

## V.5 GIZA 29: A NEW HIGH-YIELDING LENTIL CULTIVAR

HAMDI, A., ZAKIA M. EZZAT, M. SHAABAN, T.A.A. SELIM, E.K. GENDY, E.M. RABIE, KH.M. YAMANI, M.A. RASLAN, M.A. BAKHEIT, G.A. ABDEL-HAFEZ, H.T. ABDE EL-AAL, NAGAT G. ABDALLA and M.A. IBRAHIM

*Food Legumes Res. Dep., Field Crops Res. Inst., ARC, Giza, Egypt*

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### Abstract

A new Egyptian lentil (*Lens culinaris* subsp. *culinaris* Medikus) cultivar denoted 'Giza 29' was developed by the Lentil Breeding Program, Food Legumes Res. Dep., Field Crops Res. Inst., Agric. Res. Center. The cultivar is originated from the Egyptian landrace 'Family 29'. Yield potential and stability of this new lentil cultivar were evaluated under various agro-ecological zones in 62 various yield trials at agricultural research stations and on-farm trials during 2003/2004 through 2012/2013 seasons. Seed yield of Giza 29 exceeded that of the wide-spread local cultivar Giza 9 by 28.5% in preliminary yield trials, 19.9% in advanced yield trials (class A), and 13.1% in advanced yield trials (class B), 28.5% in advanced yield trials (class C), and 20.8% in the on-farm verification trials, with an overall average of 22.2%. The cultivar Giza 29 also showed considerable yield stability. Therefore, we recommend growing this cultivar in both north and south Egypt.

**Keywords:** *Cultivar release, yield stability, Lens culinaris* subsp. *culinaris* Medikus.

## INTRODUCTION

Lentil (*Lens culinaris* subsp. *culinaris* Medikus) is an important food legume crop in Egypt. It has a high nutritional value, as its seeds are a rich source of protein, minerals (K, P, Fe, Zn) and vitamins for human nutrition (Grusak, 2010). It also reduces the dependence of cropping system on nitrogenous fertilizers because of its ability to fix atmospheric nitrogen in association with rhizobia (Moawad, *et. al.*, 1998). In addition, lentil straw is also a valued animal feed (Erskine, *et. al.* 1990).

The cultivated area of lentil in Egypt has decreased sharply during the last 20 years. The lentil area in 1993 was 19040 fed (8000 ha) and total production was 15000 ton with a productivity of 4.93 ardab fed.<sup>-1</sup> (1.88 t ha<sup>-1</sup>). A dramatic reduction has been occurred, where the cultivated area in 2013 was declined to only 862 fed (362 ha) with total production of 735 ton and 5.33 ardab fed.<sup>-1</sup> (2.030 t ha<sup>-1</sup>) (Anonymous, 2013). The lentil production in 2013 covered only 2.2% of the country requirements.

The strategy of the Food Legume Research Department is to increase lentil planted area and productivity. The lentil breeding program at FCRI, ARC has released five cultivars viz.: Giza 9, Giza 370, Giza 4, Giza 51 and Sinai 1. The average seed

yield of these cultivars ranged from 394 Kg fed.<sup>-1</sup> for Sinai 1 to 703 Kg fed.<sup>-1</sup> for Giza 51 (Hamdi *et. al.*, 2013). Development of high yielding lentil genotypes adapted to Egyptian agricultural conditions with good seed quality is one of the important factors to improve lentil production.

