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Faculty of Graduate Studies

Study of Morphological and Agronomic Variation of Local and Improved Barley Lines

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Dedication

I dedicate this thesis to my father and mother, my brother and sisters, and my friends. Thank you all for your help and support.

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I would like to express my sincere thanks to my advisors Dr. Munqez Shtaya and Prof. Marwan Haddad for their help and guidance throughout my work on this thesis. In addition, I am also thankful to all the faculty members of plant production and protection master’s program.

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الإقرار

إنا الموقع أدناه مقدم الرسالة التي تحمل عنوان:

دراسة الاختلافات الظاهرية و الزراعية لأصناف شعير محلية ومحسنة

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.

Student's name: **اسم الطالب:**

Signature: **التوقيع:**

Date: **التاريخ:**

Table of Contents

List of Tables

List of Figurs

List of Abbreviations

No	Abbreviation	Full Name
1	OECD	Organisation for Economic Co-operation and Development
2	MOA	Ministry of Agriculture
3	FAO	Food and Agriculture Organization
4	ICARDA	International Centre for Agricultural Research In t he Dry Areas
5	SE	Stem Elongation
6	DtH	Days to Heading
7	DtM	Days to Maturity
8	TN	Tiller Number
9	SL	Spike length
10	SN	Spike Number
11	PH	Plant Height
12	TGY	Total Grain Yield
13	TKW	Thousand Kernels Weight
14	PCBS	Palestinian Central Bureau of Statistics

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Abstract

Barley (*Hordeum vulgare L.*)is one of the most important field crops in Palestine. The area Planted with barley exceeds 9270 ha. The average productivity in Palestine is about 1.7 ton/ha, which is less than 56% of average world productivity. This shortage is due to the effect of unfavourable local environmental conditions for used cultivars. Introducing high yielding and well-adapted cultivars could be one of the best solutions to overcome the low productivity of barley in palestine. Eighty-four accessions of landraces and cultivated varieties of barley were collected from different countries, mainly from the Fertile Crescent. A field experiment was conducted at the Faculty of Agriculture – An-Najah National University during two growing seasons 2015-2016 and 2016-2017 to evaluate several agronomical traits and to test the agronomic performance of the barley varieties under rain-fed conditions. The traits that were analysed are days to stem elongation, days to heading, days to maturity, tiller number, spike number, plant height, total grain yield, thousand kernel weight and vegetative biomass.

The results obtained from this study led to a clear morphological identification of studied varieties. Also the results indicated high genetic diversity among barley varieties, which make them potential sources for selection and hybridization programmes. The results also show that there are clear differences in most of the varieties between season 2015-2016 and season 2016-2017. These differences are due to the different climatic conditions between the two seasons in addition to the biotic and abiotic factors. The results also indicated that many of these genotypes are promising for grain yield as MK_RB_269 (409 g/m^2) variety, and others for vegetative biomass yield as MK_RB_113 (2062g/m^2) variety. Further studies are needed to compare the productivity of these genotypes with international varieties and identify QTL controlling the productivity of these genotypes and to study the variation between and within these genotypes at the molecular level.

CHAPTER ONE

INTRODUCTION

1. Introduction

Barley (*Hordeum vulgare* L.) is one of the most important cereals currently cultivated in the world. Barley considered as one of the main important source of protein and calories in human diet (Marian 2015). The chemical composition of barley seeds as the following: 78% carbohydrates, 1% fat, 10% protein and 2-3% minerals (phosphorus, calcium , magnesium and potassium). It also a good source of vitamins (vitamin B6 and niacin) (FAO, 2011). In 2016 barley was considered the fourth cereal crop production in the world with 141 million tons and 47 million ha of cultivated area (FAO, 2016). Canada was the main barley producer with 13.1 million ton (Zhang et al., 2012). Whereas total cultivated area of barley in Arab world was 6.76 million ha, with 7 million mt of grains annually produced (ICARDA, 2016).

1.1 History of Barley

Historically barley is one of the oldest domesticated grains in the world. Its cultivation started between 9500 and 8400 years ago and it played a vital role in the revolution of civilizations by providing food to humans and animals (Azhaguvel and Komatsuda, 2007). The Oxford English dictionary indicates that the word barley is derived from the old English beerlic (barley) (Zhan et al., 2012). Barley, wheat and several pulses (grain legumes) was originated in the 'Fertile Crescent', specifically Palestine - Jordan area. This area is the region in which barley was brought into culture and then spread through Syria and Lebanon to northern Iraq and Iran (Badr et al., 2000; Preece et al., 2016). Many studies had found that barley varieties were domesticated from their wild relative, *Hordeum spontaneum* which is still existed and well known in the Near East. Many of the traditional varieties are still sown and conserved *in-situ by* local farmers (Harlan and Zohary, 1966; Badr et al., 2000).

1.2 Ecology of the Crop

Barley has a wider ecological range than any other field crops. Due to its ability to ripen at rather high temperatures. Barley is not particularly winter-hardy. So it is grown as a spring crop. In areas with comparative mild winters as the Mediterranean, it is grown as a winter crop where winter is preferably sunny and moderately rainy (Bukantis and Goodman,1980).

The optimum temperature for barley growth varies according to the growth stage. It can grow at relatively low temperatures until 4 C° and higher temperatures more than wheat until 30 C° especially during spike formation, but the optimum temperature during growing period is 20 C°. It can adapt to any ecological situation, but most species do not thrive in the humid tropics (James and Duke, 1983).

Barley consumes less water per unit weight of dry matter produced than other cereals, and is able to resist dry conditions well. Barley is not actually more drought-resistant as such, but rather avoids problems due to its precocity (Harlan and Martini, 1936).

Droughts can cause large yield losses in dry areas as well as very rainy areas if droughts of various weeks occur. These may cause spike sterility, death of the stems, early maturation, etc. When a drought is combined with a heat wave during heading, a sterility of 20-90 % of the spikelet's may occur (James and Duke, 1983). When this climatic condition occurs during the filling of the grain, it causes haying off. Sensitivity to this climatic mishap varies greatly with variety (Bukantis and Goodman,1980).

Loam soil is the most suitable soil for growing barley with pH of 7–8. Moreover, barley can grow in light and weak soil which is unsuitable for wheat cultivation. In general, barley is more tolerant to salt and basic soil than wheat but more sensitive to acidic soil (James and Duke, 1983).

1.3 Barley Cultivation in Palestine

The agricultural sector is a key integral component of the cultural, social and economic fabric of Palestine. Since ancient times, agriculture in Palestine has played an important role in preserving the resilience of Palestinians during the challenging and trying times they have faced as they struggled against colonialism and occupation. Nowadays, field crops sector specially barley, wheat and legumes is one of the main agricultural sectors. It plays a central role through its contribution to the Gross Domestic Product (GDP), employment, and foreign trade. Furthermore, agriculture is a crucial driving force for other economic sectors, and foundational pillar for preserving the environment (MoA, 2014 - 2016).

Barley is the second major cultivated field crops in Palestine after wheat with 10843 ha of cultivation area with 18433 ton of production. Its cultivated area is about 22% of the total area cultivated with field crops. Ninety-seven percent (97%) of cultivated barley is under rain fed system. At the same time the production of barley in west bank is concentrated in Jenin, Hebron, Tubas, Dora, Yatta and Ramallah (Table 1- 3) (PCBs, 2017; FAO, 2017; MOA,2018).

Table 1-1Statistics of barley production in six governorates in the West Bank during 2017-2018 growing season

NO	Name of Governorate	Cultivated Area Per (ha)	Total Production of Grain / Ton	Total Production of Straw / Ton
1	Yatta	5750	6037	12650
2	Dora	1475	1504	2994
3	Ramallah	900	810	1350
4	Hebron	755	1887	3020
5	Jenin	600	1980	1800
6	Tubas	350	300	400

Most of the farmers are still planting old traditional varieties (landraces) which shows high level of resistance to biotic and abiotic stress factors. Landraces are common to farmers and they are adapted to local environment conditions. Their general performance is good under these conditions compared with foreign varieties which are introduced newly to Palestine. It was noticed that the average world productivity for barley exceeded 3 ton/ha and it is very high compared with average productivity of barley in Palestine (1.7ton/ha) (PCBs, 2010; FAO,2017; ICARDA, 2016). This big difference in average productivity of barley is due to many reasons, such as biotic and abiotic factors. For that, the responsible bodies like the Ministry of Agriculture and the research centres for many universities should find a way to improve the barley performance. For example, to establish national breeding program or to introduce new varieties to increase the production per unite area .

Barley represents an excellent crop model for many studies such as the effects of the clock on performance and stress adaptation. The reason is that barley has extensive genetic variation for resistance to many stresses. Moreover, it is an excellent system for genome mapping and map based analysis (Rollins et al. 2013). At the same time, barley is considered to have a short life cycle and it is used for plant breeding methodology, genetics, cytogenetics, pathology, virology and biotechnology studies (Hockett and Nilan, 1985). In addition, Campoli et al. (2012) have shown that many circadian clock genes are structurally conserved between barley and arabidopsis, and their circadian expression patterns suggested conserved functions.

1.4 Objective

The objective of this research is:

1. To study the morphological characterisation and the agronomic traits of 84 worldwide barley varieties.
2. To test the agronomic performance of selected wild and landrace barley lines under rain-fed conditions.

CHAPTER TWO

LITERATURE REVIEW

2. Literature Review

2.1 Taxonomy and Classification of Barley

Barley is a self-pollinating plant. It is an annual cereal and it is a member of the grass family that belong to the order Poales, genus *Hordeum* which contains many species that could be classified according to the chromosomes number and morphological characteristics (Zohary et al., 2000) .

A- Classification according to chromosomes number (Chapman and Carter,1976):

1- Dipoide Group (2n=14) this group includes *Hordeum disticum*, *Hordeum vulgare*, *Hordeum irregular* and *Hordeum agriocrithum*.

2- Tetraploid Group (2n=28) this group includes the following wild type *Hordeum bulbosum*, *Hordeum murium* and *Hordeum jubatum*.

3- Hexaploid Group (2n=42) this group contain *Hordeum nodosum*.

B- Classification according to morphological characteristics (Kumar et al., 2012):

1- Two-rowed barley with shattering spikes (wild barley) is classified as *Hordeum spontaneum* .

2- Two-rowed barley with nonshattering spikes is classified as *Hordeum distichum* L.

3- Six-row with shattering spikes as *Hordeum agriocrithon* .

4- Six-row barley with nonshattering spikes as *Hordeum vulgare L*. (or *Hordeum hexastichum* L.) .

2.2 Use and Economic Importance

Barley ranks fourth in world cereal crop production and it is among the top ten crop plants in the world. The majority of barley yield is used as animal feed, while 30 % of the world barley production is used for malting purpose. Moreover, many countries like Tunisia, Iran, Chile and China are still using barley as traditional food (OECD, 2004). Many countries consider barley grain as good commodity for trade and income. For example, European countries (1998 - 2000) exported 12.3 million tons with 1.5 billion $ at the same interval world barley grain trade was totally 20 million tons with 25 billion $ (FAO, 2004). Moreover, the total annual consumption in all Arab countries was 18.75 million mt with a deficiency of 13.33 million mt. So the self-sufficient ration is nearly 28.9% (ICARDA, 2016).

2.3 Morphological Characteristics of Plant

The morphological method is a classical method for characterizing and variety identification.

2.3.1 Stem Elongation (SE)

Stem elongation (SE) depends on environment, sowing date as well as plant genotype. SE synchronizes with leaf emergence, tillering and spike formation and usually start when the plant reach 5cm and the developing spike is carried upwards during this phase (Kirby et al., 1994; Briggs and Morrall, 1978). Kernich et al. (1995) found that stem elongation plays a vital role for grain production. At the same time long duration of this phase will increase fertile florets at anthesis and accumulation dry matter in spike, which is very important for breeding to increase yield potential. The duration of stem elongation in spring barley is varied according to variety in general between 3 and 4 weeks after plant emergence at which the internodes elongate (Anderson et al., 2013).

2.3.2 Days to Heading (DtH)

Heading date (spike emergence) is the number of days from planting the seeds until the appearance of the spike out of the flag leaf sheath which occur after germination and tillering formation (Zadoks et al., 1974). Heading date is a quantitative trait controlled by genetically endogenous and environmental factors (Alqudah and Schnurbusch, 2017). Moreover, the understanding of heading date is very important for barley breeding because this leads to understanding other developmental traits like tillering, plant height and grain number (Pasam et al., 2012; Alqudah et al., 2016).

Shtaya et al., (2010) estimated the days to heading for barley landraces and founded that HV-11 and HV-15 accessions showed lowest number of days to heading (88 and 89 days, respectively) but the HV-5 needs 112 days to heading which is considered as late producing accession .

2.3.3 Days to Maturity (DtM)

Total time to maturity depends on date of seeding, geographical location and variety. Moreover, most of barley varieties need in general between 105-157 day and around 30 - 40% moisture to reach to maturity (Thomas and Fukai, 1995). However, Ellis and Filho, (1992) found that the physiological maturity occurred between 30 and 40 days after 50% anthesis and granule moisture 40–49%.

It is Common to farmers that days to maturity is a number of days from sowing to harvest but plant breeders focus on physiological maturity when plant reached to the dough stages and maximum grain fill. At this stage transportation of water and nutrients to the spike has been cut off. Moreover, seed stop increasing in volume and stop accumulate more dry matter. In this stage the final yield has been established and green colour will be lost from the peduncle and glumes at the same time the kernel is losing water rapidly. Its consistency becomes more solid, termed "hard dough" but it become ready to threshing when the kernel moisture is around 13% (Copeland and Crookston 1985; Anderson et. al., 2013; Marian 2015).

2.3.4 Tiller Number (TN)

Barley plant consist of many branch stems called tillers, which start to develop at three leaves stage. The duration and tiller number vary according to environmental conditions and variety (Briggs and Morrall, 1978).

Barley is more competitive with weed than other cereal crops because of its greater tiller ability and below ground root competition. Moreover, Kirby and Faris (1972) reported a reduction in tilleres number in barley when it grown in field with high plant population or deep tillage land.

Anderson et al. (2013) found that some old varieties produce large number of tillers with few spikes but most modern varieties produce many tillers with fertile spikes. Tillers number is highly affected by nitrogen concentration in the soil and low temperatures at early season (Cannell, 1969, Alzueta et. al., 2012).

2.3.5 Spike length (SL)

The length of the spike is one of the main morpho-productive traits that holds great value for yield improvement in barley. Spike length varies from one cultivar to another with a general range from 7-15 cm. Moreover, Six-row barley gives spikes shorter than two-row barley. The spike length is influenced by sowing density. For example, increasing plant density causes the spike to be smaller as compared to low density population (Marian, 2015).

Paunovic et al. (2008) reported that spike length was increased from 7.19 cm under 30 kg of nitrogen / ha to 7.54 cm under 60 kg/ha. Knezevic et al. (2012) reported that any increase in seed size will lead to increase in spike dimensions and density and vice versa. For spike length, quantitative trait loci was located on chromosome 3H and one in chromosome 4H (Xue et al., 2010). Ciulca et al. (2012) also reported that the presence of the phenomena of dominance and non-allelic interactions in the genetic determinism of this trait.

2.3.6 Spike Number (SN)

High fertile tillers is one of the most important characters related to high yield. Number of spikes per plant, apart from genetically effect, is strongly affected by sowing density (Barnabás et al, 2008). So sowing rates should be confirmed in the specific area of production and for the specific genotype (Marian 2015).

2.3.7 Plant Height (PH)

Plant height found to play an important role in increasing cereal yields. The height of barley range from 70 to 90 cm (Marian 2015). Whereas Shtaya et al., (2010) reported barley genotypes with a height of up to 109.80 cm. Plant height is very important character to survive under harsh environmental conditions, but increased plant height will lead to increased lodging risk and yield loss. On the other hand low plant height make a serious problem for harvesting and reduces the ability to be competitive against other field population. Moreover, plant height is extremely influenced by drought stress (Baum et al., 2003). Plant height is a complex trait. It is controlled by one to four genes. Moreover, it can be considered as a qualitative or quantitative trait (Xue et al., 2010). Firouzian et al. (2003) and Shtaya et al. (2010) reported that the potential genetic advantage of plant height is low (8.8%) which indicates low probability of improvement of this trait in the following generations.

The stem elongation phase in wheat and barley is important for yield determination as it is the phase when stems and spikes grow actively.

2.3.8 Total Grain Yield (TGY)

Grain Yield is a quantitative trait. Around 70% of the yield depends on the cultivar and 30% on other factors such as environmental conditions, sowing density, fertilization, soil and diseases (Barnabás et al., 2008). This is due to the fact that it requires a longer period for the accumulation and filling process of grains and can have a negative impact on production. (Slafer et al., 2002).

Increasing yield can be achieved by increasing spike number per plant but selection towards higher spike number is inhibited by its low heritability (Marian 2015).

2.3.9 Thousand Kernels Weight (TKW)

The thousand kernels weight (TKW) is an indication for seed size. It is the weight in grams of 1000 seeds. The thousand kernels weight can vary from one variety to another and even from one year to another or from field to field of the same variety (Alberta, 2018). Moreover, it ranges from 24 to 58 g. Ullrich, (2010) reported that it ranges from 43-50 g for two row barley while it was between 36-42 g for six row barley.

The TKW is used mainly for calculating seeding rates and harvest losses. A producer can account for seed size variations when calculating seeding rates, calibrating seed drills and Shattering and combine losses (Alberta, 2018).

CHAPTER THREE
MATERIAL AND METHODS

3. Material and Methods

3.1 Plant Material

A collection of 84 accessions of landraces and cultivated varieties of barley from different countries, mainly from the Fertile Crescent, kindly provided by Dr. Maria von Korff, Max-Planck Institute for Plant Breeding, Germany, were used in the experiment (Table 3- 1).

Table 3-1: Barley accessions used in the study.

NO	Code/name	NO	Code/name	NO	Code/name	NO	Code/name
1	MK_RB_18	20	MK_RB_183	39	MK_RB_246	58	LR871
2	MK_RB_21	21	MK_RB_184	40	MK_RB_268	59	LR1897
3	MK_RB_86	22	MK_RB_186	41	MK_RB_269	60	Barke
4	MK_RB_87	23	MK_RB_187	42	MK_RB_270	61	Lr761
5	MK_RB_94	24	MK_RB_188	43	MK_RB_271	62	Optic
6	MK_RB_107	25	MK_RB_189	44	MK_RB_278	63	HID44
7	MK_RB_113	26	MK_RB_190	45	MK_RB_279	64	HID52
8	MK_RB_114	27	MK_RB_192	46	MK_RB_281	65	HID301
9	MK_RB_118	28	MK_RB_223	47	MK_RB_282	66	LR1043
10	MK_RB_147	29	MK_RB_224	48	MK_RB_284	67	Marthe
11	MK_RB_150	30	MK_RB_225	49	MK_RB_286	68	Bowman
12	MK_RB_152	31	MK_RB_227	50	Mutha	69	BW281
13	MK_RB_154	32	MK_RB_228	51	Rum	70	BW284
14	MK_RB_155	33	MK_RB_229	52	Aksad	71	BW285
15	MK_RB_156	34	MK_RB_230	53	Arta	72	BW287
16	MK_RB_157	35	MK_RB_232	54	Keel	73	BW289
17	MK_RB_163	36	MK_RB_233	55	Flagship	74	BW290
18	MK_RB_167	37	MK_RB_240	56	Morex	75	G400
19	MK_RB_181	38	MK_RB_241	57	Auriga		

3.2 Field Experiment

Field experiment was conducted at the experimental farm of the Faculty of Agriculture, An-Najah National University, Tulkarm (Khadouri), Palestine (32.31519º N and 35.02033º W and altitude of 75 m, average mean yearly rainfall 600 mm), during two growing seasons 2015-2016 and 2016-2017, Fig (1).

Fig 1 Field preparation and planting

3.3 Cultural Practices

The experimental open field was ploughed two times before planting. All accessions were sown in a clay loamy soil. Accessions were sown manually in November 2015 and November 2016 in three replicates. Each accession was represented by 15 seeds in a single row, 1 m long per replicates, with 40 cm spacing between rows to evaluate agronomic performance.

Protection against aphids was made by spraying "Berimor, a.i. " at a rate of 40 g per 20 L. Plants were protected against foliar fungal diseases. Hand weeding between and within rows were done and continued throughout the growing season. Plants were fertilized according to the recommendations of the MoA cultivation programme. No supplementary irrigation was used during the growing season.

3.4 Data collection

3.4.1 Pre – Harvesting Parameters.

3.4.1.1 Days to Germination:

The number of days from sowing to germination were recorded.

3.4.1.2 Growth Vigour:

The Growth Vigour for each cultivars during December of 2015 and the December of 2016 from 1-7, which 1 is the weakest and 7 is the strongest growth as in Fig (2) .

