unit at National Agricultural Research Cintre (NARC) (Table 3.1).

Table 3.1 Wheat genotypes used in experiment

No.	Genotype	Category	Source	Longitude	Latitude	Altitude (m)
1	Kahatat	Landrace	Tayasir- Tubas	35.395	32.334	352
2	Hetia safra	Landrace	Turmusa'ya- Ramalla	35.303	32.256	758
3	Heitia beda 1	Landrace	Tayasir- Tubas	35.395	32.334	352
4	Heitia beda 2	Landrace	Tamun-Tubas	35.400	32.233	311
5	Heitia soda	Landrace	Qabalan	35.285	32.094	573
6	Heitia	Landrace	Abu falah- Ramalla	35.294	32.007	770
7	Debbiya	Landrace	Kufrmalik- Ramalla	35.305	31.987	812
8	Soori	Landrace	Rantis- Ramalla	35.340	32.028	744
9	Noorsi	Landrace	Mazra'a- Ramalla	35.263	32.000	769
10	Kahla	Landrace	Sawia- Nablus	35.261	32.097	511
11	Nabeljamal	Landrace	Silwad- Ramalla	35.234	31.994	676
12	Horani 27	Introduced	Syria			
13	Numra 8	Introduced	Tubas	35.386	32.323	450
14	Cham 5	Introduced	ICARDA-Syria			
15	Anbar	Introduced	Local market			

3.2 Experimental Locations and Seasons

The experiment was conducted at five locations (Fig.3.1) in five different governorates in Palestine (Table 3.1) in two growing seasons (2012-2013 and 2013-2014). The locations were: Beit Qad Agricultural station, Tubas, Tulkarm agricultural station, Za'tara village, and Al-aruob Agricultural station. In each site, 1.5 dunum was allocated for the experiment. All morphological characteristics were measured at two locations (Beit- Qad and Tubas) for one growing season (2012- 2013). Evaluation of agronomical traits was conducted in the two growing seasons.

Figure 3.1 Selected Locations for Experiment trials in Palestine.

Table.3.2: Locations of Experiment.

Location	Governorate	Elevation (m)	Rainfall (mm) 2012-2013	Rainfall (mm) 2013-2014	Annual mean Rainfall (mm)	Annual mean temperature (C°)	Longitude	Latitude	Location topography
Beit Qad	Jenin	144	436	233.5	414.4	20.3	35.345	32.474	Inner plain
Tubas	Tubas	493	388	238.5	431.2	20.4	35.386	32.323	Hilly
Tulkarm	Tulkarm	61	720	460	602.4	18.9	35.019	32.316	Coastal plain
Za'tara	Bethlehem	617	320	310	340	22	35.273	31.675	Eastern foothill
Arrub	Hebron	812	550	485.2	632.3	15.5	35.131	31.621	Mountain

3.3 Field preparation

Fields in different locations were prepared according to the recommended applications, Essential fertilizations were applied. Phosphate was added to the soil as Super phosphate 25% (20 kg/dunum). Nitrogen was added in the form of Ammonium sulphate 21% (12.5kg/dunum).

3.4 Sowing.

Seeds were sown manually. Each plot consisted of 6 rows 2 meters long with 30cm spacing between rows, 10 grams of seeds were sown in each row, seeding rate was 15kg/dunum.

3.5 Cultural Practices

3.5.1 Weed control

Weeds were controlled by Alber Super (2,4-D) application. The dosage was (150ml/ dunum). Spray was done during15 th -30th , January, followed by hand weeding at the second half of March.

3.5.2 Additive fertilization

10 kg/ dunum of Ammonium Sulphate fertilizer (21% nitrogen) were spread manually during growing season (February) before expected rain at tillering stage.

Fields were supplementary irrigated three times (during February and March) at 2013-2014 growing season by 30 mm each time (90 mm in total).

3.5.3 Harvesting and threshing

One square meter from the middle of each experimental plot was harvested manually after full maturity, tied and labeled, dried for two days under shade then weighed for biological yield and threshed using experimental threshing machine.

3.6 Measured Parameters

3.6.1 Morphological Characterization

Morphological traits characterization was done according to the guidelines described in the instructions of the International Union for the Protection of new Varieties of Plants (UPOV) (Test Guidelines) which elaborates the principles contained in the General Introduction (document TG/1/3) for the examination of distinctness, uniformity and stability (DUS) and, in particular, to identify appropriate characteristics for the examination of DUS and production of harmonized variety descriptions (UPOV, 2012). The morphological characterization parameters are described as follows:

3.6.1.1 Plant vegetative characteristics

3.6.1.1.1 Coleoptile Anthocyanin Coloration (CAC)

100 seeds were placed on moistened filter paper in a Petri dish until germination, after the coleoptiles have reached a length of about 1 cm in darkness they were placed in artificial light for sixteen hours a day (daylight equivalent), 12,000 to 15,000 lux continuously for 3 - 4 days, with incubation temperature at 20°C, data were recorded when coleoptiles were fully developed (about 1 week from the start) at stage 09-11 (Zadoks, 1974). The presence of anthocyanin coloration on coleoptiles was assessed and reported as absent or very weak, weak, medium, strong and very strong.

3.6.1.1.2 Flag leaf Anthocyanin Coloration of Auricles (FACA)

Anthocyanin coloration of auricles was assessed visually (stage 55-59 on Zadoks scale) according to their frequency and intensity within whole plot and categorized as absent or very weak, weak, medium, strong and very strong.

3.6.1.1.3 Frequency of plants with recurved flag leaves (FPRF)

Recurved flag leaves plants were assessed visually at (stage 50-51) according to their frequency (percentage) within whole plot and categorized as absent or very low (0-20%), low (21-40%), medium (41-60%), high (61-80%) and very high (81-100%).

3.6.1.1.4 Glaucosity of lower side of flag leaf blade (GF)

The thickness of the waxy layer on lower side of the flag leaf blade was assessed by touching flag leaves of ten plants selected randomly between fingers (stage 55-65), average assessment was scored as absent or very weak, weak, medium, strong and very strong .

3.6.1.1.5 Glaucosity of spike's neck (GN)

The density of the waxy layer on spikes neck was assessed (stage 60-69) by touching spikes neck of ten plants selected randomly between fingers. Average assessment was scored as absent or very weak, weak, medium, strong and very strong.

3.6.1.1.6 Peduncle attitude (PA)

Ten spikes were picked randomly at maturity (stage 90-92) with its peduncle from each plot. Peduncles were observed visually for attitude and grouped as straight, medium and crooked.

3.6.1.1.7 Straw pith in cross (SPC)

Ten plants from whole plot were selected randomly at maturity (stage 90-92). The pith in cross section was observed half way between base of spike and stem node below. Assessment was reported for mean of stems as thin, medium and thick (Figure 3.2).

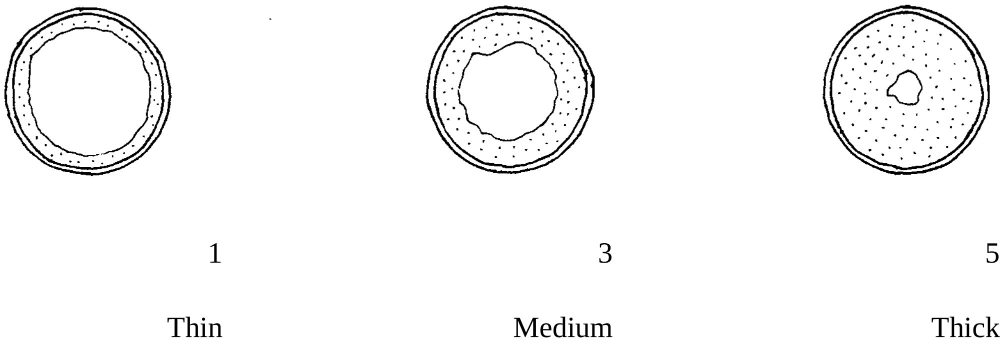


Fig.3.2: Categorization of straw pith in cross

3.6.1.1.8 Plant growth habit (GH)

Ten plants from each plot were observed randomly, growth habit was assessed visually from the attitude of the leaves and tillers at tillering stage. The angle formed by the outer leaves and the tillers with an imaginary middle axis was observed and the average score were registered as erect, semi erect, intermediate, semi prostrate and prostrate (Fig. 3.3).

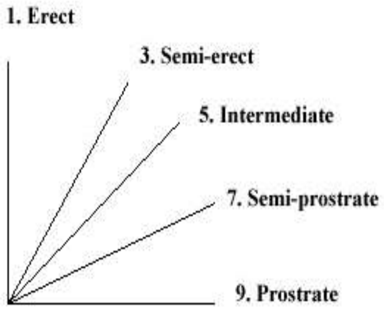


Fig.3.3: Categorization of Plant growth habit

3.6.1.2 Spike Characteristics

10 main spikes from each plot were selected randomly; the following characteristics were measured as described below.

3.6.1.2.1 Spike glaucosity (EG)

The density of waxy layer was assessed by touching spike between fingers (after spike fully appeared), average assessment was scored as absent or very weak, weak, medium, and strong.

3.6.1.2.2 Spike shape (SS)

Spike shape was observed visually and grouped as tapering, parallel sided, semi clavate, clavate and fusiform.

3.6.1.2.3 Spike density (SD)

Spike density was determined by counting the number of spikelets and then dividing the number by the spike length. The higher ratio indicated the higher density. They were categorized as lax, medium and dense (Fig. 3.4).

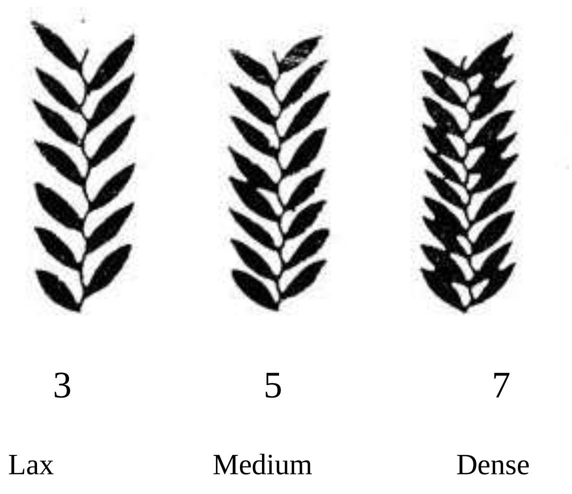


Fig.3.4: Categorization of Spike density

3.6.1.2.4 Spike color (SC)

Color of spike was assessed (at maturity) and registered as white, slightly colored and strongly colored.

3.6.1.2.5 Awns color (AC)

Color of spike awns was assessed (at maturity) and scored as white, light brown, medium purple and dark purple.

3.6.1.2.6 Awns attitude (AA)

Awns attitude (rate of awns spreading against spikes main axis) was observed visually (at maturity) and grouped as oppressed, medium and spreading.

3.6.1.2.7 Awns roughness (AR)

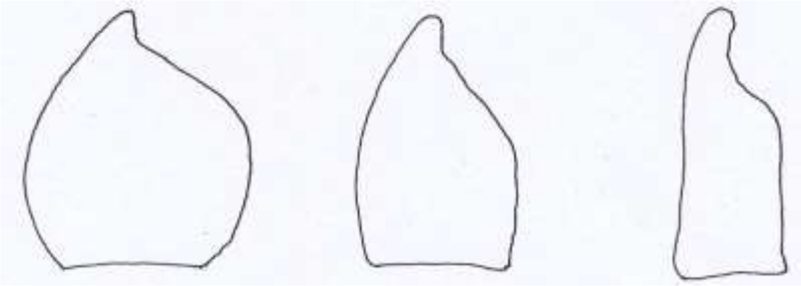
Awns roughness was checked by touching by hand (at maturity) and grouped as smooth, medium and rough.

3.6.1.2.8 Awns or scurs presence (ASP)

Awns or scurs presence was observed visually (at maturity) and scored as awns and scurs absent, awns present and scurs present.

3.6.1.2.9 Lower glume shape (GS)

Lower glume shape was observed on mid third of spikes (at maturity)and classified as ovoid, medium oblong and narrow oblong (Fig. 3.5).



1 Ovoid

2 Medium oblong

3 Narrow oblong

Fig.3.5: Categorization of lower glume shape

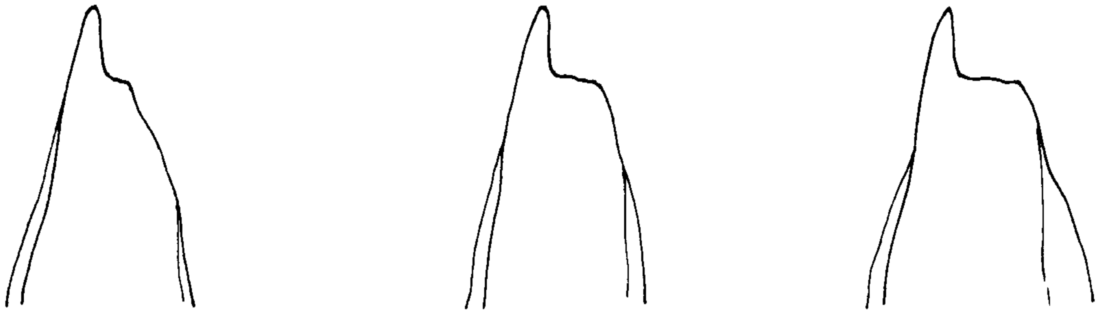
3.6.1.2.10 Lower glume external hairiness (GEH)

Hairs on external surface of lower glume were observed on mid third of spikes (at maturity) and classified as absent, short, medium and long.

Note: Observations were made with a hand lens (x10 magnification).

3.6.1.2.11 Lower glume shoulder width (GSW)

Lower glume shoulder width was observed on mid third of spikes (at maturity) and classified as narrow, medium and broad (Fig 3.6).



3 Narrow

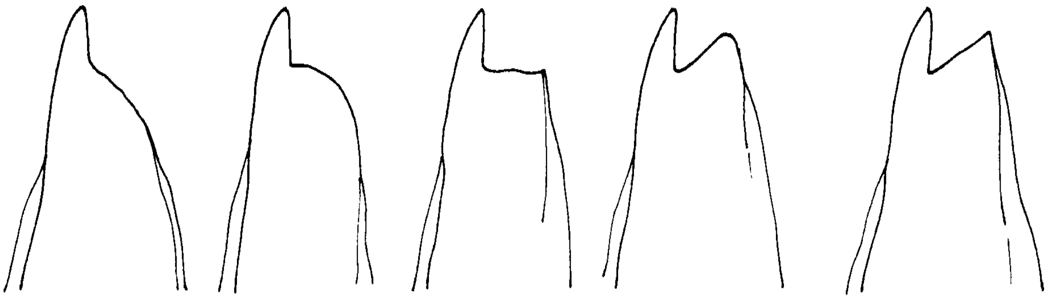
5 Medium

7 Broad

Fig.3.6: Categorization of lower glume shoulder width

3.6.1.2.12 Lower glume shoulder shape (GSS)

Lower glume shoulder shape was observed on mid third of spikes (at maturity) and classified as sloping, rounded, straight, elevated and elevated with 2nd peak (Fig. 3.7).



1 Sloping

2 Rounded

3 Straight

4 Elevated

5 Elevated with a 2nd beak

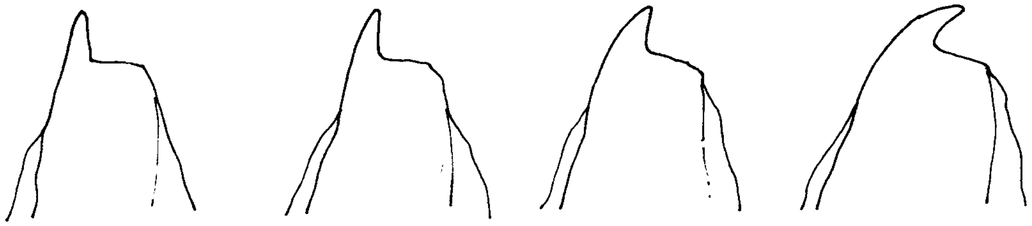
Fig.3.7: Categorization of lower glume shoulder shape

3.6.1.2.13 Lower glume peak length (GPL)

Lower glume beak length was observed on mid third of spikes (at maturity) and classified as very short, short, medium and long (Figure 3.8).

3.6.1.2.14 Lower glume peak curvate (GPC)

Lower glume beak shape was observed on mid third of spikes (at maturity) and classified as absent, weak, moderate and strong (Fig. 3.8).



1 Absent | 3 Weak | 5 Moderate | 7 Strong

Fig.3.8: Categorization of lower glume peak curvate.

3.6.1.3 Grain characteristics

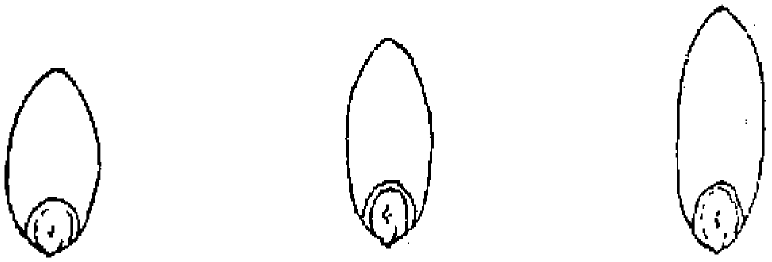
100 grains were selected randomly, the following characteristics were observed as bellow.

3.6.1.3.1 Grain color (GC)

Grain color was observed and scored as whitish, reddish and dark.

