

Performance of Eight Varieties of Onion (*Allium cepa* L.) Cultivated under Open Field in Tunisia

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Abstract

A field experiment was conducted from September 2010 to July 2011 at Research Station Farm of Higher Institute of Agronomy, Chott Mariem, Sousse (Tunisia) in order to evaluate the performance of seven onion varieties: 'GIZA 6', 'Red Amposta', 'Z6', 'Morada de Amposta', 'Yellow Dessex', 'Early Yellow Texas Grano 502' and 'Keep Red' against the commonly grown variety 'Blanc Hâtif de Paris' under field conditions. The experiment was conducted in a randomized complete block design with three replications. Results obtained showed that onion varieties were significantly different when it comes to the plant and bulb morphological characteristics. Variety 'Morada de Amposta' recorded the highest leaf length (68.06 cm), pseudostem diameter (8.63 cm), number of leaves (8.71), plant height (76.95 cm), in addition to the greatest yields (32.88 t/ha) which were significantly ($p \leq 0.05$) increased by respectively 66.2, 88.8, 2.1, 61.2, 63, 27.9 and 28.4% compared to those obtained from the regular variety 'Blanc Hâtif de Paris'. Variety 'Blanc Hâtif de Paris' was the earliest to maturity and recorded the most preferment bulb weight (155.02 g) and diameter (8.21 cm). 'Keep Red' variety had the highest height of the bulb (7.19 cm). Variety 'Z6' recorded the minimum data in all measured parameters.

Keywords: cultivars, growth, morphology, onion, production

Introduction

Onion (*Allium cepa* L.) is an important worldwide vegetable crop (Best, 2000) which belongs to the family of Liliaceae. It is divided into three groups: *Allium cepa*, *Allium aggregatum*, *Allium prolifum*, which are all diploids ($2n = 2x = 16$) (Boukary *et al.*, 2012 a). The crop is a biennial herb of Central Asian origin (Afghanistan, Iran and Pakistan) and is cultivated all around the world. Onion occupies the 4th world rank of consumed vegetables after tomato, cabbage and watermelon with a global annual production of 25 million tonnes (Boukary *et al.*, 2012a).

Tunisians appreciate onion for its distinctive flavor and it is considered as the most important crop in all condiments. It is daily used at immature and mature stage in salads, cooked or eaten raw as a vegetable. In Tunisia, the culture of onion is important and the country was classified in 2012 at the 7th world rank with a production of 228600 MT (FAO STAT, 2012).

In fact, successful onion production depends mainly on the selection of varieties that are adapted to different conditions imposed by specific environment. In Tunisia, 'Blanc Hâtif de Paris' is the most popular variety grown by framers, both for home use and source of income. Therefore, the introduction of new varieties represents an important axe to enhance production by increasing the number of cultivars available for growers, which is not only

an advantage for them but also for markets and processing industries.

Hence, the present research was conducted to evaluate performance of seven introduced varieties of common onion against the commonly grown variety 'Blanc Hâtif de Paris' with the objective of identifying the variety/varieties with a higher yield performance to replace or be used with the low yielding local variety under Tunisian field conditions.

Material and Methods

Field experiment was conducted in the experimental station (research farm) in Higher Institute of Agriculture of Chott Mariem, Sousse (Tunisia). The area is located on 35.8° N latitude and 10.6° E longitude, on the Eastern coastal part of Tunisia. The region belongs to semi-arid bioclimatic stage characterized by sweet winter and cool summer. Mean temperature varies from 11.4 °C (January) to 28 °C (August), annual rainfall recorded is above 300 mm and relative humidity ranges from 20 (December) to 80% (August). Direction of wind is North and North-Ouest with variable speed. The soil is sandy clay limestone and water is characterized by a pH 7 and salinity of 1 g/l. The site into which the trial was conducted was previously cultivated with maize.

Seven onion varieties: 'GIZA 6' (G6) from Egypt, 'Red

Amposta' (RA), 'Z6', 'Morada de Amposta' (MA) from Italy, 'Yellow Dessex' (YD) from Spain, 'Early Yellow Texas Grano 502' (G502), 'Keep Red' (KR) from America, were evaluated alongside the commonly cultivated variety in Tunisia "Blanc Hâtif de Paris" (BHP). They were studied for their growth and yield performance based on morphological and agronomical measurements.

