TANNER, D.G., M. VAN GINKEL, AND W. MWANGI, eds. 1990. SIXTH REGIONAL Wheat Workshop for Eastern, Central, and Southern Africa. Mexico, D.F.: CIMMYT.

Book Chapter

1

ON-FARM VERIFICATION OF FOUR BREAD WHEAT VARIETIES UNDER HIGH AND FARMERS' WEED MANAGEMENT LEVELS

Dereje Dejenne[1], Douglas G. Tanner[2] and Wilfred Mwangi[3]

[1]Economist,
Institute of Agricultural Research,
P.O. Box 2003,
Addis Ababa, Ethiopia

[2]Wheat Agronomist, [3]Economist,
CIMMYT,
P.O. Box 5689,
Addis Ababa, Ethiopia

Abstract

An informal survey conducted in the Sinana mixed farming zone indicated that peasant farmers obtain low yields of bread wheat, primarily due to the use of a low yielding local variety; in addition, farmers seldom practice thorough weeding of the crop. This trial was designed to test the performance of three released bread wheat varieties, DASHEN, ET-13 and K6295-4A, relative to the farmers' local variety, WOLLANDI, under both a high level of weeding and the farmers' practice. Agronomic and economic criteria as well as the farmers' assessment were used to evaluate the performance of the variety by weeding combinations. The results indicated significant differences amongst varieties (P<.001), locations (P<.001), and weed management levels for grain yield (P<.05). All interactions were nonsignificant; however, the variety by location interaction was almost significant (P<.1). There was no appreciable difference in the weight of weed biomass removed from each of the four varieties, and the labor requirement for weeding each variety was similar. Variable costs ranged from 265 to 308 Birr/ha for the high weed management level, and from 163 to 201 Birr/ha for the low weed management level. Under the high weed management level, over 30% of the variable cost was spent on the labor input for weeding.

ET-13 gave the highest net benefit at both the local market price and the Agricultural Marketing Corporation (AMC) price, using 50% as the minimum acceptable marginal rate of return; at the farmers' weeding level, the net benefits were 1322 and 589 Birr/ha, respectively. Marginal rate of return analysis indicated that it was not profitable for the farmers to hand weed ET-13. ET-13 gave the highest incremental net benefit over the local variety under both weed management levels and at both grain price levels. Farmers expressed a preference for ET-13 and WOLLANDI due to their effective competition with weeds, ease of harvesting and bundling, greater height and white grain color. They were critical of DASHEN, in particular, because of its susceptibility to stripe rust, perceived poor weed competition ability and the difficulty in harvesting and bundling this semi-dwarf cultivar. The red seed color of K6295-4A was discriminated against.

Introduction

Wheat is one of the most important crops grown in the Bale highlands, in general, and the Sinana area, in particular. It ranks as the second crop in area as well as in the amount produced. However, the farmers in the Sinana mixed farming zone harvest low yields, reportedly in the range of 8-10

q/ha, primarily because of the use of local, low yielding varieties. Crop management is also poor: improved varieties and management practices such as hand weeding and fertilizer usage have not been adopted in the area as most of the local population has only been involved in sedentary agriculture for about 30 years (1).

This paper reports on the results of a trial initiated to test the performance of three "improved" and released bread wheat varieties grown on farmers' fields under two weed management levels, the recommended level and the farmers' practice. The objective was to evaluate the new varieties from both an agronomic and economic point of view, taking into consideration the farmers' assessment. It was hypothesized that improved varieties under improved weed management levels would give higher yields and economically benefit the farmers relative to the traditional variety and management practices.

Materials and Methods

The trial was conducted using three released bread wheat varieties, DASHEN, ET-13 and K6295-4A, which were characterized as having high yield potential and a high level of resistance to the major wheat diseases in the Ethiopian highlands, *Puccinia striiformis* and *Septoria tritici*; the predominant local variety known as WOLLANDI, a tall awnless line, was used as the check. Two weed management levels were used: the cooperating farmers' practice which consisted of at most one partial hand weeding, and the level recommended by research staff: twice hand weeded at 25-30 and 40-45 days post-emergence.

In order to generate data covering a representative range of soil types in the Sinana zone, trials were planned for ten sites in the Sinana woreda in both the belg and meher (main) seasons of the years 1988 and 1989. This paper covers only the results of the belg and meher seasons of 1988.

The altitude of the study area ranges from 2300 to 2400 masl. Rainfall was 480 mm during the meher cropping season of 1988. The soils in the trial sites were classified as loamy clays and were brown in color.