3.6.1.3.2 Grain shape (GS)

Grain shape was observed in dorsal view and scored as slightly elongated, moderately elongated, strongly elongated and extremely elongated (Fig. 3.9).



1 slightly elongated | 2 moderately elongated | 3 Strongly elongated

Fig.3.9: Categorization of grain shape.

3.6.2. Agronomic Traits Evaluation

3.6.2.1 Field growth performance

3.6.2.1.1 Number of fertile tillers per plant (NT)

Ten plants from each plot were selected randomly before maturity, fertile tillers (tillers that contain grains) were counted and mean was recorded as low (1-2 fertile tillers), medium (3-4 fertile tillers) and high (more than 4 fertile tillers).

3.6.2.1.2 Plant height (PTHT)

Plant length was measured at maturity including stem, spike and awns. The length was taken from the base of the plant to the tip of the highest awn. The genotypes were grouped as very short (< 60 cm), short (60-75 cm), medium (75.1-90 cm), long (90.1-115 cm) and very long (> 115 cm).

3.6.2.1.3 Spike length (EL)

Ten spikes were picked randomly from each plot at maturity, spike length was measured (excluding awns) and the average was recorded. Genotypes were grouped on spike length base as very short (<50 mm), medium (short (50-60 mm), medium (60.1-80 mm), long (80.1-110 mm) and very long (> 110 mm).

3.6.2.1.4 Awns length (AL)

Ten spikes were picked randomly from each plot at maturity, awns length was measured and the average was recorded. Genotypes were grouped on awns length base as very short (<50 mm), short (50-80 mm), medium (80.1-100 mm), long (100.1-120 mm) and very long (> 120 mm).

3.6.2.1.5 Days to spike emergence (DSE)

Date of spike emergence was scored when the first spikelet visible on spikes of 50% of the plants, it was converted to days by counting the days from planting date up to date of 50% spikes emergence, then genotypes were categorized as early (<110 days), medium (110- 120 days) and late (> 120 days).

3.6.2.1.6 Days to maturity (DMAT)

Date of 50% of plants within plot mature (ready to harvest by suitable moisture content estimated manually in field), Days from sawing to maturity of 50% of spikes was recorded, genotypes were grouped into three categories as early (< 164 days), medium (164-174 days) and late (> 174 days).

3.6.2.1.7 Filling period (FP)

Filling period is the period (in days) between spike emergence and maturity. Genotypes were grouped into three categories as short (< 50 days), medium (50-55 days) and late (> 55 days).

3.6.2.2 Reaction to rust and lodging

3.6.2.2.1 Leaf rust reaction (LRR)

Twenty plants were taken randomly at the stage of filling, natural infestation with leaf rust disease was assessed visually, infestation ratio was recorded in a scale 1-5 (1= no symptoms, 2= symptoms covers less than 30% of plant, 3= symptoms covers 30-50% of plant, 4= symptoms covers 51-75% of plant, 5= symptoms covers more than 75% of plant (Figure 3.10), genotypes were grouped on average score as:

Resistant: 1.00-1.99
Semi resistant: 2.00-2.99
Semi susceptible: 3.00-3.99
Susceptible: 4.00-5.00

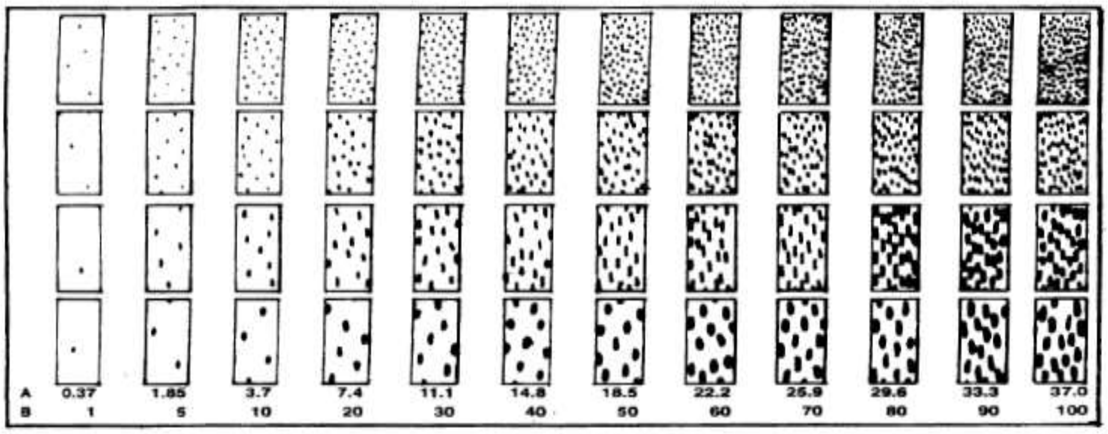


Fig.1.10: estimating scale for rust infestation rate on vegetative parts of plant (Peterson et al 1948).

4.6.2.2.2 Lodging reaction (LOD)

Percentage of lodged (bending or breaking of lower culm internodes) plants in whole plot was assessed visually in a scale (1-5), (1= lodged plants less than 10%, 2= lodged plants 11-30%, 3= lodged plants 31-50%, 4= lodged plants 51-75%, 5= lodged plants more than 75%, genotypes were grouped on average score as :

Resistant: 1.00-1.99

Semi resistant: 2.00-2.99

Semi susceptible: 3.00-3.99

Susceptible: 4.00-5.00

3.6.2.3 Yield performance

3.6.2.3.1 Number of spiklets per spike (NSPS)

Ten spikes were harvested randomly from each plot, spiklets on each spike were counted, mean was recorded, genotypes were grouped into three categories as low (< 20 spiklets), medium (20-22 spiklets) and high (> 22 spiklets).

3.6.2.3.2 Number of grains per spike (NGS)

Ten spikes were harvested randomly from each plot, threshed separately, grains within each spike were counted and means were recorded, genotypes were grouped into three categories as low (< 46 grains), medium (46-55 grains) and high (> 55 grains).

3.6.2.3.3 Thousand Grain weight by grams (TGW)

Randomly 1000 grains were collected from the bulk for each plot yield and weighed. Three replicates were scored and mean was recorded, different genotypes were grouped into three categories as low (< 40 grams), medium (40-50 grams), and high (> 50 grams).

3.6.2.3.4 Hectoliter grain weight (HGW)

Three samples of grains from each plot yield were taken randomly, Hectoliter grain weight (weight of 100 liters volume of grain by kilograms) was estimated for each sample using a special machine (EASI- WAY

Hectoliter test weight machine, Manufactured by FARM- TEC), genotypes were grouped into three categories as low (< 75), medium (75-78) and high (> 78).

3.6.2.3.5 Biological Yield (BYLD)

One square meter was allocated in the middle of plot, all plants within this area were harvested manually ten centimeters above ground level, plants were tied into bundles and weighed, weight was modified to one dunum. Genotypes were grouped into three categories as following:

Low : < 550 Kg/dunum
Medium: 550-1000 Kg/dunum
High : > 1000 Kg/dunum

3.6.2.3.6 Grain Yield (GYLD)

The harvested plants of one square meter from middle of plot were threshed using experimental machine and grains weighed, weight was modified to one dunum. Genotypes were grouped into three categories as following:

Low : < 250 Kg/dunum
Medium: 250-350 Kg/dunum
High : > 350 Kg/dunum

3.6.2.3.7 Straw Yield (SYLD)

Straw weight was calculated by subtracting grain weight above (GYLD) from biological yield (BYLD), weight was modified to one dunum. Three replicates /plot was measured, genotypes were grouped into three categories as following:

Low : < 300 Kg/dunum
Medium: 300-650Kg/dunum

High : > 650 Kg/dunum.

3.7 Experimental Design and Data analysis

Completely randomized block design (RCBD) was used in the trial with fifteen wheat genotypes (Kahatat, Heitia safra, Heitia beda 1, Heitia beda 2, Heitia soda, Heitia, Debbiya, Soori, Noorsi, Kahla, Nabeljamal, Horani 27, Numra 8, Cham 5 and Anbar) in three replications (Figure 3.11), plot area was 4 square meters.

Data were analyzed using GENSTAT program, 12th edition.

Analysis of variance for genotype, environment, year, genotype * environment, genotype* year and genotype* environment* year was made.

Cluster analysis was made by a dendogram (Figure 4.1) using UPGMA based on Jaccard genetic similarity index (Jaccard, 1908).

Replication 1	Heitia beda 2	Noorsi	Anbar	Heitia soda	Debbiya	Heitia safra	Nabeljamal	Cham 5	Heitia beda 1	Horani 27	Kahatat	Soori	Kahla	Numra 8	Heitia
Replication 2	Numra 8	Nabeljamal	Debbiya	Noorsi	Heitia beda 2	Heitia beda 1	Horani 27	Heitia safra	Kahatat	Soori	Anbar	Heitia	Heitia soda	Cham 5	Kahla
Replication 3	Kahatat	Heitia	Cham 5	Heitia beda 1	Nabeljamal	Horani 27	Soori	Anbar	Kahla	Heitia soda	Noorsi	Numra 8	Debbiya	Heitia beda 2	Heitia safra

Figure 3.13. Completely randomized block design of fifteen durum wheat genotype treatment and three replications.

Chapter Four

Results and Discussion

4.1 Morphological Characterization

Twenty four characters were studied covering morphological traits of wheat plant at different growth stages and plant parts including intact plant, spikes and grains, this evaluation were conducted at two locations (Beit-Qad and Tubas) for one growing season (2012-2013).

4.1.1 Plant vegetative characteristics

4.1.1.1 Coleoptile Anthocyanin Coloration (CAC)

Coleoptile Anthocyanin coloration varied among the 15 genotypes (Table 4.1). Two genotypes showed absent or very weak coloration (Kahatat and Debbiya), other nine showed weak coloration (Heitia safra, Heitia beda 1, Heitia beda 2, Heitia soda, Heitia, Noorsi, Kahla, Horani 27 and Cham 5), and two genotypes (Soori and Nabeljamal) were Medium colored and the rest two (Numra 8 and Anbar) had strong color.

The intensity of pigment in plant organs is genetically controlled and is also affected by abiotic stress mainly drought and salinity under which genes responded for anthocyanin production are activated (Tereshchenko, et al. 2012). This study showed a clear variation among genotypes under investigation in terms of the presence of the anthocyanin pigmentation in coleoptiles at the beginning of growth. It was weak in most of local varieties, medium in two of them and strong in two improved varieties. The results were obtained under laboratory conditions without stress which indicates that the pigmentation appeared clearly due to weak stimulation for the pigmentation genes. Khoufi et al. (2012) characterized the variation in some wheat varieties using coleoptiles anthocyanin coloration as an effective trait to distinguish between genetically apparent genotypes.

4.1.1.2 Flag leaf Anthocyanin Coloration of Auricles (FACA)

There was a low variation among the studied wheat genotypes based on flag leaf anthocyanin coloration of auricles (Table 4.1). Twelve of them were weak colored (Kahatat, Heitia safra, Heitia beda 2, Heitia, Debbiya, Soori, Noorsi, Kahla, Nabeljamal, Horani 27, Numra8 and Anbar) and three genotypes were medium colored (Heitia beda 1, Heitia soda and Cham 5). This result may indicate that the two local genotypes (Heitia beda 1 and Heitia soda) have stress tolerance genes, while Cham 5 is a drought resistant variety and recommended to be cultivated in semi dry zones (ICARDA, 1995). Similar results were observed by Haljak et al. (2008) in which winter wheat cultivars were grouped into weak, medium and strong colored.

4.1.1.3 Frequency of plants with recurved flag leaves (FPRF)

Table 4.1 shows a moderate variation among the studied genotypes according to the frequency of plants with recurved flag leaves. Among the 15 genotypes, two showed low frequency (Kahatat, Debbiya), nine showed medium (Heitia beda 1, Heitia beda 2, Heitia safra, Heitia, Heitia soda, Cham 5, Noorsi, Horani 27, Numra 8) and four genotypes (Soori, Kahla, Nabeljamal, and Anbar) showed high frequency of plants with recurved flag leaves. This variation could be attributed to the effect of the variety itself and less affected by environment (Haljak et al. 2008).This characteristic with some other morphological traits was used by El- Kalla, et al. (2010) for the determination of genetic purity in three common wheat varieties.

4.1.1.4 Glaucosity of lower side of flag leaf blade (GF)

The 15 studied genotypes didn't vary in glaucosity of lower side of flag leaf blade. All of them had a medium layer of glaucosity (Table 4.1).

This result indicates that the genes responsible for this trait are closely associated in the studied varieties. The locus controlling this trait, corresponding to a single dominant gene, was mapped on the telomeric region of short arm of chromosome 2B (Banio, 2012) and this trait was utilized as a high heritability and easy to measure character in cereals for selection to drought resistance (Ribot et al. 2012).

4.1.1.5 Glaucosity of spike's neck (GN)

The wheat genotypes in this study showed different patterns on basis of glaucosity on the neck of spike. Two of them had weak glaucosity (Heitia, Heitia soda), One genotype had a strong glaucosity (Cham 5), while the other 12 were medium (Table 4.1).

The majority of studied genotypes (12 of 15) showed medium glaucosity on spikes neck, this may be due to the genetic association among these genotypes in terms of this trait. El- Kalla, et al., (2010) used this character to distinguish between three cultivars of bread wheat showing variations in this trait. Similar results were obtained by Haljak et al., (2008) in assessing the variation in winter wheat varieties showing variations from medium to strong glaucosity.

4.1.1.6 Peduncle attitude (PA)

Peduncle attitude varied among the 15 studied genotypes (Table 4.1). Only Horani 27 was straight, ten were medium (Heitia beda 1, Heitia beda 2, Heitia soda, Heitia, Noorsi, Kahla, Nabeljamal, Numra 8, Cham 5 and Anbar), and four were crooked (Kahatat, Heitia safra, Debbiya and Soori).

The results revealed that, the studied genotypes varied in three groups (straight, medium and crooked) peduncle. Mansing (2010) reported the presence of similar variation between 22 different varieties of wheat.

4.1.1.7 Straw pith in cross (SPC)

Based on straw pith in cross trait, the genotypes were separated into two categories (Table 4.1); six of them showed thick pith (Heitia soda, Noorsi, Kahla, Nabeljamal, Horani 27, Numra 8) while the remaining nine genotypes had medium pith (Kahatat, Heitia safra, Heitia beda 1, Heitia beda 2. Heitia, Debbiya, Soori, Cham 5, Anbar).

This trait is a genetic and highly heritable trait in wheat that is frequently used in breeding programs (Van Den Berg, 2008). It was reported that, there is a significant positive correlation between straw thickness of wheat and lodging resistance in bread wheat varieties (Karim and Jahan, 2013).

4.1.1.8 Plant growth habit (GH)

Genotypes in this study were separated into two categories; nine of them were erect (Kahatat, Heitia safra, Heitia beda 1, Heitia beda 2, Debbiya, Noorsi, Kahla and Anbar) and six genotypes were semi erect (Heitia soda, Debbiya, Soori, Numra 8 and Cham 5) (Table 4.1).

All studied genotypes appeared as erect or semi erect but none of them were near to prostrate habit. This is a favorable trait for the selection of high production and low grain and straw loss. Ruiz and Martin (2000) studied growth habit among Spanish landraces of durum wheat and showed that 93 % of studied genotypes appeared as erect or intermediate.

Table 4.1. Identification wheat genotypes based on Coleoptile Anthocyanin Coloration (CAC), Flag leaf Anthocyanin Coloration of Auricles (FACA), and Frequency of plants with recurved flag leaves (FPRF), Glaucosity of lower side of flag leaf blade (GF), Glaucosity of spike's neck (GN) Peduncle attitude (PA), Straw pith in cross (SPC) and Plant growth habit (GH).

Trait / Genotype	CAC	FACA	FPRF	GF	GN	PA	SPC	GH
Kahatat	Absent or very week	Weak	Low	Medium	Medium	Crooked	Medium	Erect
Heitia safra	Week	Weak	Medium	Medium	Medium	Crooked	Medium	Erect
Heitia beda 1	Week	Medium	Medium	Medium	Medium	Bent	Medium	Erect
Heitia beda 2	Week	Weak	Medium	Medium	Medium	Bent	Medium	Erect
Heitia soda	Week	Medium	Medium	Medium	Weak	Bent	Thick	Semi erect
Heitia	Week	Weak	Medium	Medium	Weak	Bent	Medium	Semi erect
Debbiya	Absent or very week	Weak	Low	Medium	Medium	Crooked	Medium	Erect
Soori	Medium	Weak	High	Medium	Medium	Crooked	Medium	Semi erect
Noorsi	Week	Weak	Medium	Medium	Medium	Bent	Thick	Erect
Kahla	Week	Weak	High	Medium	Medium	Bent	Thick	Erect
Nabeljamal	Medium	Weak	High	Medium	Medium	Bent	Thick	Semi erect
Horani 27	Week	Weak	Medium	Medium	Medium	Straight	Thick	Erect
Numra 8	Strong	Weak	Medium	Medium	Medium	Bent	Thick	Semi erect
Cham 5	Week	Medium	High	Medium	Strong	Bent	Medium	Semi erect
Anbar	Strong	Weak	High	Medium	Medium	Bent	Medium	Erect

4.1.2 Spike Characteristics:

4.1.2.1 Spike glaucosity (SG)

According to spike glaucosity, the results of this study showed that one genotype (Cham 5) had strong spike glaucosity characteristic while the remaining fourteen genotypes were found medium (Table 4.2).