The trial began on September 2010. Soil was cleared from weeds, rotovated and divided into seedbeds on which well-decomposed beef manure was applied and incorporated manually (360 g per plot) into the soil. Each seedbed (110 m²) was divided into three plots. Each plot contained the eight varieties in a randomized design. Two grams of seeds from each variety were sown on September 30th in rows at spacing of 25 cm and a depth of 1 cm (every variety is represented by 15 rows). Irrigation was done manually using a fine watering. When seedlings began emergence, irrigation drip system was installed and used for irrigation and fertilization at an advanced stage. After seven weeks, only 10 seedlings spaced with 10 cm per row were left to record the observations. Weeding was done manually as needed and the fight against mildew and *Alternaria* was done chemically (copper: 400 g/hl). Harvesting took place when a large per cent of the leaves were dry and it lasted from April to July 2011 according to the variety.

Before studying the behaviour of the different cultivars, information about plant and bulb morphology in Tunisian climatic conditions were examined according to TG/46/7 UPOV (2008) guidelines for *Allium* on 50 plants from each variety which were randomly chosen. Vegetative data included the number of leaves, fresh weight of leaves (g), plant height (cm), and plant weight (g). Bulb characteristics concerned height (cm), diameter (cm), weight (g) and number of axes. The parameters related to the shape, skin (colour, adherence and thickness), width of neck and position of maximal diameter was determined also following the TG/46/7 UPOV (2008) guidelines. Finally, yield (t/ha) was estimated and number of days to maturity from sowing were counted.

"SPSS software 13.00" was used to analyze the data and Duncan's multiple range test was used to separate the means at 5% ($p < 0.05$).

Results and Discussion

The morphological characteristics of the eight varieties of onion cultivated under Tunisian climatic conditions concerned foliage and bulb and are presented in Tab. 1 and Tab. 2. Results showed a significant ($p < 0.05$) variability between the varieties in all traits. The foliage positions were erect for BHP and G502 cv., semi-erect for 'YD', 'RA' and 'KR' cv. and erect to semi-erect for 'Z6', 'MA', and 'G6' cv. For leaf wariness, it was the same as for BHP cv. (weak) only in four varieties 'YD', 'G502', 'Z6' and 'G6'; for the others varieties, leaf had medium wariness. Also, leaf cranking, it was absent only in BHP and 'Z6' cv. but intermediate in cultivars 'RA', 'MA' and 'KR' or strong in the three others genotypes. Green color of leaf in all new varieties was different from 'BHP' cv. (light). Two varieties had very light color ('MA' and 'Z6'), three had medium color ('G502', 'RA' and 'G6') and two were characterized by a dark color ('YD' and 'KR'). The measurement of

diameter and length of leaf showed remarkable divergence among varieties. 'MA' cv. had the highest length with 68.06 cm followed by 'YD' (61.75 cm) and 'KR' (56.01 mm) whereas 'Z6' (35.5 mm) and 'G502' (36.22 mm) had the lowest values. Similarly, 'MA' had the largest leaf (17.98 mm) followed by 'KR' (16.01 mm) contrary to 'G502' cv. which showed the smallest diameter of 7.61 mm. Concerning pseudostem, results demonstrated that its length ranged from 9.48 ('G502' cv.) to 16.35 cm ('RA' cv.) and its diameter varied from 4.21 ('BHP' cv.) and 8.57 cm ('YD' cv.).

Stavěliková (2008) found similar results in foliage attitude in accessions of garlic and Ahmed *et al.* (2013) confirmed our finding on waxiness and cranking by studying the morphology of the 30 varieties of onion cultivated in Kashmir. Boukary *et al.* (2012a) studied the color of leaf on 21 Nigerian accessions of onion and indicated that 17 cultivars had green-gray leaf color whereas only four cultivars had green color. The same researchers observed also the difference in length of leaves which ranged from 17.08 ('JaI' cv.) to 41 cm ('BSn' cv.). Dela Rosa *et al.* (2005) also confirmed our results in leaf width which varied significantly between the 30 genotypes of rice characterized in Philippines. According to Nilufar (2009), the difference in foliage traits is mainly genetically related to the cultivar.