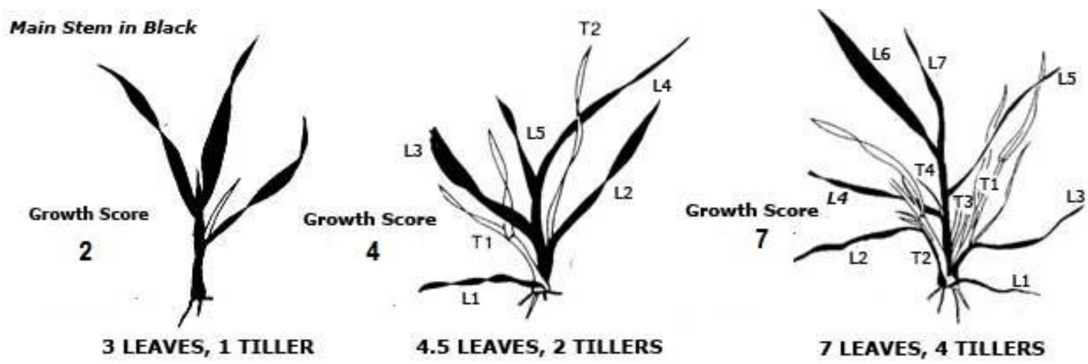

Fig 2 Growth Scale of Cereals (Zadoks et al . , 1974)

3.4.1.3 Growth Habit:

Growth habit was assessed visually from the beginning of tiller and leaves at tillering stages. The angle formed by the outer leaves and the tillers with an imaginary middle axis was observed and the average scored were registed as erect and prostrate.

3.4.1.4 Days to Stem Elongation:

The number of days from seedling emergence to the start of erect growth as we see in (Fig3).

Fig3 Stem Elongation

3.4.1.5 Days to Heading

Number of days from sowing until 50% of the plants per accession were flowering.

3.4.1.6 Days to maturity

Number of days from sowing until maturity. Two parameters are normally used to indicate reaching barley to physiological maturity. The first one is estimated manually in the field, when the plant reached to the dough stages and maximum grain fill. The second parameter is estimated visually when the plants loss the green color from the uppermost internode or peduncle. The uppermost portion of the peduncle, just below the spike, will have turned very light green or yellow.

3.4.2 Post – Harvesting Parameters.

3.4.2.1 Plant Height

The height was taken from the soil surface to the upper side of the main spike. The height of 3 plants in each row was measured and then the average was used for statistical analysis.

3.4.2.2 Tiller Number

The total number of fertile and unfertile tillers was counted for three plants per row and the average number was used for statistical analysis.

3.4.2.3 Spike Number

Number of spikes for three plant per accession was accounted and the average was recorded.

3.4.2.4 Spike Length

Spike length was measured for ten randomly selected spikes per row and the average was used for statistical analysis.

3.4.2.5 Vegetative Biomass

All plants in each row were harvested manually and weighted at a two digit electrical balance.

3.4.2.6 Total Grain Yield

Spikes were threshed using a threshing machine and then all the seeds for each accession was weighted.

3.4.2.7 Thousand kernel weight (TKW)

Thousand kernel weight (TKW) was measured for randomly selected 1000 seeds from the bulk for each row using a two digit electronic balance.

CHAPTER FOUR
RESULTS AND DISCUSSION

4. Results and Discussion

4.1 Pre – Harvesting Parameters

4.1.1 Days to Stem Elongation

Days to stem elongation ranged from 40 days to 90 days in 2015-2016 growing season and from 50 days to 81 days in 2016-2017 growing season (Fig 4). The average days to stem elongation in season 2015-2016 was higher than that of season 2016-2017. This difference might be due to environmental factors such as the rainfall. The total rain accumulation in November and December of the 2015-2016 raining season was 194.8 mm while it was 150 mm in 2016-2017 raining season. Also, the distribution of rainy days during stem elongation phase in season 2015-2016 was 12 days in November and 5 days in December, While in season 2016-2017 it was 9 days in November and 7 days in December.

The results also showed that the varieties with the highest day to stem-elongation in season 2015-2016 was MK_RB_155 and MK_RB_157 and in season 2016-2017 was MK_RB_157, On the other hand the varieties with the lowest day to stem elongation in season 2015-2016 was BW284, BW290 and BW289 and in season 2016-2017 was BW284 and BW290.

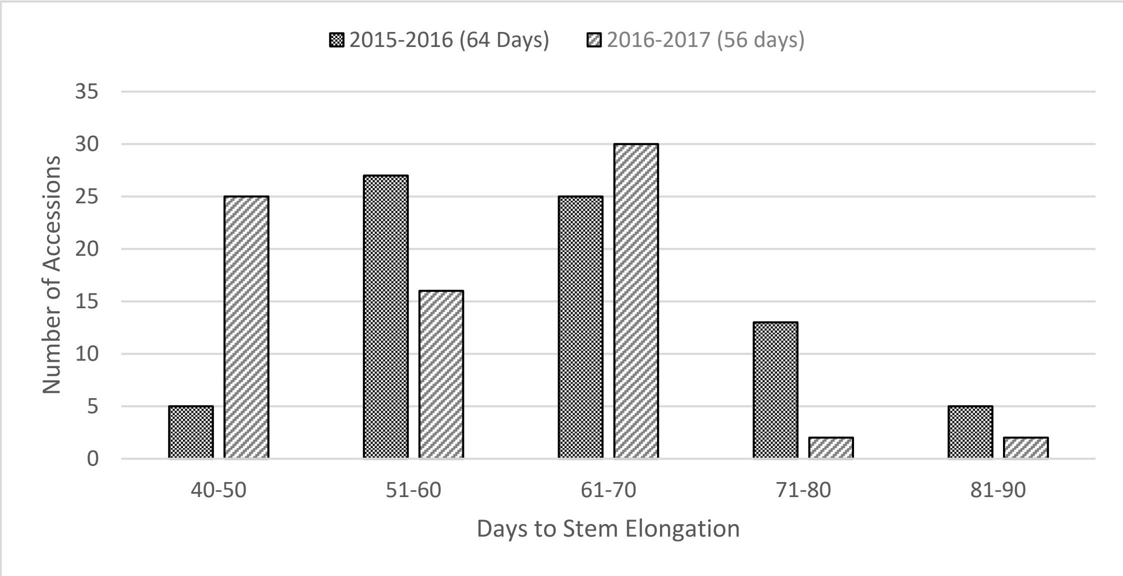

Fig 4 Days to stem elongation of studied barley accessions during 2015-2016 and 2016-2017 growing seasons

4.1.2 Days to Heading

Days to heading ranged from 45 days to 101 days in 2015-2016 growing season and from 65 days to 130 days in 2016-2017 growing season (Fig 5). The mean day to heading in season 2016-2017 was higher than that of season 2015-2016. Environmental condition specially temperature have significant effect on the number of day to heading. The mean temperature in February and March 2016 were 17 and 19 respectively, while in February and March 2017 they were 14 and 18. Higher temperature accelerates the flowering which reduces the days to heading. This was reflected in the results shown in Figure 5, where days to heading were higher in 2016-2017 season because it was colder in March and February in this season.

The results also show that the varieties with the highest day to heading in season 2015-2016 was MK_RB_184, MK_RB_157 and MK_RB_156 but in 2016-2017 season was MK_RB_157, MK_RB_154 and LR1043 On the other hand the variety with the lowest day to heading in season 2015-2016 and in 2016-2017 season was BW290 and BW289.

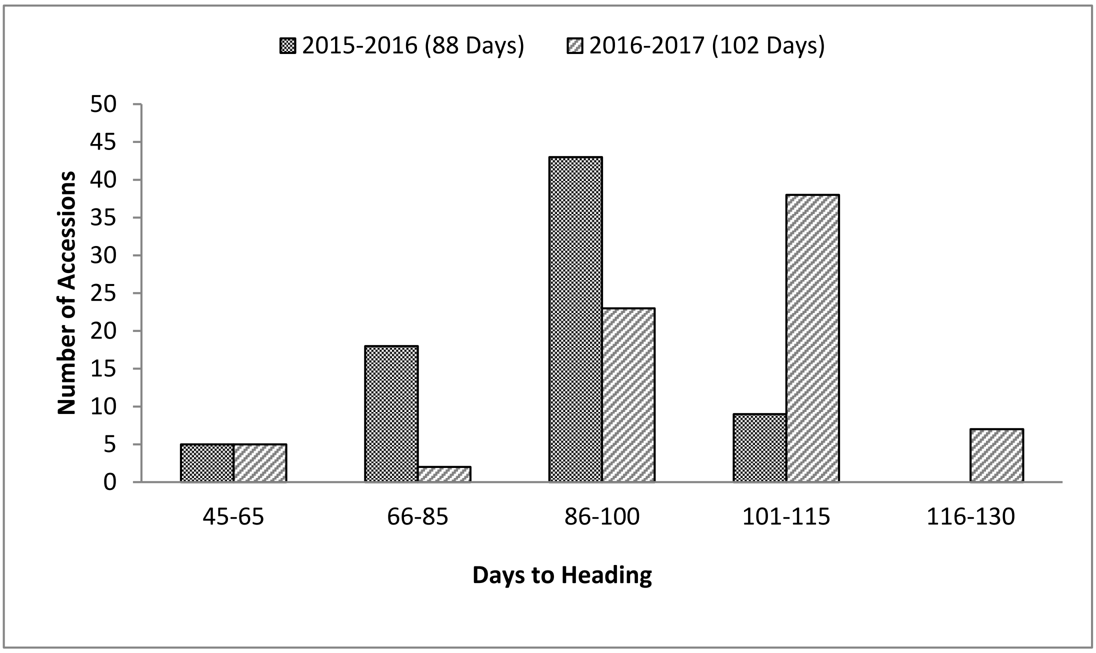

Fig 5 Days to heading of studied barley accessions during 2015-2016 and 2016-2017 growing seasons

4.1.3 Days to maturity

Days to maturity ranged from 80 days to 121 days in 2015-2016 growing season and from 100 days to 150 days in 2016-2017 growing season (Fig 6). This difference may be attributed to environmental factors, as in hot and dry condition, plants grow and mature faster than it cold and moisture condition (Inamullah and Khalil, 2011). The mean temperature in April 2016 was 21, while in April 2017 was 20. Even slightly higher temperature accelerates the maturity which reduces the days to maturity. This was reflected in the results shown in Figure 6, where days to maturity were higher in 2016-2017 season because it was colder in April in this season.

The results also show that the variety with the highest day to maturity in 2015-2016 season was MK_RB_157 , MK_RB_246 and MK_RB_156 but in 2016-2017 season was MK_RB_157, MK_RB_150 and LR1043 On the other hand the variety with the lowest day to maturity in 2015-2016 season and in 2016-2017 season was BW290 and BW289.

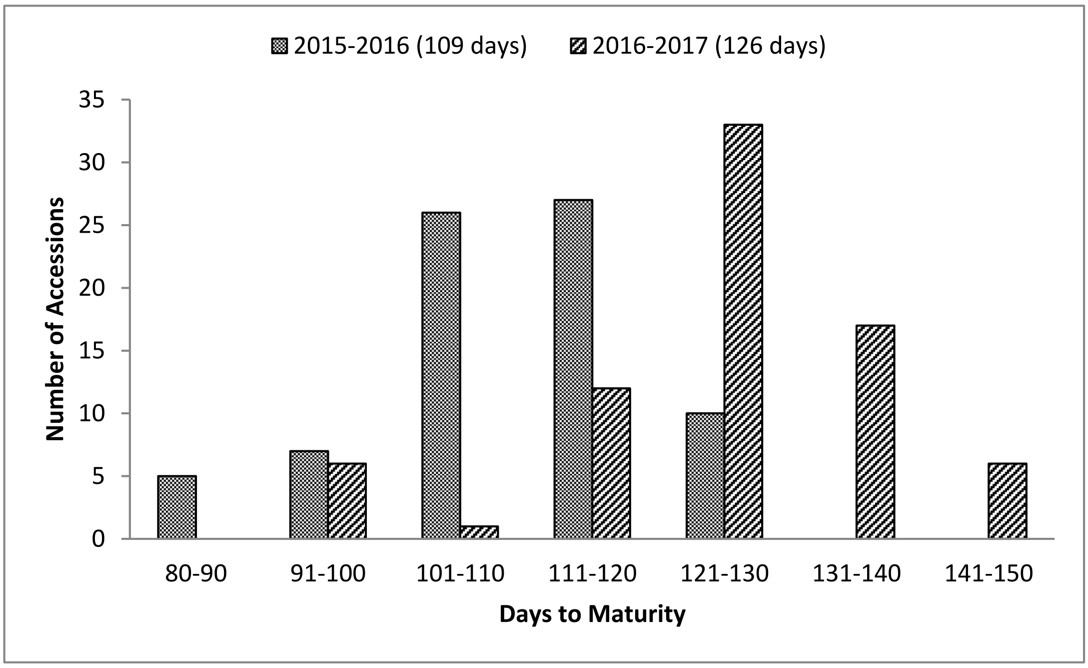

Fig 6 Days to maturity of studied barley accessions during 2015-2016 and 2016-2017 growing seasons

4.2 Post – Harvesting Parameters.

4.2.1 Tiller Number

Number of tillers ranged from 10 tillers to 31 tillers in 2015-2016 growing season and from 20 tillers to 35 tillers in 2016-2017 growing season (Fig 7). In season 2016-2017 all genotypes showed higher values for the number of tiller compared with season 2015-2016. It is very obvious that agronomic factors such as sowing density, nitrogen fertilizer and drought stress affect the tiller number (Marian,2015). In 2015-2016 season the weed density was higher than that in 2016-2017 season, which means more competition for light and nutrition. This resulted in less tiller number in this season as shown in Fig 7. The variation in genetic factor could be attributed to the presence of tillering inhibitor gene (tin) in the genotype (Ribot et al.,2017).

A favorable response for tillers capacity in uncompetitive system can noted the MK_RB_241 variety that in season 2015-2016 had average number of tiller of 27 but in the season 2016-2017 was 37. The results also show that the variety with the highest tiller number in 2015-2016 season was BW284 and flagship and in 2016-2017 season was MK_RB_241 and LR1897 on the other hand The variety with the lowest tiller number in 2015-2016 season was Morex and Lr761 but in 2016-2017 season was MK_RB_281 and Morex.

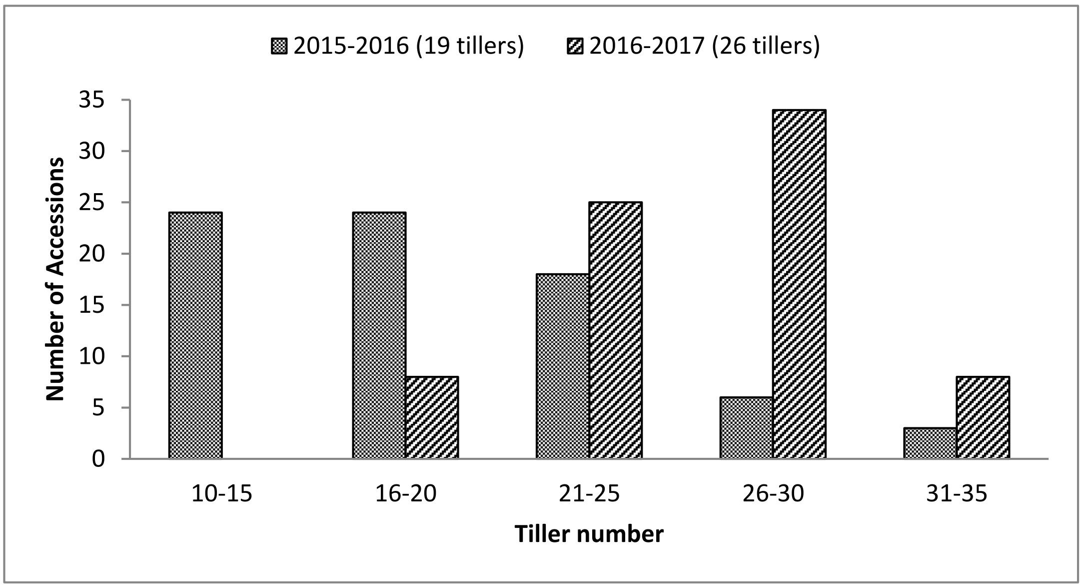

Fig 7 Tiller number of studied barley accessions during 2015-2016 and 2016-2017 growing seasons

4.2.2 Spike Number

Number of spikes ranged from 5 spikes to 26 spikes per plant in 2015-2016 growing season and from 15 spikes to 30 spikes in 2016-2017 growing season (Fig 8). The average spike number in 2016-2017 season was higher than that of 2015-2016 season. This difference due to environmental stress conditions (high temperatures, drought) during or/after floral initiation, and this factors some time affected on the genotype capacity of flowering (Barnabás et al, 2008). The temperature in 2015-2016 season was higher than that in 2016-2017 season, which explains the lower spike number in that season.

The results also show that the variety with the highest spike number in 2015-2016 season was flagship, Arta and BW284(27spike) but in 2016-2017 season was LR1897 and MK_RB_241(32spike) On the other hand the variety with the lowest spike number in 2015-2016 season was MK_RB_114 (8spike) and in 2016-2017 season was MK_RB_227 (11spike).

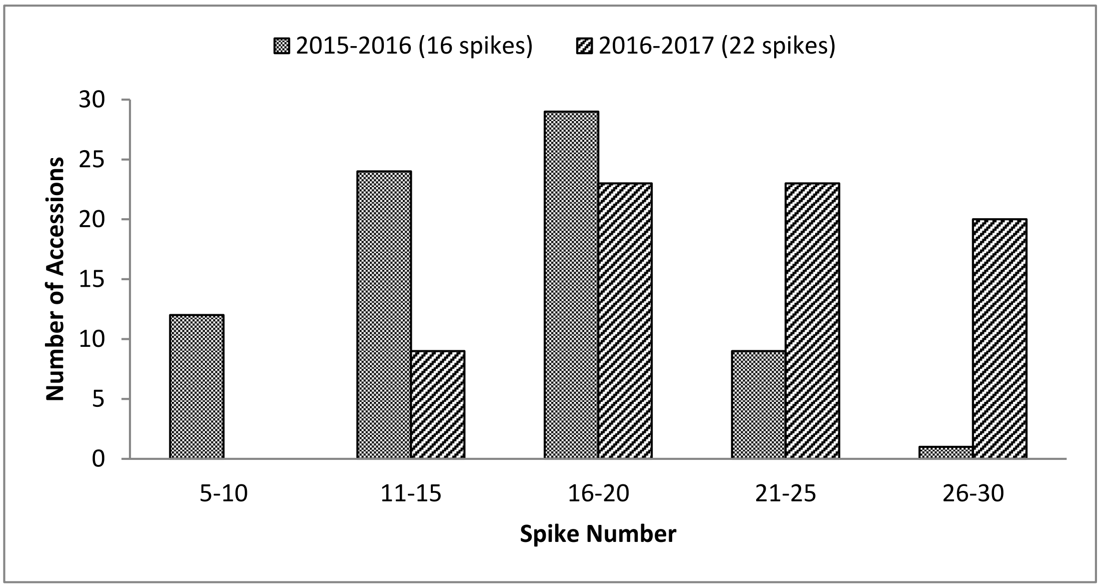

Fig 8 Spike number of studied barley accessions during 2015-2016 and 2016-2017 growing seasons

4.2.3 Plant Height

Plant height ranged from 40cm to 101cm in 2015-2016 growing season and from 60cm to 110 cm in 2016-2017 growing season (Fig 9). Plant height in 2016-2017 season was higher than 2015-2016 season. This difference might be due to drought stress and many studies indicated the relation between plant height and rainfall while others related it with soil fertility (Marian 2015). The rainfall in 2016-2017 season was higher than that in 2015-2016 season, which explains the higher plant height in that season. Plant height plays vital role in reducing production losses that are recorded after falling plant and harvest index rise. Main limitation was due to the influence of lodging cultivars in the later growth stages, producing irregular plant height (Vaezi et al., 2010). The results also show that the variety with the highest plant height in 2015-2016 season was MK_RB_94 and Morex and in 2016-2017 season was Morex and MK_RB_107 on the other hand, the variety with the plant height in 2015-6 season was MK_RB_86 and in 2016-2017 season was MK_RB_223.