All genotypes under investigation showed medium spike glaucosity except cham 5 which had strong glaucosity. The appearance of this trait is attributed to genetic structure with single gene (Banio, 2012) and is associated with drought resistance (Ribot et al., 2012), accordingly it is documented that, Cham 5 is recommended to be cultivated in semi dry zones (ICARDA, 1995).

4.1.2.2 Spike shape (SS)

Spike shape varied among the studied 15 genotypes (Table 4.2). Ten of them had the tapering shape (Kahatat, Heitia safra, Heitia beda 2, Heitia soda, Noorsi, Nabeljamal, Horani 27, Numra 8, Cham 5 and Anbar) and five were parallel sided in shape (Heitia beda 1, Heitia, Debbiya, Soori and Kahla).

This trait was used by Al- khanjari et al (2008) in characterizing the Omani wheat landraces reporting that this trait was very polymorphic characteristic. In another investigation on Bulgarian wheat landraces all genotypes were grouped into pyramidical or cylindrical shapes (Deshava, 2014).

4.1.2.3 Spike density (SD)

Table 4.2 shows that the 15 genotypes were segregated in terms of spike density. Four of them have very dense spike (Kahatat, Heitia safra, Debbiya and Noorsi), eight genotypes have dense spike (Heitia Beda 1, Heitia, Soori, Kahla, Horani 27, Numra 8, Cham 5 and Anbar) and three genotypes (Heitia Beda 2, Heitia soda and Nabeljamal) have medium spike density.

The large variation between the studied genotypes in terms of spike density reflects the genetic variation. In particular, landraces varied from very dense spike, dense to medium. This trait in tetraploid wheat is controlled by two genes in recessive state (Goncharov et al, 2002). It was documented that, the wild relatives of wheat beard the variation in spike density as Einkorn (*T. monococum*. L.) and Emmer (*T. dicocum* SCHUEBL) had short and dense spikes, while Spelta (*T. spelta* L.) had long and lax spikes (Konvalina et al. 2010). Similar results were recorded by Ruiz and Martin (2000) showed a wider variation between Spanish wheat landraces ranged high dense to lax spikes.

4.1.2.4 Spike color (SC)

Spike color varied among the studied genotypes (Table 4.2). Four showed white color (Heitia beda1, Heitia beda2, Numra 8 and Cham 5), eight had slight color (Kahatat, Heitia safra, Heitia, Debbiya, Soori, Noorsi, Kahla and Horani 27), two were strongly colored (Nabeljamal and Anbar) and one genotype showed black color (Heitia soda).

The spike color in studies genotypes ranged widely from white through slightly and strongly colored to black spikes. The traditional naming of some of the local varieties depended primarily on spike color (Heitia beda means white heitia, Heitia safra means yellow heitia, and finally Heitia soda means black heitia). This wide range of spike color reflects the wide variability of wheat landraces in Palestine as a part the origin of wheat. Similar results were reported concerning Spanish wheat land races that varied widely in spike color from white to purple- grey to black (Ruiz and Martin, 2000).

4.1.2.5 Awns color (AC)

Awns color varied widely among the studied 15 genotypes (Table 4.2). Four genotypes were white (Heitia beda 1, Heitia beda 2, Numra 8 and Cham 5), six were light brown (Kahatat, Heitia safra, Heitia, Debbiya, Soori and Horani 27), two were medium purple (Nabeljamal and Anbar) and three genotypes were deep purple (Heitia soda, Noorsi and Kahla).

The wide variation of awns color among studied genotypes reflects the variation in genetic structure among these genotypes. Data regarding Spanish wheat landraces reported the variation of awns color from white to red brown (Ruiz and Martin, 2000), while Omani landraces represent dominant black awns color (Al- khanjari et al., 2008).

4.1.2.6 Awns attitude (AA)

Table 4.2 displays the variation of awns attitude among the studied genotypes. Oppressed type of awns was observed in four genotypes (Soori, Noorsi, Kahla and Cham 5), eight seemed medium (Heitia safra, Heitia beda 1, Heitia beda 2, Heitia, Nabeljamal, Horani 27, Numra 8 and Anbar) while three genotypes had spreading awns (Kahatat, Heitia soda and Debbiya).

In another study on Omani landraces, the majorly of landraces appeared as oppressed awns attitude (Al- khanjari et al. 2008), this comparison reveals the wider variability of Palestinian wheat landraces as compared to Omani landraces in base of awns attitude.

4.1.2.7 Awns roughness (AR)

The genotypes under study varied in terms of awns roughness (Table 4.2). Five of them were found smooth (Heitia beda 1, Heitia beda 2, Horani 27, Numra 8 and Cham 5), six genotypes were medium (Kahatat, Heitia safra, Heitia, Debbiya, Soori and Anbar) and four had rough awns (Heitia soda, Noors,i Kahla and Nabeljamal).

The genetic variability in studied genotypes affected awns roughness. The Spanish landraces studied by Ruiz and Martin (2000) showed that 98.9 % of the collections had rough awns, smooth awns which is considered as favorable trait for stockholders while rough awns had the advantage in terms of the protection of grains against bird damage (Al- khanjari et al. 2008).

4.1.2.8 Awns or scurs presence (ASP)

No variation was observed among the studied genotypes in terms of ASP in which all the 15 showed awns presence (Table 4.2).

This trait is well noticed mainly in tetraploid durum wheat more than in hexaploid bread wheat genotypes (Watkins and Elerton, 1940). Moreover, the presence of awns can double the photosynthesis rates especially under drier conditions then enhance drought resistance (Sourdille, 2002), which is considered as an important agronomic advantage in durum wheat varieties.

Table 4.2: Identification of wheat genotypes based on Spike glaucosity (SG), Spike shape (SS), Spike density (SD), and Spike color (SC) Awns color (AC), Awns attitude (AA), Awns roughness (AR) and Awns or scurs presence (ASP).

Trait Genotype	SG	SS	SD	SC	AC	AA	AR	ASP
Kahatat	Medium	Tapering	Very dense	Slightly colored	Light brown	Spreading	Medium	Awns presence
Heitia safra	Medium	Tapering	Very dense	Slightly colored	Light brown	Medium	Medium	Awns presence
Heitia beda 1	Medium	Parallel sided	Dense	White	White	Medium	Smooth	Awns presence
Heitia beda 2	Medium	Tapering	Medium	White	White	Medium	Smooth	Awns presence
Heitia soda	Medium	Tapering	Medium	Black	Deep purple	Spreading	Rough	Awns presence
Heitia	Medium	Parallel sided	Dense	Slightly colored	Light brown	Medium	Medium	Awns presence
Debbiya	Medium	Parallel sided	Very dense	Slightly colored	Light brown	Spreading	Medium	Awns presence
Soori	Medium	Parallel sided	Dense	Slightly colored	Light brown	Oppressed	Medium	Awns presence
Noorsi	Medium	Tapering	Very dense	Slightly colored	Deep purple	Oppressed	Rough	Awns presence
Kahla	Medium	Parallel sided	Dense	Slightly colored	Deep purple	Oppressed	Rough	Awns presence
Nabeljamal	Medium	Tapering	Medium	Strongly colored	Medium purple	Medium	Rough	Awns presence
Horani 27	Medium	Tapering	Dense	Slightly colored	Light brown	Medium	Smooth	Awns presence
Numra 8	Medium	Tapering	Dense	White	White	Medium	Smooth	Awns presence
Cham 5	Strong	Tapering	Dense	White	White	Oppressed	Smooth	Awns presence
Anbar	Medium	Tapering	Dense	Strongly colored	Medium purple	Spreading	Medium	Awns presence

4.1.2.9 Lower glume shape (GS)

The 15 studied genotypes varied according to lower glume shape (Table 4. 3). The majority of genotypes were medium oblong (Heitia beda 1, Heitia beda 2, Heitia soda, Heitia, Soori, Noorsi, Kahla, Horani 27, Cham 5 and Anbar). Three were ovoid (Kahatat, Heitia safra and Debbiya). Only Nabeljamal and Numra 8 were narrow oblong in lower glume shape.

As glume of studied genotypes had three shapes, most were medium oblonged. In a previous study concerning Omani landraces, most genotypes had oblong glume shape (Al- khanjari et al., 2008). Similar results were reported concerning Spanish collections (Ruiz and Aguiriano, 2004).

4.1.2.10 Lower glume external hairiness (GEH)

A high level of variation among the studied genotypes according to lower glume external hairiness was observed (Table 4.3). Nine genotypes were absent hairiness (Kahatat, Heitia safra, Heitia beda 1, Heitia beda 2, Heitia, Debbiya, Noorsi, Horani 27 and Numra 8), weakness observed with four genotypes (Heitia soda, Soori, Kahla and Cham 5), medium in Anbar, and strong in Nabeljamal genotypes.

This wide variation reflects the broad genetic base of this trait, although most of genotypes had smooth and weak glume hairs Nabeljamal was distinctive in presence of long and extensive hairs. The results agreed with Al- Khanjari et al. (2008) which indicated polymorphism in glume hairiness in Omani wheat landraces. Similar results were reported by Ruis and Martin (2000) concerning Spanish landraces collection in which there was a variation in glume hairs in spite of 70 % had absent glume hairs.

4.1.2.11 Lower glume shoulder width (GSW)

There were two types of lower glume shoulder width among the fifteen genotypes in this study (Table 4.3). All evaluated genotypes showed narrow except for Heitia beda 1 and Heitia soda that showed medium lower glume shoulder width.

Similar results were observed in the description of wheat landraces from Spain by Ruiz and Aguiriano (2004) who showed that most of studied landraces had narrow glume shoulder width.

4.1.2.12 Lower glume shoulder shape (GSS)

The 15 genotypes in this investigation varied in terms of lower glume shoulder shape (Table 4.3). Seven of them showed rounded (Kahatat, Heitia safra, Heitia beda 2, Heitia soda, Heitia, Debbiya and Noorsi), four showed elevated (Heitia beda 1, Nabeljamal, Numra 8 and Anbar) and four genotypes had straight glume shoulder shape (Soori, Kahla, Horani 27 and Cham 5).

Ruiz and Aguiriano (2004) demonstrated that Spanish landraces varied in glume shoulder shape with clear rise in landraces with elevated shoulders.

4.1.2.13 Lower glume peak length (GPL)

The studied wheat genotypes differed in base of lower glume peak length (Table 4.3). Peak was found very short in three of them (Kahatat, Heitia, safra and Debbiya), short in five (Heitia beda 2, Heitia, Horani 27, Cham 5 and Anbar), medium in other five (Heitia beda 1, Heitia soda, Soori, Noorsi and Kahla) and long in two genotypes (Nabeljamal and Numra 8).

Similar variation was observed in a study demonstrating morphological traits of some wheat varieties in Bangladesh (Tasnuva et al., 2010) in which a significant variation (range 1.2- 10 mm) in peak length was recorded.

Table 4.3. Identification of wheat genotypes based on Lower glume shape (GS), Lower glume external hairiness(GEH), Lower glume shoulder width (GSW), Lower glume shoulder shape (GSS) and Lower glume peak length (GPL).

Trait / Genotype	GS	GEH	GSW	GSS	GPL
Kahatat	Ovoid	Absent	Narrow	Rounded	Very short
Heitia safra	Ovoid	Absent	Narrow	Rounded	Very short
Heitia beda 1	Medium oblong	Absent	Medium	Elevated	Medium
Heitia beda 2	Medium oblong	Absent	Narrow	Rounded	Short
Heitia soda	Medium oblong	Weak	Medium	Rounded	Medium
Heitia	Medium oblong	Absent	Narrow	Rounded	Short
Debbiya	Ovoid	Absent	Narrow	Rounded	Very short
Soori	Medium oblong	Weak	Narrow	Straight	Medium
Noorsi	Medium oblong	Absent	Narrow	Rounded	Medium
Kahla	Medium oblong	Weak	Narrow	Straight	Medium
Nabeljamal	Narrow oblong	Strong	Narrow	Elevated	Long
Horani 27	Medium oblong	Absent	Narrow	Straight	Short
Numra 8	Narrow oblong	Absent	Narrow	Elevated	Long
Cham 5	Medium oblong	Weak	Narrow	Straight	Short
Anbar	Medium oblong	Medium	Narrow	Elevated	Short

4.1.2.14 Lower glume peak curvate (GPC)

Table 4.4 shows that 14 out of the 15 studied genotypes had weak lower glume peak curvate, while only Nabeljamal had moderate curvate.

Similar results were reported by Ruiz and Aguiriano (2004) concerning Spanish wheat landraces, as 87 % of the studied genotypes had weak or no curved peaks and the remained had medium peaks.

Table 4.4. Identification of wheat genotypes based on Lower glume peak shape (GPS), Lower glume peak curvate (GPC), Grain color (GC) and Grain shape (GS)

Trait / Genotype	GPC	GC	GS
Kahatat	Weak	Reddish	Slightly elongated
Heitia safra	Weak	Reddish	Moderately elongated
Heitia beda 1	Weak	Whitish	Moderately elongated
Heitia beda 2	Weak	Whitish	Moderately elongated
Heitia soda	Weak	Dark	Strongly elongated
Heitia	Weak	Reddish	Moderately elongated
Debbiya	Weak	Reddish	Slightly elongated
Soori	Weak	Whitish	Moderately elongated
Noorsi	Weak	Dark	Strongly elongated
Kahla	Weak	Dark	Strongly elongated
Nabeljamal	Moderately curved	Reddish	Extremely elongated
Horani 27	Weak	Reddish	Slightly elongated
Numra 8	Weak	Whitish	Strongly elongated
Cham 5	Weak	Whitish	Strongly elongated
Anbar	Weak	Reddish	Strongly elongated

4.1.3 Grain characteristics

4.1.3.1 Grain color (GC)

The 15 genotypes in our study were grouped in terms of grain color (Table 4.4). Five of them were whitish (Heitia beda 1, Heitia beda 2, Soori, Numra 8 and Cham 5), seven were reddish (Kahatat, Heitia safra, Heitia, Debbiya, Nabeljamal, Horani 27 and Anbar) and three had dark color (Heitia soda, Noorsi and Kahla).

This wide variation in our study agreed with a study conducted using Omani landraces in which red grain color was dominant (Al- khanjari et al. 2008). In contract to a study conducted on wheat landraces in Spain, the dominant grain color was white over red.

4.1.3.2 Grain shape (GS)

Grain shape varied strongly among the studied genotypes as shown in Table 4.4 Three were slightly elongated (Kahatat, Debbiya and Horani 27), five were moderately elongated (Heitia safra, Heitia beda 1, Heitia beda 2, Heitia and Soori), six were strongly elongated (Heitia soda, Noorsi, Kahla, Numra 8, Cham 5 and Anbar) and one genotype (Nabeljamal) was extremely elongated.

Grain shape is one of the most important parameters used in classification, identification and study of variation in wheat varieties (Mebatsion et al. 2012).The was a wide variation according to grain shape among studied genotypes reflects broad genetic variability among the Palestinian wheat landraces which could be easily distinguished by grain shape. Similar results were obtained in a study on phenotypic classification of some Palestinian wheat landraces in which genotypes were classified into rounded, oval and elongated (Sawalha, et al. 2008).

4.2. Agronomic Traits Evaluation (Field growth performance)

The goal of this part of study is to evaluate agronomic and yield performance for different landraces of durum wheat in Palestine. The studied traits covered the vegetative field growth performance, time needed for heading and maturity, reaction to rust and lodging, yield components and capacity for grain and straw production, etc. these traits were studied at five locations representing different environmental conditions in Palestine, study was conducted through two growth seasons. In total sixteen traits were evaluated.

4.2.1 Number of fertile tillers per plant (NT)

Number of fertile tillers per plant varied significantly among the studied genotypes (Table 4.7) with an average of 3.79 tillers. The genotype Heitia soda had the highest mean fertile tillers (4.44 tillers) while Soori had the lowest mean number (3.46 tillers). This variation could be attributed to genetic factors that genotypes did or not have the tillering inhibitor gene (tin), in addition to environmental and agronomic factors as sowing density, nitrogen fertilization and drought stress (Ribot et al., 2012).

Location affected number of fertile tillers per plant which varied from 4.242 tillers (in mean at Tubas site) to 2.868 tillers at Za'tara site (Table 4.6). The decrease in fertile tillers per plant at Za'tara site may be due to drought stress that decrease tillering (Ribot et al., 2012), as this site receive low rainfall. Similar results were shown by Salimia and Atawnah (2014) in a study of wheat genotypes in three sites in south Palestine namely the site of Janata with low annual rainfall had the fewest fertile tillers comparative with Arrub and Dora sites that have higher rainfall.

4.2.2 Plant height (PTHT)

Plant height varied significantly among the 15 genotypes (Table 4.7). The average was 98.53 cm. The genotype Nabeljamal showed the highest mean height (121.31cm) while Soori had the lowest (82.80 cm) height. This high variation could be attributed to genetic differences between genotypes as this plant height is a quantitative trait controlled by many genes (Yao, et al., 2011). Landraces showed higher mean plant height (102.27) cm compared with (84.49) cm in mean for the introduced varieties (Anbar, Cham 5 and Numra 8) with an increase of 21% (Table 4.22). Similar results were reported in studying phenotypic variability of durum wheat from Jordan in which most landraces had plant average height higher than the improved varieties (Rawashdeh, et al., 2007).

Plant height was affected by experimental location as highest mean was recorded in Tulkarm (108.37 cm) while Za'tara site with mean of (82.87 cm) was the lowest (Table 4.6). As being a quantitative trait, Environmental conditions especially water availability and soil fertility affects plant height, this fact can clarify our results demonstrating the tallest plants of the same genotype were in Tulkarm site (Highest rainfall) while shortest were in Za'tara (lowest rainfall). Similar results were cleared by Salimia and Atawnah (2014) revealing that plant height was positively correlated with the site average rainfall.

