

Yield performance and stability of the new durum wheat cultivar "Bani Suef 8"

Kumber R.M.A., I.A. Amin, S.M.A. Abdel-Dayem, S.M. Hammad, M.A. Abdel-Rahman, M.A. Hassan, M.A.M.A. El-Maghraby, M.Y. Ghoneam, H.M. El-Gharabawy, A.A. Hagra, T.H. Abd El-Salam, E.A. Abd El-Hameed, M.A. Aglan, Kh.I. Gad, W.Z.E. Farahat, A.T.H. Moustafa, S.T. Eissa, M.M. Mohamed, M.M.M. Abdel-Salam, G.A. Nour El-Din, Kh.El. Ibraheem, M.N.A. El-Hawary. M.S.M. Mahmoud. I.S.M. Abdel-Kader, M.N.T. Abdel-Kader, E.Gh. Galal, M.A. Darweesh, A.G. Abd El-Rady, M.S. Salous, S.A. Mohamed, A.A. Zain El-Abdeen, M.M.M. Yasseen, M.M. Mokhtar, M.M. Zakaria, A.I. Abdel-Sadek, G.M.M. Soliman, A.F.A. El-Kot, A.M. Sharshar, Y.S.I. Koubissy, Y.M. Faltaos, El-Masry EL.L.EL., Abdel-Hameed A.S., Y.A. El-Gohary, M.O.E. Mohamed, O.M. Elmoselhy, Z.A.A. El-Rashidy, A.M. Mostafa, S.E. Ibrahim, E.M.A. Khalefa, A.H.A. Hussen, M.A.M.A. Gad Allah, A.M.S.H. El-Fana, A.M.A. Nagy, W.M.A. Ghanem, W.A.A. El-Hag, E.F. Morgan, D.A.M. Hamza, H.H.A. El-Feky, A.R.H. Ibrahim, M.A. Gouda, T.M. Shehab El Din, M.M.M. Abde-Aleem, M.A.M. Abo Shereef, M.A.M. Eid, A.A. Ageez, S.R.S. Sabry, N.S. Hanna, M.S.A. Sharshar, E.M. Sadek, M.A. Moustafa, A.A. Hamada, S.E.A. Abdel-Majeed, A.M. Tammam, E.A.M. El-Sayd, H.A. Ashoush, N.R. Abdel-Fatah, H.S. Mahgoub, M.B. Tawfiles. H.I. Hendawy, H.S. El-Borhamy, A. Menshawy, W.A.M. El-Awady, S.H. Abo El-Ela, N.A. Reiad, A.A. Sewalam, S.A.M. Seleem. M.A. Ismail, S.M. Hassan, S.A. El-Sawi, R.A. Abdel Salam, F.A.M. Hefnawy, S.A. Ali, A.A. El-Hag, G.A. Shaaray, A.M. Gad-Allah, A.M. Abdel-All, A.A. Morad, M.E.E. Saleh¹, Doaa R. El-Naggar², Walid M. El-Oraby², Mohamed Abo-Zeid²



Address:

¹ Wheat Research Department, Field Crops Research Institute, Agricultural Research Center, Egypt

² Wheat Diseases Research Department, Plant Diseases Research Institute, Agricultural Research Center, Egypt

* Corresponding author's; **email:** mossad_abdelaleem@hotmail.com

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ABSTRACT

The newly released durum wheat cultivar Bani Suef 8 was selected from the advanced lines among CTMMYT collections grown in Shandaweel Agricultural Research Station, Wheat Research Department, Field Crops Research Institute, Agricultural Research Center, Egypt, during 2014-2015 and 2015-2016 growing seasons. Then, it was evaluated in 24 yield trials (one screening yield trial, seven preliminary yield trials, sixteen advanced yield trials) started in 2016/2017 through 2018/2019 growing seasons. These yield trials were conducted in Middle and Upper Egypt either in old or new lands. Results proved the superiority and grain yield stability of the new durum wheat cultivar Bani Suef 8, since it out yielded the commercial durum wheat cultivars Bani Suef 1, Bani Suef 5, Bani Suef 7, Sohag 4 and Sohag 5. Also, the new cultivar Bani Suef 8 possesses good resistance degrees against wheat yellow, leaf and stem rusts and powdery mildew, and stable grain yield under different agro-climatic zones of Egypt. The new cultivar is recommended to be cultivated in Middle and Upper Egypt.