Evaluation of Giza 29 (under its old name of Family 29) with other lentil genotypes was previously made in many research studies. Giza 29 is characterized with an erect growth habit, tall plants, medium leaf size and brown seed coat color with red cotyledon color (Shaaban *et. al.* 2009). Giza 29 has small seed size (1000 seed weight = 22 g), and it is faster in cooking (14.8 min) than Giza 9 and other 28 lentil genotypes (20.8 min) tested by Hamdi and Rabeia (1991). Giza 29 reached 50% flowering and 90 maturity at 71 and 147.3 days, respectively comparing with 68.3 and 143.7 days for Giza 9, the average number of pods and seeds plant<sup>-1</sup> and seed yield plant<sup>-1</sup> of Giza 29 were 26.8, 43, and 1.78g, respectively, while the corresponding values for Giza 9 were 20, 22.2, and 1.23g, respectively (Hamdi *et. al.* 2012). In addition, the water requirement of Giza 29 is less than Giza 9 and other 98 lentil genotypes, and it has little response to increase water frequency (Hamdi and El-Assily 1995). Giza 29 showed yield stability ( $b = 1.0$ ,  $R^2 = 0.97^{**}$ ) over 12 locations from Nubaria in north Egypt to Mallawy in Middle Egypt (Hamdi *et. al.*, 1995), and it was also stable ( $b = 0.9$ ,  $S^2d = 2.6$ ) in other study also over 12 environments from Sakha in north Egypt to Mataana in the south (Hamdi *et. al.*, 1991). A molecular study showed that Giza 29 had low similarity indices and hence it is genetically different from the released lentil cultivars Giza 9, Giza 4, Giza 51 and Sinai 1 (Hamdi *et. al.*, 2012). The aim of the present study was to evaluate the yield potential and stability of the new lentil cultivar Giza 29 under various agro-ecological zones in Egypt.

## MATERIALS AND METHODS

The cultivar 'Giza 29' was developed by bulk selection from the Egyptian land race 'Family 29'. The cultivar was evaluated in comparison with the wide spread local cultivar 'Giza 9' over wide range of locations and growing seasons. A total of 62 trials were carried out, the trials including 11 preliminary yield trials in five seasons, 14 advanced yield trials class-A in five seasons, nine advanced yield trials class-B in three seasons, 14 advanced yield trials class-C in five seasons, and 14 on-farm verification trials on farmer's fields in four seasons. The yield trials were carried out at various research stations of ARC, including Gemmeiza, in Middle Nile Delta, Sids and Mallawy research stations (Middle Egypt), Mataana and El-Wady El-Gadded research stations in south Egypt. On-farm verification trials were conducted on farmers' fields at Sharkia,

Dakahlia and Ismailia (old lands) in north Egypt, and at Assiut in south Egypt, and in new lands at El-Wady El-Gadded in south Egypt. In Sharkia, Assiut and El-Wady El-Gadded in 2011/2012 season two sites in each governorate were conducted. The trials were carried out over 10 years during 2003/2004 through 2012/2013 winter growing seasons.

In preliminary yield trials 4 rows, 3-m long and 0.3-m width giving 4.8 m<sup>2</sup> plot size was used. In advanced yield trials and on-farm trials, a plot size of 14.4 m<sup>2</sup> was used (12 rows plot<sup>-1</sup>, 4-m long and 0.3-m width). In all trials the wide spread local cultivar 'Giza 9' was included for comparison. Seeding rate was 50 kg fed.<sup>-1</sup>, all trials were sown during November. All other agronomic practices were applied as recommended. At harvest, plants plot<sup>-1</sup> were uprooted by hand, threshed, and seeds were weighed. In each type of yield trials, a separate analysis of variance was done for each environment (location or season) according to the randomized complete block design. The Bartlett's test was used to examine the homogeneity of error variances of all the trials before combining them (Gomez and Gomez, 1984). Since the error variances were homogeneous combined analysis of variance for environments was made used a random model (Gomez and Gomez, 1984). Stability analysis was calculated according to the method described by Eberhart and Russell (1966).

## RESULTS AND DISCUSSION

Results showed that the differences among environments (locations and seasons) and between Giza 29 and Giza 9 and variety x environment interaction were highly significant for seed yield in all types of trials. These results indicated that wide differences among the used locations and seasons were existed and wide variation between Giza 29 and Giza 9 was also occurred (not tabulated). The data in Table 1 show the average seed yield for the new lentil cultivar 'Giza 29' compared with the check cultivar Giza 9 evaluated in 11 preliminary yield trials at various agricultural research stations in five seasons. The cultivar Giza 29 gave an overall average seed yield of 695.386 kg fed.<sup>-1</sup> comparing with 541.205 kg fed.<sup>-1</sup> for Giza 9. The percentage yield increase of Giza 29 over Giza 9 was 28.49% as presented in Table 6. The highest seed yield for both cultivars was observed at Mallawy research station in 2005/2006 season, where Giza 29 gave 1091.250 kg fed.<sup>-1</sup>, while Giza 9 performed 970.500 kg fed.<sup>-1</sup> (Table 1).