4.2.3 Spike length (SL)

The 15 genotypes of wheat showed significant variation based on spike length (Table 4.8). The average was (70.37 mm). Nabeljamal genotype had the most spike length (100.10 mm) while Kahatat had the fewest spike length (49.07 mm).This result reflects the broad genetic structure of these varieties. Similar results on a study of phenotypic classification of local and improved wheat varieties in Palestine indicated a wide variation from 40 mm in Kahatat to 70 mm in Nabeljamal for spike length (Sawalha, et al. 2008). Landraces showed shorter spikes (70) mm in compared with (76.7) mm in mean for the introduced varieties (Anbar, Cham 5 and Numra 8) (Table 4.22) with a decrease of 9%%, while three landraces (Noorsi, Kahla and Nabeljamal) were longer spikes with (87.37) mm in mean and (14%) over introduced varieties.

Spike length was affected by the experimental location which varied from 74.99 mm) at Tubas to 59.46 mm in Za'tara (Table 4.6). Spike length was the lowest at Za'tara, this may be due to drought stress as annual rainfall is the lowest. This result was supported by the results of Salimia and Atawnah (2014) in which spike length was the lowest at Janata (lowest rainfall) than Arrub and Dura (higher rainfall) for most of studied varieties.

4.2.4 Awns length (AL)

Awns length varied significantly among the 15 genotypes (Table 4.8) with (107.10) mm as average. Nabeljamal genotype had the tallest awns (135.00 mm) while Kahatat had the shortest (81.67 mm). This variation was closely related to spike length. In a study done by Nawaz et al (2013) using wheat landraces Pakistan, there was a high significant variation among twenty five genotypes based on awns length.

Landraces had shorter awns with a mean of (105.33) mm in compared with (113.78) mm in mean for the introduced varieties (Anbar, Cham 5 and Numra 8) with a decrease of 7.5%%, while three landraces (Noorsi, Kahla and Nabeljamal) had longer spikes with (125.78) mm in mean and (10.5%) increase over introduced varieties(Table 4.22). It is clear that there was a strong association between awns length and spike length for all studied genotypes.

Table 4.5. Analysis of variance of wheat genotypes based on Number of fertile tillers per plant (NT), Plant height (PTHT), Spike length (SL) and Awns length (AL).

	NT				PTHT				SL				AL			
Item	df	SS	MS	F pr	df	SS	MS	F pr	df	SS	MS	F pr	df	SS	MS	F pr
G	14	30.1807	2.1558	<0.001	14	62586.30	4470.45	<.001	14	63517.03	4536.93	<.001	14	17376.27	1241.16	<.001
G*E	53	47.1612	0.8898	<0.001	53	7038.54	132.80	<.001	44	3237.93	73.59	<.001				
G*Y	13	3.8328	0.2948	0.669	13	1167.87	89.84	<.001	10	287.54	28.75	0.015				
G*E*Y	52	11.7860	0.2267	0.984	52	4094.26	78.74	<.001	40	571.91	14.30	0.285				
Residual	283	105.7778	0.3725		284	5575.56	19.63	<.001	236	2986.67	12.66		75	5663.83	75.52	

Table 4.6. Location and season mean of wheat genotypes based on Number of fertile tillers per plant (NT), Plant height (PTHT), Spike length (SL) and Awns length (AL).

Trait	NT			PTHT			SL		
Season Location	2012-2013	2013-2014	Mean	2012-2013	2013-2014	Mean	2012-2013	2013-2014	Mean
Beit- Qad	3.76	4.61	4.18	106.56	96.65	101.6	74.80	72.63	73.71
Tubas	4.07	4.42	4.24	96.36	106.72	101.54	74.73	75.24	74.99
Tulkarm	3.46	3.46	3.46	108.22	108.52	108.37	72.52	71.21	71.87
Za'tara	2.86	2.87	2.87	83.20	82.53	82.87	59.66	59.26	59.46
Arrub	4.17	4.23	4.2	104.93	91.60	98.26	71.79	71.82	71.81

Table 4.7. Identification of wheat genotypes based on Number of fertile tillers per plant (NT) and Plant height (PTHT).

Trait Genotype	NT						PTHT					
Genotype / Location	Beit- Qad	Tubas	Tulkarm	Za'tara	Arrub	Mean	Beit- Qad	Tubas	Tulkarm	Za'tara	Arrub	Mean
Kahatat	4.00	4.50	3.00	2.83	4.17	3.70	97.83	102.17	106.67	84.33	87.0	95.60
Heitia safra	4.67	4.50	3.67	3.00	4.33	4.03	100.0	102.17	104.5	78.06	90.8	95.11
Heitia beda 1	4.17	4.17	3.33	2.72	4.67	3.81	94.00	96.50	105.8	84.72	97.8	95.78
Heitia beda 2	4.00	4.00	3.00	2.61	4.33	3.59	98.83	102.83	109.5	89.39	92.8	98.68
Heitia soda	4.72	5.13	4.06	3.46	4.81	4.44	123.88	107.05	117.23	85.87	104.8	107.77
Heitia	3.83	4.33	3.33	2.67	3.83	3.60	103.0	99.17	106.17	87.17	103.3	99.77
Debbiya	3.83	3.83	2.83	2.83	4.17	3.50	90.67	97.50	105.83	81.00	106.5	96.30
Soori	4.00	3.83	3.00	2.78	3.67	3.46	83.67	83.33	93.83	70.17	83.0	82.80
Noorsi	4.50	3.33	3.50	3.00	4.00	3.67	125.83	117.50	130.0	96.00	108.3	115.53
Kahla	4.50	4.33	4.67	2.67	4.17	4.07	121.67	124.67	125.0	96.17	114.17	116.33
Nabeljamal	3.83	4.00	2.67	2.67	4.67	3.57	122.83	127.0	134.67	99.22	122.83	121.31
Horani 27	4.00	4.00	3.67	4.00	3.33	3.80	102.5	101.83	106.17	86.17	100.67	99.47
Numra 8	4.17	4.17	3.33	2.44	4.33	3.69	85.00	87.67	95.33	69.78	86.67	84.89
Cham 5	4.17	5.00	3.67	2.33	4.00	3.83	85.33	88.33	95.17	65.00	92.33	85.23
Anbar	4.33	4.50	4.17	3.00	4.50	4.10	89.00	85.33	89.67	69.94	82.83	83.36
Mean						3.79						98.53
SE						0.61						4.43
CV						16.1						4.5
LSD						0.98						7.12

Table 4.8. Identification and grouping of wheat genotypes based on Spike length (SL) and Awns length (AL).

Trait Genotype	SL						AL
Genotype / Location	Beit- Qad	Tubas	Tulkarm	Za'tara	Arrub	Mean	Mean
Kahatat	52.85	49.83	50.5	41.83	50.33	49.07	81.67
Heitia safra	62.18	63.83	63	51	61.83	60.37	94.33
Heitia beda 1	72.35	76.83	68	55.33	63.66	67.23	101.67
Heitia beda 2	67.35	70.66	64	48.66	62	62.53	104.33
Heitia soda	76.44	81.50	75.25	63.00	75.19	74.28	115.00
Heitia	73.21	65.9	70.82	58.57	70.76	70.67	97.50
Debbiya	51.52	52.5	52	43.5	52	50.30	83.50
Soori	77.68	85.83	70.66	65.66	71	74.17	103.33
Noorsi	77.76	80.2	75.24	63	75.18	80.33	120.67
Kahla	81.01	79.55	75.85	63.61	75.79	81.67	121.67
Nabeljamal	101.35	105.66	103.66	86	103.83	100.10	135.00
Horani 27	71.18	67	71.16	63.33	77.83	70.10	106.50
Numra 8	79.68	78.33	76.33	62.83	79.83	75.40	113.33
Cham 5	77.68	79.33	79.5	61.5	78.16	75.23	116.67
Anbar	83.68	87.83	82	64	79.66	79.43	111.33
Mean						70.37	107.10
SE						3.557	8.690
CV						5.1	8.1
LSD						5.722	9.995

4.2.5 Days to spike emergence (DSE)

The days from planting to emergence of first spiklet varied significantly among the 15 genotypes (Table 4.11). The average was 112 days. Heitia beda1 was the earliest (106 days), while Nabeljamal was the latest (125 days) to spike emergence. This wide range of days needed from sowing to spike emergence (19 days) reflects the genetic differences among these genotypes as heading time is controlled by specified genes (Law et al., 1976). Similar results were presented in comparison between twelve bread wheat genotypes in Iran which varied significantly in terms of days to spike emergence with a range of 11 days (Mollasaddeghi, et al., 2012).

Landraced were generally late in days to spike emergence with mean of (113) days compared with of (108.2) days for the introduced varieties (Anbar, Cham 5 and Numra 8) (Table 4.22). This result may be explained by the higher vegetative production (plant height, biological and straw yield) which alter reproductive development of plant (spike emergence and maturity). One landrace (Heitia beda 1) was earlier with (106.3) days than introduced varieties.

Days of spike emergence in the studied genotypes were affected significantly by locations, as Tubas showed the fewest mean days (104.982) while Arrub location showed the largest (119.557) mean days (Table 4.10). Environmental conditions especially temperature significantly affects the days from sowing to spike emergence reversibly (Tsenov, 2009). This was clearly observed in this study as in Arrub location with higher elevation and least temperatures, had the longest time to spike emergence among genotypes. Similar results showed that spike emergence of local wheat accessions from Karak region (high temperature) was earlier than those from Ajloun region by 8 days (Rawashdeh, et al., 2007).

4.2.6 Days to maturity (DMAT)

The days from planting to full maturity varied significantly among the 15 genotypes under study (Table 4.11). The average of days taken by genotypes to mature was (165 days). Heitia soda took the fewest mean days (158) while Nabeljamal took the highest mean (177 days). This result agrees with Woldesemayat and Tanto (2012) findings comparing wheat varieties from Ethiopia in which genotypes varied significantly with range of 12 days to maturity. In comparison with introduced variety (Anbar, Cham 5 and Numra 8) that took 162.25 days in mean to mature, four landraces were later (Heitia safra, Noorsi, Kahla and Nabeljamal) with 172.82 days mean, while the other landraces were earlier with 161.2 days mean(Table 4.22). Later maturity landraces had the higher vegetative mass parameters (plant height, biological and straw yields) that may alter reproductive development (spike emergence and maturity).

Days to maturity in the studied genotypes were affected significantly by experimental location (Table 4.10), as Za'tara showed the fewest mean days (160days) while Arrub location showed the highest mean (168 days).

The significant difference may be attributed to environmental conditions, as in hot and dry conditions, plant grow and mature faster than it under colder and moister conditions (Inamullah and Khalil, 2011). The result of this study agreed with the findings of Salimia and Atawnah (2014) in which varieties at higher temperature location (Janata) matured earlier than them at colder locations (Arrub and Dura).

4.2.7 Filling period (FP)

The days from spike emergence to fully maturity (Filling Period of spikes) varied significantly among the studied genotypes (Table 4.11). The average of days required by genotypes for grain filling was (53 days). Kahatat required the fewest days (48) while Anbar took the most days (56).

Grain filling period is the time between heading and physiological maturity, it is affected by environmental conditions as temperature and light, as well as the genotype. It is an important trait affected by heat stress conditions in which varieties with short filling period are highly producible (Uliah et al., 2014), While in optimal conditions, longer grain filling period with earlier heading and maturity is a desirable combination for breeders (Rawashdeh, et al., 2007). In this study, there was a difference in grain filling period among genotypes (3 days) due to genotype effect. Sourour, et al (2010) explores a range of 23 days in terms of filling period among wheat land races collected from Tunisia.

Grain filling period of spikes with mature grains was affected significantly by location of experiment (Table 4.10). At Arroub, the genotypes needed the fewest mean days (48.39), in contrary; they needed the most days at Tubas (58.69). Environmental conditions of the experimental location affected grain filing period of wheat genotypes as reported by Rawashdeh, et al., (2007) showed that accessions from Karak region (highly temperature area) had shorter filling period than others from Ajloun (lower temperature area) by about 5.6 days. In our study, the genotypes grown in Arroub site showed shorter days, this may be due to interaction between genotypes and environment.

4.2.8 Leaf rust reaction (LRR)

There was a significant variation among the 15 genotypes based on leaf rust reaction (Table 4.14). The mean score was 3.142, Genotype Numra 8 showed the highest resistance reaction (2.73) while Heitia soda showed the least (4.00).

Similar results were reported by Nawaz, et al. (2013) in a study of agromorphological traits of local durum wheat varieties in Pakistan in which varieties varied significantly based on rust reaction. Landraces showed higher mean susceptibility to leaf rust (3.28) mean score compared with 2.82 mean score for introduced varieties (Anbar, Cham 5 and Numra 8) (Table 4.22). This may be attributed to the production of more vegetative parts in landraces with higher moisture content which enhance disease spreading.

Location environmental conditions affected genotypes leaf rust reaction by normal infection in field. The highest mean score of infection was signed at Tulkarm site (3.955), but in the other hand the same figure in Za'tara signed lowest mean score (2.043) (Table 4.13). Leaf rust development in wheat is greatly affected by environment, moderate temperatures, high relative humidity and wind velocity are the primary three climatic factors affecting leaf rust in wheat (Riaz, et al., 2013). Study results showed that the highest infection occurred at high relative humidity at Tulkarm site while the least

Table 4.9. Analysis of variance of wheat genotypes based on Days to spike emergence (DSE), days to maturity (DMAT) and filling period (FP).

	DSE				DMAT				FP			
Item	df	SS	MS	F pr	df	SS	MS	F pr	df	SS	MS	F pr
G	14	14703.	1050.	<.001	14	14858	1061		14	2122.	151.	<.001
G*E	53	3337.	62.9	<.001	53	2091.	39.4	<.001	53	1989.	37.5	<.001
G*Y	13	2016.	155.	<.001	13	400.	30.8	<.001	13	1045.	80.4	<.001
G*E*Y	52	2075.	39.8	<.001	52	1455.	27.9	<.001	52	2212.	42.5	<.001
Residual	284	877.	3.08		284	1150.	4.05		284	1918.	6.7	

Table 4.10. Location and season mean of wheat genotypes based on days to spike emergence (DSE), days to maturity (DMAT) and filling period (FP).

	DSE			**DMAT**			**FP**		
Location/ Season	2012-2013	2013-2014	Mean	2012-2013	2013-2014	Mean	2012-2013	2013-2014	Mean
Beit- Qad	110.	105.	108.	159.	174.	167.	49.3	68.3	58.8
Tubas	108.	101.	105.	158.	169.	164.	49.9	67.5	58.7
Tulkarm	110.	124.	117.	159.377	172.	166.	49.6	47.5	48.5
Za'tara	111.	110.	110.	160.	159.	159.	49.1	49.2	49.1
Arrub	117.	122.	120.	168.	168.	168.	51.1	45.7	48.4

Table 4.11. Identification of wheat genotypes based on Days to spike emergence (DSE) and days to maturity (DMAT) and Filling period (FP).

Trait Genotype	DSE						DMAT						FP					
Genotype / Location	Beit- Qad	Tubas	Tulkarm	Za'tara	Arrub	Mean	Beit- Qad	Tubas	Tulkarm	Za'tara	Arrub	Mean	Beit- Qad	Tubas	Tulkarm	Za'tara	Arrub	Mean
Kahatat	107.33	107.67	121.33	110.17	123.00	113.90	164.95	164.01	165.00	152.68	161.34	161.60	57.62	56.34	43.68	42.51	38.34	47.70
Heitia safra	107.00	107.67	118.83	106.50	116.17	111.23	165.95	163.68	164.84	158.68	168.01	164.23	58.96	56.01	46.01	52.18	51.84	53.00
Heitia beda1	106.17	99.167	111.00	100.33	114.83	106.30	165.12	161.68	161.84	153.34	164.01	161.20	58.96	62.51	50.84	53.01	49.18	54.90
Heitia beda2	105.83	105.50	109.00	108.33	116.83	109.10	164.95	160.51	155.84	155.18	164.51	160.20	59.12	55.01	46.84	46.84	47.68	51.10
Heitia soda	103.04	101.06	115.52	107.20	118.53	109.07	156.02	153.73	161.9	154.43	164.81	158.19	52.99	52.67	46.45	47.20	46.29	49.12
Heitia	104.33	103.00	117.83	108.67	120.17	110.80	164.12	164.68	164.34	159.01	168.68	164.17	59.79	61.68	46.51	50.34	48.51	53.37
Debbiya	105.00	103.67	118.17	103.00	114.00	108.77	164.9	161.68	164.51	153.01	162.18	161.23	59.79	58.01	46.34	50.01	48.51	52.47
Soori	106.67	100.83	115.33	106.17	116.67	109.13	165.45	160.68	162.51	156.34	163.68	161.73	58.79	59.84	47.18	50.18	47.01	52.60
Noorsi	114.50	110.33	129.33	124.00	126.50	120.93	175.95	173.68	180.84	172.01	175.68	175.63	61.46	63.34	51.51	48.01	49.18	54.70
Kahla	117.50	111.00	129.50	124.17	129.83	122.30	175.29	172.34	176.68	170.84	176.84	174.40	57.79	61.34	47.18	46.68	47.51	52.10
Nabeljamal	119.00	112.00	134.00	130.67	129.83	125.10	177.95	172.84	180.51	173.51	180.18	177.00	58.96	60.84	46.51	42.84	50.34	51.90
Horani 27	105.00	105.00	107.83	108.83	114.17	108.17	166.95	164.01	157.18	162.01	168.18	163.67	61.96	59.01	49.34	53.18	54.01	55.50
Numra 8	106.83	104.33	109.17	104.33	119.33	108.80	165.12	162.34	162.68	158.51	168.34	163.40	58.29	58.01	53.51	54.18	49.01	54.60
Cham 5	104.00	102.17	108.67	109.17	117.50	108.30	160.12	157.34	162.01	156.84	165.34	160.33	56.12	55.18	53.34	47.68	47.84	52.03
Anbar	104.50	101.33	111.17	104.00	116.50	107.50	165.62	162.01	163.84	156.18	167.51	163.03	61.12	60.68	52.68	52.18	51.01	55.53
Mean						111.96						164.67						52.71
SE						1.76						2.013						2.60
CV						1.6						1.2						4.9
LSD						2.82						3.235						4.18

Infection score was found at Za'tara site with lower relative humidity. Similar results were obtained in a study evaluating yellow rust reaction in 38 wheat varieties under six different locations in Pakistan in which higher severity of the disease was scored at higher relative humidity and low temperature locations (Ali, et al., 2009).