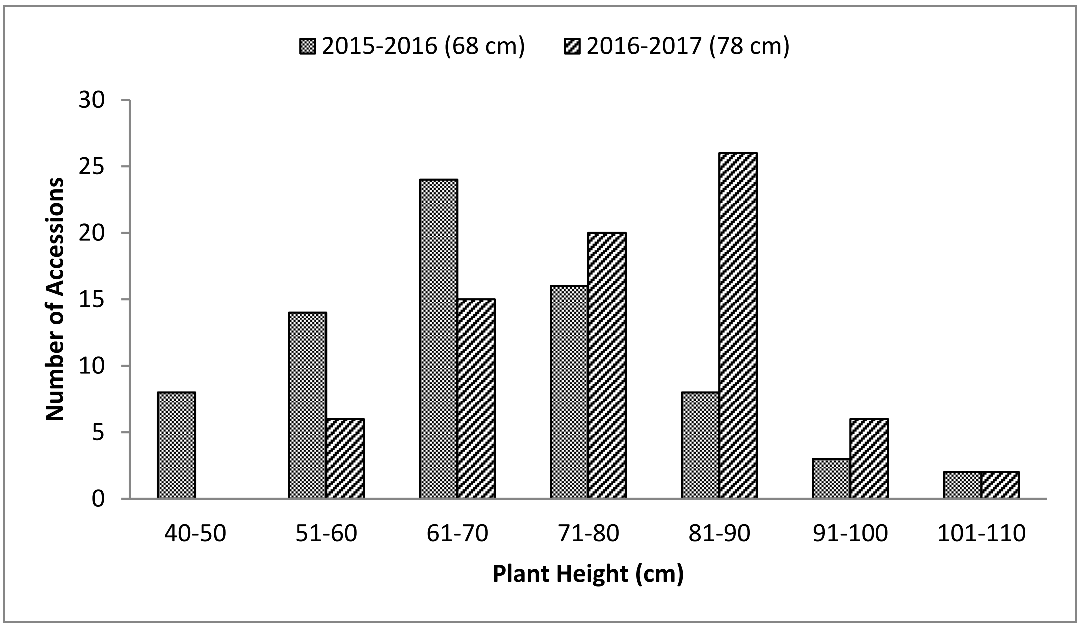

Fig 9 The plant height of studied barley accessions during 2015-2016 and 2016-2017 growing seasons

4.2.4 Total Grain Yield

Total grain yield ranged from 50 g to 251 g per accession in 2015-2016 growing season and from 100 g to 350 g in 2016-2017 growing season (Fig10). The mean total grain yield in 2016-2017 season was higher than 2015-2016 season. Grain yield is a quantitative trait that is strongly influenced by biotic and abiotic conditions because it requires a longer period for formation, which obviously can coincide with less favourable environmental conditions (drought, foliar diseases), for the accumulation and filling process of grains and can experience a negative impact on production and consequently low yield (Marian, 2015). Moreover, environmental condition have a major influence on the genotype potential for grain yield production considering drought and high temperature as key stress factor with negative impact on crop yield (Barnabás et al., 2008). In 2015-2016 season there was a late start of the rainfall season and many foliar diseases and insects were noticed. Also, the harvest in that season was delayed due to late rainfall, which allowed loss of grains by birds and winds. These factors resulted in less grain yield in that season.

The results also show that the variety with the highest total grain yield in 2015-2016 season was MK_RB_113 (262g) and MK_RB_152 (277g) and in 2016-2017 season was Aksad (336g) and Keel (315g). The varieties with the lowest total grain yield in 2015-2016 season was MK_RB_183 (56g) and in 2016-2017 season was MK_RB_94 (53g).

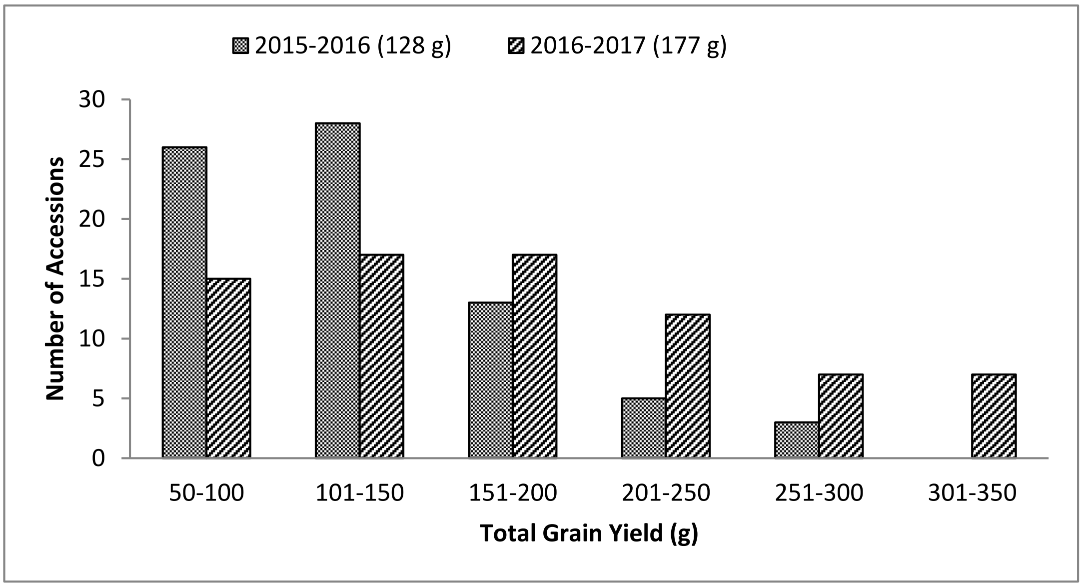

Fig 10 Total grain yield of studied barley accessions during 2015-2016 and 2016-2017 growing seasons

4.2.5 Thousand Kernel Weight

Thousand kernel weight ranged from 25 g to 51 g in 2015-2016 growing season and from 30 g to 55 g in 2016-2017 growing season (Fig 11). There was a slight difference in the mean of thousand kernel weight between the two seasons. Thousand kernel weight are characteristics that depend not only on the cultivar but are influenced as well by conditions such as environment specially water stress, plant cultivation and in-ear position of grains. In addition, these characteristics are also very much influenced by sowing density (Tashiro and Wardlaw, 1990; Vaezi et al., 2010). The variety with the highest thousand kernel weight in 2015-2016 season was LR871 and LR1897 (52 g) but in 2016-2017 season was LR871 and LR1897 (54 g). On the other hand The variety with the lowest thousand kernel weight in 2015-2016 season was MK_RB_229 (27 g) and BW287(29 g) but in 2016-2017 season was BW287(29 g).

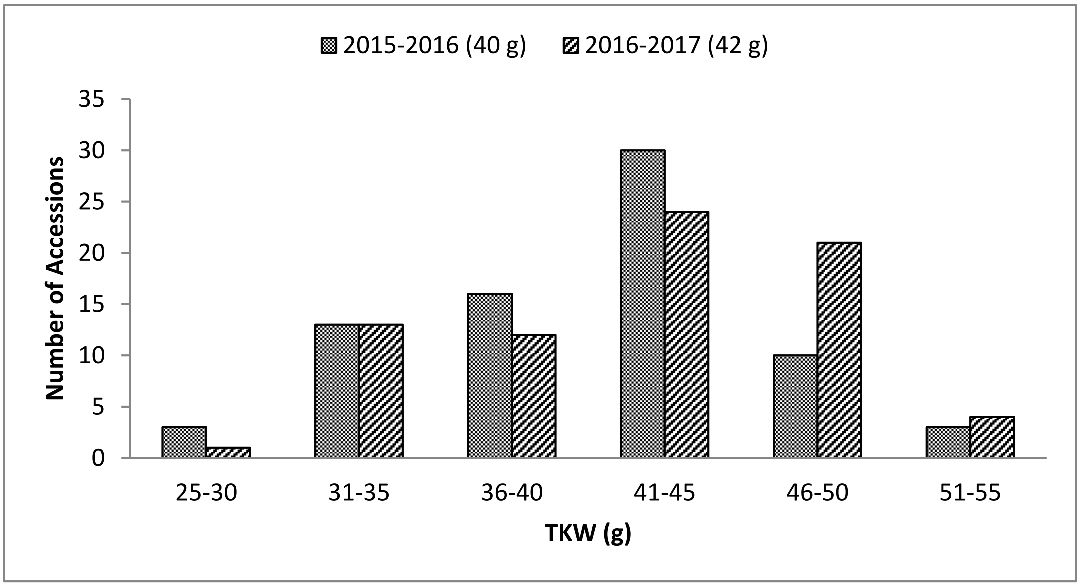

Fig 11 Thousand kernel weight of studied barley accessions during 2015-2016 and 2016-2017 growing seasons

4.2.6 Vegetative Biomass

Vegetative biomass ranged from 100 g to 501 g per accession in 2015-2016 growing season and from 500 g to 2500 g in 2016-2017 growing season (Fig 12). The mean vegetative biomass in 2016-2017 season was higher than in 2015-2016 season. Vegetative biomass is strongly influenced by biotic and abiotic conditions because it requires a longer period for formation, depend not only on the cultivar – they are influenced as well by sowing density and growth conditions such as rainfall and temperature (Barnabás et al., 2008).

The mean vegetative biomass in season 2016-2017 was higher than season 2015-2016. This is due to late harvest in 2015-2016 season because of late rainfall (in May) which resulted in many foliar diseases such as powdery mildew. This resulted in lower vegetative biomass in that season. On the other hand, in season 2016-1017 there was no late rainfall. The results also show that the variety with the highest vegetative biomass in 2015-2016 season was MK_RB_113 (565 g) and in 2016-2017 season was MK_RB_113 (2062 g). The variety with the lowest vegetative biomass in 2015-2016 season was HID44 (124 g) and in 2016-2017 season wasMK_RB_229 (239 g).

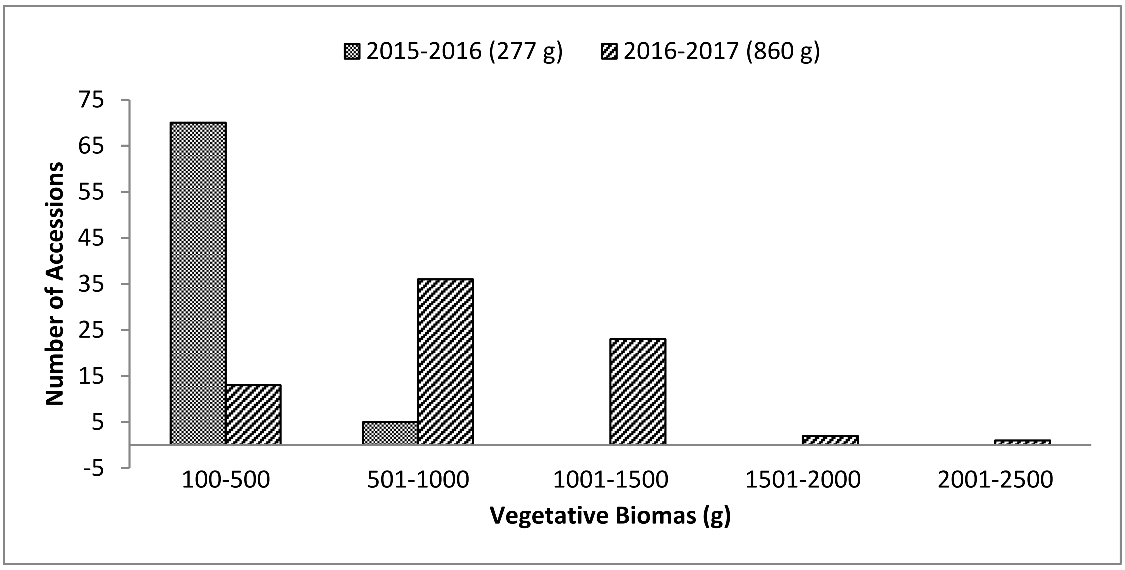

Fig 12 Vegetative biomass of studied barley accessions during 2015-2016 and 2016-2017 growing seasons

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATION

5. Conclusions and Recommendations

From the results of the present study, the following conclusions can be drawn:

1- Clear phonotypic variation was observed between genotypes and it was enough to distinguish between them.
2- Many of these genotypes are promising for grain yield and others for vegetative yield as straw.
3- These genotypes can be considered of breeding operations as well as for further study for developing superior barley genotypes. These barley genotypes need to be crossed and selected to develop high yielding pure line variety.
4- Improve the barley performance in Palestine by establish national breeding program or to introduce new varieties to increase the production per unite area.
5- Further studies are needed to investigate the variation between and within these genotypes at molecular level.

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Appendix 1: Environmental Data

The weather data for the experiment site was taken for the years 2014,2015 and 2016 we attached the following table for more details.

Table 1. weather data during 2014.

Month / Element	JAN	FEB	MAR	MAY	SEP	OCT	NOV	DEC
Mean Monthly max temp (c)								18.6
Mean Monthly Minimum Temperature								13.4
Monthly Average Temperature								16.0
Absolute Monthly Maximum Temperature								21.2
Absolute Monthly Minimum Temperature								12.0
Monthly Total Rainfall	12.5	5.0	92.5	33.0	0.5	27.5	161.5	33.3
Maximum Monthly rainfall	12.5	5.0	92.5	33.0	0.5	27.5	161.5	33.3
Mean Monthly Relative Humidity								65.7
Mean Monthly Pressure At Station Level								1013.9
Mean Monthly Wind Speed								2.3
Total Number Of Rainy Days per month	3.0	2.0	6.0	2.0	1.0	3.0	12.0	5.0
Mean Monthly Solar Radiation								0.1

Table 2. weather data during 2015.

Month / Element	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Mean Monthly max temp (c)		17.8	21.2	22.7	27.4	27.5	30.6	32.9	32.0	28.2	24.2	18.7
Mean Monthly Minimum Temperature		11.3	14.2	14.8	19.6	21.4	23.5	26.0	25.3	21.5	16.9	12.6
Monthly Average Temperature		14.3	17.6	18.7	23.4	24.4	26.8	29.1	28.2	24.6	20.5	15.3
Absolute Monthly Maximum Temperature		27.5	30.1	36.5	40.7	34.3	34.3	37.7	36.1	35.7	28.9	21.2
Absolute Monthly Minimum Temperature		3.8	11.2	9.4	15.5	19.0	20.8	24.5	22.5	16.7	0.0	6.8
Monthly Total Rainfall	117.5	107.1	55.4	47.5	33.0				0.5	46.0	109.7	40.3
Maximum Monthly rainfall	222.5	209.2	92.5	47.5	33.0				0.5	64.5	161.5	47.3
Mean Monthly Relative Humidity		60.5	59.1	58.7	55.8	62.8	65.6	63.1	61.8	65.1	54.6	61.3
Mean Monthly Pressure At Station Level		1007.5	1009.6	1008.5	1005.3	1004.3	1001.8	1002.6	1004.7	1006.9	1009.4	1014.4
Mean Monthly Wind Speed		3.6	3.1	3.1	2.8	3.2	3.0	2.8	2.7	2.4	2.9	2.3
Total Number Of Rainy Days per month	4.5	4.0	6.5	2.0	2.0				1.0	5.5	9.5	6.5
Mean Monthly Solar Radiation		0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1

Table 3. weather data during 2016.

Month / Element	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Mean Monthly max temp (c)	16.1	20.6	22.1	27.1	27.3	31.6	31.2	31.3	30.1	29.4	25.0	17.8
Mean Monthly Minimum Temperature	10.1	13.2	14.3	17.4	18.7	23.2	24.7	25.3	23.2	21.3		
Monthly Average Temperature	12.8	16.6	18.3	22.1	23.1	26.9	27.8	28.0	26.5	24.7	20.3	13.6
Absolute Monthly Maximum Temperature	23.6	29.1	31.0	38.1	39.2	38.5	32.8	33.1	32.2	36.6	30.4	22.5
Absolute Monthly Minimum Temperature	4.2	0.0	11.2	12.0	0.0	20.0	23.4	24.3	20.1	19.1		
Monthly Total Rainfall	128.6	87.3	30.1	11.9	0.0						0.0	289.7
Maximum Monthly rainfall	128.6	87.3	30.1	11.9	0.0						0.0	289.7
Mean Monthly Relative Humidity	65.2	60.8	55.3	49.9	54.6	55.1	65.0	65.6	60.6	56.8	41.9	66.1
Mean Monthly Pressure At Station Level	1013.0	1012.4	1007.9	1005.7	1006.2	1003.0	1000.6	1002.4	1005.4	1007.3	1010.9	1013.0
Mean Monthly Wind Speed	2.8	2.3	2.1	1.8	3.1	2.9	3.0	2.8	2.8	2.3	3.1	3.0
Total Number Of Rainy Days per month	10.0	5.0	9.0	2.0	0.0						0.0	12.0
Mean Monthly Solar Radiation	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1

Appendix 2: Data Analyses

Field Data 2015-2016

Class	Levels	Values
Line	75	Aksad Arta Auriga BW281 BW284 BW285 BW287 BW289 BW290 Barke Bowman G400 HID301 HID44 HID52 Keel LR1043 LR1897 LR871 Lr761 MKRB107 MKRB113 MKRB114 MKRB118 MKRB147 MKRB150 MKRB152 MKRB154 MKRB155 MKRB156 MKRB157 MKRB163 MKRB167 MKRB18 MKRB181 MKRB183 MKRB184 MKRB186 MKRB187 MKRB188 MKRB189 MKRB190 MKRB192 MKRB21 MKRB223 MKRB224 MKRB225 MKRB227 MKRB228 MKRB229 MKRB230 MKRB232 MKRB233 MKRB240 MKRB241 MKRB246 MKRB268 MKRB269 MKRB270 MKRB271 MKRB278 MKRB279 MKRB281 MKRB282 MKRB284 MKRB286 MKRB86 MKRB87 MKRB94 Marthe Morex Mutha Optic Rum flagship
Rep	3	1 2 3

Number of observations 225

Dependent Variable: Days to Stem Elongation

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	76	20664.88000	271.90632	16.78	<.0001
Error	148	2397.76000	16.20108		
Corrected Total	224	23062.64000			

R-Square	Coeff Var	Root MSE	DaystoStemElongation Mean
0.896033	6.326053	4.025057	63.62667

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Line	74	20616.64000	278.60324	17.20	<.0001
Rep	2	48.24000	24.12000	1.49	0.2290

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Line	74	20616.64000	278.60324	17.20	<.0001
Rep	2	48.24000	24.12000	1.49	0.2290

Dependent Variable: Days to Heading

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	76	31913.51111	419.91462	58.80	<.0001
Error	148	1057.00444	7.14192		
Corrected Total	224	32970.51556			

R-Square	Coeff Var	Root MSE	DaystoHeading Mean
0.967941	3.032572	2.672437	88.12444

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Line	74	31861.18222	430.55652	60.29	<.0001
Rep	2	52.32889	26.16444	3.66	0.0280

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Line	74	31861.18222	430.55652	60.29	<.0001
Rep	2	52.32889	26.16444	3.66	0.0280

Dependent Variable: Days to maturity

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	76	22616.41778	297.58444	21.35	<.0001
Error	148	2062.76444	13.93760		
Corrected Total	224	24679.18222			

R-Square	Coeff Var	Root MSE	Daystomaturity Mean
0.916417	3.431631	3.733309	108.7911

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Line	74	22576.51556	305.08805	21.89	<.0001
Rep	2	39.90222	19.95111	1.43	0.2422

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Line	74	22576.51556	305.08805	21.89	<.0001
Rep	2	39.90222	19.95111	1.43	0.2422

Dependent Variable: Tiller number

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	76	7480.231111	98.424094	25.60	<.0001
Error	148	568.951111	3.844264		
Corrected Total	224	8049.182222			

R-Square	Coeff Var	Root MSE	Tillernumber Mean
0.929316	10.43408	1.960680	18.79111

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Line	74	7477.182222	101.043003	26.28	<.0001
Rep	2	3.048889	1.524444	0.40	0.6733

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Line	74	7477.182222	101.043003	26.28	<.0001
Rep	2	3.048889	1.524444	0.40	0.6733

Dependent Variable: Spike number

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	76	5138.764444	67.615322	23.81	<.0001
Error	148	420.231111	2.839399		
Corrected Total	224	5558.995556			

R-Square	Coeff Var	Root MSE	Spikenumber Mean
0.924405	10.60819	1.685052	15.88444

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Line	74	5105.662222	68.995435	24.30	<.0001
Rep	2	33.102222	16.551111	5.83	0.0037

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Line	74	5105.662222	68.995435	24.30	<.0001
Rep	2	33.102222	16.551111	5.83	0.0037

Dependent Variable: Spike length

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	76	2064.692800	27.167011	1.18	0.1927
Error	148	3399.207200	22.967616		
Corrected Total	224	5463.900000			

R-Square	Coeff Var	Root MSE	Spikelength Mean
0.377879	60.00569	4.792454	7.986667

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Line	74	2022.713333	27.333964	1.19	0.1860
Rep	2	41.979467	20.989733	0.91	0.4032

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Line	74	2022.713333	27.333964	1.19	0.1860
Rep	2	41.979467	20.989733	0.91	0.4032

Dependent Variable: Plan height

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	76	41351.83111	544.10304	48.12	<.0001
Error	148	1673.29778	11.30607		
Corrected Total	224	43025.12889			

R-Square	Coeff Var	Root MSE	Planheight Mean
0.961109	4.972730	3.362449	67.61778

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Line	74	41314.46222	558.30354	49.38	<.0001
Rep	2	37.36889	18.68444	1.65	0.1951

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Line	74	41314.46222	558.30354	49.38	<.0001
Rep	2	37.36889	18.68444	1.65	0.1951

Dependent Variable: Total Grain yield

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	76	649008.3200	8539.5832	39.09	<.0001
Error	148	32329.4400	218.4422		
Corrected Total	224	681337.7600			

