Agricultural Science, Engineering and Technology Research
Vol. 4, No. 1, March 2016, pp. 1-11, ISSN: 2333-0953 (Online)
Available online at http://asetr.org/

Research article

Yield Performance and Participatory evaluation of Introduced Improved Durum Wheat Varieties in Palestine

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Abstract

Durum wheat (Triticum durum) is conceders one of most cultivated crops in Palestine. Sixteen durum wheat genotypes were evaluated for yield performance and its participatory evaluation of the farmers during 2012/13 and 2013/14 under rainfed conditions in five locations in Palestine. The results revealed that the best performance varieties for grain yield were Baraka in Tulkarem (4995 kg/ ha), Umurrabi in Bethlehem, Hebron (3168 and 4760), Mike in Jenin (3383 kg/ha) and Ammar in Tubas (3967 kg/ha). The best performance varieties for biomass yield were Faranci in Tulkarem, Jenin and Tubas (13660, 6540 and 9730 kg/ha respectively). In Hebron location, Um qais gave (13300 kg/ha) and in Bethlehem, Ammar gave 8230 kg/ha. The evaluation by the farmers in Jenin, Hebron, Bethlehem and Tubas governorates showed that variety (Umurrabi) took the first place whereas in Tulkarem governorate 870 took the first place.

Keywords: durum wheat, variety, yield, genetic variability, biplot

Introduction

Wheat (Triticum spp.) is one of the world's major crops, which accounted for 4.6 percent of total planted agricultural area [8]. The total planted area of wheat in Palestine is 22944.1 ha [14]. About 98% of planted wheat is in under rainfed condition where water shortage is very common. Selection of wheat genotypes for advancement in breeding programs or for planting in producer fields requires information about genotype performance. That information typically is generated through a series of field tests designed to sample the target environments and predict genotype performance in those environments [6]. Wheat yield and end-use quality depend upon the environment, genotype, and their interaction [16]. Many studies have also reported the high influence of environment and genotype-environment interaction in determining wheat grain yield and quality [12],[10],[9]. Among different factors, drought is a serious issue of low productivity for the last 5-6 years. There is almost no rainfall in most part of the country in winter [18]. The ability of a cultivar to produce high yield over a wide range of environmental condition is very important [18]. The response of plants to water stress depends on several factors such as developmental stage, severity and duration of stress and cultivar genetics [5]. Loss of yield is the main concern of plant breeders and they hence emphasize on yield performance under moisture stress conditions. But variation in yield potential could arise from factors related to adaptation rather than to drought tolerance. Breeding programs played a great role through the use of highly-yield of genetically improved wheat varieties to decrease struggle the starvation worldwide and maintain food security [2]. Breeders also look for genetic variation among the characteristics to select the desirable types. Some of these characters are highly associated among them and with grain yield [21]. Participatory variety selection can effectively be used to identify farmer-acceptable varieties and thereby overcome the constraints that cause farmers to grow old or obsolete varieties. Moreover, participatory research increases farmers' knowledge and increase adoption rates when farmers are allowed to participate in variety evaluation and selection [15]. The primary goal of this study is to identify superior cultivars for the target region and the performance of these cultivars under diffident rainfall regimes in Palestine and association of yield to genetic variability in improved durum wheat varieties under different rainfall regimes. In addition, to evaluate and explore farmers opinion about the newly introduced varieties.

Materials and Method

The experiment was conducted at two farmer's fields in Bethlehem, Jenin and Tubas and in Tulkarem and Arob stations of the National Agriculture Research Center in 2012/13 and 2013/14 growing seasons (Table 1).

Table 1: Site, governorates, rainfall, latitude, longitude and altitude of the conducted experiments.

no.	Site	Governorate	Rainfall	Latitude	Longitude	Altitude
1	Tayaser	Tubas	350	32202061	35234774	295
2	Arabonia	Jenin	414	32304279	35215156	237
3	Tulkarem	Tulkarem	604	32184304	35013605	102
4	Arob	Hebron	633	31370155	35083666	833
5	Zatra	Bethlehem	380	31402807	35151834	589

In each site 14 improved durum wheat varieties and two local controls were evaluated (Table 2). The experimental design was Completely Randomized Block Design (CRBD) with three replications. Seeds were hand sown in 4 cm depth with density of 30 gm/m-2. Each plot consisted of 6 rows with 2 m length, spaced 30 cm apart. All plots were fertilized with the fertilizers containing N 50, P2O5 90 and K2O 50 kg ha-1 were broadcast before sowing. An additional 50 kg of N ha-1 were applied at tillering growth stages. Weeds were chemically controlled, using Albersuber (2 liter/ha)

Table 2: Wheat genotypes evaluated for their performance during seasons 2012/13 and 2013/14 in Tubas, Jenin, Tulkarem, and Hebron governorates.