4.2.9 Lodging reaction (LOD)

There was a significant variation among the 15 genotypes based on lodging reaction (Table 4.14) with mean score of 3.38, Cham 5 genotype showed the best resistance (2.07) while Nabeljamal showed the worst score (4.60).

Many factors affect lodging in cereals besides the genetic structure, plant height, stem solidness (Karim and Jahan, 2013) and environmental conditions in field as wind and rain. In this study the shorter the genotypes showed the higher lodging resistance. Similar conclusion was reported by Karim and Jahan, (2013) as they screened wheat genotypes for lodging resistance. Landraces were more susceptible to lodging with (3.7) mean score compared with 2.18 mean score for improved varieties (Anbar, Cham 5 and Numra 8) (Table 4.22). Lodging susceptibility is strongly related to plant height as most landraces are taller with (102.27) cm in mean than introduced varieties with (84.49) cm.

Location conditions affected genotypes lodging in field, higher score of lodging was signed at Tulkarm (4.34) while Za'tara location signed lower mean score (1.97) (Table 4.13).

Lodging tendency among studied genotypes was strongly affected by the environmental conditions as the highest score was signed at Tulkarm location having the highest relative humidity and precipitation, while the lowest score of lodging was recorded at Za'tara, with lowest relative humidity and rainfall. Khakwani et al (2010) exploit a decrease in grain production of six wheat varieties by 38% under lodging conditions (High rain and wind velocity) than of them under optimal conditions.

Yield performance

4.2.10 Number of spikelets per spike (NSPS)

Table 4.17 shows a significant variation among the 15 genotypes in terms of number of spikelets per spike with an average of 21.87 spikelets per spike. Nabeljamal had the most spikelets number (24.10) per spike, while Heitia beda 1 genotype had the least number (20.77). This variation may due to genetic variability among genotypes which is an important factor of grain components, and is affected by environmental interaction (Zecevic et al., 2009). Similar results were obtained by Nawaz et al (2013) in which there were a significant variation among Pakistani wheat varieties in terms of number of spicklets per spike ranged from22.1 to 16.44. Although there was no significant difference between landraces and introduced varieties (Anbar, Cham 5 and Numra 8) in mean Number of spikelets per spike (Table 4.22), three landraces (Noorsi, Kahla and Nabeljamal) showed an increase by 7.4% higher than introduced varieties mean.

There was a significant influence of the location on genotype affecting the number of spikelets per spike (Table 4.16). Highest mean was observed at Arrub (22.6 spikelets) and lowest mean was observed at Za'tara (20.41 spikelets per spike). This result may be attributed mainly to the effect of

Table 4.12. Analysis of variance of wheat genotypes based on Leaf rust reaction (LRR) and Lodging reaction (LOD).

	LRR				LOD			
Item	df	SS	MS	F pr	df	SS	MS	F pr
G	14	69.51	4.97	<.001	14	303.89	21.71	<.001
G*E	53	73.31	1.38	0.169	53	76.89	1.45	0.011
G*Y	13	24.75	1.90	0.069	13	20.99	1.615	0.051
G*E*Y	52	38.52	0.74	0.971	52	48.97	0.942	0.442
Residual	284	325.3	1.146		284	262.0	0.923	

Table 4.13. Location and season mean of wheat genotypes based on Leaf rust reaction (LRR) and Lodging reaction (LOD).

	LRR			LOD		
Location/ Season	2012-2013	2013-2014	Mean	2012-2013	2013-2014	Mean
Beit- Qad	2.82	3.14	2.98	3.58	3.44	3.51
Tubas	3.09	2.66	2.87	3.67	3.15	3.41
Tulkarm	3.87	4.04	3.96	4.34	4.35	4.34
Za'tara	2.13	1.95	2.04	2.02	1.93	1.97
Arrub	3.82	3.89	3.86	3.61	3.77	3.69

Table 4.14. Identification of wheat genotypes based on Leaf rust reaction (LRR) and Lodging reaction (LOD).

Trait Genotype	LRR						LOD					
Genotype / Location	Beit- Qad	Tubas	Tulkarm	Za'tara	Arrub	Mean	Beit- Qad	Tubas	Tulkarm	Za'tara	Arrub	Mean
Kahatat	2.67	2.67	4.00	2.00	3.34	2.93	4.00	3.99	4.33	1.67	2.99	3.40
Heitia safra	3.33	3.33	3.67	2.00	4.00	3.27	4.34	3.67	4.99	1.67	3.33	3.60
Heitia beda 1	3.33	3.33	5.00	3.00	3.67	3.67	3.34	3.99	4.99	2.67	4.33	3.87
Heitia beda 2	3.00	3.33	4.34	2.00	3.67	3.27	4.34	3.99	5.67	2.33	3.67	3.99
Heitia soda	5.00	3.44	4.70	2.31	4.54	4.00	2.96	3.42	4.49	1.57	3.68	3.22
Heitia	2.67	3.00	4.00	1.34	4.34	3.07	4.34	3.67	4.67	2.33	3.99	3.80
Debbiya	2.33	3.00	3.67	2.34	4.34	3.13	3.34	4.99	3.67	1.67	3.67	3.47
Soori	2.67	2.00	4.67	2.00	4.34	3.13	2.00	1.33	2.99	1.00	3.33	2.13
Noorsi	3.67	3.34	3.67	2.34	3.00	3.20	4.34	4.33	4.99	3.67	4.67	4.40
Kahla	2.33	2.33	3.67	2.00	3.67	2.80	4.00	4.33	4.67	2.99	5.33	4.27
Nabeljamal	3.33	4.00	4.00	2.33	4.33	3.60	4.67	4.33	5.00	3.33	3.33	4.60
Horani 27	3.00	3.33	3.67	2.00	3.67	3.13	3.67	3.33	4.99	1.67	3.67	3.47
Numra 8	2.33	2.00	3.67	1.67	4.00	2.73	2.34	1.99	3.33	1.00	2.99	2.33
Cham 5	3.00	2.00	4.00	1.33	4.00	2.87	2.34	1.99	2.99	1.00	1.99	2.07
Anbar	2.00	2.00	2.67	2.00	3.00	2.87	2.67	1.67	2.99	1.00	2.33	2.13
Mean						3.14						3.38
SE						1.07						0.96
CV						34.1						28.4
LSD						1.72						1.54

mean temperature at the experimental location. There was a positive correlation between the length of the vegetative phase and the number of spikelets per spike. Therefore, shortening the duration of the vegetative stage of the apex of plant induces fewer spikelets per spike (Barnabas et al., 2008).

4.2.11 Number of grains per spike (NGS)

Number of grains per spike varied significantly among the 15 genotypes as shown in Table 4.17. The mean number was 49.00 grain per spike. The genotype Anbar had the highest grains per spike (56.07) while Heitia beda 1 had the fewest value (43.77). This effect of genotype on this trait was indicated in a study of Omani wheat landraces that showed a significant variation among landraces in terms of number of grains per spike (Khakwani et al., 2010). NGS in mean was lower in landraces (47.82) seeds than it in introduced varieties; Anbar, Cham5 and Numra 8 (53.62) seeds (Table 4.22).

There was a variation among genotypes in terms of number of grains per spike according to experimental location (Table 4.16). Tubas site showed the highest number (49.98) while Za'tara location produced the fewest (44.67). This result may be due to variation of environmental conditions especially temperature. The main effect of heat stress after/during floral initiation is observed on grain number. Floral abnormalities induced by heat cause spikelet sterility, and subsequently, a decrease in number of grains per spike (Barnabas et al., 2008). Results from a study on wheat landraces from Jordan showed that accessions from Ajloun with relatively low temperatures had higher number of grains per spike than those from Karak with relatively high temperatures (Rawashdeh, et al., 2007).

4.2.12 Thousand Grain weight by grams (TGW)

Thousand grain weight (TGW) varied significantly among the 15 genotypes (Table 4.17). An average of 50.56g was reported. Nabeljamal genotype had the highest weight (67.82g) while Debbiya had the least weight (45.13g).Similar result was reported by Sawalha, et al. (2008) in which a significant variation among studied genotypes was found, as Nabeljamal had highest TGW.

In comparison between landraces and introduced varieties (Anbar, Cham 5 and Numra 8), there was no significant difference in mean TGW, although Kahatat and Debbiya landraces showed lower mean (45.28) g while Nabeljamal was higher with (67.82) g (Table 4.22).

The experimental location had a significant influence on TSW of the studied genotypes (Table 4.16). Beit- Qad location had the highest mean of TSW (53.57g), while Za'tara had the lowest mean weight (44.75g). This could be explained by the effect of climatic conditions especially temperature. High temperatures around 34 °C during filling period decreases synthesis and function of enzymes responsible of starch accumulation in grain (Barnabas et al., 2008). Similar results were reported by Salimia and Atawnah (2014) in which grain weight vary according to the experimental site, where hey found the highest TGW at Arroub and the lowest value at Janata site.

4.2.13 Hectoliter grain weight (HGW)

Hectoliter grain weight varied among the 15 genotypes under study (Table 4.18). Average value was (76.87) kg. The highest weight (78.93) kg was scored in Kahatat genotype while the lowest weight (74.67) kg was found in Nabeljamal. The observed variation in the HSW among genotypes was highly significant, that may be attributed to genetic variability among genotypes in addition to other factors as growing environment, crop management, plant diseases such (Fusarium Head Blight , pests such as Russian Wheat Aphid) (Fox et al., 2007).

Landraces showed higher mean HGW (77.2) kg compared with (75.87) kg for introduced varieties (Anbar, Cham 5 and Numra 8) (Table 4.22).

Table 4.15. Analysis of variance of wheat genotypes based on Number of spikelets per spike (NSPS), Number of grains per spike (NGS), Thousand Grain weight by grams (TGW) and Hectoliter grain weight (HGW).

	NSPS				NGS				TGW				HGW			
Item	df	SS	MS	F pr	df	SS	MS	F pr	df	SS	MS	F pr	Df	SS	MS	F pr
G	14	380.	27.2	<.001	14	4901.	350.	<.001	14	13315.	951.	<.001	14	65.6	4.68	<.001
G*E	53	214.	4.04	<.001	53	1765.	33.3	<.001	53	1742.	32.8	<.001				
G*Y	13	18.2	1.4	0.37	13	326.	25.1	0.002	13	270.	20.8	<.001				
G*E*Y	52	77.8	1.49	0.23	52	982.	18.9	<.001	52	695.	13.3	0.001				
Residual	284	366.6	1.29		284	2758.	9.7		284	2099.	7.3		30	2.66	0.088	

Table 4.16. Location and season mean of wheat genotypes based on Number of spikelets per spike (NSPS), Number of grains per spike (NGS) and Thousand Grain weight by grams (TGW)

	NSPS			NGS			TGW		
Location/ Season	2012-2013	2013-2014	Mean	2012-2013	2013-2014	Mean	2012-2013	2013-2014	Mean
Beit- Qad	22.09	21.32	21.70	51.11	51.51	51.31	53.91	53.22	53.57
Tubas	22.80	21.6	22.2	51.04	48.92	49.98	50.73	49.19	49.96
Tulkarm	22.47	22.42	22.45	49.37	49.27	49.32	52.80	51.89	52.34
Za'tara	20.31	20.51	20.41	44.97	44.38	44.67	44.95	44.55	44.75
Arrub	22.67	22.54	22.60	49.76	49.66	49.71	52.46	51.89	52.18

Table 4.17. Identification of wheat genotypes based on Number of spikelets per spike (NSPS), Number of grains per spike (NGS) and Thousand Grain weight by grams (TGW).

Trait Genotype	NSPS						NGS						TGW					
Genotype / Location	Beit- Qad	Tubas	Tulkarm	Za'tara	Arrub	Mean	Beit- Qad	Tubas	Tulkarm	Za'tara	Arrub	Mean	Beit- Qad	Tubas	Tulkarm	Za'tara	Arrub	Mean
Kahatat	20.83	22.50	22.33	17.67	22.50	21.17	48.99	46.34	49.34	41.34	48.17	46.83	45.10	45.48	46.14	42.81	47.64	45.43
Heitia safra	21.00	22.67	23.00	20.17	20.84	21.73	50.99	48.00	50.00	44.67	50.00	48.73	48.60	45.48	50.31	41.81	45.48	46.33
Heitia beda 1	21.33	21.50	20.34	19.34	21.34	20.77	47.99	48.17	41.84	38.84	42.00	43.77	49.76	44.81	52.31	44.31	49.64	48.17
Heitia beda 2	21.14	22.17	21.00	18.67	21.67	20.93	51.49	48.84	45.00	40.84	44.67	46.17	49.60	43.14	53.31	42.51	49.81	47.67
Heitia soda	20.39	20.83	22.02	19.57	22.21	20.99	46.35	47.43	48.34	42.62	48.81	46.71	59.18	53.12	55.17	45.83	54.97	53.66
Heitia	22.99	21.84	21.84	19.34	21.84	21.57	50.32	46.84	48.17	47.50	50.84	48.73	52.43	45.81	50.14	40.51	50.14	47.81
Debbiya	20.66	22.34	21.84	19.34	22.67	21.37	51.65	47.17	50.50	42.84	50.84	48.60	48.60	46.48	43.98	40.98	45.64	45.13
Soori	19.99	22.17	22.67	21.00	22.67	21.70	55.82	56.67	52.17	51.17	53.34	53.83	57.60	51.31	52.98	47.84	53.81	52.71
Noorsi	22.66	23.67	25.67	22.00	23.67	23.53	47.82	49.34	54.00	45.50	49.50	49.23	55.14	53.98	52.64	48.98	55.14	53.23
Kahla	22.99	22.84	21.67	22.00	22.84	22.47	48.99	48.50	41.34	42.34	43.84	45.00	57.60	51.81	54.81	40.78	55.48	52.09
Nabeljamal	24.66	23.34	24.67	23.17	24.67	24.10	49.32	46.00	50.00	45.17	51.67	48.43	72.76	69.31	69.81	57.58	69.64	67.82
Horani 27	22.66	22.7	23.00	21.34	23.50	22.53	50.15	47.50	48.34	43.67	50.84	48.10	49.10	47.64	52.64	41.98	44.64	47.20
Numra 8	24.67	21.84	22.50	20.84	23.17	22.00	56.82	54.84	53.50	51.34	52.67	53.83	52.76	51.64	52.81	48.98	55.14	50.56
Cham 5	20.33	20.84	21.84	20.50	22.84	21.27	51.65	52.34	50.84	45.84	54.17	50.97	49.76	47.48	44.81	42.81	52.64	47.50
Anbar	21.16	22.34	22.34	21.34	22.67	21.97	61.15	61.84	56.50	46.50	54.34	56.07	56.60	51.64	52.98	47.71	56.48	53.08
Mean						21.87						49.00						50.56
SE						1.136						3.12						2.72
CV						5.2						6.4						5.4
LSD						1.83						5.01						4.37

Table 4.18. Identification of wheat genotypes based on Hectoliter grain weight (HGW) and Biological yield (BYLD).

Trait / Genotype	HGW	BYLD					
Genotype / Location	Mean	Beit- Qad	Tubas	Tulkarm	Za'tara	Arrub	Mean
Kahatat	78.93	684.0	1125.4	1076.3	948.8	1108.3	988.57
Heitia safra	76.47	768.2	972.1	1231.3	972.1	988.9	986.53
Heitia beda 1	76.33	874.2	958.8	1381.4	785.9	870.9	974.27
Heitia beda 2	77.53	936.4	805.4	1000.4	997.9	1225.6	993.17
Heitia soda	77.23	772.0	929.7	1181.5	864.1	986.2	946.7
Heitia	77.80	896.5	1095.4	1107.8	990.4	1346.3	1087.30
Debbiya	78.33	821.7	1110.4	1188.8	1056.9	960.1	1027.60
Soori	76.33	843.9	1145.4	1239.8	1039.9	755.6	1004.93
Noorsi	78.53	1015.7	1278.8	1305.4	870.4	1046.6	1103.40
Kahla	77.00	773.5	1172.9	1324.6	1106.3	1175.8	1110.63
Nabeljamal	74.67	1049.9	1257.1	1423.9	835.9	1051.9	1123.77
Horani 27	76.33	1019.9	986.3	1210.4	1041.3	1064.3	1064.43
Numra 8	75.43	765.9	994.6	1138.1	818.8	984.9	940.47
Cham 5	77.10	953.5	923.4	1087.3	915.4	1096.3	995.20
Anbar	75.07	876.0	1037.9	1132.9	913.8	986.6	989.47
Mean	76.873						1022.4
SE	0.2978						162.34
CV	0.4						15.9
LSD	0.4965						260.91

4.2.14 Biological Yield (BYLD)

Biological yield (by grams per square meter) varied significantly among the 15 genotypes (Table 4.18) with an average of 1022.4 g. The genotype Nabeljamal had the highest yield (1123.8g) while Numra 8 genotype had the least yield (940.5g).