R-Square	Coeff Var	Root MSE	TotalGrainyield Mean
0.952550	11.53590	14.77979	128.1200

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Line	74	648419.0933	8762.4202	40.11	<.0001
Rep	2	589.2267	294.6133	1.35	0.2627

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Line	74	648419.0933	8762.4202	40.11	<.0001
Rep	2	589.2267	294.6133	1.35	0.2627

Dependent Variable: TKW

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	76	7349.382578	96.702402	8.68	<.0001
Error	148	1649.759644	11.147025		
Corrected Total	224	8999.142222			

R-Square	Coeff Var	Root MSE	TKW Mean
0.816676	8.246006	3.338716	40.48889

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Line	74	7229.975556	97.702372	8.76	<.0001
Rep	2	119.407022	59.703511	5.36	0.0057

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Line	74	7229.975556	97.702372	8.76	<.0001
Rep	2	119.407022	59.703511	5.36	0.0057

Dependent Variable: Vegetative biomass

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	76	3058817.191	40247.595	49.33	<.0001
Error	148	120759.858	815.945		
Corrected Total	224	3179577.049			

R-Square	Coeff Var	Root MSE	Vegetativebiomass Mean
0.962020	10.30111	28.56475	277.2978

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Line	74	3057487.049	41317.393	50.64	<.0001
Rep	2	1330.142	665.071	0.82	0.4446

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Line	74	3057487.049	41317.393	50.64	<.0001
Rep	2	1330.142	665.071	0.82	0.4446

Days to Stem Elongation

REGWQ Grouping													Mean	N	Line
							A						83.000	3	MKRB157
							A						83.000	3	MKRB246
			B				A						81.000	3	MKRB155
			B				A		C				80.667	3	MKRB156
			B				A		C				80.667	3	MKRB268
			B		D		A		C				80.000	3	MKRB150
			B		D		A		C				79.333	3	MKRB114
			B		D		A		C				79.333	3	Optic
			B		D		A		C				79.333	3	MKRB189
	E		B		D		A		C				75.000	3	Lr761
	E		B		D		A		C				74.667	3	MKRB147
	E		B		D		A		C		F		73.333	3	MKRB190
	E		B		D		A		C		F		72.333	3	MKRB18
	E		B		D		A		C		F		72.333	3	MKRB167
	E		B		D		A		C		F		72.000	3	Arta
	E		B		D		A	G	C		F		71.667	3	MKRB184
	E		B		D	H	A	G	C		F		71.333	3	Barke
	E		B	I	D	H	A	G	C		F		71.000	3	MKRB270
	E	J	B	I	D	H	A	G	C		F		70.333	3	MKRB187
K	E	J	B	I	D	H	A	G	C		F		70.000	3	MKRB118
K	E	J	B	I	D	H	L	G	C		F		69.667	3	MKRB86
K	E	J	B	I	D	H	L	G	C		F	M	69.333	3	MKRB281
K	E	J	B	I	D	H	L	G	C		F	M	69.333	3	MKRB223
K	E	J	B	I	D	H	L	G	C	N	F	M	68.333	3	MKRB232
K	E	J		I	D	H	L	G	C	N	F	M	67.667	3	MKRB188
K	E	J		I	D	H	L	G		N	F	M	67.000	3	MKRB224
K	E	J		I	D	H	L	G		N	F	M	67.000	3	MKRB230
K	E	J		I	D	H	L	G		N	F	M	67.000	3	MKRB94
K	E	J		I	D	H	L	G		N	F	M	67.000	3	HID301
K	E	J		I	D	H	L	G		N	F	M	67.000	3	LR1043
K	E	J		I		H	L	G		N	F	M	65.000	3	MKRB154
K	E	J	O	I		H	L	G		N	F	M	64.667	3	MKRB233
K	E	J	O	I		H	L	G		N	F	M	64.000	3	LR1897
K	E	J	O	I		H	L	G		N	F	M	64.000	3	MKRB192
K	E	J	O	I		H	L	G		N	F	M	64.000	3	Auriga
K	E	J	O	I		H	L	G		N	F	M	64.000	3	HID52
K	E	J	O	I		H	L	G	P	N	F	M	62.333	3	HID44
K		J	O	I		H	L	G	P	N	F	M	61.000	3	MKRB21
K		J	O	I		H	L	G	P	N	F	M	61.000	3	MKRB282
K		J	O	I		H	L	G	P	N	F	M	61.000	3	MKRB87
K		J	O	I		H	L	G	P	N	F	M	61.000	3	Marthe
K		J	O	I		H	L	G	P	N	F	M	61.000	3	MKRB271
K		J	O	I		H	L	G	P	N	F	M	61.000	3	MKRB229
K		J	O	I		H	L	G	P	N	F	M	60.000	3	MKRB183
K		J	O	I	Q	H	L	G	P	N		M	58.333	3	Aksad
K		J	O	I	Q	H	L		P	N		M	58.000	3	MKRB113
K		J	O	I	Q	H	L		P	N		M	58.000	3	flagship
K		J	O	I	Q	H	L		P	N		M	58.000	3	Keel
K		J	O	I	Q	H	L		P	N		M	58.000	3	Morex
K		J	O	I	Q	H	L		P	N		M	58.000	3	Rum
K		J	O	I	Q	H	L		P	N		M	58.000	3	LR871
K		J	O	I	Q	H	L		P	N		M	58.000	3	MKRB163
K		J	O	I	Q	H	L		P	N		M	58.000	3	MKRB107
K		J	O	I	Q	H	L		P	N		M	58.000	3	MKRB152
K		J	O	I	Q	H	L		P	N		M	58.000	3	MKRB284
K		J	O	I	Q		L		P	N		M	57.667	3	Mutha
K		J	O		Q		L		P	N		M	57.333	3	MKRB186
K		J	O		Q		L		P	N		M	56.667	3	BW281
K		J	O		Q		L		P	N		M	56.667	3	BW287
K		J	O		Q		L		P	N		M	56.667	3	MKRB228

K		O	Q	L	P	N		M	56.333	3	MKRB181
	R	O	Q	L	P	N		M	56.000	3	MKRB286
	R	O	Q	L	P	N		M	56.000	3	MKRB278
	R	O	Q	L	P	N		M	56.000	3	MKRB225
	R	O	Q	L	P	N		M	56.000	3	Bowman
	R	O	Q		P	N		M	55.667	3	MKRB279
	R	O	Q	S	P	N			55.000	3	MKRB269
	R	O	Q	S	P	N			55.000	3	MKRB241
	R	O	Q	S	P	N			54.667	3	MKRB227
	R	O	Q	S	P		T		51.333	3	MKRB240
	R		Q	S	P		T		49.333	3	BW284
	R		Q	S			T		46.000	3	BW285
	R			S			T		43.333	3	G400
				S			T		42.667	3	BW289
							T		41.667	3	BW290

Days to Heading

REGWQ Grouping														Mean	N	Line
							A							110.667	3	MKRB156
							A							109.333	3	MKRB167
			B				A							106.000	3	MKRB86
			B				A							105.333	3	MKRB157
			B				A			C				104.000	3	MKRB150
			B		D		A			C				103.333	3	MKRB246
			B		D		E			C				100.667	3	MKRB94
			B		D		E			C				100.667	3	MKRB154
			B		D		E			C				100.667	3	MKRB184
	F		B		D		E			C				100.333	3	MKRB114
	F		B		D		E			C		G		100.000	3	MKRB155
	F		B		D		E	H		C		G		99.667	3	Optic
	F		I		D		E	H		C		G		96.667	3	MKRB268
	F		I		D		E	H		J		G		95.333	3	MKRB18
	F		I		D		E	H		J		G		95.333	3	MKRB147
	F		I		D	K	E	H		J		G		95.000	3	Lr761
	F		I		D	K	E	H		J		G		95.000	3	MKRB189
	F		I		L	K	E	H		J		G		94.667	3	MKRB190
	F		I		L	K	E	H		J		G		94.667	3	LR1043
	F		I	M	L	K	E	H		J		G		94.333	3	Barke
	F		I	M	L	K	E	H		J		G		94.000	3	MKRB224
	F		I	M	L	K	E	H		J		G		94.000	3	MKRB233
	F		I	M	L	K	E	H		J		G		93.667	3	MKRB87
	F	N	I	M	L	K	E	H		J		G		93.333	3	Marthe
	F	N	I	M	L	K	E	H		J		G		93.333	3	MKRB270
	F	N	I	M	L	K	E	H		J		G		93.333	3	Auriga
O	F	N	I	M	L	K	E	H		J		G		93.000	3	MKRB281
O	F	N	I	M	L	K	E	H		J		G	P	92.667	3	MKRB230
O	F	N	I	M	L	K	E	H		J	Q	G	P	92.000	3	MKRB223
O	F	N	I	M	L	K	E	H		J	Q	G	P	92.000	3	MKRB107
O	F	N	I	M	L	K	R	H		J	Q	G	P	91.667	3	MKRB113
O		N	I	M	L	K	R	H		J	Q	G	P	91.333	3	MKRB271
O	S	N	I	M	L	K	R	H		J	Q		P	91.000	3	MKRB21
O	S	N	I	M	L	K	R			J	Q	T	P	90.333	3	HID44
O	S	N	I	M	L	K	R	U		J	Q	T	P	90.000	3	MKRB118
O	S	N	I	M	L	K	R	U		J	Q	T	P	90.000	3	Arta
O	S	N	I	M	L	K	R	U		J	Q	T	P	90.000	3	MKRB187
O	S	N	I	M	L	K	R	U	V	J	Q	T	P	89.667	3	MKRB284
O	S	N	I	M	L	K	R	U	V	J	Q	T	P	89.000	3	MKRB227
O	S	N	I	M	L	K	R	U	V	J	Q	T	P	88.333	3	MKRB232
O	S	N	I	M	L	K	R	U	V	J	Q	T	P	88.000	3	MKRB163
O	S	N	I	M	L	K	R	U	V	J	Q	T	P	88.000	3	MKRB188
O	S	N	I	M	L	K	R	U	V	J	Q	T	P	88.000	3	MKRB192
O	S	N		M	L	K	R	U	V	J	Q	T	P	87.667	3	LR1897
O	S	N		M	L	K	R	U	V	J	Q	T	P	87.333	3	MKRB181
O	S	N		M	L	K	R	U	V	J	Q	T	P	86.667	3	MKRB186
O	S	N		M	L	K	R	U	V	J	Q	T	P	86.667	3	flagship
O	S	N		M	L	K	R	U	V	J	Q	T	P	86.667	3	Aksad
O	S	N		M	L	K	R	U	V		Q	T	P	86.000	3	Rum
O	S	N		M	L	K	R	U	V		Q	T	P	86.000	3	HID52
O	S	N		M	L	K	R	U	V		Q	T	P	86.000	3	LR871
O	S	N		M	L		R	U	V		Q	T	P	85.667	3	MKRB183
O	S	N		M			R	U	V		Q	T	P	85.333	3	MKRB229
O	S	N		M			R	U	V		Q	T	P	85.333	3	HID301
O	S	N	W				R	U	V		Q	T	P	84.667	3	MKRB225
O	S	N	W				R	U	V		Q	T	P	84.667	3	MKRB152
O	S		W				R	U	V		Q	T	P	84.333	3	BW287
	S		W				R	U	V		Q	T	P	84.000	3	Morex
	S		W				R	U	V		Q	T		83.667	3	MKRB228
	S		W				R	U	V		Q	T		83.333	3	MKRB278
	S		W				R	U	V			T		83.000	3	MKRB269

S	W		U	V		T	82.333	3	Bowman
	W	X	U	V		T	82.000	3	BW281
	W	X	U	V	Y		81.333	3	Mutha
	W	X		V	Y		81.000	3	Keel
	W	X		V	Y		81.000	3	MKRB241
	W	X			Y		76.667	3	MKRB282
	Z	X			Y		74.000	3	MKRB279
	Z				Y		73.333	3	MKRB286
	Z	A					67.000	3	MKRB240
	B	A					60.667	3	BW284
	B						59.000	3	BW285
	B	C					57.000	3	G400
	D	C					51.000	3	BW290
	D						47.667	3	BW289

Days to maturity

REGWQ Grouping										Mean	N	Line
						A				125.667	3	MKRB156
						A				125.667	3	MKRB246
		B				A				123.667	3	MKRB86
		B				A				123.667	3	MKRB114
		B				A		C		123.000	3	MKRB150
		B		D		A		C		122.667	3	MKRB167
		B		D		A		C		122.667	3	MKRB157
E		B		D		A		C		122.333	3	MKRB184
E		B		D		A		C	F	121.333	3	Optic
E		B		D		A		C	F	121.333	3	MKRB94
E		B		D		A	G	C	F	117.333	3	MKRB154
E		B		D		A	G	C	F	117.000	3	MKRB224
E		B		D		A	G	C	F	117.000	3	MKRB155
E		B		D	H	A	G	C	F	116.333	3	MKRB268
E		B		D	H	A	G	C	F	115.667	3	Auriga
E		B		D	H	A	G	C	F	115.333	3	Barke
E		B	I	D	H	A	G	C	F	115.000	3	MKRB227
E		B	I	D	H	A	G	C	F	114.667	3	MKRB190
E		B	I	D	H	A	G	C	F	114.667	3	MKRB284
E		B	I	D	H	A	G	C	F	114.667	3	MKRB189
E	J	B	I	D	H	A	G	C	F	114.000	3	Lr761
E	J	B	I	D	H	A	G	C	F	114.000	3	MKRB18
E	J	B	I	D	H	A	G	C	F	113.667	3	MKRB107
E	J	B	I	D	H	A	G	C	F	113.333	3	LR1043
E	J	B	I	D	H		G	C	F	113.000	3	Aksad
E	J	B	I	D	H		G	C	F	112.333	3	MKRB271
E	J	B	I	D	H		G	C	F	112.333	3	Marthe
E	J	B	I	D	H		G	C	F	112.333	3	MKRB113
E	J	B	I	D	H		G	C	F	112.333	3	flagship
E	J	B	I	D	H		G	C	F	112.333	3	MKRB223
E	J	B	I	D	H	K	G	C	F	112.000	3	Rum
E	J	B	I	D	H	K	G	C	F	112.000	3	MKRB230
E	J	B	I	D	H	K	G	C	F	112.000	3	MKRB147
E	J	B	I	D	H	K	G	C	F	111.667	3	MKRB21
E	J	B	I	D	H	K	G	C	F	111.667	3	Arta
E	J	L	I	D	H	K	G	C	F	111.000	3	MKRB192
E	J	L	I	D	H	K	G	C	F	110.667	3	Keel
E	J	L	I	D	H	K	G		F	110.333	3	MKRB225
E	J	L	I	D	H	K	G		F	110.333	3	MKRB233
E	J	L	I		H	K	G		F	110.000	3	MKRB187
	J	L	I		H	K	G	M	F	109.333	3	MKRB188
	J	L	I		H	K	G	M	F	109.000	3	MKRB232
	J	L	I		H	K	G	M	F	109.000	3	LR1897
	J	L	I		H	K	G	M		108.333	3	MKRB270
	J	L	I		H	K	G	M		108.000	3	BW287
	J	L	I	N	H	K	G	M		107.667	3	Mutha
	J	L	I	N	H	K	G	M		107.667	3	BW281
	J	L	I	N	H	K	G	M		107.667	3	MKRB229
	J	L	I	N	H	K	G	M		107.667	3	MKRB87
	J	L	I	N	H	K	G	M		107.000	3	MKRB118
	J	L	I	N	H	K	G	M		107.000	3	LR871
	J	L	I	N	H	K	G	M		106.667	3	MKRB186
	J	L	I	N	H	K	G	M		106.667	3	MKRB281
	J	L	I	N	H	K	G	M		105.333	3	MKRB183
	J	L	I	N	H	K	G	M		105.000	3	HID301
	J	L	I	N	H	K	G	M		105.000	3	HID44
	J	L	I	N	H	K	G	M		105.000	3	MKRB228
	J	L	I	N	H	K	G	M		104.667	3	MKRB163
	J	L	I	N	H	K	G	M		104.667	3	MKRB152
O	J	L	I	N	H	K		M		103.667	3	MKRB181
O	J	L	I	N		K		M	P	102.333	3	HID52

O	J	L	I	N	K	M	P	102.333	3	MKRB278
O	J	L		N	K	M	P	101.667	3	Bowman
O		L		N	K	M	P	99.667	3	MKRB241
O		L		N		M	P	99.000	3	MKRB282
O				N	Q	M	P	97.000	3	Morex
O		R		N	Q		P	95.667	3	MKRB269
O		R			Q	S	P	92.333	3	MKRB279
		R			Q	S	P	91.333	3	MKRB286
		R			Q	S	P	91.000	3	MKRB240
		R			Q	S		87.000	3	G400
		R				S		84.667	3	BW284
						S		84.000	3	BW285
						S		83.000	3	BW289
						S		82.333	3	BW290

Tiller number

REGWQ Grouping												Mean	N	Line
							A					35.667	3	MKRB223
			B				A					34.333	3	MKRB224
			B				A		C			31.667	3	MKRB190
			B				D		C			29.333	3	Arta
			B				D		C			28.667	3	BW284
			E				D		C			28.333	3	BW287
			E		F		D		C			28.000	3	flagship
	G		E		F		D		C			27.000	3	BW281
	G		E		F		D		C			27.000	3	MKRB241
	G		E		F		D		H			25.000	3	MKRB113
	G		E		F		D		H	I		24.333	3	BW285
	G		E		F		D	J	H	I		23.333	3	Optic
	G		E		F		D	J	H	I		23.333	3	MKRB268
	G		E		F		K	J	H	I		22.333	3	MKRB150
	G		E		F		K	J	H	I		22.333	3	MKRB225
	G		E		F		K	J	H	I		22.333	3	MKRB228
	G		L		F		K	J	H	I		22.000	3	MKRB279
	G		L		M		K	J	H	I		21.667	3	Mutha
	G		L		M		K	J	H	I		21.667	3	MKRB270
	G		L		M		K	J	H	I		21.667	3	MKRB246
	G		L		M		K	J	H	I		21.667	3	MKRB192
	G		L		M	N	K	J	H	I		21.000	3	LR1897
	G		L		M	N	K	J	H	I		21.000	3	MKRB147
	G		L		M	N	K	J	H	I		21.000	3	MKRB281
	G		L		M	N	K	J	H	I		21.000	3	MKRB187
	G		L		M	N	K	J	H	I		20.667	3	HID301
	G		L		M	N	K	J	H	I		20.667	3	MKRB189
	O		L		M	N	K	J	H	I		20.333	3	MKRB229
	O		L		M	N	K	J	H	I		20.333	3	Barke
	O		L		M	N	K	J	H	I		20.333	3	MKRB230
	O		L		M	N	K	J	H	I		20.333	3	HID52
	O		L	P	M	N	K	J	H	I		20.000	3	MKRB286
	O		L	P	M	N	K	J	H	I		20.000	3	BW290
	O		L	P	M	N	K	J	H	I		20.000	3	LR871
	O		L	P	M	N	K	J	H	I		20.000	3	MKRB157
	O	Q	L	P	M	N	K	J	H	I		19.667	3	MKRB232
R	O	Q	L	P	M	N	K	J	H	I		19.000	3	MKRB21
R	O	Q	L	P	M	N	K	J	H	I		19.000	3	HID44
R	O	Q	L	P	M	N	K	J	S	I		18.333	3	MKRB183
R	O	Q	L	P	M	N	K	J	S	I		18.333	3	MKRB156
R	O	Q	L	P	M	N	K	J	S	I		18.000	3	Keel
R	O	Q	L	P	M	N	K	J	S	I		18.000	3	MKRB282
R	O	Q	L	P	M	N	K	J	S	I		18.000	3	BW289
R	O	Q	L	P	M	N	K	J	S	T		17.667	3	Bowman
R	O	Q	L	P	M	N	K	J	S	T	U	17.000	3	MKRB181
R	O	Q	L	P	M	N	K		S	T	U	16.667	3	MKRB154
R	O	Q	L	P	M	N	K	V	S	T	U	16.333	3	MKRB155
R	O	Q	L	P	M	N	K	V	S	T	U	16.333	3	MKRB188
R	O	Q	L	P	M	N	K	V	S	T	U	16.000	3	MKRB233
R	O	Q	L	P	M	N	K	V	S	T	U	16.000	3	MKRB278
R	O	Q	L	P	M	N		V	S	T	U	15.667	3	MKRB87
R	O	Q		P	M	N		V	S	T	U	15.333	3	MKRB186
R	O	Q		P	M	N		V	S	T	U	15.333	3	Marthe
R	O	Q		P		N		V	S	T	U	15.000	3	MKRB240
R	O	Q		P				V	S	T	U	14.000	3	LR1043
R	O	Q		P				V	S	T	U	14.000	3	MKRB163
R		Q		P				V	S	T	U	13.667	3	Auriga
R		Q		P				V	S	T	U	13.667	3	MKRB271
R		Q		P				V	S	T	U	13.667	3	Rum
R		Q						V	S	T	U	13.333	3	MKRB94
R								V	S	T	U	13.000	3	MKRB152