No	Name	Local/ improved	Source
1	Anbar	Improved	Local companies
2	Cham 1	Improved	ICARDA
3	Cham 3	Improved	ICARDA
4	Cham 5	Improved	ICARDA
5	F-8	Improved	Farmers Tubas
6	870	Improved	Farmers
7	Acsad 65	Improved	Jordan
8	Ammar	Improved	ICARDA
9	Baraka	Improved	Farmers
10	Faranci	Improved	Farmers
11	Horani nawawi	Landrace	ICARDA
12	Mike	Improved	ICARDA
13	Suri	Improved	Farmers
14	Kahatat	Landrace	Farmers Tubas
15	Um qais	Improved	Jordan
16	Umurrabi	Improved	ICARDA

Data was recorded on the following: Biomass yield (kg ha-1), Grain yield (kg ha-1)

Genotypes, Environments and their resultant interactions were tested by ANOVA for all measured parameters using GenStat ver. 7. The genotypes means were separated by least square difference ($\alpha = 0.05$).

Farmer's assessment, the selection of the farmer was made during several meeting with key farmers familiar with the wheat to determine the preference and adaptability of each variety in each governorate. In total 22 farmers were selected from Jenin, Hebron, Bethlehem, Tubas and Tulkarem governorates. Field evaluation and group discussions were made focused on: Yield potential, Growth performance, Seed size and color and Resistant to disease and insect pests. The ranking method was used to analyze the position of each variety in tested areas by the farmers. A matrix table of varieties in each governorate was constructed.

Results and Discussion

Significant variation (sig. > 0.05) among wheat varieties were observed for grain yield and biomass yield. The genotypes were significantly interacted with all of the locations for grain and biomass yield. Significant variations were also found among locations and for the grain yield between years whereas no significant variations were found for biomass yield between years (Table 3).

Table 3: Analysis of variance of grain and straw yield for wheat genotypes during seasons 2012/13 & 2013/14 in Tubas, Jenin, Tulkarem, Hebron and Bethlehem governorates.

		Grain yield		Biomass yield	
Source of variation	d.f.	s.s.	m.s.	s.s.	m.s.
Genotype (G)	15	835929	55729**	1833657	122244**
Location (L)	4	1901594	475398**	17942857	4485714**
Year (Y)	1	225282	225282*	14157	14157
G.L	57	1012659	17766**	7887518	138378**
G.Y	15	204637	13642*	1102323	73488
L.Y	4	1778408	444602**	8863996	2215999**
G.L.Y	49	516393	10539	3051974	62285

In 2011/12 season, the mean yield of all genotypes was 3280 and 7755 kg/ha for grain and biomass yield respectively; in 2012/13 season, the mean yield of all genotypes was 2840 and 7865 kg/ha for grain and biomass yield respectively (Table 4).

Table 4: The mean of grain and biomass yield (kg/ha) in 2012/13 and 2013/14 under five location for 16 improved durum wheat varieties.

	Gran yield		Biomass yield	
Varieties	2012/13	2013/14	2012/13	2013/14
870	3475	2281	7710	6950
Acsad 65	3267	2896	7680	7080
Ammar	3610	3522	7700	8240
Anbar	3461	3340	7560	7450
Baraka	3436	2937	6610	7090
Cham 1	3152	2523	6700	8000
Cham 3	3218	2677	7400	9030
Cham 5	3248	3051	6940	9150
F-8	3043	2837	6580	6820
Faranci	1735	1976	9410	9200
Horani Nawawi	3346	3052	8270	8640
Kahhatat	2426	2723	8430	8020
Mike	3956	2971	8130	7540
Suri	3354	2792	7940	7340
Um qais	3667	2679	8090	8120
Umurrabi	4090	3293	8930	7180
Mean	3280	2840	7755	7865
CV	8		4	

Among the varieties, Umurrabi produced highest grain yield (3692 kg/ ha), followed by Ammar (3566 kg/ ha). In case of interactions, maximum grain yield (4995 kg ha-1) was recorded for Baraka in Tulkarem location, followed by Cham 3 (4932 kg /ha) in Tulkarem location. In Bethlehem and Hebron, Umurrabi was the best performance variety which gave 3168 and 4760 (kg/ha) respectively. In Jenin Mike gave 3383 (kg/ha) and in Tubas Ammar gave

3967 (kg/ha). The minimum grain yield was recorded for Faranci (1485 kg/ ha) followed by Baraka (1700 kg /ha) in Bethlehem location (Table 5).