The results of 14 advanced yield trials class-A, which carried out during 2003/2004– 2012/2013 (Table 2) showed that the seed yield of Giza 29 ranged from 1244 kg fed.<sup>-1</sup> at Mataana research station in 2012/2013 to 223 kg fed.<sup>-1</sup> at Sids

research station in 2012/2013. The highest seed yield for both cultivars was observed at Mataana in 2012/2013.

Table 1. Average seed yield (kg fed.<sup>-1</sup>) for the new lentil cultivar 'Giza 29' compared with the check cultivar 'Giza 9' evaluated in 11 preliminary yield trials at various agricultural research stations in five seasons.

No.	Location	Season	Seed yield (kg fed. <sup>-1</sup> )		
			Giza 29	Giza 9	Mean
1	Mataana	2009/2010	453.000	320.000	386.500
2	Gemmeiza	2008/2009	441.250	421.000	431.125
3	Mallawy	2008/2009	502.500	450.000	476.250
4	Mataana	2008/2009	617.000	537.000	577.000
5	Gemmeiza	2005/2006	675.000	650.000	662.500
6	Sids	2005/2006	460.000	435.000	447.500
7	Mallawy	2005/2006	1091.250	970.500	1030.875
8	Gemmeiza	2004/2005	910.250	550.000	730.125
9	Mallawy	2004/2005	990.000	599.750	794.875
10	Gemmeiza	2003/2004	950.000	715.000	832.500
11	Mallawy	2003/2004	559.000	305.000	432.000
Mean			695.386	541.205	618.295
LSD at 0.05			84.874		48.328

Table 2. Average seed yield (kg fed.<sup>-1</sup>) for the new lentil cultivar 'Giza 29' compared with the check cultivar 'Giza 9' evaluated in 14 advanced yield trials class-A at various agricultural research stations in five seasons.

No.	Location	Season	Seed yield (kg fed. <sup>-1</sup> )		
			Giza 29	Giza 9	Mean
1	Gemmeiza	2012/2013	455.000	398.750	426.875
2	Sids	2012/2013	223.000	212.000	216.000
3	Mataana	2012/2013	1244.000	1213.250	1228.625
4	Gemmeiza	2010/2011	1155.000	991.500	1073.250
5	Sids	2010/2011	748.500	891.000	819.750
6	Mataana	2010/2011	684.500	611.250	647.875
7	Gemmeiza	2005/2006	832.500	540.000	686.250
8	Sids	2005/2006	760.000	585.750	672.875
9	Mallawy	2005/2006	856.750	825.250	841.000
10	Gemmeiza	2004/2005	530.000	265.750	397.875
11	Sids	2004/2005	440.750	340.500	390.625
12	Mallawy	2004/2005	882.500	654.000	768.250
13	Gemmeiza	2003/2004	1218.750	1021.250	1120.000
14	Mallawy	2003/2004	1218.750	828.750	1023.750
Mean			803.357	669.929	736.643
LSD at 0.05			66.727		50.166

Giza 29 cultivar gave an overall average seed yield of 803.357 kg fed.<sup>-1</sup> compared with 669.929 kg fed.<sup>-1</sup> for Giza 9. The percent yield increase of Giza 29 over Giza 9 was 19.92% as presented also in Table 6. Concerning advanced yield trials class-B, the data in Table 3 show that the seed yield of Giza 29 ranged from 1298.250 kg fed.<sup>-1</sup> at Malloway research station in 2004/2005 to 430 kg fed.<sup>-1</sup> at Sids research station in 2003/2004. While the average seed yield of Giza 9 ranged from 1095 kg fed.<sup>-1</sup> at Gemmeiza research station in 2003/2004 to 292.500 kg fed.<sup>-1</sup> at Sids research station in 2004/2005. The cultivar Giza 29 gave an overall average seed yield of 764.778 kg fed.<sup>-1</sup> compared with 676.222 kg fed.<sup>-1</sup> for Giza 9. The percent yield increase of Giza 29 over Giza 9 recorded 13.10% (Table 6).