R	V	S	T	U	12.667	3	G400
R	V	S	T	U	12.667	3	MKRB18
	V	S	T	U	12.333	3	MKRB107
	V	S	T	U	12.333	3	MKRB269
	V	S	T	U	12.000	3	MKRB284
	V	S	T	U	12.000	3	MKRB227
	V	S	T	U	12.000	3	MKRB118
	V		T	U	11.333	3	MKRB184
	V			U	11.000	3	MKRB167
	V			U	11.000	3	Aksad
	V			U	10.667	3	MKRB114
	V				10.000	3	Morex
	V				10.000	3	Lr761
	V				10.000	3	MKRB86

Spike number

					REGWQ Grouping									Mean	N	Line
							A							27.000	3	BW284
			B				A							25.333	3	Arta
			B				A			C				25.000	3	BW287
			B		D		A			C				24.333	3	MKRB241
	E		B		D		A			C				24.000	3	MKRB223
	E		B		D		A			C		F		23.667	3	BW281
	E		B		D		A			C		F		23.667	3	flagship
	E		B		D		A	G		C		F		22.667	3	MKRB190
	E		B		D	H	A	G		C		F		22.333	3	MKRB113
	E		B		D	H	I	G		C		F		21.000	3	Optic
	E		J		D	H	I	G		C		F		20.000	3	MKRB150
	E		J		D	H	I	G		C		F		20.000	3	MKRB281
	E		J	K	D	H	I	G		C		F		19.667	3	MKRB246
	E		J	K	D	H	I	G		C		F		19.667	3	MKRB268
	E		J	K	D	H	I	G		C		F		19.667	3	MKRB270
	E		J	K	D	H	I	G				F		19.333	3	Mutha
	E		J	K	D	H	I	G				F		19.333	3	Barke
	E		J	K	D	H	I	G				F		19.333	3	MKRB230
	E		J	K	D	H	I	G		L		F		19.000	3	BW285
	E		J	K	D	H	I	G		L		F		19.000	3	MKRB189
	E		J	K	D	H	I	G		L		F		19.000	3	MKRB192
	E		J	K	M	H	I	G		L		F		18.667	3	MKRB279
	E		J	K	M	H	I	G		L		F		18.667	3	MKRB286
	N		J	K	M	H	I	G		L		F		18.333	3	MKRB147
	N		J	K	M	H	I	G		L		F		18.333	3	BW290
	N		J	K	M	H	I	G		L		F		18.333	3	HID52
	N		J	K	M	H	I	G		L		F		18.333	3	MKRB187
	N		J	K	M	H	I	G		L		F		18.333	3	MKRB157
	N		J	K	M	H	I	G		L		O		18.000	3	MKRB224
	N		J	K	M	H	I	G		L		O		18.000	3	LR1897
	N		J	K	M	H	I	G		L		O		18.000	3	HID301
	N	P	J	K	M	H	I	G		L		O		17.667	3	MKRB228
	N	P	J	K	M	H	I	G		L		O		17.667	3	MKRB225
Q	N	P	J	K	M	H	I	G		L		O		17.333	3	MKRB282
Q	N	P	J	K	M	H	I	G		L		O		17.333	3	MKRB229
Q	N	P	J	K	M	H	I	R		L		O		17.000	3	HID44
Q	N	P	J	K	M	S	I	R		L		O		16.000	3	BW289
Q	N	P	J	K	M	S	I	R		L		O		16.000	3	MKRB156
Q	N	P	J	K	M	S	I	R		L		O		16.000	3	LR871
Q	N	P	J	K	M	S	T	R		L		O		15.333	3	MKRB21
Q	N	P	J	K	M	S	T	R		L		O		15.333	3	MKRB183
Q	N	P	J	K	M	S	T	R		L		O		15.333	3	Keel
Q	N	P	J	K	M	S	T	R		L		O	U	15.000	3	MKRB232
Q	N	P	J	K	M	S	T	R		L	V	O	U	14.667	3	MKRB233
Q	N	P	J	K	M	S	T	R	W	L	V	O	U	14.333	3	MKRB181
Q	N	P	J	K	M	S	T	R	W	L	V	O	U	14.333	3	MKRB154
Q	N	P	X	K	M	S	T	R	W	L	V	O	U	14.000	3	MKRB87

Q	N	P	X	Y	M	S	T	R	W	L	V	O	U	13.667	3	Bowman
Q	N	P	X	Y	M	S	T	R	W	Z	V	O	U	13.333	3	MKRB155
Q	N	P	X	Y	A	S	T	R	W	Z	V	O	U	13.000	3	MKRB186
Q	N	P	X	Y	A	S	T	R	W	Z	V	O	U	13.000	3	MKRB278
Q		P	X	Y	A	S	T	R	W	Z	V	O	U	12.667	3	MKRB240
Q		P	X	Y	A	S	T	R	W	Z	V		U	12.333	3	MKRB188
Q			X	Y	A	S	T	R	W	Z	V		U	12.000	3	Auriga
Q			X	Y	A	S	T	R	W	Z	V		U	12.000	3	Marthe
			X	Y	A	S	T	R	W	Z	V		U	11.667	3	MKRB94
			X	Y	A	S	T	R	W	Z	V		U	11.667	3	G400
			X	Y	A	S	T	R	W	Z	V		U	11.667	3	MKRB163
			X	Y	A	S	T	R	W	Z	V		U	11.667	3	MKRB271
			X	Y	A	S	T	R	W	Z	V		U	11.667	3	Rum
			X	Y	A	S	T		W	Z	V		U	11.333	3	MKRB152
			X	Y	A	S	T		W	Z	V		U	11.333	3	MKRB227
			X	Y	A	S	T		W	Z	V		U	10.667	3	MKRB18
			X	Y	A		T		W	Z	V		U	10.333	3	MKRB184
			X	Y	A		T		W	Z	V		U	10.000	3	MKRB284
			X	Y	A				W	Z	V		U	9.667	3	LR1043
			X	Y	A				W	Z	V			9.333	3	Aksad
			X	Y	A				W	Z	V			9.333	3	MKRB107
			X	Y	A				W	Z	V			9.333	3	MKRB269
			X	Y	A				W	Z				9.000	3	MKRB167
			X	Y	A					Z				8.667	3	Morex
			X	Y	A					Z				8.667	3	MKRB118
				Y	A					Z				8.333	3	MKRB114
					A					Z				8.000	3	Lr761
					A									7.667	3	MKRB86

Plant height

REGWQ Grouping											Mean	N	Line
							A				108.333	3	Morex
							A				102.333	3	MKRB94
			B				A				100.000	3	HID52
			B				C				92.000	3	MKRB184
			B				C				90.667	3	Lr761
							C				90.000	3	HID301
			D				C				87.333	3	MKRB114
			D				C		E		84.000	3	Rum
			D				C		E		84.000	3	MKRB284
			D		F		C		E		83.000	3	MKRB227
	G		D		F		C		E		82.667	3	MKRB270
	G		D		F		C		E		82.333	3	MKRB225
	G		D		F		C		E		82.000	3	MKRB278
	G		D		F		H		E		78.000	3	LR871
	G		D		F		H		E		78.000	3	BW287
	G		D		F		H		E		77.667	3	MKRB282
	G		D		F		H		E		77.333	3	MKRB167
	G		I		F		H		E		75.333	3	BW281
	G		I		F		H		E	J	74.667	3	MKRB107
	G		I		F		H	K	E	J	73.667	3	MKRB152
	G		I		F	L	H	K	E	J	73.333	3	MKRB163
	G		I		F	L	H	K	E	J	73.333	3	LR1043
	G		I		F	L	H	K	E	J	73.333	3	MKRB233
	G		I		F	L	H	K	M	J	72.333	3	MKRB21
	G		I		F	L	H	K	M	J	72.333	3	MKRB228
	G		I		F	L	H	K	M	J	72.333	3	Aksad
	G		I		N	L	H	K	M	J	72.000	3	MKRB156
	G		I		N	L	H	K	M	J	72.000	3	MKRB118
			I		N	L	H	K	M	J	71.000	3	MKRB87
	O		I		N	L	H	K	M	J	70.000	3	MKRB271
	O		I		N	L	H	K	M	J	70.000	3	MKRB183
	O		I		N	L	H	K	M	J	70.000	3	MKRB181
	O		I		N	L	H	K	M	J	69.667	3	flagship
	O		I	P	N	L	H	K	M	J	68.667	3	Mutha
	O	Q	I	P	N	L	H	K	M	J	67.667	3	MKRB269
	O	Q	I	P	N	L	H	K	M	J	67.667	3	MKRB186
R	O	Q	I	P	N	L	H	K	M	J	67.000	3	BW284
R	O	Q	I	P	N	L	S	K	M	J	64.333	3	Optic
R	O	Q	T	P	N	L	S	K	M	J	64.000	3	MKRB281
R	O	Q	T	P	N	L	S	K	M	J	63.667	3	MKRB279
R	O	Q	T	P	N	L	S	K	M	U	63.000	3	MKRB154
R	O	Q	T	P	N	L	S	K	M	U	63.000	3	MKRB187
R	O	Q	T	P	N	L	S	K	M	U	63.000	3	MKRB268
R	O	Q	T	P	N	L	S		M	U	62.333	3	MKRB286
R	O	Q	T	P	N	L	S		M	U	62.333	3	LR1897
R	O	Q	T	P	N	L	S		M	U	62.333	3	MKRB246
R	O	Q	T	P	N		S	V	M	U	62.000	3	MKRB113
R	O	Q	T	P	N		S	V	M	U	62.000	3	MKRB230
R	O	Q	T	P	N		S	V	M	U	61.667	3	MKRB150
R	O	Q	T	P	N		S	V	M	U	61.667	3	HID44
R	O	Q	T	P	N		S	V	M	U	61.333	3	Marthe
R	O	Q	T	P	N		S	V	W	U	61.000	3	Bowman
R	O	Q	T	P	N		S	V	W	U	61.000	3	MKRB241
R	O	Q	T	P			S	V	W	U	59.667	3	MKRB190
R	O	Q	T	P			S	V	W	U	59.667	3	MKRB157
R	O	Q	T	P	X		S	V	W	U	59.333	3	MKRB232
R	O	Q	T	P	X	Y	S	V	W	U	59.000	3	Keel
R	Z	Q	T	P	X	Y	S	V	W	U	57.667	3	MKRB147
R	Z	Q	T		X	Y	S	V	W	U	57.333	3	Barke
R	Z	Q	T		X	Y	S	V	W	U	57.000	3	MKRB229
R	Z		T	A	X	Y	S	V	W	U	56.000	3	G400

Z		T	A	X	Y	S	V	W	U	54.333	3	MKRB189
Z		T	A	X	Y	S	V	W	U	54.333	3	MKRB192
Z	B	T	A	X	Y	S	V	W	U	53.667	3	MKRB223
Z	B	T	A	X	Y		V	W	U	53.000	3	MKRB240
Z	B		A	X	Y		V	W	U	52.333	3	MKRB155
Z	B		A	X	Y		V	W		51.000	3	MKRB224
Z	B		A	X	Y			W		50.333	3	MKRB188
Z	B		A	X	Y			W		50.333	3	Auriga
Z	B		A	X	Y					48.667	3	Arta
Z	B		A	X	Y					48.667	3	MKRB86
Z	B		A		Y					48.333	3	BW285
Z	B		A							47.000	3	MKRB18
	B		A							46.000	3	BW290
	B									43.000	3	BW289

Total Grain yield

REGWQ Grouping													Mean	N	Line
							A						276.67	3	MKRB152
			B				A						261.67	3	MKRB113
			B				A						255.67	3	MKRB107
			B				A		C				234.33	3	MKRB286
			B				D		C				226.67	3	MKRB228
			B		E		D		C				220.33	3	MKRB269
			F		E		D		C				206.33	3	Auriga
	G		F		E		D		C				202.00	3	Mutha
	G		F		E		D		C		H		199.67	3	MKRB225
	G		F		E		D		C		H		198.00	3	flagship
	G		F		E		D	I	C		H		191.33	3	BW287
	G		F		E		D	I	J		H		184.00	3	MKRB18
	G		F		E		K	I	J		H		180.67	3	MKRB184
	G		F		E		K	I	J		H		176.00	3	Morex
	G		F		L		K	I	J		H		170.33	3	MKRB167
	G		F		L	M	K	I	J		H		166.00	3	BW289
	G		F	N	L	M	K	I	J		H		160.33	3	Arta
	G	O	F	N	L	M	K	I	J		H		159.67	3	Bowman
	G	O		N	L	M	K	I	J		H		158.33	3	MKRB118
	G	O	P	N	L	M	K	I	J		H		155.00	3	Barke
	Q	O	P	N	L	M	K	I	J		H		153.33	3	MKRB186
	Q	O	P	N	L	M	K	I	J		R		150.00	3	Rum
	Q	O	P	N	L	M	K	I	J		R		150.00	3	Aksad
	Q	O	P	N	L	M	K	I	J		R		148.67	3	Marthe
S	Q	O	P	N	L	M	K	I	J		R		147.67	3	MKRB181
S	Q	O	P	N	L	M	K	I	J		R		147.67	3	Keel
S	Q	O	P	N	L	M	K	I	J		R	T	146.67	3	LR871
S	Q	O	P	N	L	M	K	U	J		R	T	143.00	3	MKRB156
S	Q	O	P	N	L	M	K	U	J		R	T	140.33	3	MKRB270
S	Q	O	P	N	L	M	K	U	J		R	T	139.00	3	MKRB163
S	Q	O	P	N	L	M	K	U	J		R	T	138.67	3	LR1897
S	Q	O	P	N	L	M	K	U	V		R	T	135.33	3	Lr761
S	Q	O	P	N	L	M	W	U	V		R	T	126.67	3	MKRB279
S	Q	O	P	N	L	M	W	U	V		R	T	126.33	3	BW284
S	Q	O	P	N	L	M	W	U	V		R	T	125.33	3	MKRB282
S	Q	O	P	N	L	M	W	U	V		R	T	125.33	3	MKRB246
S	Q	O	P	N	L	M	W	U	V	X	R	T	122.33	3	BW285
S	Q	O	P	N	Y	M	W	U	V	X	R	T	117.33	3	MKRB94
S	Q	O	P	N	Y		W	U	V	X	R	T	115.33	3	MKRB227
S	Q	O	P	N	Y		W	U	V	X	R	T	112.33	3	MKRB147
S	Q	O	P	N	Y		W	U	V	X	R	T	112.00	3	BW281
S	Q	O	P	N	Y		W	U	V	X	R	T	111.33	3	MKRB192
S	Q	O	P		Y		W	U	V	X	R	T	110.67	3	MKRB268
S	Q		P		Y	Z	W	U	V	X	R	T	109.00	3	MKRB229
S	Q		P		Y	Z	W	U	V	X	R	T	108.33	3	MKRB241
S	Q		P	A	Y	Z	W	U	V	X	R	T	107.33	3	Optic
S	Q		P	A	Y	Z	W	U	V	X	R	T	107.00	3	MKRB188
S	Q		B	A	Y	Z	W	U	V	X	R	T	105.00	3	MKRB230
S			B	A	Y	Z	W	U	V	X	R	T	102.67	3	MKRB114
S	C		B	A	Y	Z	W	U	V	X		T	99.33	3	MKRB155
	C		B	A	Y	Z	W	U	V	X		T	98.33	3	MKRB150
	C		B	A	Y	Z	W	U	V	X		T	98.00	3	MKRB21
	C		B	A	Y	Z	W	U	V	X		T	97.67	3	MKRB154
	C		B	A	Y	Z	W	U	V	X		T	97.67	3	MKRB190
	C		B	A	Y	Z	W	U	V	X			97.00	3	MKRB187
	C		B	A	Y	Z	W		V	X	D		87.67	3	MKRB86
	C		B	A	Y	Z	W		V	X	D		86.67	3	MKRB278
	C		B	A	Y	Z	W		V	X	D		86.33	3	MKRB224
	C		B	A	Y	Z	W			X	D		84.00	3	HID301
	C		B	A	Y	Z	W			X	D		78.00	3	MKRB233
	C		B	A	Y	Z				X	D		75.00	3	MKRB271

C	B	A	Y	Z	X	D	73.33	3	LR1043
C	B	A	Y	Z		D	72.67	3	MKRB157
C	B	A	Y	Z		D	71.33	3	HID52
C	B	A	Y	Z		D	71.00	3	MKRB284
C	B	A	Y	Z		D	70.33	3	BW290
C	B	A		Z		D	61.67	3	MKRB223
C	B	A		Z		D	61.33	3	MKRB240
C	B	A				D	58.67	3	MKRB189
C	B					D	57.33	3	HID44
C	B					D	56.67	3	MKRB281
C	B					D	56.33	3	MKRB183
C						D	51.33	3	G400
						D	48.33	3	MKRB87
						D	45.33	3	MKRB232

TKW

REGWQ Grouping																		Mean	N	Line
										A								51.767	3	LR1897
										A								51.667	3	LR871
			B							A								51.467	3	Mutha
			B							A				C				49.467	3	MKRB240
			B			D				A				C				49.067	3	MKRB286
	E		B			D				A				C				47.967	3	MKRB225
	E		B			D				A				C		F		47.367	3	Auriga
	E		B			D				A				C		F		47.200	3	MKRB21
	E		B			D				A				C		F		47.067	3	MKRB188
	E		B			D				A		G		C		F		46.700	3	Aksad
	E		B			D				A		G		C		F		46.667	3	MKRB147
	E		B			D		H		A		G		C		F		45.800	3	MKRB118
	E		B			D		H		A		G		C		F		45.700	3	MKRB228
	E		B	I		D		H		A		G		C		F		45.433	3	MKRB156
	E	J	B	I		D		H		A		G		C		F		45.133	3	Keel
	E	J	B	I		D		H		A		G		C		F		45.100	3	MKRB224
	E	J	B	I		D		H		A		G		C		F		44.933	3	Arta
K	E	J	B	I		D		H		A		G		C		F		44.500	3	Rum
K	E	J	B	I		D		H		A		G		C		F		44.467	3	LR1043
K	E	J	B	I		D		H		A		G		C		F	L	44.167	3	Bowman
K	E	J	B	I		D		H		A		G		C		F	L	43.933	3	MKRB190
K	E	J	B	I		D		H		A		G		C	M	F	L	43.833	3	MKRB241
K	E	J	B	I		D		H		A		G		C	M	F	L	43.600	3	MKRB233
K	E	J	B	I		D		H		A		G		C	M	F	L	43.500	3	Optic
K	E	J	B	I		D		H		A		G	N	C	M	F	L	43.433	3	MKRB269
K	E	J	B	I		D		H		A		G	N	C	M	F	L	43.300	3	Marthe
K	E	J	B	I		D		H		A		G	N	C	M	F	L	43.000	3	HID52
K	E	J	B	I		D		H		A	O	G	N	C	M	F	L	42.800	3	Barke
K	E	J	B	I		D		H	P	A	O	G	N	C	M	F	L	42.533	3	MKRB192
K	E	J	B	I		D		H	P	A	O	G	N	C	M	F	L	42.533	3	MKRB183
K	E	J	B	I		D		H	P	A	O	G	N	C	M	F	L	42.467	3	MKRB107
K	E	J	B	I		D	Q	H	P	A	O	G	N	C	M	F	L	41.933	3	MKRB278
K	E	J	B	I		D	Q	H	P	A	O	G	N	C	M	F	L	41.933	3	MKRB154
K	E	J	B	I		D	Q	H	P	A	O	G	N	C	M	F	L	41.867	3	flagship
K	E	J	B	I		D	Q	H	P	A	O	G	N	C	M	F	L	41.767	3	MKRB230
K	E	J	B	I		D	Q	H	P	A	O	G	N	C	M	F	L	41.733	3	MKRB227
K	E	J	B	I		D	Q	H	P	A	O	G	N	C	M	F	L	41.500	3	MKRB187
K	E	J	B	I	R	D	Q	H	P	A	O	G	N	C	M	F	L	41.467	3	MKRB189
K	E	J	B	I	R	D	Q	H	P	A	O	G	N	C	M	F	L	41.267	3	MKRB270
K	E	J	B	I	R	D	Q	H	P	A	O	G	N	C	M	F	L	41.133	3	BW281
K	E	J	B	I	R	D	Q	H	P	A	O	G	N	C	M	F	L	40.967	3	MKRB163
K	E	J	B	I	R	D	Q	H	P	A	O	G	N	C	M	F	L	40.900	3	MKRB184
K	E	J	B	I	R	D	Q	H	P	A	O	G	N	C	M	F	L	40.667	3	MKRB186
K	E	J	B	I	R	D	Q	H	P	A	O	G	N	C	M	F	L	40.400	3	MKRB152
K	E	J	B	I	R	D	Q	H	P		O	G	N	C	M	F	L	40.267	3	G400
K	E	J		I	R	D	Q	H	P		O	G	N	C	M	F	L	39.933	3	MKRB113
K	E	J		I	R	D	Q	H	P		O	G	N	C	M	F	L	39.867	3	MKRB223
K	E	J		I	R	D	Q	H	P	S	O	G	N	C	M	F	L	39.467	3	MKRB281
K	E	J		I	R	D	Q	H	P	S	O	G	N	C	M	F	L	38.400	3	MKRB279
K	E	J		I	R	D	Q	H	P	S	O	G	N	C	M	F	L	38.200	3	MKRB86
K	E	J	T	I	R	D	Q	H	P	S	O	G	N		M	F	L	37.767	3	BW285
K	E	J	T	I	R	D	Q	H	P	S	O	G	N		M	F	L	37.733	3	MKRB246
K	E	J	T	I	R	D	Q	H	P	S	O	G	N		M	F	L	37.633	3	MKRB94
K	E	J	T	I	R		Q	H	P	S	O	G	N		M	F	L	37.200	3	MKRB268
K	E	J	T	I	R		Q	H	P	S	O	G	N		M	F	L	36.933	3	MKRB282
K	E	J	T	I	R		Q	H	P	S	O	G	N		M	F	L	36.767	3	MKRB157
K	E	J	T	I	R		Q	H	P	S	O	G	N		M	F	L	36.733	3	MKRB232
K		J	T	I	R		Q	H	P	S	O	G	N		M	F	L	36.267	3	BW284
K		J	T	I	R		Q	H	P	S	O	G	N		M	F	L	36.267	3	MKRB155
K		J	T	I	R		Q	H	P	S	O	G	N		M		L	35.333	3	MKRB18
K		J	T	I	R		Q	H	P	S	O		N		M		L	34.500	3	Morex