Keywords: Durum wheat, high yield, new cultivar, stability.

INTRODUCTION

Wheat crop is one of the most important human food grain crops in the world. In Egypt, it is considered the first food grain crop for more than 7000 years. Wheat straw is also used in animal feed. The cultivated area in Egypt reached 3.43 million feddans (one faddan = 4200 m²) in 2020/2021 growing season with an average grain yield of 19.0 ardab/faddan or 7.00 ton/ha (Economic Affairs Annual report 2021). Wheat is grown in most governorates of Egypt, and the cultivation of durum wheat is dominated in Middle and Upper Egypt, where it produces high-quality semolina, which plays a major role in making macaroni and other pasta products, derived from durum wheat flour (Sadek *et al.*, 2011).

Growing durum wheat in Middle and Upper Egypt is facing some environmental stresses, such as high air temperature and hot dry wind, especially during the period of grain filling. Therefore, it is important to continue breeding and developing new varieties of durum wheat tolerant to high air temperatures and adapted to the prevailing environmental conditions of Middle and Upper Egypt. These varieties should be high yielding with good grain quality and resistance to wheat rusts (Sadek *et al.*, 2011).

Since late of seventies, Wheat Research Department of ARC, is working constantly on developing new durum wheat varieties superior to their predecessor in yield and grain quality. The Wheat Research Department released many high-yielding durum wheat cultivars of high quality, which had a big role in the increase of production. These durum wheat cultivars started with the cultivar Sohag 1 (Gomaa et al., 1979), and then followed by a series of durum wheat cultivars, Bani Suef 1 and Sohag 2 (Abdel-Shafi et al., 1989), Sohag 3, which out yielded Sohag 1 by an average of 10% (Ghanem et al., 1991), Bani Suef 3 (Ghanem et al., 1996), Bani Suef 4, which proved its superiority in grain yield compared with the other commercial cultivars (Abdel-Aleem et al., 2008), Bani Suef 5 of the high yielding ability (Moustafa et al., 2008) and Bani Suef 6, which has better stability parameters in' Middle and Upper Egypt (Sadek et al., 2011) -and recently Sohag 4 (Hamada et al., 2015), Sohag 5 (Hamada et al., 2016) and Bani Suef 7 for Middle and Upper Egypt (Abd El-Majeed et al., 2017).

The development of varieties which can be adapted to a wide range of environments is the important goal of plant breeders in a crop improvement program (Lin and Binns, 1988). Both biotic and abiotic stresses are the major threat to crop production in Egypt. Rust diseases of wheat including yellow rust (*Puccinia f. sp. striiformis*), leaf rust (*Puccinia triticina*) and stem rust (*Puccinia graminis tritici*) are serious disease all over the world (McIntosh et al., 1997). Under favorable climatic conditions, these diseases can cause epidemics and considerably reduce yield, but this reduction depends upon the time of infection and intensity of the disease (Afzal et al., 2007 and El-Orabey and Elkot, 2020). Rust epidemic can reduce wheat grain yield up to 50% (Shahin and El-Orabey, 2016 and Shahin et al., 2020). Therefore, development and broad cultivation of rust-resistant varieties is of supreme significance (Hussain et al., 2010). Continual release of rust-resistant varieties in Egypt reduced the losses caused by rust due to rapid recombination and/or mutations in causal organisms, new rust races also develop which become virulent for newly released rust-resistant varieties.

The present investigation is an evaluation of yielding ability and stability of the newly developed durum wheat cultivar, Bani Suef 8, compared to the Egyptian commercial durum wheat cultivars under Middle and Upper Egypt conditions.

MATERIAL AND METHODS

The new durum wheat cultivar Bani Suef 8 has been selected from CIMMYT materials grown at Shandaweel Agricultural Research Station, ARC, Sohag Governorate, Egypt, in 2014-2015 growing season.