Biological yield in landraces showed higher mean weight (1031.35) g/m2 compared with (975) g/m2 for the introduced variety (Anbar, Cham 5 and Numra 8) (Table 4.22). This result could be attributed to the capacity of these landraces to produce straw mass because of their more plant height over the improved cultivars (Jaradat, 2011)

Table 4.20 shows a significance effect of the experimental location on biological yield. The location at Tulkarm produced the highest biological yield (1202.4g) while Beit- Qad location had the least (868.7g). This may be attributed to environmental conditions mainly rainfall as the highest weight was obtained at Tulkarm with highest annual rainfall while the lowest total yield was recorded at Beit- Qad with lower precipitation. In the same line with our results, Salimia and Atawneh (2014) reported a higher total yield (grains and hay) of wheat genotypes at Arrub with higher annual rainfall compared to that at Dura and Janata locations with lower rainfall.

4.2.15 Grain yield (GYLD)

Table 4.21 shows a significant variation among the 15 genotypes based on grain yield (g/m^2). The average grain yield was 268.3g/m^2. Anbar genotype produced the highest grain yield (355.11g/ m^2) while Nabeljamal had the least yield (201.27g/ m^2).

Grain yield is considered as a complex trait being controlled by several genes and their expression is affected by the environmental conditions and nutrient availability (Rasheed et al 2012). The variation of grain yield among wheat genotypes agreed with the results of previous investigators (Fecauda, et al., 2014; Sawalha, et al., 2008; Inamullah et al., 2011; Talebi et al., 2012; Rawashdeh et al., 2007).

All landraces showed lower grain yield with a mean of (245.6) g/m2 compared with (340) g/m2 in mean for the three introduced varieties (Anbar, Cham 5 and Numra 8) (Table 4.22) with a decrease of 28.2%. This result may be attributed to the higher production of vegetative parts (stem and leaves) for landraces that affect the production of reproduction parts (seeds).

Table 4.20 shows a significant effect of the experimental location on grain yield. Higher grain yield was obtained at Tulkarm (330.6g/m^2), while the lowest grain yield was obtained at Za'tara (218.2g/m^2). Environmental conditions have a major influence on the genotype capacity for grain yield production considering drought and high temperature as key stress factors with negative impact on crop yield (Barnabas et al 2008). Similar results confirmed by Salimia and Atawnah (2014) who stated that the highest grain yield was obtained at Arroub site (high rainfall) followed by Dura and Janata respectively (Low rainfall).

4.2.16 Straw Yield (SYLD)

Straw weight (g/m^2) varied significantly among the 15 genotypes (Table 4.21). The average straw yield was 750.04 g/m^2. Nabeljamal had the highest yield (922.50 g/m^2) while Numra 8 genotype had the least value (625.93 g/m^2). Landraces showed higher mean straw yield (786.6) g/m2 in comparison with (635) g/m2 in mean for the three introduced varieties (Anbar, Cham 5 and Numra 8) (Table 4.22), which represents 28.8% higher in ratio).

It is clear that local varieties had higher straw mass yield, associated with taller plants and high vegetative biomass (Jaradat, 2011). Similar results obtained from an experiment conducted in Jordan using improved wheat and landraces cleared that landraces had higher biological yield and lower harvest index in comparison with improved varieties because of higher straw yield in landraces, combined with taller plants (Rawashdeh et al 2007)

Experimental location had a significant effect on straw yield of studied genotypes (Table 4.20); Tulkarm location scored highest mean straw production (871.8g/m^2), while Za'tara gave lowest mean straw yield (726 g/m^2). As mentioned previously in grain yield, straw yield is affected strongly by the environmental conditions mainly water and temperatures. Salimia and Atawnah (2014) reported similar results in which Arrub site with higher annual rainfall produced higher hay yield than Dora and Janata with more severe drought conditions.

Table 4.19. Analysis of variance of wheat genotypes based on Biological yield (BYLD), Grain yield (GYLD) and Straw yield (SYLD) .

	BYLD				GYLD				SYLD			
Item	Df	SS	MS	F pr	df	SS	MS	F pr	df	SS	MS	F pr
G	14	1524037.	108860.	<.001	14	920655.	65761.	<.001	14	3498114.	249865.	<.001
G*E	53	4582936.	86470.	<.001	53	489090.	9228.	<.001	53	3840941.	72471.	<.001
G*Y	13	669381.	51491.	0.025	13	104356.	8027.	0.009	13	693555.	53350.	0.006
G*E*Y	52	2735929.	52614.	<.001	52	490500.	9433.	<.001	52	2103664.	40455.	0.002
Residual	284	7484749.	26355.		284	1025410.	3611.		284	6469774.	22781.	

Table 4.20. Location and season mean of wheat genotypes based on Biological yield (BYLD), Grain yield (GYLD) and Straw yield (SYLD) .

	BYLD			GYLD			SYLD		
Location/ Season	2012-2013	2013-2014	Mean	2012-2013	2013-2014	Mean	2012-2013	2013-2014	Mean
Beit- Qad	946.3	791.1	868.7	248.8	271.3	260	697.5	519.7	608.6
Tubas	1062.8	1043.7	1053.3	339.8	240.0	289.9	723.0	803.8	763.4
Tulkarm	1078.9	1325.9	1202.4	293.0	368.2	330.6	785.9	957.7	871.8
Za'tara	967.6	920.8	944.2	231.4	205.0	218.2	736.2	715.8	726
Arrub	1062.2	1025.0	1043.6	227.2	258.3	242.8	835.0	766.7	800.8

Table 4.21. Identification of wheat genotypes based on Grain yield (GYLD) and Straw yield (SYLD) .

Trait Genotype	GYLD						SYLD					
Genotype / Location	Beit- Qad	Tubas	Tulkarm	Za'tara	Arrub	Mean	Beit- Qad	Tubas	Tulkarm	Za'tara	Arrub	Mean
Kahatat	220.5	303.4	321.2	210.7	235.5	258.3	463.2	822.2	755.2	738.2	872.8	730.30
Heitia safra	210.5	277.5	291.7	232.2	196.9	241.8	557.4	694.7	939.7	740.0	792.2	744.77
Heitia beda 1	276.0	260.9	364.9	220.9	212.4	267.0	597.9	698.0	1016.7	565.2	658.7	707.27
Heitia beda 2	309.7	176.7	228.7	229.9	242.9	237.6	626.3	628.8	771.8	768.2	982.8	755.58
Heitia soda	203.4	227.0	327.7	189.6	219.7	233.5	568.6	702.7	853.8	674.5	766.5	713.2
Heitia	248.1	313.4	270.2	201.4	226.7	251.9	648.1	782.2	837.7	789.2	1119.7	835.35
Debbiya	219.4	250.9	342.5	212.2	227.0	250.4	602.0	859.7	846.3	844.8	733.2	777.18
Soori	282.2	357.5	343.2	248.5	258.2	297.9	561.3	788.0	896.7	791.5	497.5	706.98
Noorsi	231.7	261.7	223.7	158.2	207.9	216.6	783.7	1017.2	1081.8	712.3	838.8	886.77
Kahla	221.4	260.9	307.7	204.0	194.9	237. 8	551.8	912.2	1017.0	902.3	981.0	872.85
Nabeljamal	187.5	260.9	195.9	150.0	212.0	201.3	862.0	996.3	1228.2	686.0	840.0	922.50
Horani 27	361.9	290.9	405.0	275.0	219.7	310.5	657.6	695.5	805.5	766.3	844.7	753.92
Numra 8	266.8	378.4	445.2	210.0	272.2	314.5	498.7	616.3	693.0	608.8	712.8	625.93
Cham 5	333.4	366.7	421.9	268.3	360.8	350.2	619.9	556.8	665.5	647.3	735.5	644.99
Anbar	325.8	362.1	469.6	263.0	355.0	355.1	549.9	675.9	663.5	650.8	631.7	634.36
Mean						268.3						750.04
SE						60.09						150.93
CV						22.4						20.0
LSD						96.57						242.57

Table 4.22. Means of wheat landraces and introduced varieties based on all 16 agronomic traits in study.

Trait Landrace	NT	PTHT	SL	AL	DSE	DMAT	FP	LRR	LOD	NSPS	NGS	TGW	HGW	BYLD	GYLD	SYLD
Kahatat	3.70	95.60	49.07	81.67	113.90	161.60	47.70	2.93	3.40	21.17	46.83	45.43	78.93	988.57	258.30	730.30
Heitia safra	4.03	95.11	60.37	94.33	111.23	164.23	53.00	3.27	3.60	21.73	48.73	46.33	76.47	986.53	241.80	744.77
Heitia beda 1	3.81	95.78	67.23	101.67	106.30	161.20	54.90	3.67	3.87	20.77	43.77	48.17	76.33	974.27	267.00	707.27
Heitia beda 2	3.59	98.68	62.53	104.33	109.10	160.20	51.10	3.27	3.99	20.93	46.17	47.67	77.53	993.17	237.60	755.58
Heitia soda	4.44	107.77	74.28	115.00	109.07	158.19	49.12	4.00	3.22	20.99	46.71	53.66	77.23	946.70	233.50	713.20
Heitia	3.60	99.77	70.67	97.50	110.80	164.17	53.37	3.07	3.80	21.57	48.73	47.81	77.80	1087.30	251.90	835.35
Debbiya	3.50	96.30	50.30	83.50	108.77	161.23	52.47	3.13	3.47	21.37	48.60	45.13	78.33	1027.60	250.40	777.18
Soori	3.46	82.80	74.17	103.33	109.13	161.73	52.60	3.13	2.13	21.70	53.83	52.71	76.33	1004.93	297.90	706.98
Noorsi	3.67	115.53	80.33	120.67	120.93	175.63	54.70	3.20	4.40	23.53	49.23	53.23	78.53	1103.40	216.60	886.77
Kahla	4.07	116.33	81.67	121.67	122.30	174.40	52.10	2.80	4.27	22.47	45.00	52.09	77.00	1110.63	237. 8	872.85
Nabeljamal	3.57	121.31	100.1	135.00	125.10	177.00	51.90	3.60	4.60	24.10	48.43	67.82	74.67	1123.77	201.30	922.50
LR mean **Introduced**	**3.77**	**102.27**	**70.07**	**105.33**	**113.33**	**165.42**	**52.09**	**3.28**	**3.70**	**21.85**	**47.82**	**50.91**	**77.20**	**1031.53**	**245.63**	**786.61**
Horani 27	3.80	99.47	70.10	106.50	108.17	163.67	55.50	3.13	3.47	22.53	48.10	47.20	76.33	1064.43	310.50	753.92
Numra 8	3.69	84.89	75.40	113.33	108.80	163.40	54.60	2.73	2.33	22.00	53.83	50.56	75.43	940.47	314.50	625.93
Cham 5	3.83	85.23	75.23	116.67	108.30	160.33	52.03	2.87	2.07	21.27	50.97	47.50	77.10	995.20	350.20	644.99
Anbar	4.10	83.36	79.43	111.33	107.50	163.03	55.53	2.87	2.13	21.97	56.07	53.08	75.07	989.47	355.10	634.36
Introduced mean	**3.87**	**84.49**	**76.69**	**113.78**	**108.20**	**162.25**	**54.05**	**2.82**	**2.18**	**21.75**	**53.62**	**50.38**	**75.87**	**975.05**	**339.93**	**635.09**

4.3 Similarity matrix and Cluster Analysis

4.3.1 Similarity matrix

Table 4.23. Similarity coefficient among wheat cultivars based on Jaccard similarity index.

1)Kahatat	----													
2) Heitia safra	93.7	----												
3) Heitia beda1	80.3	81.9	----											
4) Heitia beda2	91.0	90.8	88.4	----										
5) Heitia soda	70.3	70.5	71.1	71.6	----									
6) Heitia	88.2	88.6	85.2	91.1	74.7	----								
7) Debbiya	**96.6**	92.0	83.8	89.1	66.5	92.1	----							
8) Soori	79.7	83.9	83.9	85.7	68.5	91.5	83.4	----						
9) Noorsi	79.8	84.4	71.4	81.2	70.7	85.2	78.9	78.5	----					
10) Kahla	76.8	81.6	77.6	80.6	72.2	87.5	79.7	82.6	94.6	----				
11) Nabeljamal	52.3	61.0	59.2	65.3	64.2	70.5	51.7	72.7	80.5	82.9	----			
12) Horani 27	87.9	89.5	86.6	93.3	72.8	89.8	87.2	86.0	86.5	85.7	71.1	----		
13) Numra 8	74.7	78.8	82.3	85.2	67.4	83.2	73.4	90.8	72.9	73.4	71.1	88.4	----	
14) Cham 5	75.6	77.9	82.3	84.2	66.4	80.9	73.5	87.0	69.9	70.4	63.1	84.4	89.1	
15) Anbar	77.3	83.4	78.5	81.9	68.8	80.6	76.2	88.9	78.4	80.6	71.5	89.1	89.3	83.1
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**

Table 4.23 shows the similarity between each pair of studied genotypes (Jaccard 1908). The higher similarity (96.6) was observed between Kahatat and Debbiya than other genotypes combinations. The lowest similarity

(51.7) was found between Debbiya and Nabeljamal pair. The average similarity was (79.8) among all genotypes.

The high similarity coefficient observed between genotypes like Kahatat and debbiya (96.6), Noorsi and Kahla (94.6), Kahatat and heitia safra (93.7), Heitia and Debbiya (92.1), Heitia safra and Debbiya (92) reflects the similarity in morphological traits and agronomic performance between each pair of genotypes which may be attributed to genetic similarity among landraces that developed from the same ancestor.

4.3.2 Cluster Analysis

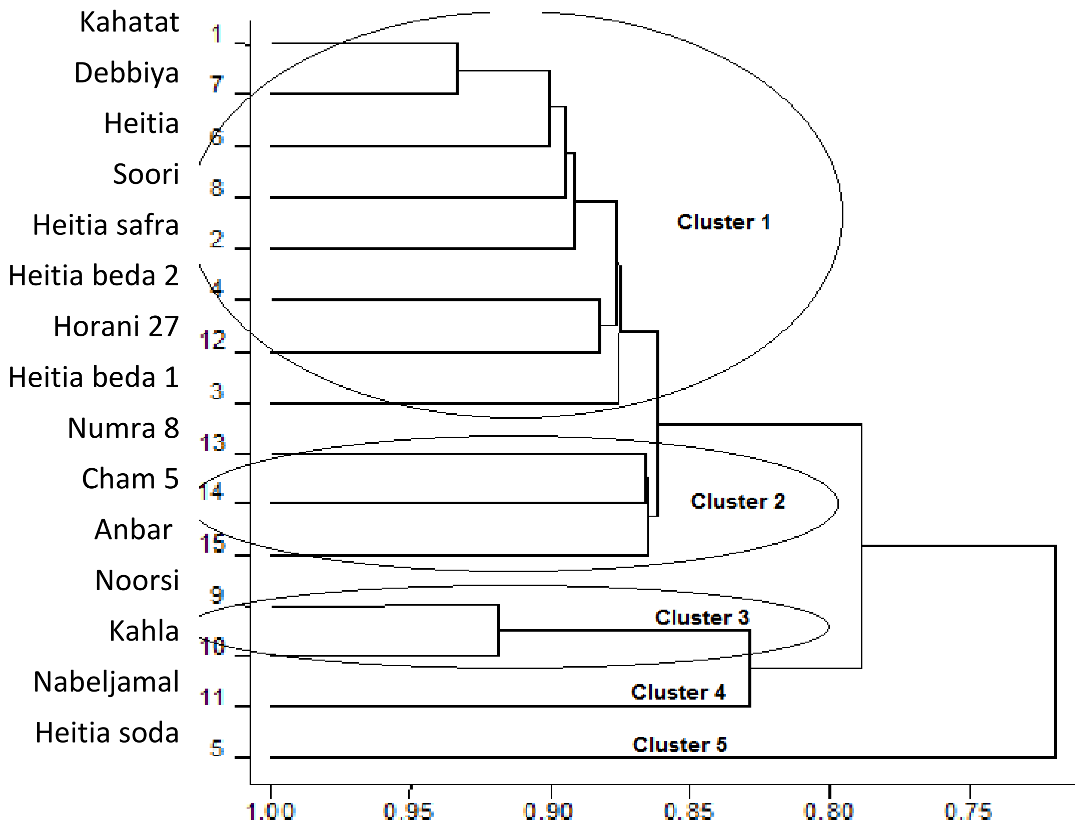


Figure 4.1. UPGMA dendrogram of the genetic similarity of the fifteen wheat genotypes based on Jaccard similarity index (Jaccard, 1908).