The treatments were arranged in a split plot layout in an RCB design: weeding level was the main plot and varieties were subplots. The main plot size was 10 x 20 m while the subplot was 5m x 10m. There were two replications per site. The first and second hand weedings were done at 25 days (tillering stage) and 45 days (end of tillering) post-emergence, respectively.

Out of the nine cooperating farmers in the 1988 meher season, one farmer carried out one hand weeding, one did a partial hand weeding, and the rest did no weeding.

In the 1988 meher season, the nonexperimental variables, with the exception of seed rate and fertilizer rate, were determined by each farmer according to his preference and custom (Table 1).

Trial sites were selected based on their representativeness of the zone, their accessibility and the willingness of the individual farmer to host and manage the trial.

Three types of data were recorded in this study. Agronomic data were generated from the trials, including grain yield, weight of weeds removed from each plot, disease scores, and weed infestation scores. Labor data for weeding were recorded from individual plots, while harvesting and threshing labor data were obtained from the survey report (1) and from interviews with the farmers. Data on prices were obtained from the Agricultural Development office of Goba woreda. Farmers' qualitative assessments of the varieties according to several criteria were recorded while the crop was standing, at harvest and after threshing and processing.

Statistical and economic analyses coupled with farmers' assessments were used to evaluate the experimental treatments, according to CIMMYT methodology (2). Local market prices and Agricultural Marketing Corporation (AMC) prices were used in the economic analysis: for WOLLANDI, ET-13, DASHEN and K6295-4A local market prices were 74, 74, 69 and 65 Birr/q and AMC prices were 38, 38, 37 and 36 Birr/q, respectively.

Results and Discussion

As indicated in the Materials and Methods section, the experiment was planned to be conducted on ten sites in both the belg and meher seasons of 1988. We were able to plant only four sites and to harvest three sites in the belg season due both to lack of transport and weather irregularities. In the meher season, ten sites were planted and nine sites were successfully harvested.

There was a wide variation in the seed and fertilizer rates used by farmers in the belg season as farmers were allowed to select their own rates from researcher-supplied bulk quantities of the improved seeds and DAP (Table 1). This contributed to variability in post-emergence plant populations (Table 2), and led us to fix the seed and fertilizer rates in the meher season taking into account the germination ability of each variety and the average rate of fertilizer usage reported by the farmers (Table 1). Given the high variability in the 1988 belg season due to farmer selection of an abnormally wide range of seed and fertilizer rates, this paper focuses on the trial results from the meher season of 1988.

The combined statistical analysis of grain yields over the nine sites (Table 3) indicated significant differences among sites ($P<.001$), varieties ($P<.001$) and between weeding practices ($P<.05$). Mean site yields varied from 1332 to 2981 kg/ha. Mean yield for the farmers' weed management level was 2201 kg/ha, while the hand weeded treatment yielded 2421 kg/ha. Variety mean yields are listed in Table 4. Interactions were all non-significant; however, the variety by location interaction was almost significant ($P<.1$). The absence of a variety by weeding interaction disagrees with previous reports that improved varieties were more responsive to improved weed management (3). It should be noted, however, that weed densities in the meher season were lower than in the belg; in the previous report, variety by weeding interaction was only significant in the belg season. In the absence of interactions, main effects for each of the factors were used in subsequent calculations and comparisons.

Data from the belg season on the early post-emergence plant populations (Table 2) indicated that DASHEN has a relatively poor emergence capacity; plant populations were low despite using an average of 180 kg seed/ha (Table 1). However, DASHEN exhibited the highest tillering capacity, resulting in 469 tillers/m^2 by jointing stage.

K6295-4A and ET-13 were resistant to stripe rust (*Puccinia striiformis*), while DASHEN was seriously affected; the farmers' local variety, WOLLANDI, exhibited a moderate level of infection.

From the observed levels of weed infestation, DASHEN seemed to be a relatively weak competitor with weeds; however, there was no difference amongst the weights of weeds removed from each variety (Table 5), and no variety by weeding interaction effect on grain yield (Table 3). This suggests that the four varieties responded equally to weed competition and to improved weed management.