Table 1. Releasing variety Bani Suef 8

Pedigree	Selection History	Source	Proposed Name	
SOOTY_9/RASCON_37//STORLOM/5/TOSKA_2 6/RASCON_37//SNITAN/4/ARMENT//SRN_3/N IGRIS_4/3/CANELO_9.1/6/RISSA/GAN//POHO_ 1/3/PLATA_3//CREX/ALLA*2/4/ARMENT//SRN _3//NIGRIS_4/3/CANELO_9.1	CDSS07Y00575T-099Y- 099M-13Y-1M-04Y-0B-0EG	2014/15- 46 th IDYN-715 2015/16- A-EDWFT-8 2016/17- A(D.W) -9 2017/18 – D(D.W) -5 2018/19 – D(D.W) -8	D.W	Beni- Suef 8

After that it was advanced to Shandaweel wheat screening nursery in 2015/2016 growing season. In 2016/2017 growing season, it was tested, at the national level, for yielding ability with the commercial durum wheat's at seven Agricultural Research Stations, in the preliminary yield trials. In the two successive growing seasons 2016/2017 through 2018/2019, it was retested in the advanced yield trial in Middle and Upper Egypt, comparing with the superior Egyptian commercial durum wheat cultivars, in the total number of 16 trials in eight locations each season. The experimental plot area of the preliminary yield trials was 4.2 m² (6 rows x 3.5 m long and 20 cm apart) with 50 kg/faddan seeding .rate in rows and in the advanced yield trials it was 10.5 m² (3 m x 3.5 m), with 60 kg/faddan seeding rate with broadcast planting. All other recommended agricultural practices for each region were applied for all trials. The experimental sites were Sids and Mallawy at Middle Egypt, Shandaweel , Mattana and Kom-Ombo at Upper Egypt and New Valley, Assiut and Toshka at new land .

At harvesting time, all of the experimental areas were harvested and threshed. The clean kernels of each plot were weighed to estimate the grain yield and adjusted to ardab/faddan.

The statistical design used in all trials was the Randomized Complete Block (RCBD) with four replications, and statistical analyses were applied according to (Steel and Torrie, 1980).

The reactions of the new cultivar to the three rusts and powdery mildew, under natural infection, were recorded. Also, stability parameters for grain yield of the advanced yield trials were calculated according to (Eberhart and Russell, 1966). The wheat variety Bani Suef 8 was tested for rust resistance at six locations i.e. Sakha, Gemmeiza, Nubaria, Itay El-Barod, Kafr El-Hamam and Sids Agricultural Research Station during two successive growing seasons i.e. 2017/18 and 2018/19.

The field experiment were laid out in three replicates with randomized complete block design lattice design with three replications. The experimental field plot was 6 rows of 2.5 m long with a 0.2 m inter-row. The experiment was bordered by spreader rows sown with mixtures of highly susceptible cultivars (Morocco, Thatcher and *Triticum spelta sahariensis*). The spreader plants were artificially inoculated using a mixture of urediniospores of the prevalent leaf, stem and stripe rust races mixed with talcum powder at a rate of 1: 20 (v:v) (spores: talcum powder) (Tervet and Cassell, 1951) in addition to the natural infection during late tillering and late elongation stages. The urediniospores of leaf, stem and stripe rusts received from Wheat Diseases Res. Dept., Plant Pathology Res. Inst., ARC, Egypt. For disease assessment of leaf, stem

and stripe rust pathogens were recorded after heading stage using a modified Cobb's scale (Peterson *et al.*, 1948). The type of infection i.e. Immune = (0), resistant= (R), moderately resistant= (MR), moderately susceptible= (MS) and susceptible= (S) was recorded according to Roelfs *et al.*, (1992). Also, final rust severity (FRS %) was assessed as a percentage of disease severity for each of the tested wheat cultivars when the highly susceptible (check) cultivar, i.e., Morocco, was severely rusted and its disease severity reached a maximum and final level (Das *et al.*, 1993).