The results of 14 advanced yield trials class-C, carried out during 2003/2004 – 2007/2008 (Table 4) show that the highest average seed yield of Giza 29 was 1030 kg fed.<sup>-1</sup>, which occurred at Gemmeiza in 2003/2004, while the highest average seed yield of Giza 9 was 1006.250 kg fed.<sup>-1</sup> also at Gemmeiza in 2003/2004. The cultivar Giza 29 gave an overall average seed yield of 635.071 kg fed.<sup>-1</sup> comparing with 494.071 kg fed.<sup>-1</sup> for Giza 9, with a percent yield increase of 28.54% as presented in Table 6.

Table 3. Average seed yield (kg fed.<sup>-1</sup>) for the new lentil cultivar 'Giza 29' compared with the check cultivar 'Giza 9' evaluated in nine advanced yield trials class-B at various agricultural research stations in three seasons.

No.	Location	Season	Seed yield (kg fed. <sup>-1</sup> )		
			Giza 29	Giza 9	Mean
1	Gemmeiza	2005/2006	697.500	573.750	635.625
2	Sids	2005/2006	626.500	503.250	564.875
3	Malloway	2005/2006	752.750	798.500	776.125
4	Gemmeiza	2004/2005	544.500	422.000	483.250
5	Sids	2004/2005	430.000	292.500	361.250
6	Malloway	2004/2005	1298.250	1004.750	1151.500
7	Gemmeiza	2003/2004	1183.750	1095.000	1139.375
8	Sids	2003/2004	717.500	775.000	746.250
9	Malloway	2003/2004	631.250	621.250	626.250
Mean			764.778	676.222	720.500
LSD at 0.05			77.566		54.461

Regarding the 14 on-farm verification trials carried out in farmers' fields at five governorates, the results in Table 5 show that the average seed yield of Giza 29 ranged from 1402.500 kg fed.<sup>-1</sup> at Sharkia Governorate in 2012/2013 to 532.500 kg fed.<sup>-1</sup> at Dakahlia Governorate in 2010/2011 season. While the average seed yield of

Giza 9 ranged from 1210 kg fed.<sup>-1</sup> also at Sharkia Governorate in 2012/2013 to 456.250 kg fed.<sup>-1</sup> also at Dakahlia Governorate in 2010/2011 season. The cultivar Giza 29 gave an overall average seed yield of 942.500 kg fed.<sup>-1</sup> compared with 780.518 kg fed.<sup>-1</sup> for Giza 9. The percent yield increase of Giza 29 over Giza 9 reached 20.75% (Table 6).

Table 4. Average seed yield (kg fed.<sup>-1</sup>) for the new lentil cultivar 'Giza 29' compared with the check cultivar 'Giza 9' evaluated in 14 advanced yield trials class-C at various agricultural research stations in five seasons.

No.	Location	Season	Seed yield (kg fed. <sup>-1</sup> )		
			Giza 29	Giza 9	Mean
1	Gemmeiza	2007/2008	791.250	660.000	725.625
2	Sids	2007/2008	498.750	368.750	433.750
3	Mallawy	2007/2008	393.750	308.750	351.250
4	Gemmeiza	2006/2007	666.250	442.500	554.375
5	Sids	2006/2007	487.500	287.500	387.500
6	Mallawy	2006/2007	402.500	337.500	370.200
7	Gemmeiza	2005/2006	537.500	431.250	484.375
8	Sids	2005/2006	937.500	633.250	785.375
9	Mallawy	2005/2006	891.750	480.000	685.875
10	Gemmeiza	2004/2005	516.250	457.500	486.875
11	Gemmeiza	2003/2004	1030.000	1006.250	1020.625
12	Sids	2003/2004	766.250	662.500	714.375
13	Mallawy	2003/2004	453.750	346.250	400.000
14	Mataana	2003/2004	513.000	495.000	504.000
Mean			635.071	494.071	564.571
LSD at 0.05			70.772		38.732

Table 5. Average seed yield (kg fed.<sup>-1</sup>) for the new lentil cultivar 'Giza 29' compared with the check cultivar 'Giza 9' evaluated in 14 on-farm verification trials on farmers' fields at five governorates in four seasons.