In Tab. 2 are presented the morphological characteristics of the bulb of the eight studied varieties. Four shapes of bulb were observed which were different from 'BHP' cv. shape (Transverse narrow elliptic): circular ('YD' and 'RA'), rhombic ('Z6', 'G6' and 'KR'), broad ovate ('G502') and broad elliptic ('MA' cv.). Also, two colors of skin other than 'BHP' cv. grey color were detected: brown in 'MA' and 'Z6' skin and pink color in the other varieties. Among the eight genotypes, five had middle position of the maximal diameter ('YD', 'Z6', 'MA', 'KR' and 'G7'). For the rest, towards root end position was observed in bulb of 'BHP' and 'RA' cv. and towards stem end position in 'G502' cv. bulb. For thickness of skin, cultivars 'YD' and 'Z6' marked thick skin while 'BHP' and 'MA' varieties had thin skin. The other varieties maintained medium thick. The adherence of these skins was observed and results showed that it was medium in 'RA', 'MA' and 'G7' cvs. whereas strong in all other varieties. For the width of bulb neck, it was very narrow only in 'G502' cv. as for 'BHP' cv., narrow ('YD' and 'KR'), medium ('RA' and 'G6') and broad ('Z6' and 'MA'). According to statistical analysis, quantitative characteristics of bulb were significantly different ($p < 0.05$) from one variety to another. Results in Tab. 2 showed that all genotypes had higher height but lower diameter compared to 'BHP' cv. Indeed, the biggest bulb of 8.21 cm diameter was noticed in 'BHP' cv. followed by 'Z6' (7.43 cm) and 'G6' (6.12 cm), whereas 'KR' and 'MA' cvs. expressed the smallest diameter of bulb with 5.47 and 4.63 cm respectively. For height of the bulb, the highest value was observed in the case of 'KR' cv. (7.19 cm) followed by 'YD' cv. (6.55 cm) while the lowest one was in 'Z6' (5032 cm) and 'BHP' (3.67 cm).

Onion bulb is the widely consumed part of the plant, that is why its characteristics interested several works which insisted on the existence of genetic difference between the varieties of onion in diameter of neck (Gautam *et al.*, 2006), skin thickness (Boukary *et al.*, 2012a), color of skin (Currah

Tab. 1. Foliage characteristics of eight varieties of onion cultivated under temperate conditions of Tunisian

Variety	Foliage attitude	Leaf waxiness	Intensity of green color	Leaf cranking	Leaf length (cm)	Leaf diameter (mm)	Pseudostem length (cm)	Pseudostem diameter (cm)
BHP	Erect	Weak	Light	Absent	40.96 d	13.74 ab	15.25 b	4.57 d
YD	Semi-erect	Weak	Dark	Strong	61.75 ab	15.19 a	14.19 c	8.57 a
G502	Erect	Weak	Medium	Strong	36.22 d	7.61 c	9.48 f	4.21 de
RA	Semi-erect	Medium	Medium	Intermediate	55.91bc	14.86 ab	16.35 a	6.78 c
Z6	Erect to semi-erect	Weak	Very light	Absent	35.50 d	10.03 bc	13.84 d	7.84 b
MA	Erect to semi-erect	Medium	Very light	Intermediate	68.06 a	17.98 a	12.78 e	8.63 a
KR	Semi-erect	Medium	Dark	Intermediate	56.91bc	16.01 a	16.13 a	5.95 d
G6	Erect to semi-erect	Weak	Medium	Strong	53.11 c	13.31 ab	14.58bc	6.84 cd

Means in the same colone followed by the same letter are not significantly different at 5% level according to Duncan test. RA: RedAmposta, MA: Morada de Amposta, YG: YellowDessex, KR: Keep Red, BHP: Blanc Hâtif de Paris, G502: Early Yellow Texas Grano 502