K	J	T	I	R	Q	H	P	S	O	N	M	L	34.367	3	Lr761
K	J	T	I	R	Q		P	S	O	N	M	L	34.067	3	MKRB114
K	J	T		R	Q		P	S	O	N	M	L	33.833	3	MKRB181
K		T		R	Q		P	S	O	N	M	L	33.300	3	BW289
		T		R	Q		P	S	O	N	M	L	32.833	3	HID301
		T		R	Q		P	S	O	N	M		32.500	3	MKRB167
		T		R	Q		P	S	O	N			32.100	3	MKRB271
		T		R	Q		P	S	O				31.467	3	MKRB87
		T		R	Q		P	S					31.200	3	BW290
		T		R	Q			S					30.967	3	MKRB150
		T		R	Q			S					30.933	3	HID44
		T		R				S					30.200	3	MKRB284
		T						S					28.567	3	BW287
		T											26.967	3	MKRB229

Vegetative biomass

REGWQ Grouping												Mean	N	Line
							A					597.00	3	MKRB152
			B				A					564.67	3	MKRB113
			B				A					551.67	3	MKRB107
			B				C					508.67	3	MKRB269
			B				C					505.67	3	MKRB286
			B				C		D			488.67	3	MKRB228
			E				C		D			441.00	3	Auriga
			E		F		C		D			435.67	3	Mutha
	G		E		F		C		D			431.00	3	flagship
	G		E		F		C		D			430.67	3	MKRB225
	G		E		F		H		D			415.67	3	BW287
	G		E		F		H		I			396.67	3	MKRB18
	G		E		F		H		I	J		389.33	3	MKRB184
	G		E		F		H	K	I	J		379.67	3	Morex
	G		E		F	L	H	K	I	J		366.67	3	MKRB167
	G		E	M	F	L	H	K	I	J		359.67	3	BW289
	G	N	E	M	F	L	H	K	I	J		353.00	3	Bowman
	G	N	O	M	F	L	H	K	I	J		346.67	3	Arta
	G	N	O	M	P	L	H	K	I	J		341.67	3	MKRB118
	Q	N	O	M	P	L	H	K	I	J		336.33	3	Barke
R	Q	N	O	M	P	L	H	K	I	J		330.67	3	MKRB186
R	Q	N	O	M	P	L	S	K	I	J		324.00	3	Aksad
R	Q	N	O	M	P	L	S	K	I	J		323.33	3	Rum
R	Q	N	O	M	P	L	S	K	I	J		320.67	3	Marthe
R	Q	N	O	M	P	L	S	K	I	J		318.67	3	Keel
R	Q	N	O	M	P	L	S	K	I	J		318.33	3	MKRB181
R	Q	N	O	M	P	L	S	K	I	J		316.33	3	LR871
R	Q	N	O	M	P	L	S	K	I	J	T	307.67	3	MKRB156
R	Q	N	O	M	P	L	S	K	U	J	T	302.67	3	MKRB270
R	Q	N	O	M	P	L	S	K	U	J	T	300.00	3	MKRB163
R	Q	N	O	M	P	L	S	K	U	J	T	299.00	3	LR1897
R	Q	N	O	M	P	L	S	K	U		T	291.67	3	Lr761
R	Q	N	O	M	P	L	S		U	V	T	274.67	3	BW284
R	Q	N	O	M	P	L	S		U	V	T	273.33	3	MKRB279
R	Q	N	O	M	P		S		U	V	T	270.00	3	MKRB282
R	Q	N	O	M	P		S		U	V	T	269.33	3	MKRB246
R	Q	N	O		P		S		U	V	T	265.00	3	BW285
R	Q		O		P		S	W	U	V	T	253.33	3	MKRB94
R	Q		X		P		S	W	U	V	T	248.33	3	MKRB227
R	Q		X		Y		S	W	U	V	T	243.33	3	BW281
R	Q		X		Y		S	W	U	V	T	242.33	3	MKRB147
R			X		Y		S	W	U	V	T	240.00	3	MKRB192
R			X		Y		S	W	U	V	T	238.67	3	MKRB268
			X		Y		S	W	U	V	T	234.67	3	MKRB229
			X		Y		S	W	U	V	T	233.67	3	MKRB241
			X		Y		S	W	U	V	T	231.33	3	Optic
			X		Y		S	W	U	V	T	230.67	3	MKRB188
			X		Y		S	W	U	V	T	229.67	3	MKRB230
			X		Y		Z	W	U	V	T	221.33	3	MKRB114
	A		X		Y		Z	W	U	V	T	213.67	3	MKRB155
	A		X		Y		Z	W	U	V		211.67	3	MKRB150
	A		X		Y		Z	W	U	V		211.00	3	MKRB21
	A		X		Y		Z	W	U	V		210.33	3	MKRB154
	A		X		Y		Z	W	U	V		210.33	3	MKRB190
	A		X		Y		Z	W	U	V		208.33	3	MKRB187
	A		X		Y		Z	W	B	V		188.67	3	MKRB86
	A		X		Y		Z	W	B	V		188.67	3	MKRB271
	A		X		Y		Z	W	B	V		186.67	3	MKRB278
	A		X		Y		Z	W	B	V		185.67	3	MKRB224
	A		X		Y		Z	W	B	V		180.33	3	HID301
	A		X		Y		Z	W	B			168.33	3	MKRB233

A	X	Y	Z	B	157.67	3	LR1043
A	X	Y	Z	B	157.00	3	MKRB157
A	X	Y	Z	B	153.67	3	HID52
A	X	Y	Z	B	153.33	3	BW290
A		Y	Z	B	153.00	3	MKRB284
A			Z	B	132.67	3	MKRB223
A			Z	B	131.67	3	MKRB240
A			Z	B	127.67	3	MKRB183
A				B	123.67	3	HID44
A				B	122.00	3	MKRB281
A				B	120.67	3	G400
				B	106.00	3	MKRB189
				B	104.67	3	MKRB87
				B	97.33	3	MKRB232

Field data 2016-2017

The GLM Procedure

Class Level Information

Class	Levels	Values
Line	75	Aksad Arta Auriga BW281 BW284 BW285 BW287 BW289 BW290 Barke Bowman G400 HID301 HID44 HID52 Keel LR1043 LR1897 LR871 Lr761 MKRB107 MKRB113 MKRB114 MKRB118 MKRB147 MKRB150 MKRB152 MKRB154 MKRB155 MKRB156 MKRB157 MKRB163 MKRB167 MKRB18 MKRB181 MKRB183 MKRB184 MKRB186 MKRB187 MKRB188 MKRB189 MKRB190 MKRB192 MKRB21 MKRB223 MKRB224 MKRB225 MKRB227 MKRB228 MKRB229 MKRB230 MKRB232 MKRB233 MKRB240 MKRB241 MKRB246 MKRB268 MKRB269 MKRB270 MKRB271 MKRB278 MKRB279 MKRB281 MKRB282 MKRB284 MKRB286 MKRB86 MKRB87 MKRB94 Marthe Morex Mutha Optic Rum flagship
Rep	3	1 2 3
Number of observations		225

Dependent Variable: Days to stem elongation

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	76	81973.7935	1078.6025	6.46	<.0001
Error	147	24543.5636	166.9630		
Corrected Total	223	106517.3571			

R-Square	Coeff Var	Root MSE	Daystostemelongation Mean
0.769582	22.49299	12.92142	57.44643

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Line	74	81570.69048	1102.30663	6.60	<.0001
Rep	2	403.10306	201.55153	1.21	0.3020

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Line	74	81547.78775	1101.99713	6.60	<.0001
Rep	2	403.10306	201.55153	1.21	0.3020

Dependent Variable: Days to heading

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	76	70828.59147	931.95515	171.19	<.0001
Error	147	800.26568	5.44398		
Corrected Total	223	71628.85714			

R-Square	Coeff Var	Root MSE	Daystoheading Mean
0.988828	2.289088	2.333235	101.9286

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Line	74	70806.19048	956.84041	175.76	<.0001
Rep	2	22.40099	11.20050	2.06	0.1314

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Line	74	70827.89414	957.13370	175.81	<.0001
Rep	2	22.40099	11.20050	2.06	0.1314

Dependent Variable: Days to maturity

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	76	29115.96173	383.10476	24.99	<.0001
Error	147	2253.42667	15.32943		
Corrected Total	223	31369.38839			

R-Square	Coeff Var	Root MSE	Daystomaturity Mean
0.928165	3.112992	3.915282	125.7723

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Line	74	29103.38839	393.28903	25.66	<.0001
Rep	2	12.57333	6.28667	0.41	0.6643

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Line	74	29114.95802	393.44538	25.67	<.0001
Rep	2	12.57333	6.28667	0.41	0.6643

Dependent Variable: Tiller Number

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	76	4003.616836	52.679169	1.87	0.0006
Error	147	4133.164414	28.116765		
Corrected Total	223	8136.781250			

R-Square	Coeff Var	Root MSE	TillerNumber Mean
0.492039	20.41887	5.302524	25.96875

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Line	74	3905.447917	52.776323	1.88	0.0006
Rep	2	98.168919	49.084459	1.75	0.1781

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Line	74	3913.327117	52.882799	1.88	0.0006
Rep	2	98.168919	49.084459	1.75	0.1781

Dependent Variable: Spike Number

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	76	6030.61022	79.35013	2.46	<.0001
Error	147	4738.23192	32.23287		
Corrected Total	223	10768.84214			

R-Square	Coeff Var	Root MSE	SpikeNumber Mean
0.560005	26.09228	5.677400	21.75893

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Line	74	5709.662143	77.157597	2.39	<.0001
Rep	2	320.948076	160.474038	4.98	0.0081

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Line	74	5720.626959	77.305770	2.40	<.0001
Rep	2	320.948076	160.474038	4.98	0.0081

Dependent Variable: Spike Length

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	76	213.9102016	2.8146079	5.57	<.0001
Error	147	74.2784480	0.5052956		
Corrected Total	223	288.1886496			

R-Square	Coeff Var	Root MSE	SpikeLength Mean
0.742258	8.630036	0.710841	8.236830

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Line	74	208.6036496	2.8189682	5.58	<.0001
Rep	2	5.3065520	2.6532760	5.25	0.0063

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Line	74	208.6846782	2.8200632	5.58	<.0001
Rep	2	5.3065520	2.6532760	5.25	0.0063

Dependent Variable: Plant Height

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	76	31525.09626	414.80390	4.47	<.0001
Error	147	13631.66891	92.73244		
Corrected Total	223	45156.76517			

R-Square	Coeff Var	Root MSE	PlantHeight Mean
0.698126	12.29732	9.629769	78.30786

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Line	74	30038.35937	405.92378	4.38	<.0001
Rep	2	1486.73689	743.36845	8.02	0.0005

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Line	74	30044.82541	406.01115	4.38	<.0001
Rep	2	1486.73689	743.36845	8.02	0.0005

Dependent Variable: Total Grain Yield

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	76	1712836.918	22537.328	14.62	<.0001
Error	147	226649.881	1541.836		
Corrected Total	223	1939486.799			

R-Square	Coeff Var	Root MSE	TotalGrainYield Mean
0.883139	22.05945	39.26622	178.0018

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Line	74	1699321.993	22963.811	14.89	<.0001
Rep	2	13514.925	6757.463	4.38	0.0142

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Line	74	1700082.026	22974.081	14.90	<.0001
Rep	2	13514.925	6757.463	4.38	0.0142

Dependent Variable: TKW

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	76	7887.81805	103.78708	5.68	<.0001
Error	147	2687.69909	18.28367		
Corrected Total	223	10575.51714			

R-Square	Coeff Var	Root MSE	TKW Mean
0.745856	10.08561	4.275941	42.39643

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Line	74	7737.812143	104.565029	5.72	<.0001
Rep	2	150.005911	75.002955	4.10	0.0185

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Line	74	7726.772082	104.415839	5.71	<.0001
Rep	2	150.005911	75.002955	4.10	0.0185

Dependent Variable: Vegetative Biomass

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	76	30241501.37	397914.49	43.54	<.0001
Error	147	1343300.06	9138.10		
Corrected Total	223	31584801.43			

R-Square	Coeff Var	Root MSE	VegetativeBiomass Mean
0.957470	11.07549	95.59339	863.1071

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Line	74	30238382.76	408626.79	44.72	<.0001
Rep	2	3118.61	1559.30	0.17	0.8433

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Line	74	30241292.94	408666.12	44.72	<.0001
Rep	2	3118.61	1559.30	0.17	0.8433

Days to stem elongation

REGWQ Grouping	Mean	N	Line
A	194.67	3	MKRB268
B	81.33	3	MKRB157
B	77.00	3	MKRB150
B	71.33	3	MKRB155
B	68.67	3	MKRB189
B	65.00	3	MKRB87
B	65.00	3	MKRB188
B	64.67	3	MKRB156
B	64.67	3	MKRB230
B	64.67	3	MKRB167
B	64.67	3	MKRB232
B	64.00	3	MKRB192
B	64.00	3	HID44
B	64.00	3	MKRB114
B	64.00	3	MKRB163
B	64.00	3	MKRB94
B	64.00	3	Arta
B	64.00	3	MKRB86
B	64.00	3	MKRB21
B	64.00	3	MKRB233
B	64.00	3	MKRB18
B	64.00	3	MKRB281
B	64.00	3	MKRB246
B	64.00	3	Optic
B	64.00	3	Lr761
B	64.00	3	MKRB184
B	61.67	3	LR1897
B	61.67	3	MKRB187
B	61.67	3	Barke
B	61.67	3	MKRB223
B	61.67	3	MKRB154
B	61.67	3	MKRB229
B	61.67	3	MKRB183
B	59.33	3	MKRB270
B	59.33	3	Auriga
B	59.33	3	HID301
B	59.33	3	Marthe
B	59.33	3	MKRB224
B	57.67	3	MKRB147
B	57.00	3	flagship
B	57.00	3	MKRB282
B	57.00	3	Mutha
B	57.00	3	MKRB271
B	56.00	3	HID52
B	56.00	3	MKRB181
B	53.67	3	MKRB228
B	53.67	3	Keel
B	51.33	3	MKRB113
B	51.33	3	MKRB227
B	48.00	3	Morex
B	48.00	3	MKRB186
B	48.00	3	Rum
B	48.00	3	BW281
B	45.67	3	MKRB284
B	45.67	3	LR1043
B	45.67	3	MKRB225
B	45.67	3	Bowman
B	45.67	3	LR871
B	40.00	3	MKRB240
B	40.00	3	MKRB107
B	40.00	3	MKRB279

B	40.00	3	MKRB278
B	40.00	3	MKRB118
B	40.00	3	Aksad
B	40.00	3	MKRB286
B	40.00	3	MKRB241
B	40.00	3	G400
B	40.00	3	BW284
B	40.00	3	BW285
B	40.00	3	BW287
B	40.00	3	BW289
B	40.00	2	BW290
B	40.00	3	MKRB269
B	40.00	3	MKRB152

Days to heading

REGWQ Grouping					Mean	N	Line
			A		130.000	3	LR1043
			A		129.000	3	MKRB156
	B		A		126.667	3	MKRB154
	B		A	C	125.000	3	MKRB86
	B		A	C	125.000	3	MKRB157
	B	D	A	C	123.333	3	MKRB150
	B	D	E	C	121.333	3	MKRB268
	B	D	E	C	119.667	3	MKRB94
	B	D	E	C	119.667	3	MKRB167
		D	E	C	119.000	3	MKRB246
		D	E	C	119.000	3	MKRB87
		D	E	C	118.667	3	Morex
	F	D	E	C	118.333	3	MKRB21
G	F	D	E	C	118.000	3	Optic
G	F	D	E	H	117.333	3	MKRB114
G	F	D	E	H	117.000	3	MKRB184
G	F	I	E	H	114.333	3	MKRB155
G	F	I	J	H	111.333	3	MKRB18
G		I	J	H	111.000	3	MKRB189
		I	J	H	110.667	3	MKRB229
		I	J		109.667	3	MKRB281
		I	J		109.667	3	MKRB187
		I	J		109.333	3	MKRB224
		I	J		109.000	3	Barke
		I	J		109.000	3	MKRB270
		I	J		109.000	3	MKRB223
		I	J		108.000	3	MKRB163
		I	J		108.000	3	MKRB271
		I	J		108.000	3	MKRB230
		I	J		108.000	3	MKRB284
		I	J		107.667	3	Arta
		I	J		107.667	3	Lr761
		I	J		107.667	3	MKRB233
		I	J		107.333	3	flagship
		I	J		107.000	3	MKRB113
		I	J		107.000	3	MKRB227
		I	J		107.000	3	MKRB192
		I	J		107.000	3	MKRB147
		I	J		106.667	3	Marthe
	K		J		105.667	3	HID44
	K		J		105.333	3	MKRB188
	K		J		105.333	3	MKRB232
	K		J		105.333	3	Auriga
	K		J		105.000	3	MKRB190
	K		J	L	103.667	3	MKRB107
	K		M	L	99.333	3	MKRB181
	K		M	L	99.000	3	MKRB118
	N		M	L	97.667	3	LR1897
	N		M	O	96.333	3	BW281
	N		M	O	96.333	3	MKRB228
	N		M	O	96.000	3	Keel
	N		M	O	96.000	3	MKRB183
	N		M	O	96.000	3	MKRB225
	N		M	O	96.000	3	LR871
	N		M	O	96.000	3	Aksad
	N		M	O	94.667	3	MKRB269
	N	P	M	O	93.667	3	MKRB186
Q	N	P	M	O	93.333	3	HID52
Q	N	P	M	O	93.000	3	Rum
Q	N	P	M	O	92.333	3	Mutha
Q	N	P	M	O	92.333	3	HID301

Q	N	P	M	O	92.333	3	BW287
Q	N	P		O	91.333	3	MKRB278
Q	N	P		O	91.000	3	MKRB152
Q		P		O	90.000	3	Bowman
Q		P			86.667	3	MKRB282
Q		P			86.333	3	MKRB241
Q					86.000	3	MKRB279
			R		74.000	3	MKRB286
			S		66.000	3	MKRB240
			T		59.333	3	BW285
			T		58.000	3	BW284
			U		47.333	3	G400
			U		46.333	3	BW289
			U		46.000	2	BW290