No.	Location	Season	Seed yield (kg fed. <sup>-1</sup> )		
			Giza 29	Giza 9	Mean
49	Sharkia	2012/2013	1402.500	1210.000	1306.250
1	Assiut	2012/2013	1260.000	1084.750	1172.375
2	W.G. <sup>¶</sup>	2012/2013	790.000	692.500	741.250
3	Sharkia-1	2011/2012	1316.250	960.000	1138.125
4	Sharkia-2	2011/2012	1247.500	890.000	1068.750
5	Assiut-1	2011/2012	1025.000	1000.000	1012.500
6	Assiut-2	2011/2012	1025.000	900.000	962.500
7	W.G.-1	2011/2012	790.000	580.000	685.000
8	W.G.-2	2011/2012	765.000	622.500	693.750
9	Dakahlia	2010/2011	532.500	456.250	494.375
10	Ismailia	2010/2011	730.000	550.000	640.000
11	Sharkia	2010/2011	647.500	540.000	593.750
12	Sharkia	2009/2010	932.500	750.000	841.250
13	Assiut	2009/2010	731.250	691.250	711.250
Mean			942.500	780.518	969.107
LSD at 0.05			83.379		80.682

¶: W.G. = El-Wady El-Gadded Research Station.

The summary of yield performance for the new lentil cultivar 'Giza 29' compared with the check cultivar 'Giza 9' in all yield and on-farm verification trials is given in Table 6. As shown in this table a total of 62 trials were conducted during 10 seasons (2003/2004–2012/2013). The overall data show that the average seed yield of Giza 29 ranged from 942.500 kg fed.<sup>-1</sup> in the on-farm trials to 635.071 kg fed.<sup>-1</sup> in the advanced yield trials class-C. The corresponding range of Giza 9 was from 780.518 kg fed.<sup>-1</sup> in the on-farm trials to 494.071 kg fed.<sup>-1</sup> in the advanced yield trials class-C. The range of the percent yield increase of Giza 29 over Giza 9 was 13.10 – 28.54%, with an average of 22.16%.

Table 6. Summary of yield performance for the new lentil cultivar 'Giza 29' compared with the check cultivar 'Giza 9' in all yield and on-farm trials.

Yield trial	No. of		Average seed yield (kg fed. <sup>-1</sup> )		
	Trials	Seasons	Giza 29	Giza 9	Inc. %
Preliminary	11	5	695.386	541.205	28.49
Advanced (class-A)	14	5	803.357	669.929	19.92
Advanced (class-B)	9	3	764.778	676.222	13.10
Advanced (class-C)	14	5	635.071	494.071	28.54
On-farm	14	4	942.500	780.518	20.75
Overall mean	-	-	772.020	633.266	22.16

Regarding the performance of Giza 29 and Giza 9 in various agro-ecological zones in Egypt, the two cultivars gave 872.80 and 686.73 kg fed.<sup>-1</sup> in North Egypt, respectively. In Middle Egypt, the corresponding seed yields were 678.29 kg fed.<sup>-1</sup> for Giza 29 and 554.11 kg fed.<sup>-1</sup> for Giza 9, while their seed yields in South Egypt were 831.40 kg fed.<sup>-1</sup> for Giza 29 and 695.30 kg fed.<sup>-1</sup> for Giza 9. These results also confirmed the superiority of Giza 29 over Giza 9 especially in North Egypt. However, the variation in seed yield of both cultivars at various sites and seasons may be due to the differences in environmental and seasonal conditions. The differences among locations and seasons in lentil seed yield in Egypt and in other countries have been reported previously by many scientists (Hamdi, 1987, Hamdi *et al.*, 1991, Hamdi and Rabeia, 1991, Erskine and El-Ashkar, 1993, Silim *et al.*, 1993, Chowdhury *et al.*, 1998, Elwafa, 1999, Solanki, 2001, and Hamdi *et al.*, 2002).