RESULTS

Preliminary yield trials:

The results in Table (1) show the grain yield of the new cultivar Bani Suef 8 and three durum wheat commercial cultivars Bani Suef 1, Bani Suef 5 and Sohag 5 in the preliminary yield trials conducted at seven research stations in 2016/2017 growing season, these stations represent the old and new lands in Middle and Upper Egypt. In the first test at the national level in the preliminary yield trials, results showed that the new cultivar Bani Suef8 gave the highest grain yield in Sids, El-Mattana and Kom ombo agricultural research station was the only station in the old land where the new cultivar did not outyield the other checks, and it also did not perform well in the new land outside the valley.

Table 1: Grain yield (ardab/faddan) of the preliminary yield trials for Bani Suef 8 and three durum wheat check cultivars, in 2016/2017 growing season at seven locations.

Cultivar	Sids	Mallawy	Middle Egypt	Shandaweel	Mattana	Kom-ombo	Upper Egypt	New valley	Assiut	New land	Over all Egypt
Bani Sewef 8	30.12	22.53	26.33	20.58	29.27	18.96	22.94	10.22	20.57	15.39	21.75
Bani Sewef 1	28.64	23.08	25.86	21.53	28.62	23.63	24.59	15.40	22.64	19.02	23.36
Bani Sewef 5	30.45	20.46	25.45	25.62	26.38	19.25	23.75	9.76	21.66	15.71	21.94
Sohag 5	26.69	19.25	22.97	23.15	24.33	24.21	23.89	9.25	20.78	15.02	21.09
G. Mean	28.42	21.59	25.01	22.18	25.60	21.17	22.98	10.82	20.87	15.84	21.52
LSD 5%	2.12	3.53	2.04	Ns	2.03	2.77	2.04	2.01	Ns	2.00	1.21

Advanced yield trials:

The data in Table (2) show the grain yield of the advanced yield trials for Bani Suef 8 in comparison to the durum wheat commercial cultivars Bani Suef 5, Bani Suef 7, Sohag 4 and Sohag 5 in the two successive growing seasons 2017- 2018 and 2018/2019. These trials were conducted in five Agricultural Research Stations in old land, Sids and Mallawey in Middle Egypt, Shandaweel, Mattana and Kom-ombo in Upper Egypt, and in three Agricultural Research Stations, Assuit, New valley and Toshka in the newly reclaimed lands in the two growing seasons, with the total number of 16 trials in old and new lands of Middle and Upper Egypt.

In the first season, 2017/2018 the new durum wheat Bani Suef 8 gave the highest grain yield compared with the check cultivars. In Middle Egypt it out yielded the check cultivars in Sids. In the second season, 2018/2019 the durum wheat Bani Suef 8 exceeded the check in Sids, Mallawey, Shandaweel, Mattana and Kom-ombo in old land, but in the new lands, the new cultivar gave higher grain yield only in Assuit. So the new cultivar Bani Sewef 8 is suitable for Middle and Upper Egypt as a new variety high yielded in old land.

Table 2. Grain yield (ardab/faddan) of the advanced yield trials for Bani Suef 8 and four durum wheat check cultivars, at eight locations in 2017/2018 season

Cultivar	2017/2018											Over all Egypt
	Middle Egypt			Upper Egypt				Assiut	New valley	Toshka	Mean	
	Sids	Mallawy	Mean	Shandaweel	Mattana	Kom-ombo	Mean					
Bani Sewef 8	27.99	20.37	24.18	18.14	23.77	16.73	19.55	14.88	13.09	4.10	10.69	17.38
Bani Sewef 5	24.49	23.20	23.85	20.30	23.21	14.53	19.35	17.47	15.75	4.82	12.68	17.97
Bani Sewef 7	27.87	20.06	23.96	21.46	26.10	18.94	22.17	17.19	15.61	5.54	12.78	19.10
Sohag 4	24.07	19.14	21.60	18.65	26.55	17.27	20.82	16.34	15.33	6.76	12.81	18.01
Sohag 5	27.84	19.13	23.49	21.47	24.71	17.66	21.28	16.63	12.39	3.19	10.74	17.88
G. Mean	25.63	19.93	22.78	19.44	25.27	17.21	20.64	16.55	13.77	4.43	11.58	17.78
LSD 5%	1.87	n.s	2.11	n.s	n.s	ns	n.s	n.s	n.s	n.s	1.91	1.19
2018/2019												
Bani Sewef 5	30.28	23.70	26.99	31.01	20.19	22.97	24.56	12.40	12.52	15.44	13.45	21.00
Bani Sewef 8	30.40	26.73	28.56	37.16	26.19	27.04	30.13	13.13	12.89	13.24	13.08	23.34
Bani Sewef 7	30.10	21.23	25.66	33.28	22.44	24.60	26.77	10.60	12.52	16.55	13.22	21.41
G. Mean	29.42	23.55	26.48	33.21	24.34	23.89	27.15	12.93	12.93	14.84	13.57	21.89
LSD 5%	ns	2.6	2.07	4.80	2.43	2.49	2.09	2.32	n.s	1.69	1.10	1.03