Days to maturity

REGWQ Grouping														Mean	N	Line
							A							149.000	3	MKRB156
			B				A							147.667	3	MKRB150
			B				A							147.000	3	MKRB167
			B				A			C				143.667	3	MKRB157
			B		D		A			C				141.333	3	MKRB114
	E		B		D		A			C				141.000	3	LR1043
	E		B		D		A			C		F		140.000	3	Optic
	E		B		D		A			C		F		139.667	3	MKRB268
	E		B		D		A			C		F		139.000	3	MKRB227
	E		B		D		A	G		C		F		138.333	3	MKRB86
	E		B		D	H	A	G		C		F		137.667	3	Barke
	E		B	I	D	H	A	G		C		F		137.333	3	MKRB246
	E	J	B	I	D	H	A	G		C		F		136.667	3	MKRB154
	E	J	B	I	D	H		G		C		F		136.333	3	MKRB18
	E	J	B	I	D	H		G		C		F		136.333	3	MKRB281
	E	J	B	I	D	H	K	G		C		F		135.333	3	MKRB94
	E	J	L	I	D	H	K	G		C		F		134.333	3	MKRB270
M	E	J	L	I	D	H	K	G		C		F		134.000	3	MKRB184
M	E	J	L	I	D	H	K	G		C		F	N	132.333	3	Lr761
M	E	J	L	I	D	H	K	G		C		F	N	132.333	3	MKRB271
M	E	J	L	I	D	H	K	G		C		F	N	132.000	3	MKRB155
M	E	J	L	I	D	H	K	G		C	O	F	N	131.333	3	MKRB224
M	E	J	L	I	D	H	K	G	P	C	O	F	N	131.000	3	MKRB87
M	E	J	L	I	D	H	K	G	P	Q	O	F	N	130.000	3	MKRB187
M	E	J	L	I	D	H	K	G	P	Q	O	F	N	129.667	3	MKRB190
M	E	J	L	I	D	H	K	G	P	Q	O	F	N	129.000	3	HID44
M	E	J	L	I	D	H	K	G	P	Q	O	F	N	129.000	3	MKRB230
M	E	J	L	I	D	H	K	G	P	Q	O	F	N	128.667	3	MKRB21
M	E	J	L	I	D	H	K	G	P	Q	O	F	N	128.667	3	MKRB147
M	E	J	L	I	D	H	K	G	P	Q	O	F	N	128.333	3	MKRB229
M	E	J	L	I	D	H	K	G	P	Q	O	F	N	128.333	3	MKRB189
M	E	J	L	I	D	H	K	G	P	Q	O	F	N	128.333	3	MKRB232
M	E	J	L	I		H	K	G	P	Q	O	F	N	128.000	3	MKRB223
M		J	L	I	R	H	K	G	P	Q	O	F	N	127.000	3	Arta
M		J	L	I	R	H	K	G	P	Q	O	F	N	127.000	3	MKRB284
M		J	L	I	R	H	K	G	P	Q	O	F	N	127.000	3	MKRB163
M		J	L	I	R	H	K	G	P	Q	O		N	125.667	3	MKRB192
M		J	L	I	R	H	K	G	P	Q	O		N	125.667	3	MKRB188
M		J	L	I	R	H	K	G	P	Q	O		N	125.667	3	MKRB107
M		J	L	I	R	H	K	G	P	Q	O		N	125.333	3	MKRB118
M		J	L	I	R	H	K		P	Q	O		N	125.000	3	Auriga
M		J	L	I	R	H	K		P	Q	O		N	125.000	3	MKRB113
M		J	L	I	R	H	K		P	Q	O		N	124.667	3	MKRB225
M		J	L	I	R		K		P	Q	O		N	124.333	3	MKRB183
M		J	L		R		K		P	Q	O		N	123.667	3	Mutha
M			L		R		K		P	Q	O		N	122.667	3	MKRB228
M			L		R		K		P	Q	O		N	122.333	3	MKRB152
M			L		R				P	Q	O		N	122.000	3	MKRB186
M			L		R				P	Q	O		N	122.000	3	MKRB181
M			L		R				P	Q	O		N	122.000	3	LR1897
M			L		R				P	Q	O		N	122.000	3	MKRB233
M			L		R				P	Q	O		N	121.667	3	LR871
M			L		R				P	Q	O		N	121.333	3	MKRB269
M					R				P	Q	O		N	121.000	3	flagship
					R				P	Q	O		N	120.667	3	Keel
					R				P	Q	O		N	120.667	3	BW281
					R				P	Q	O		N	120.333	3	HID301
					R				P	Q	O		N	120.333	3	Morex
					R				P	Q	O		N	120.000	3	Marthe
					R				P	Q	O		N	120.000	3	BW287
					R				P	Q	O		N	119.667	3	MKRB278

	R	S	P	Q	O	N	119.333	3	Aksad
	R	S	P	Q	O	N	119.000	3	Rum
	R	S	P	Q	O		118.000	3	Bowman
	R	S	P	Q			117.667	3	MKRB279
	R	S		Q			117.000	3	MKRB282
	R	S		Q			116.667	3	MKRB241
	R	S					114.333	3	HID52
T		S					107.333	3	MKRB286
T							98.000	3	G400
T							98.000	3	MKRB240
T							98.000	3	BW289
T							98.000	3	BW284
T							98.000	3	BW285
T							98.000	2	BW290

Tiller Number

REGWQ Grouping		Mean	N	Line
	A	36.667	3	MKRB241
	A	36.667	3	LR1897
B	A	34.000	3	MKRB118
B	A	33.333	3	flagship
B	A	32.333	3	Auriga
B	A	31.667	3	Keel
B	A	31.333	3	MKRB232
B	A	31.000	3	Mutha
B	A	30.333	3	BW284
B	A	30.333	3	HID44
B	A	30.000	3	MKRB225
B	A	30.000	3	Marthe
B	A	29.667	3	Bowman
B	A	29.667	3	MKRB87
B	A	29.333	3	BW285
B	A	29.000	3	MKRB268
B	A	29.000	3	MKRB157
B	A	29.000	3	MKRB230
B	A	29.000	3	MKRB113
B	A	29.000	3	MKRB240
B	A	28.667	3	MKRB18
B	A	28.667	3	MKRB279
B	A	28.000	3	Optic
B	A	28.000	3	MKRB189
B	A	28.000	3	MKRB192
B	A	27.333	3	MKRB223
B	A	27.333	3	Aksad
B	A	27.000	3	MKRB21
B	A	27.000	3	MKRB233
B	A	27.000	3	MKRB278
B	A	27.000	3	LR871
B	A	26.667	3	MKRB163
B	A	26.667	3	MKRB188
B	A	26.333	3	MKRB150
B	A	26.333	3	HID301
B	A	26.333	3	BW289
B	A	26.333	3	MKRB155
B	A	26.333	3	MKRB269
B	A	26.000	3	BW287
B	A	26.000	3	Arta
B	A	26.000	3	MKRB147
B	A	25.667	3	MKRB224
B	A	25.333	3	BW281
B	A	25.333	3	MKRB286
B	A	25.000	3	MKRB270
B	A	25.000	3	MKRB228
B	A	24.667	3	MKRB282
B	A	24.333	3	MKRB152
B	A	24.333	3	MKRB229
B	A	24.000	3	MKRB107
B	A	24.000	3	MKRB181
B	A	24.000	3	G400
B	A	24.000	3	Barke
B	A	24.000	3	MKRB186
B	A	23.333	3	Rum
B	A	23.000	3	MKRB86
B	A	23.000	3	MKRB156
B	A	22.667	3	MKRB114
B	A	22.667	3	HID52
B	A	22.667	3	MKRB190
B	A	22.333	3	MKRB167

B	A	21.667	3	MKRB284
B	A	21.667	3	MKRB187
B	A	21.333	3	MKRB246
B	A	21.000	3	MKRB184
B	A	21.000	3	Lr761
B	A	20.333	3	MKRB271
B	A	20.000	2	BW290
B	A	19.667	3	MKRB154
B	A	19.333	3	LR1043
B	A	19.333	3	MKRB227
B	A	18.667	3	Morex
B	A	18.667	3	MKRB94
B		17.667	3	MKRB183
B		17.667	3	MKRB281

Spike Number

REGWQ Grouping			Mean	N	Line
	A		31.900	3	MKRB241
B	A		30.567	3	LR1897
B	A		30.433	3	Keel
B	A	C	29.700	3	flagship
B	A	C	29.467	3	Auriga
B	A	C	29.100	3	MKRB232
B	A	C	28.667	3	MKRB157
B	A	C	28.667	3	Mutha
B	A	C	28.467	3	MKRB118
B	A	C	28.333	3	MKRB18
B	A	C	27.867	3	MKRB225
B	A	C	27.533	3	MKRB192
B	A	C	26.767	3	MKRB230
B	A	C	26.567	3	HID44
B	A	C	26.433	3	MKRB189
B	A	C	26.300	3	MKRB268
B	A	C	26.133	3	MKRB87
B	A	C	25.800	3	Optic
B	A	C	25.533	3	MKRB113
B	A	C	25.533	3	MKRB188
B	A	C	25.433	3	MKRB269
B	A	C	25.033	3	Marthe
B	A	C	24.667	3	MKRB163
B	A	C	24.433	3	LR871
B	A	C	23.900	3	MKRB150
B	A	C	23.867	3	BW287
B	A	C	23.567	3	MKRB155
B	A	C	23.567	3	MKRB224
B	A	C	23.533	3	MKRB186
B	A	C	23.433	3	Arta
B	A	C	23.367	3	BW284
B	A	C	23.333	3	MKRB223
B	A	C	23.333	3	MKRB270
B	A	C	23.233	3	Aksad
B	A	C	23.000	3	MKRB21
B	A	C	22.667	3	BW281
B	A	C	22.100	3	MKRB147
B	A	C	21.667	3	MKRB233
B	A	C	21.333	3	MKRB282
B	A	C	21.300	3	Bowman
B	A	C	21.100	3	MKRB240
B	A	C	20.667	3	MKRB156
B	A	C	20.567	3	MKRB107
B	A	C	20.433	3	Lr761
B	A	C	20.333	3	BW289
B	A	C	20.233	3	MKRB190
B	A	C	20.100	3	BW285
B	A	C	19.900	3	MKRB187
B	A	C	19.667	3	MKRB167
B	A	C	19.667	3	Rum
B	A	C	19.433	3	MKRB86
B	A	C	19.433	3	MKRB152
B	A	C	19.000	3	MKRB229
B	A	C	18.567	3	MKRB246
B	A	C	18.567	3	Barke
B	A	C	18.433	3	MKRB181
B	A	C	17.700	3	HID52
B	A	C	17.667	3	MKRB114
B	A	C	17.233	3	MKRB284
B	A	C	17.100	3	MKRB228
B	A	C	17.100	3	MKRB279

B	A	C	17.000	3	G400
B	A	C	16.800	3	HID301
B	A	C	16.200	3	MKRB271
B	A	C	15.800	3	MKRB94
B	A	C	15.567	3	MKRB184
B	A	C	15.200	2	BW290
B	A	C	15.000	3	MKRB278
B	A	C	14.533	3	Morex
B	A	C	13.767	3	MKRB286
B	A	C	13.500	3	MKRB281
B	A	C	13.433	3	MKRB183
B		C	11.667	3	LR1043
B		C	11.300	3	MKRB154
		C	10.533	3	MKRB227

Spike Length

REGWQ Grouping													Mean	N	Line
							A						10.7667	3	MKRB278
			B				A						10.6667	3	MKRB286
			B				A		C				10.4333	3	MKRB241
			B		D		A		C				10.3667	3	MKRB181
	E		B		D		A		C				10.2667	3	MKRB240
	E		B		D		A		C		F		10.1667	3	MKRB230
	E		B		D		A	G	C		F		9.7000	3	MKRB163
	E		B		D		A	G	C		F		9.7000	3	LR1897
	E		B		D	H	A	G	C		F		9.5667	3	MKRB279
	E		B	I	D	H	A	G	C		F		9.4333	3	Morex
	E	J	B	I	D	H	A	G	C		F		9.1333	3	MKRB183
K	E	J	B	I	D	H	A	G	C		F		9.1000	3	MKRB188
K	E	J	B	I	D	H	A	G	C		F	L	9.0333	3	MKRB233
K	E	J	B	I	D	H	A	G	C		F	L	9.0000	3	MKRB228
K	E	J	B	I	D	H	A	G	C		F	L	8.9333	3	Marthe
K	E	J	B	I	D	H	A	G	C		F	L	8.7667	3	MKRB21
K	E	J	B	I	D	H	A	G	C		F	L	8.7667	3	Mutha
K	E	J	B	I	D	H	A	G	C		F	L	8.7667	3	MKRB282
K	E	J	B	I	D	H	A	G	C		F	L	8.6667	3	Barke
K	E	J	B	I	D	H	A	G	C		F	L	8.6000	3	MKRB156
K	E	J	B	I	D	H	A	G	C		F	L	8.5667	3	MKRB18
K	E	J	B	I	D	H	A	G	C		F	L	8.5333	3	LR871
K	E	J	B	I	D	H	A	G	C	M	F	L	8.4667	3	MKRB87
K	E	J	B	I	D	H	A	G	C	M	F	L	8.4333	3	LR1043
K	E	J	B	I	D	H	A	G	C	M	F	L	8.4333	3	MKRB192
K	E	J	B	I	D	H	A	G	C	M	F	L	8.4000	3	MKRB189
K	E	J	B	I	D	H	A	G	C	M	F	L	8.4000	3	Bowman
K	E	J	B	I	D	H		G	C	M	F	L	8.3333	3	MKRB225
K	E	J	B	I	D	H		G	C	M	F	L	8.3333	3	Keel
K	E	J	B	I	D	H		G	C	M	F	L	8.3000	3	MKRB187
K	E	J		I	D	H		G	C	M	F	L	8.2333	3	MKRB167
K	E	J		I	D	H		G	C	M	F	L	8.2333	3	MKRB157
K	E	J		I	D	H		G	C	M	F	L	8.2333	3	Auriga
K	E	J		I	D	H		G	C	M	F	L	8.2000	3	MKRB271
K	E	J		I	D	H		G	C	M	F	L	8.1667	3	MKRB147
K	E	J		I	D	H		G	C	M	F	L	8.1667	3	MKRB154
K	E	J		I	D	H		G	C	M	F	L	8.1000	3	Optic
K	E	J		I	D	H		G	C	M	F	L	8.0667	3	MKRB246
K	E	J		I	D	H		G	C	M	F	L	8.0333	3	HID301
K	E	J		I	D	H		G	C	M	F	L	8.0333	3	BW281
K	E	J		I	D	H		G	C	M	F	L	8.0333	3	MKRB155
K	E	J		I	D	H		G		M	F	L	8.0000	3	HID44
K	E	J		I	D	H		G		M	F	L	8.0000	3	MKRB223
K	E	J		I	D	H		G		M	F	L	7.9667	3	MKRB269
K	E	J		I	D	H		G		M	F	L	7.9667	3	MKRB94
K	E	J		I		H		G		M	F	L	7.9000	3	MKRB224
K	E	J		I		H		G		M	F	L	7.9000	3	MKRB107
K	E	J		I		H		G		M	F	L	7.9000	3	MKRB232
K	E	J		I		H		G		M	F	L	7.8667	3	MKRB86
K		J		I		H		G		M	F	L	7.8000	3	MKRB268
K		J		I		H		G		M	F	L	7.7667	3	BW287
K		J		I		H		G		M	F	L	7.7667	3	MKRB284
K		J		I		H		G		M	F	L	7.7667	3	MKRB281
K		J		I		H		G		M	F	L	7.7333	3	Lr761
K		J		I		H		G		M		L	7.7000	3	HID52
K		J		I		H		G		M		L	7.6333	3	MKRB150
K		J		I		H		G		M		L	7.6333	3	MKRB118
K		J		I		H		G		M		L	7.6333	3	MKRB184
K		J		I		H		G		M		L	7.6333	3	MKRB114
K		J		I		H		G		M		L	7.6167	3	MKRB190
K		J		I		H		G		M		L	7.5667	3	MKRB186

K	J	I	H	G	M	L	7.5000	3	MKRB229
K	J	I	H	G	M	L	7.5000	3	Arta
K	J	I	H	G	M	L	7.5000	3	flagship
K	J	I	H	G	M	L	7.4000	3	BW284
K	J	I	H		M	L	7.2000	2	BW290
K	J	I	H		M	L	7.1667	3	MKRB227
K	J	I	H		M	L	7.1333	3	BW285
K	J	I			M	L	7.0333	3	BW289
K	J	I			M	L	7.0000	3	MKRB152
K	J				M	L	6.7667	3	Rum
K	J				M	L	6.7000	3	G400
K					M	L	6.6333	3	MKRB270
					M	L	6.5667	3	Aksad
					M		6.0333	3	MKRB113

Plant Height

REGWQ Grouping										Mean	N	Line
						A				108.110	3	MKRB107
		B				A				103.887	3	Morex
		B				A		C		97.333	3	Rum
		B		D		A		C		95.447	3	MKRB282
E		B		D		A		C		93.890	3	MKRB184
E		B		D		A		C	F	92.887	3	MKRB156
E		B		D		A	G	C	F	91.113	3	MKRB278
E		B		D		A	G	C	F	91.003	3	MKRB86
E		B		D	H	A	G	C	F	90.223	3	MKRB186
E		B		D	H	A	G	C	F	90.113	3	MKRB271
E		B		D	H	A	G	C	F	89.890	3	MKRB269
E		B		D	H	A	G	C	F	89.667	3	MKRB241
E		B		D	H	A	G	C	F	89.557	3	MKRB152
E		B		D	H	A	G	C	F	89.447	3	MKRB114
E		B	I	D	H	A	G	C	F	88.330	3	BW287
E		B	I	D	H	A	G	C	F	87.890	3	HID52
E		B	I	D	H	A	G	C	F	87.887	3	Lr761
E		B	I	D	H	A	G	C	F	87.110	3	MKRB113
E		B	I	D	H	A	G	C	F	87.000	3	Aksad
E		B	I	D	H	A	G	C	F	86.557	3	HID301
E		B	I	D	H	A	G	C	F	86.223	3	MKRB230
E		B	I	D	H	A	G	C	F	85.887	3	Keel
E		B	I	D	H	A	G	C	F	85.447	3	LR871
E	J	B	I	D	H	A	G	C	F	84.667	3	MKRB233
E	J	B	I	D	H	A	G	C	F	84.333	3	Mutha
E	J	B	I	D	H	A	G	C	F	83.667	3	LR1897
E	J	B	I	D	H	A	G	C	F	83.443	3	Auriga
E	J	B	I	D	H	A	G	C	F	83.113	3	MKRB94
E	J	B	I	D	H	A	G	C	F	83.000	3	MKRB118
E	J	B	I	D	H	A	G	C	F	82.890	3	Bowman
E	J	B	I	D	H	A	G	C	F	82.670	3	MKRB270
E	J	B	I	D	H	A	G	C	F	82.667	3	BW284
E	J	B	I	D	H	A	G	C	F	81.553	3	Optic
E	J	B	I	D	H	A	G	C	F	80.667	3	G400
E	J	B	I	D	H	A	G	C	F	80.000	3	MKRB163
E	J	B	I	D	H	A	G	C	F	79.333	3	MKRB225
E	J	B	I	D	H	A	G	C	F	78.777	3	HID44
E	J	B	I	D	H	A	G	C	F	78.777	3	MKRB279
E	J	B	I	D	H	A	G	C	F	78.663	3	MKRB188
E	J	B	I	D	H	A	G	C	F	78.553	3	MKRB284
E	J	B	I	D	H	A	G	C	F	77.557	3	MKRB246
E	J	B	I	D	H	A	G	C	F	77.553	3	MKRB286
E	J	B	I	D	H	A	G	C	F	76.553	3	BW285
E	J	B	I	D	H	A	G	C	F	76.553	3	MKRB167
E	J	B	I	D	H	A	G	C	F	76.333	3	Barke
E	J	B	I	D	H	A	G	C	F	76.220	3	MKRB240
E	J	B	I	D	H	A	G	C	F	76.000	3	BW281
E	J	B	I	D	H	A	G	C	F	75.887	3	MKRB181
E	J	B	I	D	H	A	G	C	F	75.330	3	flagship
E	J	B	I	D	H		G	C	F	74.667	3	MKRB227
E	J	B	I	D	H		G	C	F	74.553	3	Marthe
E	J	B	I	D	H		G	C	F	74.220	3	MKRB157
E	J	B	I	D	H		G	C	F	73.777	3	MKRB18
E	J	B	I	D	H		G	C	F	72.557	3	MKRB228
E	J		I	D	H		G	C	F	70.167	3	MKRB189
E	J		I	D	H		G	C	F	69.780	3	MKRB155
E	J		I	D	H		G	C	F	69.000	3	MKRB21
E	J		I	D	H		G	C	F	68.110	3	MKRB150
E	J		I	D	H		G	C	F	67.890	3	MKRB183
E	J		I	D	H		G	C	F	67.113	3	MKRB147
E	J		I	D	H		G	C	F	66.667	3	MKRB192

E	J	I	D	H	G	C	F	66.220	3	LR1043
E	J	I	D	H	G	C	F	65.000	3	MKRB187
E	J	I	D	H	G	C	F	64.443	3	MKRB190
E	J	I	D	H	G		F	63.333	3	MKRB224
E	J	I	D	H	G		F	63.333	3	MKRB268
E	J	I	D	H	G		F	62.890	3	BW289
E	J	I		H	G		F	61.333	3	MKRB281
E	J	I		H	G		F	61.003	3	Arta
	J	I		H	G		F	59.997	3	MKRB232
	J	I		H	G			58.670	2	BW290
	J	I		H				57.443	3	MKRB229
	J	I		H				56.943	3	MKRB154
	J	I						55.887	3	MKRB87
	J							51.890	3	MKRB223