Labor input for weeding the four varieties varied between 38 and 41 mandays/ha (Table 5). Harvesting labor for the same varieties, as estimated by farmers, ranged from 16 to 21 mandays/ha. The threshing labor ranged from 9 to 13 mandays/ha (1). Partial budget analysis and marginal net benefit analysis were carried out using yield and labor data for each variety x weeding combination. Labor was valued at 1.95 Birr/manday plus a lunch allowance of 0.55 Birr/day. This was also considered to be the farmers' opportunity cost in the area and has not changed in the last 15 years. The variable costs ranged from 265 to 308 Birr/ha for the twice hand weeded treatments

and from 161 to 201 Birr/ha for the farmers' weed management treatments (Table 6). Under high management, over 30% of the variable cost was spent on the labor input for weeding. ET-13 gave the highest net benefit under both weed management levels at both AMC and local market prices, providing an additional net benefit of 204 and 230 Birr/ha over the farmers' practice (i.e., WOLLANDI under farmers' weed management) at local market price under the low and high weed management levels, respectively; it gave 100 and 66 Birr/ha extra, respectively, under AMC prices. Variety K6295-4A gave negative marginal net benefits relative to the farmers' practice under both weed management levels and at both AMC and local market prices. Marginal rate of return analysis indicated that, in this particular season (i.e., 1988 meher), it was not profitable to weed ET-13; the maximum net benefits for hand weeded ET-13 of 1348 and 555 Birr/ha at the local and AMC market prices, respectively, did not have an acceptable marginal rate of return relative to the corresponding net benefits for ET-13 under farmers' weed management (i.e., 1322 and 589 Birr/ha).

Farmers' qualitative assessments of the varieties tested were quite variable (Table 7). However, most of the cooperating farmers expressed interest in planting ET-13 in the future because of its perceived attributes of high yield potential, disease resistance, and relative ease in harvesting and bundling. ET-13 was rated close to the local line WOLLANDI in terms of weed tolerance, desirable seed color, marketability, acceptable quality or palatability when prepared in the local dishes "genfo" (porridge) and "dabo" (flat bread). Although DASHEN was equally high yielding, most farmers were not interested in it because of its susceptibility to disease (stripe rust), the difficulty in harvesting and bundling this semidwarf variety, and its perceived inability to compete with weeds. K6295-4A was observed to be resistant to disease (stripe rust), was easy to harvest and bundle and was perceived as being more tolerant of weeds relative to DASHEN; farmers rejected this line because it was lower yielding than ET-13, was difficult to thresh, had poor seed color (i.e. red), and had a poor taste when made into "genfo". K6295-4A was perceived as being the least in demand by the local market.

Farmers appreciated the superior performance of all four varieties under the high weed management level, but are constrained by the competing demands on their labor; land preparation for the belg season fields conflicts with weeding the meher season crop. Given that farmers in the area traditionally do not weed, they are reluctant to allocate labor for two hand weedings as recommended. However, it is apparent from this study that farmers may adopt improved bread wheat varieties, such as ET-13, thereby increasing grain yield and economic benefit, without having to adopt the recommended level of hand weeding.

Pending statistical and economic analysis of trials conducted over several seasons, taken in conjunction with the farmers' qualitative assessments, it appears that ET-13 should be the recommended bread wheat variety for the Sinana mixed farming zone.

References Cited

1. Mamo, A., and S. Franzel. 1987. Initial results of informal survey: Sinana mixed farming system zone. IAR Working Paper No. 1/87.

2. CIMMYT. 1988. From Agronomic Data to Farmer Recommendations: An Economics Training Manual. Completely revised edition. Mexico, D.F.

3. Zewde, L., D.G. Tanner, E. Elias, A. Gorfu, A. Tarekegne, T. Geleto, Z. Yilma, and Gebre H. 1990. The relative importance of yield limiting factors on bread wheat in the Ethiopian highlands. *In*: These proceedings.

Table 1. Nonexperimental variables and their levels.

Item	Fixed by individual farmer	Fixed by researcher at farmers' average	Fixed by researcher at some other level
Seedbed preparation (number and method)	3-4 plowings by ox drawn plow ("maresha")	–	–
Time of planting	16th-26th of April (belg, 1988)	–	–
	10th-30th of August (meher, 1988)	–	–
Planting method	Broadcasting	–	–
Seed rate (kg/ha): WOLLANDI	Not measured (belg, 1988)	–	150 (Meher, 1988)
K6295-4A	125-200 (belg, 1988)	–	150 (Meher, 1988)
ET-13	90-200 (belg, 1988)	–	150 (Meher, 1988)
DASHEN	130-230 (belg, 1988)	–	175 (Meher, 1988)
Fertilizer rate (kg DAP/ha)	0-75 (belg, 1988)	50 (Meher, 1988)	

Table 2. Plant population counts for four bread wheat varieties at four sites (Sinana, belg season, 1988).