Stability parameters for grain yield:

Stability parameters for grain yield of the new cultivar Bani Suef 8 were estimated on the results of the advanced yield trial according to Eberhart and Russell (1966). The advanced yield trial was conducted in the two respective growing seasons of 2017/2018 and 2018/2019 in eight locations each season (16 environments), in comparison with the two commercial durum wheat cultivars Bani Suef 5 and Bani Suef 7 which are widely cultivated in the two regions. The stable cultivar was defined as one which had a high average performance over a wide range of environments, and the regression coefficient is equal to one and no deviation from regression mean square. The results in Table (3) revealed that the new durum wheat cultivar Bani Suef 8 had better stability parameters over all Middle Egypt and Upper Egypt. Therefore, the new cultivar could be recommended to be planted in those environments.

Table 3. Grain yield (ardab/feddan) and stability parameters for Bani Suef 8 along with the commercial cultivars, in the advanced yield trial.

Cultivars	Grain yield	Stability parameters	
		b	S ² d
2017/2018			
Bani Suef 8	17.38	1.134	-4.376
Bani Suef 5	17.97	0.911	2.908
Bani Suef 7	19.10	1.034	-2.039
2018/2019			
Bani Suef 8	21.89	1.446	-20.228
Bani Suef 5	21.00	0.887	7.563
Bani Suef 7	21.41	1.028	13.896
Over all seasons and Locations			
Bani Suef 8	20.84	1.139	1.430
Bani Suef 5	19.49	0.899	1.139
Bani Suef 7	20.23	0.996	0.060

Evaluation of Bani Suef 8 at adult stage under field conditions against rust diseases:

The response of the wheat variety Bani Suef 8 to rust diseases was studied at six locations i.e. Sakha, Gemmeiza, Nubaria, Itay El-Barod, Kafr El-Hamam and Sids agricultural research station during two successive growing seasons i.e. 2017/18 and 2018/19. The disease score of Bani Suef8 and the check variety (Morocco) during the two growing seasons is presented in Table (4). The comparison of Bani Suef8 with check variety (Morocco) showed that the rust score of Bani Suef8 varied from 0 to 10 MR for yellow rusts and 0 to 10 MR for leaf and stem rust as compared to 30 S to 100S for yellow rust, 40 S to 100 S for leaf rust and 30 S to 60 S for stem rust.

Table 4. Final rust severity of the wheat cultivar Bani Seif 8 to yellow, leaf, stem rusts at six locations during 2017/18 and 2018/19 growing seasons.

Disease	Genotype	Location / FRS (%)					
		Sakha	Gemmeiza	Nubaria	Itay- Elbaroud	Kafer-El hamam	Sids
2017/18							
Yellow rust	Bani Suef 8	Tr MR	0	0	0	0	0
	Morocco	80 S	70 S	60 S	30 S	80 S	100 S
Leaf rust	Bani Suef 8	10 MR	0	Tr MR	0	10MR	0
	Morocco	50 S	80 S	50 S	80 S	50 S	100 S
Stem rust	Bani Suef 8	0	0	0	0	0	0
	Morocco	50 S	60 S	50 S	50 S	40 S	30 S
2018/19							
Yellow rust	Bani Suef 8	10 MR	0	10 MR	0	Tr MR	0
	Morocco	100 S	90 S	40 S	90 S	70 S	90 S
Leaf rust	Bani Suef 8	0	0	0	0	0	0
	Morocco	70 S	70 S	60 S	40 S	40 S	40 S
Stem rust	Bani Suef 8	0	0	5 MR	0	10 MR	0
	Morocco	30 S	50 S	40 S	40 S	40 S	50 S

Distinctness Uniformity and Stability tests (DUS):

This test was carried out by the Central Administration of Seed Certification (CASC) for two successive seasons according to the International Union for the Protection of new Varieties of plants (UPOV). This test was done before registration and releasing the new cultivar. The results of the tests and the description of the new durum wheat cultivar Bani Suef 8 is presented in Table (5).