Tab. 2. Bulb morphological description of eight varieties of onion cultivated under temperate conditions of Tunisian

Variety	Height (cm)	Diameter (cm)	H/D	Width of neck (mm)	Adherence of skin	Position of maximal diameter	Shape	Skin colour	Skin thickness
BHP	3.67 f	8.21 a	0.44	Very narrow	Strong	Towards root end	Transverse narrow elliptic	Grey	Thin
YD	6.55 ab	5.69 d	1.15	Narrow	Strong	At middle	Circular	Pink	Thick
G502	6.09 c	6.00 c	1.015	Very narrow	Strong	Towards stem end	Broad obovate	Pink	Medium
RA	5.93 cd	5.58 d	1.06	Medium	Medium	Towards root end	Circular	Pink	Medium
Z6	5.32 e	7.43 b	0.72	Broad	Strong	At middle	Rhombic	Brown	Thick
MA	5.49 d	4.63 e	1.18	Broad	Medium	At middle	Broad elliptic	Brown	Thin
KR	7.19 a	5.97 d	1.31	Narrow	Strong	At middle	Rhombic	Pink	Medium
G6	5.69 d	6.12 c	0.93	Medium	Medium	At middle	Rhombic	Pink	Medium

Means in the same colon followed by the same letter are not significantly different at 5% level according to Duncan test. RA: Red Amposta, MA: Morada de Amposta, YG: Yellow Dessex, KR: Keep Red, BHP: Blanc Hâtif de Paris, G502: Early Yellow Texas Grano 502

and Proctor, 1990) and adherence of skin (Ahmed *et al.*, 2013). According to Anil (2008), onion bulb color is controlled at least by five major loci (I, C, G, L and R). Also, similar finding was obtained on onion between 18 genotypes in Spain (Rivera-Martinez *et al.*, 2005), 10 genotypes in Bengladesh (Nilufar, 2009) and 21 ecotypes in Nigeria (Boukary *et al.*, 2012b). Similarly, analogous data were founded for diameter and height of bulb by Moulin *et al.* (2012) working on different varieties of melon, tomato, pepper and potato.

The performance of the eight studied varieties was estimated by the determination of many parameters related to vegetative growth and productive stage. In all measurements, statistical analysis indicated the existence of a significant ($p < 0.05$) genetic difference between the varieties. The tallest plant was observed within the 'MA'

cultivar (76.95 cm) followed by 'YD' (70.55 cm) whereas the smallest most dwarf plant was found within 'Z6', 'G502' and 'BHP' with a plant height of 42.61, 54.47 and 47.33 cm (Tab. 3). Similar variability in plant height between varieties confirming our results was observed on onion (Ibrahim, 2010; Trivedi and Dhupal., 2010). According to Mohanty and Prusti (2001), the difference in height of the plant on onion is mainly attributed to the genetic potential but also to environmental factors especially temperature and photoperiod (Tesfay *et al.*, 2011). Also, the nutrients content in soil could be a cause in this difference in plant height, especially nitrogen and sulphur (Nasreen *et al.*, 2007) which have been proved for their enhancement effect on the vegetative growth of onion.

For number of leaves/plant, 'YD' cv. produced the greatest number (9.36) whereas minimum number of

Tab. 3. Performance of onion cultivars cultivated under temperate conditions of Tunisia

Variety	Plant height (cm)	Leaves number	Bulb weight (g)	Yield (t/ha)	Number of axes	Bulb maturation (days after sowing)
BHP	47.73 d	8.53 b	155.02 a	25.600 b	3 b	156 c
YD	70.55 ab	9.36 a	98.55 de	24.875 d	1.86 cd	158 c
G502	45.41 d	6.50 d	101.63 d	15.422 f	1.15 e	182 a
RA	63.63 bc	6.13 d	95.24 e	28.821 c	2 c	168 b
Z6	42.61 d	5.43 e	63.16 f	13.037 g	4 a	162 bc
MA	76.95 a	8.71 b	139.25 b	36.881 a	2 cd	159 c
KR	66.05 bc	7.86 c	110.43 c	21.040 e	1.38 de	166 b
G6	60.89 c	6.23 d	100.18 d	21.157 e	1.76 cd	161 c