A dendogram in Figure 4.1using UPGMA based on Jaccard genetic similarity index (1908) showed a segregation of the 15 genotypes into five main clusters, in which eight genotypes (Kahatat, Debbiya, Heitia, Soori, Heitia safra, Heitia beda 2, Horani 27 and Heitia beda 1) constitute cluster 1, three genotypes (Numra 8, Cham 5 and Anbar) grouped in cluster 2, cluster 3 consisted of two genotypes (Noorsi and Kahla) while Nabeljamal and Heitia soda genotypes each of them was solitary located in cluster 4 and 5 respectively. Cluster 1 was also observed to divide into three sub-clusters. Kahatat, Debbiya, Heitia in sub-cluster-I with high genetic similarity ranged from 96.6 % between Kahatat and Debbiya to 88.2 % Kahatat and Heitia. Soori and Heitia safra were grouped in sub- cluster 2 with similarity of (83.9), while Heitia beda 2, Horani 27 and Heitia beda 1 were grouped in sub- cluster 3 with (93.3) similarity between Heitia beda 2, Horani 27 and (86.6) similarity between Heitia beda 1, Horani 27. 88.4 Heitia beda 1 Heitia beda 2

Cluster 2 had high similarity ranged from 89.1 between Numra 8 and Cham 5 to 89.3 between Numra 8 and Anbar.

Cluster 3 which consists of two genotypes (Noorsi and Kahla) with similarity of (94.6) between them.

Nabeljamal and was solely located in cluster 4 and Heitia soda in cluster 5. The distribution of genotypes into five distinct clusters as shown in Figure 4.1 is attributed to genetic and phenotypic similarity and variation among the fifteen genotypes under study.

Chapter Five

Conclusions and Recommendations

5.1 Conclusions

The results obtained from this study led to a group of conclusions:

- Identification of studied fifteen genotypes of durum wheat grown in Palestine was achieved through studying forty morphological and agronomic traits. The synonyms and antinomy problem were removed.
- The results of the agronomic performance of varieties and landraces under different environmental conditions in Palestine showed that the performance of landraces was not stable under different conditions.
- Landraces shared some agronomic traits:
    1. High yield of straw with low grain yield compared with introduced varieties. Straw yield trait was strongly correlated to plant height in which landraces were taller than introduced varieties in mean.
    2. Varied in days to spike emergence and maturity, Heitia beda 1 and Heitia soda were early compared with introduced varieties while Noorsi, Kahla and Nabeljamal were late.
- Genetic variation among landraces was evaluated at phenotypic and agronomic levels. There was a clear genetic variation among landraces on both levels.
- Relatedness among these genotypes was obtained through a dendogram in which genotypes were grouped into five main clusters.

5.2 Recommendations

The following recommendation was drawn from this work:

- The identification manual which was developed in this study (Appendix 1) could be used by farmers and extension staff to help them recognize and distinguish deferent varieties and to chose proper of them for their conditions and needs. It may also help grain producers and technicians to produce quality grains with high purity. Researchers may also benefit from this manual in clarifying different genotypes and the promising traits they may utilize in improvement activities.
- Results obtained from genetic variation may be considered as primary steps to launch a national breeding program for the development of new wheat cultivars that have a high productivity and adaptability with Palestinian conditions.
- Landraces of wheat that were characterized in this study need to be formally registered at national and international levels to save and label them as Palestinian landraces.
- On level of establishing a grain system in Palestine, this identification could be used also as a technical document for registering and releasing selected genotypes as new cultivars, as data were obtained following an international guidelines (UPOV) that are a prior step for registering and releasing varieties.
- Further studies are still needed on chemical characterization of local wheat landraces to evaluate their nutrient value and chemical components, studying of water and nutrition use efficiency and drought tolerance physiology, etc.

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Appendices

Appendix (1)

Varietal Descriptive Identity Sheet

Table 5.1. Kahatat genotype descriptors and means.

Characteristic	Description	Mean
Coleoptile Anthocyanin Coloration	Absent or very week	
Flag leaf Anthocyanin Coloration of Auricles	Weak	
Frequency of plants with recurved flag leaves	Low	
Glaucosity of lower side of flag leaf blade	Medium	
Glaucosity of spike's neck	Medium	
Peduncle attitude	Crooked	
Straw pith in cross	Medium	
Plant growth habit	Erect	
Plant height (mean in cm)	Long	95.6
Spike glaucosity	Medium	
Spike shape	Tapering	
Spike density	Very dense	
Spike color	Slightly colored	
Spike length (mean in mm)	Very short	49.07
Awns color	Light brown	
Awns attitude	Spreading	
Awns roughness	Medium	
Awns or scurs presence	Awns presence	
Awns length (mean in mm)	Medium	81.67
Lower glume shape	Ovoid	
Lower glume external hairiness	Absent	
Lower glume shoulder width	Narrow	
Lower glume shoulder shape	Rounded	
Lower glume peak length	Very short	
Lower glume peak curvate	Weak	
Grain color	Reddish	
Grain shape	Slightly elongated	
Number of fertile tillers per plant	Medium	3.7
Days to spike emergence	Medium	114
Days to maturity	Early	162
Filling period	Short	48
Leaf rust reaction	Semi resistant	2.9
Lodging reaction	Semi susceptible	3.40
Number of spikelets per spike	Medium	21.17
Number of grains per spike	Medium	46.83
Thousand Grain weight by grams	Medium	45.43
Hectoliter grain weight	High	78.93
Biological yield	Medium	988.57
Grain yield	Medium	258.27
Straw yield	High	730.30

Table 5.2: Heitia safra genotype descriptors and means.

Characteristic	Description	Mean
Coleoptile Anthocyanin Coloration	Week	
Flag leaf Anthocyanin Coloration of Auricles	Weak	
Frequency of plants with recurved flag leaves	Medium	
Glaucosity of lower side of flag leaf blade	Medium	
Glaucosity of spike's neck	Medium	
Peduncle attitude	Crooked	
Straw pith in cross	Medium	
Plant growth habit	Erect	
Plant height (mean in cm)	Long	95.11
Spike glaucosity	Medium	
Spike shape	Tapering	
Spike density	Very dense	
Spike color	Slightly colored	
Spike length (mean in mm)	Medium	60.37
Awns color	Light brown	
Awns attitude	Medium	
Awns roughness	Medium	
Awns or scurs presence	Awns presence	
Awns length (mean in mm)	Medium	97.33
Lower glume shape	Ovoid	
Lower glume external hairiness	Absent	
Lower glume shoulder width	Narrow	
Lower glume shoulder shape	Rounded	
Lower glume peak length	Very short	
Lower glume peak curvate	Weak	
Grain color	Reddish	
Grain shape	Moderately elongated	
Number of fertile tillers per plant	High	4.03
Days to spike emergence	Medium	112
Days to maturity	Medium	164
Filling period	Medium	53
Leaf rust reaction	Semi susceptible	3.2
Lodging reaction	Semi susceptible	3.60
Number of spikelets per spike	Medium	21.73
Number of grains per spike	Medium	48.73
Thousand Grain weight by grams	Medium	46.33
Hectoliter grain weight	Medium	76.47
Biological yield	Medium	986.5
Grain yield	Low	241.77
Straw yield	High	744.77

Table 5.3: Heitia beda 1 genotype descriptors and means.

Characteristic	Description	Mean
Coleoptile Anthocyanin Coloration	Weak	
Flag leaf Anthocyanin Coloration of Auricles	Medium	
Frequency of plants with recurved flag leaves	Medium	
Glaucosity of lower side of flag leaf blade	Medium	
Glaucosity of spike's neck	Medium	
Peduncle attitude	Bent	
Straw pith in cross	Medium	
Plant growth habit	Erect	
Plant height (mean in cm)	Long	95.78
Spike glaucosity	Medium	
Spike shape	Parallel sided	
Spike density	Dense	
Spike color	White	
Spike length (mean in mm)	Medium	67.23
Awns color	White	
Awns attitude	Medium	
Awns roughness	Smooth	
Awns or scurs presence	Awns presence	
Awns length (mean in mm)	Long	101.67
Lower glume shape	Medium oblong	
Lower glume external hairiness	Absent	
Lower glume shoulder width	Medium	
Lower glume shoulder shape	Elevated	
Lower glume peak length	Medium	
Lower glume peak curvate	Weak	
Grain color	Whitish	
Grain shape	Moderately elongated	
Number of fertile tillers per plant	Medium	3.81
Days to spike emergence	Early	106
Days to maturity	Early	161
Filling period	Medium	55
Leaf rust reaction	Semi susceptible	3.67
Lodging reaction	Semi susceptible	3.87
Number of spikelets per spike	Medium	20.77
Number of grains per spike	Low	43.77
Thousand Grain weight by grams	Medium	48.17
Hectoliter grain weight	Medium	76.33
Biological yield	Medium	974.27
Grain yield	Medium	267.
Straw yield	High	707.27

Table 5.4: Heitia beda 2 genotype descriptors and means.

Characteristic	Description	Mean
Coleoptile Anthocyanin Coloration	Weak	
Flag leaf Anthocyanin Coloration of Auricles	Weak	
Frequency of plants with recurved flag leaves	Medium	
Glaucosity of lower side of flag leaf blade	Medium	
Glaucosity of spike's neck	Medium	
Peduncle attitude	Bent	
Straw pith in cross	Medium	
Plant growth habit	Erect	
Plant height (mean in cm)	Long	98.68
Spike glaucosity	Medium	
Spike shape	Tapering	
Spike density	Medium	
Spike color	White	
Spike length (mean in mm)	Medium	62.53
Awns color	White	
Awns attitude	Medium	
Awns roughness	Smooth	
Awns or scurs presence	Awns presence	
Awns length (mean in mm)	Long	104.33
Lower glume shape	Medium oblong	
Lower glume external hairiness	Absent	
Lower glume shoulder width	Narrow	
Lower glume shoulder shape	Rounded	
Lower glume peak length	Short	
Lower glume peak curvate	Weak	
Grain color	Whitish	
Grain shape	Moderately elongated	
Number of fertile tillers per plant	Medium	3.59
Days to spike emergence	Early	109
Days to maturity	Early	160
Filling period	Medium	51
Leaf rust reaction	Semi susceptible	3.27
Lodging reaction	Semi susceptible	3.99
Number of spikelets per spike	Medium	20.93
Number of grains per spike	Medium	46.17
Thousand Grain weight by grams	Medium	47.67
Hectoliter grain weight	Medium	77.53
Biological yield	Medium	993
Grain yield	Low	237.58
Straw yield	High	755.58

Table 5.5: Heitia soda genotype descriptors and means.

Characteristic	Description	Mean
Coleoptile Anthocyanin Coloration	Weak	
Flag leaf Anthocyanin Coloration of Auricles	Medium	
Frequency of plants with recurved flag leaves	Medium	
Glaucosity of lower side of flag leaf blade	Medium	
Glaucosity of spike's neck	Weak	
Peduncle attitude	Bent	
Straw pith in cross	Thick	
Plant growth habit	Semi erect	
Plant height (mean in cm)	Long	107.77
Spike glaucosity	Medium	
Spike shape	Tapering	
Spike density	Medium	
Spike color	Black	
Spike length (mean in mm)	Medium	63.00
Awns color	Deep purple	
Awns attitude	Spreading	
Awns roughness	Rough	
Awns or scurs presence	Awns presence	
Awns length (mean in mm)	Long	115.00
Lower glume shape	Medium oblong	
Lower glume external hairiness	Weak	
Lower glume shoulder width	Medium	
Lower glume shoulder shape	Rounded	
Lower glume peak length	Medium	
Lower glume peak curvate	Weak	
Grain color	Dark	
Grain shape	Strongly elongated	
Number of fertile tillers per plant	High	4.44
Days to spike emergence	Early	109
Days to maturity	Early	158
Filling period	Short	49
Leaf rust reaction	Susceptible	4
Lodging reaction	Semi susceptible	3.22
Number of spikelets per spike	Medium	20.99
Number of grains per spike	Medium	46.71
Thousand Grain weight by grams	High	53.66
Hectoliter grain weight	Medium	77.23
Biological yield	Medium	946.7
Grain yield	Low	233.5
Straw yield	High	713.2

Table 5.6: Heitia genotype descriptors and means.

Characteristic	Description	Mean
Coleoptile Anthocyanin Coloration	Week	
Flag leaf Anthocyanin Coloration of Auricles	Weak	
Frequency of plants with recurved flag leaves	Medium	
Glaucosity of lower side of flag leaf blade	Medium	
Glaucosity of spike's neck	Weak	
Peduncle attitude	Bent	
Straw pith in cross	Medium	
Plant growth habit	Semi erect	
Plant height (mean in cm)	Long	96.30
Spike glaucosity	Medium	
Spike shape	Parallel sided	
Spike density	Dense	
Spike color	Slightly colored	
Spike length (mean in mm)	Short	50.30
Awns color	Light brown	
Awns attitude	Medium	
Awns roughness	Medium	
Awns or scurs presence	Awns presence	
Awns length (mean in mm)	Medium	83.30
Lower glume shape	Medium oblong	
Lower glume external hairiness	Absent	
Lower glume shoulder width	Narrow	
Lower glume shoulder shape	Rounded	
Lower glume peak length	Very short	
Lower glume peak curvate	Weak	
Grain color	Reddish	
Grain shape	Moderately elongated	
Number of fertile tillers per plant	Medium	3.6
Days to spike emergence	Medium	118
Days to maturity	Medium	164
Filling period	Medium	53
Leaf rust reaction	Semi susceptible	3.07
Lodging reaction	Semi susceptible	3.80
Number of spikelets per spike	Medium	21.57
Number of grains per spike	Medium	48.73
Thousand Grain weight by grams	Medium	47.81
Hectoliter grain weight	Medium	77.80
Biological yield	High	1087.30
Grain yield	Medium	251.95
Straw yield	High	835.35

Table 5.7: Debbiya genotype descriptors and means.

Characteristic	Description	Mean
Coleoptile Anthocyanin Coloration	Absent or very week	
Flag leaf Anthocyanin Coloration of Auricles	Weak	
Frequency of plants with recurved flag leaves	Low	
Glaucosity of lower side of flag leaf blade	Medium	
Glaucosity of spike's neck	Medium	
Peduncle attitude	Crooked	
Straw pith in cross	Medium	
Plant growth habit	Erect	
Plant height (mean in cm)	Long	95.6
Spike glaucosity	Medium	
Spike shape	Parallel sided	
Spike density	Very dense	
Spike color	Slightly colored	
Spike length (mean in mm)	Very short	49.07
Awns color	Light brown	
Awns attitude	Spreading	
Awns roughness	Medium	
Awns or scurs presence	Awns presence	
Awns length (mean in mm)	Medium	81.67
Lower glume shape	Ovoid	
Lower glume external hairiness	Absent	
Lower glume shoulder width	Narrow	
Lower glume shoulder shape	Rounded	
Lower glume peak length	Very short	
Lower glume peak curvate	Weak	
Grain color	Reddish	
Grain shape	Slightly elongated	
Number of fertile tillers per plant	Medium	3.5
Days to spike emergence	Early	109
Days to maturity	Early	161
Filling period	Medium	52
Leaf rust reaction	Semi susceptible	3.13
Lodging reaction	Semi susceptible	3.47
Number of spikelets per spike	Medium	21.37
Number of grains per spike	Medium	48.60
Thousand Grain weight by grams	Medium	45.13
Hectoliter grain weight	High	78.33
Biological yield	High	1027.60
Grain yield	Medium	250.42
Straw yield	High	777.18

Table 5.8: Soori genotype descriptors and means.

Characteristic	Description	Mean
Coleoptile Anthocyanin Coloration	Medium	
Flag leaf Anthocyanin Coloration of Auricles	Weak	
Frequency of plants with recurved flag leaves	High	
Glaucosity of lower side of flag leaf blade	Medium	
Glaucosity of spike's neck	Medium	
Peduncle attitude	Crooked	
Straw pith in cross	Medium	
Plant growth habit	Semi erect	
Plant height (mean in cm)	Medium	82.80
Spike glaucosity	Medium	
Spike shape	Parallel sided	
Spike density	Dense	
Spike color	Slightly colored	
Spike length (mean in mm)	Medium	74.17
Awns color	Light brown	
Awns attitude	Oppressed	
Awns roughness	Medium	
Awns or scurs presence	Awns presence	
Awns length (mean in mm)	Long	103.33
Lower glume shape	Medium oblong	
Lower glume external hairiness	Weak	
Lower glume shoulder width	Narrow	
Lower glume shoulder shape	Straight	
Lower glume peak length	Medium	
Lower glume peak curvate	Weak	
Grain color	Whitish	
Grain shape	Moderately elongated	
Number of fertile tillers per plant	Medium	3.46
Days to spike emergence	Early	109
Days to maturity	Early	162
Filling period	Medium	53
Leaf rust reaction	Semi susceptible	3.13
Lodging reaction	Semi resistant	2.13
Number of spikelets per spike	Medium	21.70
Number of grains per spike	Medium	53.83
Thousand Grain weight by grams	High	52.71
Hectoliter grain weight	Medium	76.33
Biological yield	High	1004.93
Grain yield	Medium	297.95
Straw yield	High	706.98

Table 5.9: Noorsi genotype descriptors and means.

Characteristic	Description	Mean
Coleoptile Anthocyanin Coloration	Weak	
Flag leaf Anthocyanin Coloration of Auricles	Weak	
Frequency of plants with recurved flag leaves	Medium	
Glaucosity of lower side of flag leaf blade	Medium	
Glaucosity of spike's neck	Medium	
Peduncle attitude	Bent	
Straw pith in cross	Thick	
Plant growth habit	Erect	
Plant height (mean in cm)	Very long	115.53
Spike glaucosity	Medium	
Spike shape	Tapering	
Spike density	Very dense	
Spike color	Slightly colored	
Spike length (mean in mm)	Long	80.33
Awns color	Deep purple	
Awns attitude	Oppressed	
Awns roughness	Rough	
Awns or scurs presence	Awns presence	
Awns length (mean in mm)	Very long	120.67
Lower glume shape	Medium oblong	
Lower glume external hairiness	Absent	
Lower glume shoulder width	Narrow	
Lower glume shoulder shape	Rounded	
Lower glume peak length	Medium	
Lower glume peak curvate	Weak	
Grain color	Dark	
Grain shape	Strongly elongated	
Number of fertile tillers per plant	Medium	3.67
Days to spike emergence	Late	121
Days to maturity	Late	176
Filling period	Medium	55
Leaf rust reaction	Semi susceptible	3.20
Lodging reaction	Susceptible	4.40
Number of spikelets per spike	High	23.53
Number of grains per spike	Medium	49.23
Thousand Grain weight by grams	High	53.23
Hectoliter grain weight	High	78.53
Biological yield	High	1103.40
Grain yield	Low	216.63
Straw yield	High	886.77

Table 5.10: Kahla genotype descriptors and means.