Table 5. Description of durum wheat cultivar Bani Suef7 according to the International Union for the Protection of new Varieties of plants (UPOV).

Characteristics	Description
Pigmentation of coleoptils	7
Growth habit	3
Anthocyanin coloration of flag leaf auricles	7
Flag leaf rolling	1
Number of days to 50% heading	102
Glaucosity of flag leaf sheath	7
Glaucosity of the spike	5
Glaucosity of ear neck	5
Plant height	119
Thickness of parenchyma wall	4
Spike shape	2
Density of ear	7
Spike length with awns	9.6
Presence of awns	4
Awns length	13.7
Spike color at maturity	1
Hair density at the lower edge of the rachis	9
Width of lower glumes	1
Shoulder shape of glumes	1
Length of glumes beak	1
Shape of glumes beak	1
Hair density in the lower glume	9
Shape of lemma beak	1
Grain color	2
Grain color density at phenol test	3
Seasonal type	1

DISCUSSION

The superiority of the new cultivar Bani Suef 8 in old lands of Middle and Upper Egypt, as the results of the preliminary yield trial in 2016/2017 growing season (Table 2), may be due to the fact that the variety was evaluated and selected, from the beginning, by planting it under old land conditions at Middle and Upper Egypt.

Bearing in mind that selection, evaluation and cultivation of durum wheat cultivars are carried out in Middle and Upper Egypt, according to Wheat Research Department policy. And that due to the fact that the environmental conditions prevailing in the region are suitable for the cultivation of durum wheat cultivars to produce high-quality grains and excellent semolina for the pasta products. Accordingly, the new cultivar Bani Suef 8 was superior in Upper Egypt when it was cultivated in old lands. When the evaluation of the new cultivar was continued, at a more widespread level in the advanced yield trial grown in eight sites and repeated for two successive growing seasons (Table 3), the new cultivar outperformed the other check cultivars.

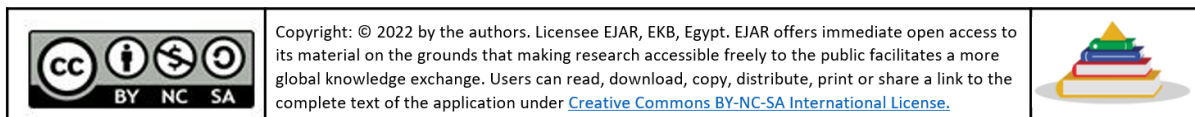
The results of Bani Suef 8 grain yield stability are referred to its good performance and having high grain yield ability under old land in Middle and Upper Egypt. The new cultivar also proved to have good genetic resistance to the three wheat rusts. The new cultivar, Beni Suef 8, was immune to yellow and stem rusts and was, at least, moderately resistant to leaf rust. which is considered a desirable character against rusts diseases. These results indicate the success of the policy of the Wheat Research Department in selecting varieties with high yield, resistance to rust diseases and high yield stability under various agricultural environments.