Table 5: The mean and coefficients of variation (CV) for grain yield (kg/ha) in 2012/13 and 2013/14 under five rainfed locations for 16 improved durum wheat genotypes.

Varieties	Bethlehem	Hebron	Jenin	Tubas	Tulkarem	Average
870	1682	2305	2456	3042	4907	2878
Acsad 65	2256	2946	2868	3292	4047	3082
Ammar	3127	3155	2758	3967	4823	3566
Anbar	2130	3017	3293	3850	4712	3400
Baraka	1700	2918	2644	3670	4995	3187
Cham 1	2185	2488	2652	2433	4429	2837
Cham 3	2227	2258	2329	2992	4932	2947
Cham 5	2267	3280	3032	3333	3835	3149
F-8	1832	2140	2670	3608	4452	2940
Faranci	1485	2003	1710	2675	1403	1855
Horani Nawawi	2379	4125	2765	2583	4145	3199
Kahhatat	2042	2380	2207	3033	3212	2575
Mike	3003	3573	3383	2933	4424	3463
Suri	2102	2582	2824	3425	4432	3073
Um qais	2346	4097	2727	2983	3712	3173
Umurrabi	3168	4760	3065	3675	3790	3692
CV	9.7					

Among the varieties, Faranci produced highest biomass yield (9310 kg/ ha), followed by Horani Nawawi (1366 kg/ ha). In case of interactions, maximum biomass yield (13660 kg /ha) was recorded for Faranci in Tulkarem location, followed by Um qais (13300 kg/ ha) in Hebron location. In Jenin and Tubas, Faranci gave highest yield (6540 and 9730 kg/ha for the two locations respectively). In Bethlehem, Ammar gave 8230 kg/ha. The minimum biomass yield was recorded for Acsad 65 (4130 kg/ha) followed by Cham 1 (4200 kg /ha) in Jenin location (Table 6).

Table 6: The mean and coefficients of variation (CV) of biomass yield (kg/ha) in 2012/13 and 2013/14 under five rainfed locations for 16 improved durum wheat genotypes.

Varieties	Bethlehem	Hebron	Jenin	Tubas	Tulkarem	Average
870	6540	8600	4590	5470	11420	7330
Acsad 65	6390	9350	4130	7120	9920	7380
Ammar	8230	7420	4570	9020	10620	7970
Anbar	6430	8240	5410	7780	9680	7510
Baraka	6560	6530	4340	7340	9460	6850
Cham 1	6470	11290	4200	6850	7940	7350
Cham 3	7040	8980	4850	8140	12050	8210
Cham 5	6430	12700	5840	5480	9780	8050
F-8	5280	8410	4970	6980	7870	6700
Faranci	6870	9730	6540	9730	13660	9310
Horani Nawawi	7460	10870	5690	7360	10870	8450
Kahhatat	7050	9600	4620	9040	10820	8220
Mike	7360	11010	5180	6180	9440	7840
Suri	7400	6200	5600	7840	11160	7640
Um qais	7110	13300	4530	7010	7570	8100
Umurrabi	6610	13760	4670	5200	10030	8050
CV	8.4					

The results of the most evaluated durum wheat varieties in partially agreement with many experiments conducted by [1],[4],[21],[19].

When the data set was subjected to principal components analysis, the first and second PCs explained 37.6 and 30%, respectively, of total variance in grain yield under 5 environments included in the experiment and 53.6 and 20.7 % of the first and second PCs, respectively, of total variance in biomass yield under five environments (figure 1).