The average seed yield of Giza 29 and Giza 9 along with their regression coefficients (*b*), deviation from regression coefficient (*S*<sup>2</sup>*d*) and coefficient of determination (*R*<sup>2</sup>) are presented in Table 7. Eberhart and Russell (1966) noted that an ideal stable genotype is one which has the highest seed yield over a broad range

of environments, a regression coefficient of one and deviation from regression of zero. The data indicated that the regression coefficients of both cultivars Giza 29 and Giza 9 were not significantly different from unity ( $b = 1$ ). In addition, the estimates of deviation from regression were also not significantly different from zero ( $S^2d = 0$ ). Coefficients of determination of Giza 29 ( $R^2 = 0.903^{**}$ ) and Giza 9 ( $R^2 = 0.878^{**}$ ) were high and highly significant, indicating a better fit of their linear model with usual regression analysis applied. These results indicated that both cultivars are stable, but since Giza 29 had higher seed yield than Giza 9 over wide range of environments, so Giza 29 is considered more stable than Giza 9. High and significant coefficients of determination were also reported previously in stability study in lentil (Hamdi *et. al.*, 1995).

Table 7. Overall average seed yield (kg fed.<sup>-1</sup>) of Giza 29 and Giza 9 with their stability parameters: regression coefficient (b), deviation from regression ( $S^2d$ ) and coefficient of determination ( $R^2$ ) in 62 yield trials (environments) carried out in Egypt during 2003/2004 – 2012/2013 seasons.

Cultivar	Average seed yield (kg fed. <sup>-1</sup> )	b	$S^2d$	$R^2$
Giza 29	772.020	1.044	0.437	0.903
Giza 9	633.266	0.984	0.616	0.878

The presented results indicated the superiority of the new lentil cultivar Giza 29 over Giza 9 in yield performance with an overall yield increase of 22.16%. In addition, Giza 29 showed also considerable yield stability over the country, therefore the new cultivar is recommended for growing in both north and south Egypt.

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## ٥-٥ "جيزة ٢٩" صنف جديد من العدس عالي المحصول

أحمد حمدي ، زكية عزت ، محمد شعبان ، طارق سليم، عماد جندى ، السيد ربيع ، خالد يمانى،  
محمود رسلان ، مصطفى بخيت، جمال عبد الحافظ ، نجاه جابر عبدالله ،  
هشام عبد العال ، مصطفى إبراهيم

قسم بحوث المحاصيل البقولية- معهد بحوث المحاصيل الحقلية، مركز البحوث الزراعية، الجيزة،  
مصر.

قام قسم بحوث المحاصيل البقولية، معهد بحوث المحاصيل الحقلية، مركز البحوث الزراعية باستنباط صنف جديد من العدس عالي المحصول باسم "جيزة ٢٩". ويرجع أصل هذا الصنف إلى السلالة المصرية "العائلة ٢٩". ويهدف هذا البحث إلى تقييم القدرة الإنتاجية وثبات المحصول لهذا الصنف الجديد تحت ظروف المناطق البيئية الزراعية المختلفة في مصر، حيث تم تقييم مستوى إنتاجيته ودرجة ثباته في ٦٢ تجربة حقلية في محطات بحوث زراعية مختلفة وفي حقول المزارعين وذلك خلال ١٠ مواسم زراعية من ٢٠٠٣/٢٠٠٤ إلى ٢٠١٢/٢٠١٣. وقد أظهرت النتائج تفوق إنتاجية هذا الصنف الجديد جيزة ٢٩ على إنتاجية الصنف واسع الانتشار جيزة ٩ بحوالي ٢٨,٥% في التجارب الأولية لمقارنة المحصول، وبنسبة ١٩,٩% في التجارب المتقدمة لمقارنة المحصول (أ)، وبنسبة ١٣,١% في التجارب المتقدمة لمقارنة المحصول (ب)، وبنسبة ٢٨,٥% في التجارب المتقدمة لمقارنة المحصول (ج)، وبنسبة ٢٠,٨% في التجارب التأكيدية في حقول المزارعين. وقد بلغ التفوق العام للصنف الجديد على الصنف جيزة ٩ نسبة ٢٢,٢%. كما أظهر الصنف الجديد ثباتا في صفة المحصول في جميع مناطق ومواسم التقييم. وبناءً على هذه النتائج نوصى بزراعة صنف العدس الجديد، جيزة ٢٩ في كل من شمال وجنوب جمهورية مصر العربية.