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- Borhamy, W.A.M. El-Awady, S.H. Abo El-Ela, R.M.A. Kombor, A.A. Sewelarn, I.A. Ameen, S.A.M. Seleem, S.M. Hassan, S.M.A. Abd El-Dayem, S.M. Hammad, M.E. Abd El-Rahman, S.A. El-Sawy, M. Abd El-Samad. M.A.M.A. El-Maghraby, A.M. Abd El-Al, M.Y. Ghoneam, A.A. Mourad, H.M. El-Gharabawy, A.T.H. Moustafa, T.H. Abd El-Salam, A.A. Hagrass, M.A. Aglan, E.A.M. Abd El-Hameed, Kh.I.M. Gad, W.Z.E. Farahat, Kh.E. Ibraheem, M.M. Zakaria, M.S.M. Mahmoud, A.M. Morssy, A.A.M. Hassan, I.S.M. Abd El-Lateef, S.N. Nathan, M.N.T. Abd El-Kader, E.Gh. Galal, M.M.M. Abd El-Salam, G.A. Nour El-Dien, M.Y.M. Yossef, M.A.H. Darweesh, A.G. Abd El-Rady, M.M.M. Gab Alah, M.N.A. El-Hawary, M.S. Salons, A.A. Zein ElAbdeen, S.A. Mohamed, M.T. Shehab El-Dien, M.M.M. Yaseen, A.I. Abd El-Sadek, A.M.S. Sharshar, E.L.E. El-Ma.sry, E.E. Moawad, Y.A. El-Gohary, Y.S.I. Koubisy, Y.M. Faltaos, G.M.M. Soliman, M.S.A. Gendy, M.O.E. Mohamed, O:M.A. El-Mosselhy, Z.A.A.El-Rashidy, S.I. El-Saied, A.A. Gomaa, E.H. Ghanem, M.G. Mosaad, A.H. Abd ElLateef, N.S. Hanna, S.A. Ali, M.A.M. Eed, M.E.E. Saleh, M.A.Gouda, F.A.M. Hefnawy, A.A. Egeez, N.R. Abd El-Fatah, M.A. Moustafa, T.M. Shehab El-Dien, A.A. El-Hag, M.A.M. Abo Shereef, S.R.S.Sabry, M.M.M. AbdelAleem, M.S.A. Sharshar, A.M. Gad Alah, G.A.M. Sharawy, I.M.M. Sadek, A.M. Tammam, M.A. Ismaiel, N.A. Reiad, A.M.M. Moussa, H.I. Hendawy, R .. A. Ramadan, A.M.A. Abo Warda, H.A.H. Ashoush (2017). Yield Performance and Stability of the New Durum Wheat Cultivar "Bani Sewef 8". *Egyptian Journal of Plant Breeding* 21 (6): 1001-1017
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القدرة المحصولية والثبات الوراثي لصنف قمح المكرونة الجديد بنى سويف 8

رضا محمد علي السيد قمبر¹، إبراهيم عبد الهادي أمين، صبحي محمد علي عبد الدايم، سعيد محمد حماد، ماجدة السيد عبد الرحمن، منال عبد الصمد حسن، ماهر عبد المنعم محمد علي، محمد يوسف غنيم مبارك، هدى مصطفى الغرباوي، عادل عبد العزيز هجرس، ثناء حمد عبد السلام، السيد علي محمد عبد الحميد، مؤمن عبد الوهاب عجلان، خالد إبراهيم محمد جاد، وليد زكي اليماني فرحات، أحمد طه حسن مصطفى، شريف ثابت عيسى، محمد مرعي محمد حمودة، محمد محي محمد عبد السلام، جيهان عبد الواحد نور الدين عبد الرحمن، خالد الدمرداش إبراهيم، محمد نبيل عوض الهواري، محمود شمروخ محمد محمود، إبراهيم صبري محمد عبد القادر، محمد نوبي طه عبد القادر، الحسين غلاب جلال، محمد عبد الكريم حسن درويش، أيمن جمال عبد الرازي، موسى شوقي سالوس، سيدهم عبد الخالق محمد، أحمد علي زين العابدين، محمد مصطفى محمد يس، مختار مراجع مختار، محمد مختار زكريا أحمد، عبد العزيز إبراهيم عبد الصادق، جمال محمد محمد سليمان، أحمد فوزي عبد النبي القط، أنس محمد صفاء الدين شرشر، ياسر سيد إبراهيم قبيصي، يوسف محسن فلتاؤوس، السيد لطفي السيد البمصري، أشرف صلاح عبد الحميد، ياسر أحمد محمد الجوهري، محمد عمر الفاروق محمد، أمنية محمود المصباحي، زينب أحمد عباس، أحمد محمد مصطفى رمضان، شيماء الدسوقي إبراهيم، إباء محمد علي خليفة، أحمد حسين أحمد حسين، مها أحمد محمد أحمد جاد الله، أحمد محمد سليمان حسنين الفنة، عبد الفتاح محمد عبد الفتاح ناجي، وائل محمد عبد الحلیم غانم، ولاء عبد ربه عبد العزيز الحاج، عماد فايق مرجان، دعاء أحمد محمد حمزة، هند حسن أحمد الفقي، أسعد رضا حسن إبراهيم، محمد عادل جودة، تاج الدين محمد علي شهاب الدين، مسعد محمد محمود عبد العليم، محروس عبد الغني محروس، محمد علي موسى عيد، أنور عبد الخالق عجيز، سامي رضا صابر صبري، نبيل سليمان حنا، محمد صفاء الدين شرشر، إيمان محمد محمد صادق، مصطفى عزب مصطفى، أسعد أحمد حمادة، صلاح الدين أحمد عبد المجيد، أحمد محمد تمام، عز الدين عبد الرحمن محمد، حسن عبد الطيف حسن عشوش، نجوى راضي عبد الفناح، هيام سيد محجوب، موريس بديع توفيليس، حمدي إبراهيم هنداوي، هاني سعد عبد الحميد البرهامي، عبد السلام منشاوي، وفاء عبد الحميد محمد العوضي، صباح حمزة أبو العلا، نادية عدلي رياض، عبد الله عبد المحسن سويلم، صبري أحمد محمد سليم، محمد عبد الكريم إسماعيل خالد، سهير محمود حسن، سيد عبده الصاوي، رمضان عبد السلام رمضان، فرغل عبد القادر مصطفى حفناوي، صلاح الدين عبد الحلیم علي، عبد ربه عبد العزيز أحمد الحاج، جمال عبد الرازق شعراوي، أحمد محمد أحمد جاد الله، عزة محمد عبد العال، عبد الفتاح عبد الرحمن مراد، محمد السيد السعيد صالح، دعاء راغب النجار²، وليد العرابي² محمد أبو زيد².