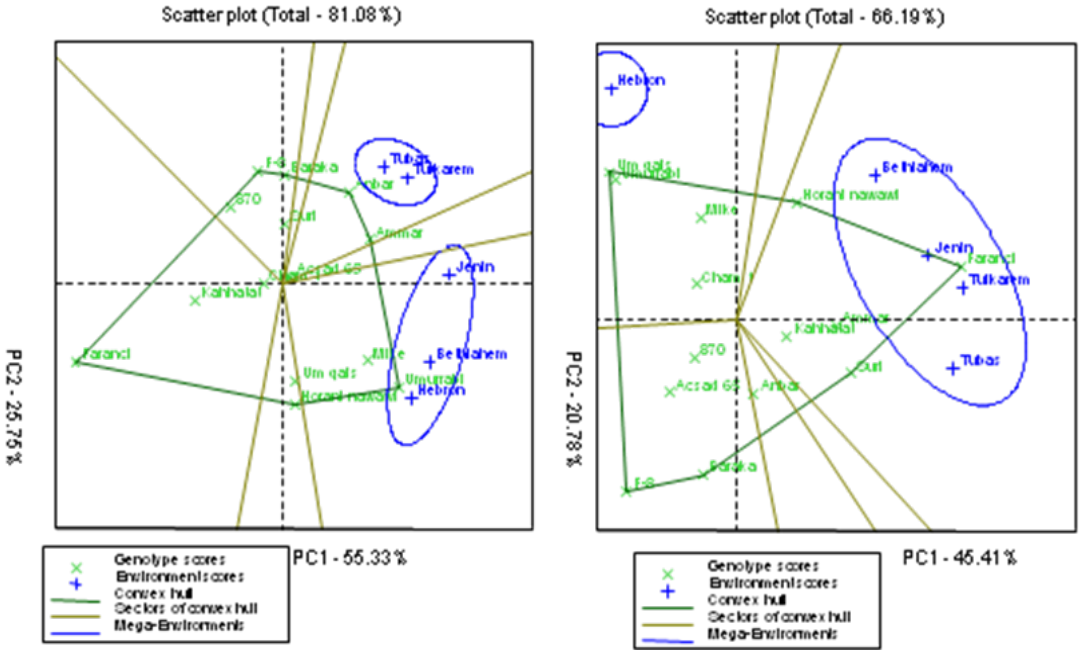

Figure 1: Biplot for grain yield (A) and biomass (B) for 16 wheat genotypes tested across 5 environments.

The figure (1) also view of a biplot explicitly displays the which-won-where pattern [11]. For grain yield, the biplot consist of a seven rays and divide the biplot into seven sectors, but environments fall into two of them, so the genotype(s) vertex in these sectors may have higher or the highest yield compared to other parts in all environments [22]. Vertex genotype for Tulkaerm and Tubas was Anber and Ammar , suggesting a higher yielding for this environments and vertex genotype for Jenin, Bethlehem and Hebron were Mike and Umurrabi, suggesting a higher yielding for this environments. For biomass yield, the biplot consist of a six rays and divide the biplot into six sectors, but environments fall into two of them. Vertex genotype for Tulkaerm, Jenin, Bethlehem and Tubas was Faranci, suggesting a higher yielding for this environments and vertex genotype for Hebron were Um qais and Umurrabi, suggesting a higher yielding for this environment. The variation in grain and biomass yield as demonstrated by biplot, confirm their differences for yield components [13]. and suggest that they require different management strategies to optimize grain yield under stress.

The evaluation by the farmers in Jenin, Hebron, Bethlehem and Tubas governorates showed that variety (Umurrabi) took the first place whereas in Tulkarem governorate 870 took the first place (Table 8). The farmer's logic behind this result manly is grain yield and seed treats. Seed treats as color and size are important characteristics to consumers. [3] and [7] revealed that seed color and seed size are important characters for farmers needs.

Table 8: Varieties and their rankings on the basis of pair-wise comparisons by 22 farmers from target governorate in Palestine.

	Governorates			
Variety	Jenin	Hebron and Bethlehem	Tubas	Tulkarem
Suri	12th	16th	13th	15th
Cham 1	9th	15th	12th	11th
Cham 5	14th	13th	15th	14th
Acsad 65	15th	4th	8th	16th
Baraka	11th	9th	16th	2nd
Horani Nawawi	16th	11th	14th	12th
Cham 3	10th	14th	7th	10th
Mike	8th	12th	11th	9th
Anbar	6th	5th	2nd	8th
870	5th	6th	4th	1st
Ammar	13th	2nd	3rd	6th
F-8	3rd	8th	10th	3rd
Um qais	2nd	3rd	9th	5th
Umurrabi	1st	1st	1st	4th
Faranci	7th	10th	6th	7th
Kahhatat	4th	7th	5th	13th

Conclusion

The average and the distribution of the rainfall played the main role in the variation among wheat varieties in grain and biomass yield and considered the main constraint limiting durum wheat production in many parts of the world. Grain and biomass yield decreased significantly under low rain locations. Understanding the effect of rainfall on yield formation becomes the essential step in the development of higher-yielding and more stable cultivars. The best performance varieties for grain yield were Baraka, Umurrabi, Mike and Ammar. The best performance varieties for biomass yield were Faranci, Um qais and Ammar.

Acknowledgement

The authors would like to express their gratitude to Netherlands government for their support and for Dr Nasri Hadad for his continuous support. Thanks to NARC staff especially, Dr Rula, Ms Ala' Medr'I, Ms Nariman Qararia and Eng Shaher Khalidi for their help during this work.

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