Means in the same colon followed by the same letter are not significantly different at 5% level according to Duncan test. RA: Red Amposta, MA: Morada de Amposta, YG: Yellow Dessex, KR: Keep Red, BHP: Blanc Hâtif de Paris, G502: Early Yellow Texas Grano 502

leaves/plant was noted in 'Z6' cv. whose plant produced a mean of 5.43 leaves/plant. Boukary *et al.* (2012a) and Dwivedi *et al.* (2012), observed the difference in production of leaves and leaf weight between varieties of onion and attributed this difference mainly to the cultivar, but other researchers confirmed that environmental conditions (Ijoyah *et al.*, 2008) in which plant grown contribute to the development of leaves on plant.

Production results showed that the yield of onion varieties ranged from 15.42 to 36.88 t/ha and that some foreign varieties had slightly higher yield than that of the commercial variety 'BHP'. The Italian cultivar 'MA' was considered as the most productive variety with its best yield of 32.88 t/ha. On the second place came the Italian cultivar 'RA' cv. (28.82 t/ha) and French cultivar BHP *cv* on the third place (25.6 t/ha). On the fourth place came the Spanish cultivar YD with 24.87 t/ha). However, the American cv. 'G502' and the Italian cv. 'Z6' had the lowest yield with 15.44 and 13.03 t/ha.

Our finding agreed with the results of other researchers on onion in India (Mahanthesh *et al.*, 2008), in Canada (Best, 2000), in Burkina Faso (Rouamba *et al.*, 2001), in Cote d'Ivoire (Silué *et al.*, 2003), in Nigeria (Kabura *et al.*, 2008; Ibrahim, 2010). The recorded variations of varieties in marketable yield could be due to their differences in genetic make-up (Pavlovic *et al.*, 2003) and/or agro ecological adaptations. Composition of growth media (Suthamathy and Seran, 2011), planting date (Hamma, 2013), degree of plant population (Kahsay *et al.*, 2013) and other differences in cultural practices could also origin of variations in yield especially irrigation (Biswas *et al.*, 2010) and fertilization (Brdar-Jakanovic *et al.*, 2011). Khokar *et al.*, (2002) reported also that the maximum temperature above 30° C and humidity (more than 80%) enhance the reduction in onion yield.

The earliness in production was studied and 'BHP' cv. was the earliest variety because it took minimum days to produce bulbs (156 days after sowing) whereas 'G502' was the last variety (182 days after sowing). Data of bulb weight indicated that 'BHP' cv. produced the biggest bulb of 155.02 g followed by MA (139.25 g) and KR (110.43 g), whereas 'Z6' cv. had the minimum weight of bulb (63.13 g). Similar result was observed on others varieties of onion (Mohanty and Prusti, 2001; Mahanthesh *et al.*, 2008; Trivedi and Dhumal, 2010; Dwivedi *et al.*, 2012) and garlic (Volk, 2009). According to Soleymani and Shahrajabian (2012), bulb size could be affected by levels of nitrogen in soil. Also, Mishu *et al.* (2013) reported that amounts of sulphur had an impact on bulb weight of onion.

Bulb predominant number of axes varied considerably within each variety. Obtained results showed that this number ranged from 1.1 in G502 *cv* to 4 axes in 'Z6' cv. Rivera-Martinez *et al.* (2005) and Ahmed *et al.* (2013) confirmed our result on 21 Spanish genotypes and 30 Indian varieties.

Conclusion

On the basis of present results, it can be concluded that the onion varieties studied can be easily differentiated from one another due to their distinctive morphological

characters and their performance under Tunisian conditions. Therefore, the Italian varieties 'Morada de Amposta' and 'Red Amposta' and the Spanish one 'Yellow Dessex' could be maintained in Tunisian practices whereas the American cultivar 'Early Yellow Texas Grano 502' and the Egyptian one 'Giza 6' must be excluded. The study of the nutritional quality of the bulbs will be very interesting to make a better selection of varieties.

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