¹ قسم بحوث القمح، معهد بحوث المحاصيل الحقلية، مركز البحوث الزراعية، مصر
² قسم بحوث أمراض القمح، معهد بحوث أمراض النباتات، مركز البحوث الزراعية، مصر
 *بريد المؤلف المراسل: mossad_abdelaleem@hotmail.com

الملخص

تم انتخاب صنف القمح القاسي بنى سويف 8 من أحد السلالات المستوردة ضمن المجموعات العالمية الواردة من المركز الدولي لتطوير الذرة والقمح بالمكسيك (CIMMYT) التي زرعت في محطة البحوث الزراعية بشندويل قسم بحوث القمح معهد بحوث المحاصيل الحقلية مركز البحوث الزراعية - مصر في موسمي 2014-2015 و 2015-2016 بمحطة بحوث شندويل وفي موسم 2016/2017 تم اختبار وتقييم تلك السلالة مع الأصناف التجارية بنى سويف 1، و بنى سويف 5 وسوهاج 5 في سبعة محطات بحثية في تجارب مقارنة المحصول الأولية وقد أثبتت السلالة نجاحاً أولياً في تلك التجربة مما كان دافعاً لإعادة اختبارها وتأكيد النتائج مع الأصناف التجارية بنى سويف 1 و بنى سويف 5 و بنى سويف 7 وسوهاج 4 وسوهاج 5 في تجارب مكبرة وذلك في ثمان مناطق في مصر الوسطى ومصر العليا سواء الأراضي القديمة (أرض الوادي) أو الأراضي الجديدة المستصلحة حديثاً لمدة موسمين 2017-2018 و 2018-2019 وأعطى الصنف الجديد بنى سويف 8 ثباتاً محصولياً في مصر الوسطى والعليا كذلك أظهر الصنف بنى سويف 8 قدره كبيرة لمطابقة صفات UPOU العالمية لتسجيل الأصناف وأظهر الصنف الجديد بنى سويف 8 درجات عالية لمقارنة أصداء القمح الثلاثة (الأصفر والبرتقالي والأسود) والبياض الدقيقي ومن ثم يوصى بزراعته في مصر الوسطى والعليا.

الكلمات المفتاحية: قمح الديورم، المحصول العالي، صنف جديد، الثبات الوراثي.