Total Grain Yield

REGWQ Grouping																	Mean	N	Line
									A								409.27	3	MKRB269
			B						A								389.67	3	MKRB186
			B						A								379.90	3	MKRB282
			B						A								375.60	3	MKRB18
			B						A				C				335.60	3	Aksad
			B		D				A				C				314.50	3	Keel
	E		B		D				A				C				307.40	3	LR871
	E		B		D				A				C		F		300.10	3	MKRB241
	E		B		D				A		G		C		F		293.60	3	Mutha
	E		B		D				H		G		C		F		280.77	3	MKRB107
	E		B		D				H		G		C		F		280.53	3	MKRB86
	E		B		D		I		H		G		C		F		275.20	3	MKRB152
	E		B		D		I		H		G		C		F		274.07	3	MKRB113
	E		B	J	D		I		H		G		C		F		266.20	3	MKRB118
	E		K	J	D		I		H		G		C		F		250.07	3	Arta
	E	L	K	J	D		I		H		G		C		F		244.47	3	Auriga
M	E	L	K	J	D		I		H		G		C		F		243.93	3	LR1897
M	E	L	K	J	D		I		H		G		C		F	N	236.33	3	MKRB224
M	E	L	K	J	D		I		H		G		C	O	F	N	227.57	3	BW287
M	E	L	K	J	D		I		H		G		C	O	F	N	227.20	3	MKRB246
M	E	L	K	J	D		I		H		G	P	C	O	F	N	225.77	3	Lr761
M	E	L	K	J	D		I		H		G	P	Q	O	F	N	204.23	3	BW284
M	E	L	K	J	D		I		H	R	G	P	Q	O	F	N	203.67	3	Morex
M	E	L	K	J	D		I		H	R	G	P	Q	O	F	N	202.20	3	Optic
M	E	L	K	J	D		I		H	R	G	P	Q	O	F	N	202.13	3	MKRB230
M	E	L	K	J	D		I		H	R	G	P	Q	O	F	N	200.50	3	MKRB270
M	E	L	K	J	D		I	S	H	R	G	P	Q	O	F	N	194.20	3	MKRB192
M	E	L	K	J	D		I	S	H	R	G	P	Q	O	F	N	192.70	3	MKRB188
M	E	L	K	J	D		I	S	H	R	G	P	Q	O	F	N	192.67	3	MKRB228
M	E	L	K	J	D	T	I	S	H	R	G	P	Q	O	F	N	187.50	3	MKRB233
M	E	L	K	J		T	I	S	H	R	G	P	Q	O	F	N	180.53	3	MKRB240
M	E	L	K	J		T	I	S	H	R	G	P	Q	O	F	N	179.47	3	MKRB190
M	E	L	K	J	U	T	I	S	H	R	G	P	Q	O	F	N	177.70	3	lagship
M		L	K	J	U	T	I	S	H	R	G	P	Q	O	F	N	174.27	3	MKRB225
M		L	K	J	U	T	I	S	H	R	G	P	Q	O	F	N	172.20	3	Marthe
M		L	K	J	U	T	I	S	H	R	G	P	Q	O	F	N	172.20	3	MKRB157
M		L	K	J	U	T	I	S	H	R	G	P	Q	O	F	N	168.87	3	BW281
M		L	K	J	U	T	I	S	H	R	G	P	Q	O		N	167.37	3	MKRB271
M		L	K	J	U	T	I	S	H	R	G	P	Q	O		N	162.90	3	MKRB167
M		L	K	J	U	T	I	S	H	R		P	Q	O		N	161.03	3	MKRB278
M		L	K	J	U	T	I	S	H	R		P	Q	O		N	156.67	3	MKRB189
M		L	K	J	U	T	I	S	H	R		P	Q	O		N	152.43	3	Barke
M		L	K	J	U	T	I	S	H	R		P	Q	O		N	152.10	3	MKRB279
M		L	K	J	U	T	I	S	H	R		P	Q	O		N	148.53	3	MKRB232
M		L	K	J	U	T	I	S	V	R		P	Q	O		N	146.27	3	MKRB155
M		L	K	J	U	T	I	S	V	R		P	Q	O		N	144.03	3	MKRB181
M		L	K	J	U	T		S	V	R		P	Q	O		N	138.60	3	Bowman
M		L	K	J	U	T		S	V	R		P	Q	O		N	138.43	3	MKRB187
M		L	K	J	U	T		S	V	R		P	Q	O		N	135.80	3	MKRB147
M		L	K	J	U	T		S	V	R		P	Q	O		N	134.87	3	MKRB284
M		L	K	J	U	T		S	V	R		P	Q	O		N	134.70	3	Rum
M		L	K		U	T		S	V	R		P	Q	O		N	132.13	3	MKRB227
M		L	K		U	T		S	V	R		P	Q	O		N	120.83	3	MKRB184
M		L	K		U	T		S	V	R		P	Q	O		N	119.73	3	MKRB281
M		L	K		U	T		S	V	R		P	Q	O		N	118.90	3	BW285
M		L			U	T		S	V	R		P	Q	O		N	113.77	3	HID44
M					U	T		S	V	R		P	Q	O		N	110.03	3	HID52
					U	T		S	V	R		P	Q	O		N	108.23	3	MKRB156
					U	T		S	V	R		P	Q	O		N	102.80	3	MKRB150
					U	T		S	V	R		P	Q	O			101.80	3	MKRB114
					U	T		S	V	R		P	Q	O			97.13	3	MKRB87

U	T	S	V	R	P	Q	92.47	3	G400
U	T	S	V	R		Q	89.30	3	MKRB268
U	T	S	V	R		Q	87.50	3	HID301
U	T	S	V	R		Q	87.17	3	MKRB163
U	T	S	V	R		Q	83.27	3	MKRB183
U	T	S	V	R		Q	74.30	3	LR1043
U	T	S	V	R		Q	72.10	3	MKRB223
U	T	S	V	R			69.20	3	MKRB286
U	T	S	V				65.27	3	MKRB229
U	T	S	V				64.57	3	MKRB21
U	T		V				54.97	3	MKRB154
U	T		V				53.27	3	MKRB94
U			V				44.83	3	BW289
			V				16.10	2	BW290

TKW

REGWQ Grouping																Mean	N	Line
								A								53.933	3	MKRB240
								A								53.767	3	LR1897
			B					A								53.567	3	LR871
			B					A				C				52.867	3	Mutha
			B		D			A				C				50.133	3	MKRB286
	E		B		D			A				C				50.000	3	MKRB94
	E		B		D			A				C		F		49.633	3	MKRB21
	E		B		D			A				C		F		49.233	3	MKRB188
	E		B		D			A				C		F		49.133	3	MKRB225
	E		B		D			A		G		C		F		48.733	3	MKRB147
	E		B		D	H		A		G		C		F		48.500	3	Auriga
	E		B	I	D	H		A		G		C		F		48.267	3	Aksad
	E	J	B	I	D	H		A		G		C		F		47.700	3	MKRB224
K	E	J	B	I	D	H		A		G		C		F		47.400	3	LR1043
K	E	J	B	I	D	H		A		G		C		F	L	47.200	3	MKRB118
K	E	J	B	I	D	H		A		G		C		F	L	46.933	3	MKRB156
K	E	J	B	I	D	H		A		G		C	M	F	L	46.633	3	MKRB228
K	E	J	B	I	D	H		A		G		C	M	F	L	46.567	3	Keel
K	E	J	B	I	D	H		A		G		C	M	F	L	46.500	3	MKRB281
K	E	J	B	I	D	H		A		G	N	C	M	F	L	46.267	3	Arta
K	E	J	B	I	D	H		A		G	N	C	M	F	L	46.233	3	MKRB233
K	E	J	B	I	D	H		A		G	N	C	M	F	L	46.067	3	MKRB190
K	E	J	B	I	D	H		A		G	N	C	M	F	L	45.867	3	Rum
K	E	J	B	I	D	H		A		G	N	C	M	F	L	45.800	3	HID52
K	E	J	B	I	D	H		A	O	G	N	C	M	F	L	45.700	3	MKRB241
K	E	J	B	I	D	H		A	O	G	N	C	M	F	L	45.433	3	Bowman
K	E	J	B	I	D	H		A	O	G	N	C	M	F	L	45.367	3	Optic
K	E	J	B	I	D	H		A	O	G	N	C	M	F	L	44.833	3	MKRB189
K	E	J	B	I	D	H		A	O	G	N	C	M	F	L	44.600	3	Marthe
K	E	J	B	I	D	H		A	O	G	N	C	M	F	L	44.333	3	MKRB269
K	E	J	B	I	D	H		A	O	G	N	C	M	F	L	44.233	3	MKRB192
K	E	J	B	I	D	H		A	O	G	N	C	M	F	L	44.100	3	MKRB278
K	E	J	B	I	D	H		A	O	G	N	C	M	F	L	44.000	3	Barke
K	E	J	B	I	D	H		A	O	G	N	C	M	F	L	43.933	3	G400
K	E	J	B	I	D	H		A	O	G	N	C	M	F	L	43.867	3	MKRB154
K	E	J	B	I	D	H	P	A	O	G	N	C	M	F	L	43.567	3	MKRB230
K	E	J	B	I	D	H	P	A	O	G	N	C	M	F	L	43.367	3	MKRB187
K	E	J	B	I	D	H	P	A	O	G	N	C	M	F	L	43.333	3	MKRB227
K	E	J	B	I	D	H	P	A	O	G	N	C	M	F	L	43.200	3	MKRB107
K	E	J	B	I	D	H	P	A	O	G	N	C	M	F	L	42.800	3	MKRB223
K	E	J	B	I	D	H	P	A	O	G	N	C	M	F	L	42.767	3	flagship
K	E	J	B	I	D	H	P	A	O	G	N	C	M	F	L	42.700	3	BW281
K	E	J	B	I	D	H	P	A	O	G	N	C	M	F	L	42.533	3	MKRB270
K	E	J	B	I	D	H	P	A	O	G	N	C	M	F	L	42.233	3	MKRB163
K	E	J	B	I	D	H	P	A	O	G	N	C	M	F	L	42.067	3	MKRB181
K	E	J	B	I	D	H	P	A	O	G	N	C	M	F	L	41.833	3	MKRB184
K	E	J	B	I	D	H	P	A	O	G	N	C	M	F	L	41.767	3	MKRB186
K	E	J	B	I	D	H	P	A	O	G	N	C	M	F	L	41.000	3	MKRB152
K	E	J	B	I	D	H	P	A	O	G	N	C	M	F	L	40.500	3	MKRB113
K	E	J	B	I	D	H	P	A	O	G	N	C	M	F	L	40.100	3	MKRB232
K	E	J	B	I	D	H	P	A	O	G	N	C	M	F	L	40.000	3	MKRB86
K	E	J	B	I	D	H	P	A	O	G	N	C	M	F	L	39.567	3	MKRB279
K	E	J	B	I	D	H	P	A	O	G	N	C	M	F	L	39.300	3	MKRB183
K	E	J	B	I	D	H	P		O	G	N	C	M	F	L	39.000	3	BW285
K	E	J	B	I	D	H	P		O	G	N	C	M	F	L	38.900	3	MKRB246
K	E	J		I	D	H	P		O	G	N	C	M	F	L	38.767	3	MKRB157
K	E	J		I	D	H	P		O	G	N	C	M	F	L	38.467	3	MKRB268
K	E	J		I	D	H	P		O	G	N		M	F	L	38.067	3	MKRB282
K	E	J		I	D	H	P		O	G	N		M	F	L	37.667	3	MKRB155
K	E	J		I	D	H	P		O	G	N		M	F	L	37.367	3	BW284
K	E	J		I	D	H	P		O	G	N		M	F	L	36.000	3	MKRB18

K	E	J	I	H	P	O	G	N	M	F	L	35.267	3	Lr761
K		J	I	H	P	O	G	N	M	F	L	35.167	3	Morex
K		J	I	H	P	O	G	N	M		L	34.200	3	HID301
K		J	I	H	P	O	G	N	M		L	34.167	3	MKRB114
K		J	I	H	P	O	G	N	M		L	34.000	3	BW289
K		J	I	H	P	O		N	M		L	33.733	3	MKRB87
K		J	I		P	O		N	M		L	33.667	3	MKRB271
K		J			P	O		N	M		L	33.167	3	MKRB167
K					P	O		N	M		L	32.733	3	HID44
					P	O		N	M		L	32.450	2	BW290
					P	O		N	M			32.000	3	MKRB150
					P	O		N				31.633	3	MKRB284
					P	O						31.033	3	MKRB229
					P							29.000	3	BW287

Vegetative Biomass

REGWQ Grouping													Mean	N	Line
							A						2062.00	3	MKRB113
			B				A						1852.00	3	BW289
			B				C						1628.00	3	MKRB107
			D				C						1489.00	3	MKRB18
			D				C		E				1431.00	3	MKRB269
			D		F		C		E				1389.00	3	MKRB86
	G		D		F		C		E				1351.33	3	MKRB278
	G		D		F		C		E		H		1342.00	3	MKRB282
	G		D		F		I		E		H		1322.00	3	MKRB241
	G		D		F		I		E		H		1304.67	3	MKRB167
	G		D		F		I		E		H		1297.00	3	MKRB233
	G		D		F		I		E		H		1287.33	3	MKRB186
	G		D		F		I		E		H		1253.33	3	Aksad
	G		J		F		I		E		H		1151.67	3	Morex
	G		J		F		I	K	E		H		1137.67	3	LR1897
	G		J		F		I	K	L		H		1118.00	3	Auriga
	G		J		F		I	K	L		H		1117.33	3	Mutha
	G		J		F	M	I	K	L		H		1094.00	3	Keel
	G		J		F	M	I	K	L		H		1090.00	3	MKRB230
	G		J		N	M	I	K	L		H		1064.67	3	BW287
	G		J	O	N	M	I	K	L		H		1058.67	3	LR871
	G	P	J	O	N	M	I	K	L		H		1055.33	3	MKRB271
	G	P	J	O	N	M	I	K	L		H		1052.67	3	MKRB225
	G	P	J	O	N	M	I	K	L		H		1051.67	3	MKRB228
	Q	P	J	O	N	M	I	K	L		H		1030.00	3	MKRB224
	Q	P	J	O	N	M	I	K	L		R		1024.33	3	MKRB284
	Q	P	J	O	N	M	S	K	L		R		943.33	3	BW284
	Q	P	J	O	N	M	S	K	L		R		940.67	3	Arta
	Q	P	J	O	N	M	S	K	L		R		927.00	3	Barke
T	Q	P	J	O	N	M	S	K	L		R		905.33	3	MKRB152
T	Q	P	J	O	N	M	S	K	L		R	U	873.33	3	BW281
T	Q	P	J	O	N	M	S	K	L	V	R	U	852.67	3	MKRB118
T	Q	P	J	O	N	M	S	K	L	V	R	U	840.67	3	MKRB189
T	Q	P	W	O	N	M	S	K	L	V	R	U	834.00	3	MKRB281
T	Q	P	W	O	N	M	S	K	L	V	R	U	823.00	3	MKRB114
T	Q	P	W	O	N	M	S		L	V	R	U	816.00	3	Bowman
T	Q	P	W	O	N	M	S		X	V	R	U	789.67	3	MKRB240
T	Q	P	W	O	N	M	S		X	V	R	U	785.67	3	Rum
T	Q	P	W	O	N		S		X	V	R	U	755.67	3	flagship
T	Q	P	W	O	N		S	Y	X	V	R	U	754.33	3	MKRB227
T	Q	P	W	O	N		S	Y	X	V	R	U	753.67	3	Lr761
T	Q	P	W	O	N	Z	S	Y	X	V	R	U	749.67	3	MKRB286
T	Q	P	W	O		Z	S	Y	X	V	R	U	745.00	3	MKRB157
T	Q	P	W		A	Z	S	Y	X	V	R	U	739.67	3	MKRB268
T	Q	P	W		A	Z	S	Y	X	V	R	U	738.33	3	MKRB156
T	Q		W		A	Z	S	Y	X	V	R	U	734.00	3	Optic
T	Q		W		A	Z	S	Y	X	V	R	U	728.00	3	MKRB223
T	Q		W		A	Z	S	Y	X	V	R	U	716.67	3	Marthe
T			W		A	Z	S	Y	X	V	R	U	711.67	3	MKRB21
T			W		A	Z	S	Y	X	V	R	U	708.33	3	HID44
T	B		W		A	Z	S	Y	X	V		U	690.33	3	HID52
T	B		W		A	Z	S	Y	X	V		U	673.00	3	MKRB150
T	B		W		A	Z	S	Y	X	V	C	U	663.33	3	MKRB147
T	B		W		A	Z	S	Y	X	V	C	U	661.67	3	MKRB188
T	B		W		A	Z	S	Y	X	V	C	U	661.67	3	MKRB192
T	B		W	D	A	Z	S	Y	X	V	C	U	649.67	3	MKRB270
T	B		W	D	A	Z	S	Y	X	V	C	U	639.00	3	BW285
T	B		W	D	A	Z	S	Y	X	V	C	U	621.67	3	MKRB279
T	B		W	D	A	Z		Y	X	V	C	U	595.33	3	MKRB246
	B		W	D	A	Z		Y	X	V	C	U	576.67	3	MKRB163
	B		W	D	A	Z	E	Y	X	V	C		540.67	3	MKRB181

B	W	D	A	Z	E	Y	X	C	517.67	3	MKRB155
B		D	A	Z	E	Y	X	C	495.33	3	HID301
B		D	A	Z	E	Y	X	C	484.33	3	MKRB184
B		D	A	Z	E	Y		C	436.33	3	MKRB232
B		D	A	Z	E			C	433.00	3	MKRB87
B		D	A		E			C	424.67	3	MKRB190
B		D			E			C	378.33	3	G400
		D			E			C	357.33	3	MKRB187
		D			E			C	355.33	3	LR1043
		D			E				347.00	3	MKRB154
		D			E				340.00	3	MKRB94
					E				267.00	2	BW290
					E				264.67	3	MKRB183
					E				239.33	3	MKRB229

جامعة النجاح الوطنية

كلية الدراسات العليا

دراسة الاختلافات الظاهرية والزراعية لأصناف شعير محلية ومحسنة

إعداد

طارق عباس سليم أبو بكر

إشراف

د. منقذ إشتيه

أ. د. مروان حداد

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

2018

دراسة الاختلافات الظاهرية و الزراعية لأصناف شعير محلية ومحسنة

إعداد

طارق عباس سليم أبو بكر

إشراف

د. منقذ إشتيه

أ. د. مروان حداد

الملخص

يعتبر الشعير من أحد أهم المحاصيل الحقلية المزروعة في فلسطين بمساحة تتجاوز 92700 دونم ومعدل إنتاجية 170 كغم/ دونم والتي تمثل اقل من 56 بالمائة من معدل إنتاجية الشعير العالمية. و يعزى هذا الانخفاض في الإنتاجية إلى الظروف البيئية الغير ملائمة للأصناف المزروعة. إن إدخال أصناف عالية الإنتاج وذات تأقلم جيد يمكن أن يكون من الحلول الفضلى. لدراسة هذه الحلول، فقد أجريت تجربة في كلية الزراعة التابعة لجامعة النجاح الوطنية في محافظة طولكرم على العديد من الأصناف وذلك خلال موسمين زراعيين (2016-2015 و 2017-2016)، حيث زرعت الأصناف في ثلاث مكررات. تم تجميع أربعة وثمانون صنف من الشعير لتنفيذ هذه التجربة ضمت أصناف محلية وأصناف أخرى من دول مختلفة. أجريت هذه التجربة من اجل دراسة الاختلافات الشكلية الخارجية والإنتاجية ومن أجل تقييم الأداء الزراعي لأصناف مختلفة من الشعير تحت الظروف البعلية. حيث تم دراسة الصفات التالية: (عدد الأيام من الزراعة حتى استطالة الساق الرئيسي ،عدد الأيام من الزراعة حتى الإزهار ،عدد الأيام من الزراعة حتى النضج ،عدد الأشطاء، عدد السنابل، ارتفاع النبات، مجموع إنتاج الحبوب، وزن الألف بذرة ووزن الكتلة الحيوية الخضرية).

قادت نتائج هذه الدراسة إلى تحديد شكلي واضح للأصناف المدروسة ،كما أشارت النتائج إلى انه يوجد تنوع جيني عالي بين أصناف الشعير ،مما يجعلها مصادر جيده لبرامج الاختيار والتهجين. يوجد اختلاف واضح في النتائج بين الموسمين الزراعيين (2016-2015 و 2017-2016) ويرجع هذا الاختلاف إلى اختلاف الظروف المناخية بين الموسمين بالإضافة إلى الظروف الحيوية

واللاحيوية. العديد من هذه الأصناف واعدة لمحصول الشعير من اجل إنتاج البذار والبعض الآخر للقش وبالتالي يمكن اعتبارها نقطة بداية لتطوير أصناف تجارية جديدة من الشعير تمتاز بإنتاجية وتأقلم عاليين. بالإضافة لذلك هناك حاجة لعمل دراسات مستقبليه حول مقارنة الإنتاجية والصفات الزراعية الشكلية لهذه الأصناف مع الأصناف العالمية وكذلك هناك حاجة لدراسة التنوع والاختلافات بين الأصناف على مستوى الوراثة الجزئية.