Characteristic	Description	Mean
Coleoptile Anthocyanin Coloration	Weak	
Flag leaf Anthocyanin Coloration of Auricles	Weak	
Frequency of plants with recurved flag leaves	High	
Glaucosity of lower side of flag leaf blade	Medium	
Glaucosity of spike's neck	Medium	
Peduncle attitude	Bent	
Straw pith in cross	Thick	
Plant growth habit	Erect	
Plant height (mean in cm)	Very long	116.33
Spike glaucosity	Medium	
Spike shape	Parallel sided	
Spike density	Dense	
Spike color	Slightly colored	
Spike length (mean in mm)	Long	81.67
Awns color	Deep purple	
Awns attitude	Oppressed	
Awns roughness	Rough	
Awns or scurs presence	Awns presence	
Awns length (mean in mm)	Very long	121.67
Lower glume shape	Medium oblong	
Lower glume external hairiness	Weak	
Lower glume shoulder width	Narrow	
Lower glume shoulder shape	Straight	
Lower glume peak length	Medium	
Lower glume peak curvate	Weak	
Grain color	Dark	
Grain shape	Strongly elongated	
Number of fertile tillers per plant	High	4.07
Days to spike emergence	Late	122
Days to maturity	Late	174.4
Filling period	Medium	52
Leaf rust reaction	Semi resistant	2.80
Lodging reaction	Susceptible	4.27
Number of spikelets per spike	High	22.47
Number of grains per spike	Low	45
Thousand Grain weight by grams	High	52.09
Hectoliter grain weight	Medium	77
Biological yield	High	1110.63
Grain yield	Low	237.78
Straw yield	High	872.85

Table 5.11: Nabeljamal genotype descriptors and means.

Characteristic	Description	Mean
Coleoptile Anthocyanin Coloration	Medium	
Flag leaf Anthocyanin Coloration of Auricles	Weak	
Frequency of plants with recurved flag leaves	High	
Glaucosity of lower side of flag leaf blade	Medium	
Glaucosity of spike's neck	Medium	
Peduncle attitude	Bent	
Straw pith in cross	Thick	
Plant growth habit	Semi erect	
Plant height (mean in cm)	Very long	121.31
Spike glaucosity	Medium	
Spike shape	Tapering	
Spike density	Medium	
Spike color	Strongly colored	
Spike length (mean in mm)	Long	100.10
Awns color	Medium purple	
Awns attitude	Medium	
Awns roughness	Rough	
Awns or scurs presence	Awns presence	
Awns length (mean in mm)	Very long	135.00
Lower glume shape	Narrow oblong	
Lower glume external hairiness	Strong	
Lower glume shoulder width	Narrow	
Lower glume shoulder shape	Elevated	
Lower glume peak length	Long	
Lower glume peak curvate	Moderately curved	
Grain color	Reddish	
Grain shape	Extremely elongated	
Number of fertile tillers per plant	Medium	3.57
Days to spike emergence	Late	125
Days to maturity	Late	177
Filling period	Medium	52
Leaf rust reaction	Semi susceptible	3.60
Lodging reaction	Susceptible	4.60
Number of spikelets per spike	High	24.10
Number of grains per spike	Medium	48.43
Thousand Grain weight by grams	High	67.82
Hectoliter grain weight	Low	74.67
Biological yield	High	1123.77
Grain yield	Low	201.27
Straw yield	High	922.50

Table 5.12: Horani 27 genotype descriptors and means.

Characteristic	Description	Mean
Coleoptile Anthocyanin Coloration	Week	
Flag leaf Anthocyanin Coloration of Auricles	Weak	
Frequency of plants with recurved flag leaves	Medium	
Glaucosity of lower side of flag leaf blade	Medium	
Glaucosity of spike's neck	Medium	
Peduncle attitude	Straight	
Straw pith in cross	Thick	
Plant growth habit	Erect	
Plant height (mean in cm)	Long	99.47
Spike glaucosity	Medium	
Spike shape	Tapering	
Spike density	Dense	
Spike color	Slightly colored	
Spike length (mean in mm)	Medium	70.10
Awns color	Light brown	
Awns attitude	Medium	
Awns roughness	Smooth	
Awns or scurs presence	Awns presence	
Awns length (mean in mm)	Long	106.50
Lower glume shape	Medium oblong	
Lower glume external hairiness	Absent	
Lower glume shoulder width	Narrow	
Lower glume shoulder shape	Straight	
Lower glume peak length	Short	
Lower glume peak curvate	Weak	
Grain color	Reddish	
Grain shape	Slightly elongated	
Number of fertile tillers per plant	Medium	3.8
Days to spike emergence	Early	108
Days to maturity	Early	163.6
Filling period	Long	56
Leaf rust reaction	Semi susceptible	3.13
Lodging reaction	Semi susceptible	3.47
Number of spikelets per spike	High	22.53
Number of grains per spike	Medium	48.10
Thousand Grain weight by grams	Medium	47.20
Hectoliter grain weight	Medium	76.33
Biological yield	High	1064.43
Grain yield	Medium	310.52
Straw yield	High	753.92

Table 5.13: Numra 8 genotype descriptors and means.

Characteristic	Description	Mean
Coleoptile Anthocyanin Coloration	Strong	
Flag leaf Anthocyanin Coloration of Auricles	Weak	
Frequency of plants with recurved flag leaves	Medium	
Glaucosity of lower side of flag leaf blade	Medium	
Glaucosity of spike's neck	Medium	
Peduncle attitude	Bent	
Straw pith in cross	Thick	
Plant growth habit	Semi erect	
Plant height (mean in cm)	Medium	84.89
Spike glaucosity	Medium	
Spike shape	Tapering	
Spike density	Dense	
Spike color	White	
Spike length (mean in mm)	Medium	75.40
Awns color	White	
Awns attitude	Medium	
Awns roughness	Smooth	
Awns or scurs presence	Awns presence	
Awns length (mean in mm)	Long	113.33
Lower glume shape	Narrow oblong	
Lower glume external hairiness	Absent	
Lower glume shoulder width	Narrow	
Lower glume shoulder shape	Elevated	
Lower glume peak length	Longt	
Lower glume peak curvate	Weak	
Grain color	Whitish	
Grain shape	Strongly elongated	
Number of fertile tillers per plant	Medium	3.7
Days to spike emergence	Early	109
Days to maturity	Early	163
Filling period	Medium	55
Leaf rust reaction	Semi resistant	2.73
Lodging reaction	Semi resistant	2.33
Number of spikelets per spike	Medium	22
Number of grains per spike	Medium	53.83
Thousand Grain weight by grams	High	50.56
Hectoliter grain weight	Medium	76.33
Biological yield	Medium	940.47
Grain yield	Medium	314.53
Straw yield	Medium	625.93

Table 5.14: Cham 5 genotype descriptors and means.

Characteristic	Description	Mean
Coleoptile Anthocyanin Coloration	Weak	
Flag leaf Anthocyanin Coloration of Auricles	Medium	
Frequency of plants with recurved flag leaves	High	
Glaucosity of lower side of flag leaf blade	Medium	
Glaucosity of spike's neck	Strong	
Peduncle attitude	Bent	
Straw pith in cross	Medium	
Plant growth habit	Semi erect	
Plant height (mean in cm)	Medium	85.23
Spike glaucosity	Strong	
Spike shape	Tapering	
Spike density	Dense	
Spike color	White	
Spike length (mean in mm)	Medium	75.23
Awns color	White	
Awns attitude	Oppressed	
Awns roughness	Smooth	
Awns or scurs presence	Awns presence	
Awns length (mean in mm)	Long	116.67
Lower glume shape	Medium oblong	
Lower glume external hairiness	Absent	
Lower glume shoulder width	Narrow	
Lower glume shoulder shape	Elevated	
Lower glume peak length	Long	
Lower glume peak curvate	Weak	
Grain color	Whitish	
Grain shape	Strongly elongated	
Number of fertile tillers per plant	Medium	3.83
Days to spike emergence	Early	108
Days to maturity	Early	160
Filling period	Medium	52
Leaf rust reaction	Semi resistant	2.87
Lodging reaction	Semi resistant	2.07
Number of spikelets per spike	Medium	21.27
Number of grains per spike	Medium	50.97
Thousand Grain weight by grams	Medium	47.50
Hectoliter grain weight	Medium	76.33
Biological yield	Medium	995.20
Grain yield	High	350.21
Straw yield	Medium	644.99

Table 5.15: Anbar genotype descriptors and means.

Characteristic	Description	Mean
Coleoptile Anthocyanin Coloration	Strong	
Flag leaf Anthocyanin Coloration of Auricles	Weak	
Frequency of plants with recurved flag leaves	High	
Glaucosity of lower side of flag leaf blade	Medium	
Glaucosity of spike's neck	Medium	
Peduncle attitude	Bent	
Straw pith in cross	Medium	
Plant growth habit	Semi erect	
Plant height (mean in cm)	Medium	83.36
Spike glaucosity	Medium	
Spike shape	Tapering	
Spike density	Dense	
Spike color	Strongly colored	
Spike length (mean in mm)	Medium	79.43
Awns color	Medium purple	
Awns attitude	Spreading	
Awns roughness	Medium	
Awns or scurs presence	Awns presence	
Awns length (mean in mm)	Long	111.33
Lower glume shape	Medium oblong	
Lower glume external hairiness	Medium	
Lower glume shoulder width	Narrow	
Lower glume shoulder shape	Elevated	
Lower glume peak length	Short	
Lower glume peak curvate	Weak	
Grain color	Reddish	
Grain shape	Strongly elongated	
Number of fertile tillers per plant	High	4.1
Days to spike emergence	Early	108
Days to maturity	Early	163
Filling period	Long	56
Leaf rust reaction	Semi resistant	2.87
Lodging reaction	Semi resistant	2.13
Number of spikelets per spike	Medium	21.97
Number of grains per spike	High	56.07
Thousand Grain weight by grams	High	53.08
Hectoliter grain weight	Medium	76.33
Biological yield	Medium	989.47
Grain yield	High	355.11
Straw yield	Medium	634.36

Appendix (2)

Table 5.16: Decimal code used to quantify the growth stages in cereals

Code	Description	Code	Description
0	**Germination**		
0.0	Dry grain	38	Flag leaf ligule just visible
0.1	Start of imbibitions	39	Flag leaf ligule just visible
0.2	Imbibition complete	**4.0**	**Booting**
0.3	Radicle emerged from grain	41	Flag leaf sheath extending
0.4	Coleoptile emerged from grain	43	Boots just visible and swollen
0.5	Leaf just at coleoptile tip	45	Boots swollen
1.0	**Grainling growth**	47	Flag leaf sheath opening
10	First leaf through coleoptiles	49	First awns visible
11	1 leaf unfolded	**5.0**	**Spike emergence**
12	2 leaves unfolded	51	First spikelet of spike just visible
13	3 leaves unfolded	53	One-fourth of spike visible
14	4 leaves unfolded	55	One-half of spike emerged
15	5 leaves unfolded	57	Three-fourths of spike emerged
16	6 leaves unfolded	59	Emergence of spike complete
17	7 leaves unfolded	**6.0**	**Flowering**
18	8 leaves unfolded	61	Beginning of flowering
19	9 leaves or more unfolded	65	Flowering half-way complete
2.0	**Tillering**	69	Flowering complete
20	Main shoot only	**7.0**	**Milk development**
21	Main shoot and 1 tiller	71	Grain water ripe
22	Main shoot and 2 tillers	73	Early milk[b]
23	Main shoot and 3 tillers	75	Medium milk
24	Main shoot and 4 tillers	77	Late milk
25	Main shoot and 5 tillers	**8.0**	**Dough development**
26	Main shoot and 6 tillers	83	Early dough (fingernail impression not held)
27	Main shoot and 7 tillers	85	Soft dough[c]
28	Main shoot and 8 tillers	87	Hard dough
29	Main shoot and 9 or more tillers	**9.0**	**Ripening**
3.0	**Stem elongation**	91	Grain hard (difficult to divide with thumbnail)
30	Pseudo-stem erection[a]	92	Grain hard (cannot dent with thumbnail)
31	1st node detectable	93	Grain loosening in daytime
32	2nd node detectable	94	Grain over-ripe; straw dead and collapsing
33	3rd node detectable	95	Grain dormant
34	4* node detectable	96	Viable grain giving 50% germination
35	5th node detectable	97	Grain not dormant
36	6th node detectable	98	Secondary dormancy induced
37	Flag leaf just visible	99	Secondary dormancy lost

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قدمت هذه الأطروحة استكمالاً لمتطلبات الحصول على درجة الماجستير في الإنتاج النباتي بكلية الدراسات العليا في جامعة النجاح الوطنية في نابلس، فلسطين.

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الملخص

يعتبر القمح أحد أهم المحاصيل الحقلية المزروعة في فلسطين بمساحة تتجاوز 220000 دنم ومعدل إنتاجية 136 كغم/ دنم والتي تمثل أقل من 45 بالمائة من إنتاجية القمح العالمية. هذا النقص قد يعزى إلى الظروف البيئية المحلية غير الملائمة للأصناف المزروعة. إن إدخال أصناف عالية الغلة وذات تأقلم جيد يمكن أن يكون من الحلول الفضلى. إن تأسيس برنامج وطني لتربية النبات سوف يسهل هذه المهمة عبر جمع وتقييم المصادر الوراثية المتوفرة. إن فلسطين تعتبر غنية بالأقارب البرية للقمح القاسي والعديد من السلالات المحلية التي ما تزال تزرع في مواقع مختلفة والتي يمكن اعتبارها كمستودع وراثي. إن القليل من المعلومات متوفرة عن الوصف الشكلي والأداء الحقلي لهذه السلالات علاوة على ذلك يوجد الكثير من التشابه والتناقض في التسميات لدى المزارعين، المهندسين الزراعيين والعلماء عند التعامل مع هذه السلالات، إن الحاجة إلي تعريف السلالات المحلية والأصناف الشائعة تعتبر أولوية، البيانات المنشورة حول التعريف الشكلي والزراعي للمصادر الوراثية للقمح القاسي في فلسطين هي نادرة وغير كافية.

الهدف الرئيسي لهذه الدراسة هو توصيف الصفات المظهرية وعناصر الغلة لخمسة عشر صنفا من القمح مزروعاً في فلسطين، منها أحدى عشرة سلالة محلية (كحاتات، هيتية صفراء، هيتية بيضاء 1، هيتية بيضاء 2، هيتية سوداء، هيتية، دبية، سوري، نورسي، كحلا وناب الجمل) وأربعة أصناف مدخلة (حوراني 27، نمرة 8، شام 5 وعنبر).

جميع الأصناف المدروسة تمت زراعتها ضمن تجارب حسب تصميم القطاعات العشوائية الكاملة في خمسة مواقع مناخية (محطة بيت قاد، طوباس، محطة طولكرم، زعترة ومحطة العروب) وذلك خلال موسمين زراعيين (2012–2013 و2013–2014). جميع الممارسات الزراعية تم تنفيذها حسب توصيات الإرشاد الزراعي. أربعين صفة شكلية وزراعية تم تقييمها. تم جمع البيانات حسب قواعد الإتحاد العالمي لتعريف وحماية الأصناف النباتية الجديدة وتحليلها باستخدام برنامج جنستات الإحصائي.

أظهرت النتائج وجود تباين بين الأصناف ضمن ثمانية وثلاثين صفة. التحليل العنقودي صنف الأصناف ضمن خمس مجموعات رئيسية استناداً لمدى التقارب والتباين لجميع الصفات المدروسة. علاوة على أن الأداء الزراعي للأصناف خاصة السلالات المحلية قد تم تقييمه تحت ظروف بيئية مختلفة في فلسطين. إن الأداء الزراعي للسلالات المحلية تحت ظروف بيئية مختلفة لم يتسم بالثبات حيث أظهرت غالبية السلالات غلة عالية من القش ومنخفضة من البذور مثل الصنف ناب الجمل، كما إن بعضها أظهر تبكيراً في الإسبال والنضج مثل الأصناف، هيتية بيضاء 1، هيتية بيضاء2 وهيتية سوداء الذي استغرق 158 يوم من الزراعة حتى النضج، بينما كان البعض الآخر متأخرا مثل أصناف نورسي، كحلا وناب الجمل الذي استغرق 177 يوم.

قادت النتائج المتحصل عليها من خلال الدراسة إلى تحديد شكلي واضح للأصناف المدروسة وخاصة السلالات المحلية بمستويات تم استبعاد مشكلة تشابه وتعارض التسميات. كشف التباين الوراثي أن السلالات المحلية يمكن اعتبارها نقطة بداية لإطلاق برنامج وطني لتربية النبات لتطوير أصناف تجارية جديدة من القمح تمتاز بإنتاجية وتأقلم عاليين تحت الظروف المناخية القاسية.