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ON-FARM ECONOMICS OF HERBICIDE USE ON DURUM WHEAT IN ADA AND AKAKI WOREDAS OF ETHIOPIA

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ABSTRACT

Weed competition is one of the major production constraints for durum wheat in Ada and Akaki woredas of Ethiopia. An on-farm trial was conducted for two years at three sites to evaluate the economic benefit of herbicide use. The results showed that herbicides were economic with an acceptable marginal rate of return under stable government controlled price levels. However, under the present exorbitant open market price for herbicides, herbicide use was not found to be economically feasible. Availability and competitive price levels for herbicides, as well as the availability of sprayers, are important conditions that should be considered in the demonstration and further refinement of weed control technology. Farmers' understanding of the use of herbicides should also be enhanced through on-farm demonstrations.

INTRODUCTION

Wheat ranks fifth in production and area and fourth in yield per hectare among Ethiopia's principal cereals (CSA 1987). Sixty percent of the total national wheat area (est. 770000 ha) is under durum wheat (Tesfaye 1987). Durum wheat is mainly produced by peasant farmers. However, Ethiopia is about 50% self-sufficient in wheat and has to import the rest to fill the gap between domestic consumption and production. Durum wheat is the second major crop in Ada and Akaki woredas, while tef (*Eragrostis tef*) is the first major crop in both woredas. In terms of land allocation, wheat, mainly durum wheat, takes the second place in Akaki (0.52 ha) and Ada (0.45 ha) woredas (Workneh 1990, 1991). Wheat yields in the peasant sector are very low (1.1 t/ha) due to a number of technical and socio-economic constraints (Hailu *et al.* 1990). Most wheat farmers use unimproved local cultivars with low genetic yield potential. Rusts (leaf and stem rust) and *Septoria* leaf blotch are the two major diseases of durum wheat (Tesfaye 1987). Grasshopper damage is another biotic problem that lowers wheat yield. Weeds are a frequently occurring production constraint in Ada woreda (Workneh 1990); yield loss due to weeds at the main station of the Debre Zeit Agricultural Research Center (DZARC) has been reported to be 25.7% using 2,4-D amine herbicide for the assessment (DZARC 1988). Another weed research report revealed that weed competition reduced wheat yields by up to 36.4% (Rezene 1985). Most farmers in Akaki and Ada woredas tend to weed later than the recommended time because of over-lapping activities. For

instance, time of wheat weeding and tef planting coincides, but farmers give priority to tef planting. In some cases, farmers do not weed at all because they claim that it is not necessary and that they lack time. Some farmers use herbicides (2,4-D) to control broadleaf weeds in wheat and tef, giving priority to tef. Farmers give priority to tef because it fetches a higher price in the market relative to durum wheat. For instance, in 1990 at harvest time in Akaki, the wheat price was 81 Birr per quintal while that of tef was 104 Birr/qt (Workneh 1991). The other weed control method employed by farmers in Ada woreda is rotating wheat fields with food legumes (Workneh 1990). Although the open market labor wage rate is much higher than the official wage rate, there is still a shortage of labor during peak seasons (Hailu *et al.* 1991). Compared to the official price of herbicides, open market prices of herbicides are 2 to 3 times higher. On the other hand, government policy has discouraged the use of herbicides by peasant farmers and hence herbicides have not in most cases been available to meet the demand by these farmers (Hailu *et al.* 1990). For instance, in one of the major wheat producing regions, the state farms applied an average of 3 l or kg of herbicidal products/ha in 1988, while small-holders applied, on average, only 40 ml of 2,4-D per ha of wheat (Tanner and Giref 1991).

This paper presents the results of on-farm trials conducted for two years with the objective of assessing the economic benefits of herbicide use on durum wheat.

MATERIALS AND METHODS

Three herbicides (2,4-D 720 amine, Duplosan and Brittox) which were screened and recommended by the weed science section of DZARC were tested on farmers' fields and compared with local farmers' practices (one hand weeding). The four treatments were laid out in an RCB design in three replications at three sites in the tef and wheat based farming system in the mid-altitude zone of Ada and Akaki woredas. The plot size was 50 m^2. The rates of herbicides used for the 1989/90 trial were: 2,4-D; 1.5 l/ha; Duplosan 2.0 l/ha, Brittox 2.5 l/ha. For the 1990/91 trial the modified rate recommended by the weed science section of DZARC was applied; each herbicide was applied at the rate of 1.0 l/ha. The seed rate used was 150 kg/ha. Fertilizer was used at the rate of 100 kg/DAP and 50 kg urea/ha. The two years' trials were conducted on different farmers' fields. Herbicides were applied by field attendants of the center under the guidance of the researcher. Seed and fertilizer broadcasting was done by the participating farmers and field attendants. The other operations (i.e. land preparation, harvesting and protection of the crop from any external damage) were undertaken by the participating farmers. Data were collected on grain yield and straw. Data were also collected on the price of herbicide, transportation cost of herbicide from local market or distribution center to farms, labor cost to haul water to prepare herbicide solution and to apply the herbicides, and the cost of sprayer service. Average Debre Zeit and Akaki market prices for 1989/90 and 1990/91 were used in the valuation of the products (Appendix 2). A partial budgeting technique was used to analyze the economics of herbicide use.