Variety	Plants per m^2 (20 days post-emergence)	Tillers per m^2 (after completion of tillering)	No. of tillers per plant
WOLLANDI	269	318	1.2
K6295-4A	219	368	1.7
ET-13	273	404	1.5
DASHEN	215	469	2.2

Table 3. Combined analysis of variance for grain yield of four bread wheat varieties under high and farmers' weed management levels at nine sites in the Meher season, 1988.

Source	df	M.S.	F	Prob.
Sites (S)	8	4292332	16.70	P<.001
Reps/sites	9	59397		
Weeding (W)	1	1739761	5.37	P<.05
S x W	8	324348	1.26	
Error(a)	9	257085		
Varieties (V)	3	2066977	10.30	P<.001
S x V	24	200939	1.62	P<.1
W x V	3	163744	1.32	
S x W x V	24	113276	0.91	
Error(b)	54	123878		

$CV_{(b)}\%$ = 15.23
Mean = 2311 kg/ha

Table 4. Mean grain yield of four bread wheat varieties under high and farmers' weed management levels at nine sites in the Meher season, 1988.

Variety	Grain yield (kg/ha) Weed management level			
	Farmers'	High	Var. mean	
WOLLANDI	2058	2163	2110	B[a]
K6295-4A	2017	2182	2099	B
ET-13	2393	2588	2491	A
DASHEN	2338	2752	2545	A
Weeding mean	2201	2421		

[a] Means followed by the same letters do not differ significantly at the 1% level of the Duncan's Multiple Range Test.

Table 5. Labor input and weight of weeds removed from the twice hand weeded plots (Sinana, Meher season, 1988).

Variety	First weeding		Second weeding		Total	
	Labor (mandays/ha)[a]	Weight of weeds (kg/ha)	Labor (mandays/ha)	Weight of weeds (kg/ha)	Labor (mandays/ha)	Weight of weeds (kg/ha)
WOLLANDI	18	1345	20	1533	38	2878
K6295-4A	22	1105	19	1399	41	2504
ET-13	20	1250	18	1666	38	2916
DASHEN	17	1060	24	1813	41	2875

[a] 1 manday equals 7 working hours.

Table 6. Partial budget for on-farm wheat variety by weeding verification trial at nine sites (Sinana, Meher season, 1988).

Item	TREATMENTS							
	Farmers' weed management				Recommended weed management			
	WOLLANDI	K6295-4A	ET-13	DASHEN	WOLLANDI	K6295-4A	ET-13	DASHEN
Average yield (kg/ha)	2058	2017	2394	2332	2163	2182	2589	2698
Adjusted yield (15%)	1749	1714	2035	1982	1839	1855	2201	2294
Gross benefit (Birr/ha):								
a) at local market price	1294	1114	1506	1368	1361	1206	1629	1583
b) at AMC price	665	617	773	733	699	668	836	849
Variable costs (Birr/ha):								
a) seed cost	111	96	111	122	111	96	111	122
b) cost of threshing	25	22	30	27	27	24	32	32
c) cost of harvesting	40	43	43	52	40	43	43	52
d) cost of weeding	0	0	0	0	95	102	95	102
Total variable costs	176	161	184	201	273	265	281	308
Net benefit (Birr/ha):								
a) at local market price	1118	953	1322	1167	1088	941	1348	1275
b) at AMC price	489	456	589	532	426	403	555	541
Incremental net benefit (Birr/ha) relative to WOLLANDI at farmers' weeding level:								
a) at local market price	-	-165	204	49	-30	-177	230	157
b) at AMC price	-	-33	100	43	-63	-86	66	52

Table 7. Farmers' qualitative assessments of four bread wheat varieties (Sinana, Meher season, 1988).

Item	Characteristics[a]	VARIETY			
		WOLLANDI	K6295-4A	ET-13	DASHEN
1	Grain yield	+[b]	-	+	+
2	Disease resistance[c]	0	+	+	-
3	Ease of harvesting and bundling	+	+	+	-
4	Weed tolerance	+	+	+	-
5	Color (appearance)	+	-	+	0
6	Marketability	+	-	+	0
7	Ease of threshing	+	-	0	0
8	Taste: "Genfo"	+	-	+	0
	"Dabo"	0	+	+	-

[a] The characteristics are listed in the order of importance according to the farmers.
[b] + = the character was reported as favorable for a specific variety, - = the character was reported as unfavorable for a specific variety, 0 = the character was reported as intermediate for a specific variety.
[c] Farmers' assessment of stripe rust resistance.