RESULTS AND DISCUSSION

The grain yields from the four methods of weed control were not found to be statistically different in both years (Table 1). However, the average grain yield from Duplosan was the highest of all treatments (Table 2). The rainfall amount and distribution in Akaki was very different from that of Ada in both years, thus, resulting in statistically significant yield difference over locations (Table 1). Akaki usually receives higher amount of rainfall than Ada (Appendix 1). With the adjusted lower herbicide rates, the grain yield of 1990/91 was found to be lower than that of 1989/90. The straw yield of 1990/91 was however higher than that of 1989/90 (Table 2). The reduction of the grain yield in 1990/91 might be attributed to the high grasshopper damage and the variation in rainfall distribution. A possible explanation for higher straw yield in 1990/91 could be that all the tillers might not have headed. The dominant broadleaf weeds identified on the trial plots just prior

to spraying were *Scorpirus muricatus, Guizota scabra, Brassica* spp., *Commelina* sp., *Amaranthus* sp., and *Cirsium arvense*. Grasshopper damage was a conspicuous problem on the test crop in all sites in both years.

Economic Evaluation

Using government supplier prices, Duplosan and Brittox gave higher net benefits with marginal rates of return of 898% and 262%, respectively relative to one hand weeding (Table 3). These results implied that use of Brittox and Duplosan provided net returns of Birr 2.62 and 8.98, respectively, for a cost of one Birr incurred in using the herbicides. The rates are higher than the minimum acceptable marginal rate of return, which is assumed to be 100%. Farmers' decisions to use herbicides are influenced by such factors as prices of herbicides, cash status of farmers, farmers' priorities in cash expenditure, the availability of efficient credit service at a fair cost, and availability and accessibility of herbicides. Hailu Beyene (1990) has also shown that the use of pre-emergence herbicides on bread wheat using government supplier prices in Holetta area provided a higher net benefit than one hand weeding. Given open market prices of herbicides, which are 2 to 3 times that of the government supplier prices, hand weeding was found to be economically superior. However, the availability of family labor or hired labor is an important condition for hand weeding to be competitive.

Apart from the price of herbicides, farmers' lack of experience in use of herbicides and availability of sprayers are important considerations that will hinder the adoption of this weed control technology.

Sensitivity analysis was conducted using the new wheat grain prices since the decontrol of grain marketing to assess whether herbicide use was now profitable relative to hand weeding using open market herbicide prices. Wheat grain prices have increased from 0.73 birr/kg to 1.35 birr/kg (85% increase). With the new wheat prices, herbicide treatments were dominated by hand weeding except Duplosan. Duplosan provided 81% more net benefit over that with the old grain price. Relative to hand weeding, however, Duplosan gave a marginal rate of return of 67% (Table 4) which is below the acceptable minimum marginal rate of return (100%). Thus, even with the new wheat prices, given the current open market herbicide prices, hand weeding is still economically superior.

CONCLUSIONS AND RECOMMENDATIONS

The use of herbicides at government controlled prices was found to be economic. However, the results of the two years' on-farm trials showed that with open market herbicide prices which are 2 to 3 times that of government fixed prices, the use of herbicides by peasant farmers is not economically feasible whether using the old or new wheat grain prices. For herbicides to be economic, their prices would have to continue to be subsidized and the government policy towards herbicide use by peasant farmers would have to change to improve availability. Alternatively, wheat grain prices would have to rise by more than 100% before herbicide use by small-holders would be economically feasible. Farmers also need to be educated in the use of herbicides through on-farm demonstrations.

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Table 1. Combined analysis of variance for on-farm herbicide trial on durum wheat in 1989/90 and 1990/91.

Source	Degrees of freedom	Sum of squares	Mean square	F value	Prob.
Year (Y)	1	13.97	13.97	7.93	.007
Location (L)	2	341.84	170.92	97.01	.000
Year x location (YL)	2	273.76	136.88	77.69	.000
Replication (R) x (LY)	12	35.82	2.99	1.69	.109
Treatment (T)	3	13.06	4.35	2.47	.077
Y x T	3	7.04	2.35	1.33	.279
L x T	6	14.73	2.46	1.39	.243
Y x L x T	6	15.28	2.55	1.45	.224
Error	36	63.43	1.76		
Coefficient of variation		14.8%			

Table 2. Adjusted[1] grain and straw yields from on-farm herbicide trials in 1989/90 and 1990/91 (kg/ha).

Treatment	1989/90		1990/91		Mean		Grain yield change (%)
	Straw	Grain	Straw	Grain	Straw	Grain	
2,4-D	2489	1584	3008	1464	2749	1524	-2.4
Duplosan	2325	1695	2793	1702	2559	1699	+8.7
Brittox	2521	1778	2651	1583	2586	1681	+7.6
One hand weeding	2462	1719	2629	1405	2546	1562	—

[1] grain yields were adjusted downwards by 10% to approximate yields under farmers' management since herbicide application, sowing and fertilization were done under the researcher's control.

Table 3. Partial budget for herbicide applications and one hand weeding for Ada and Akaki woredas in 1989/90 and 1990/91 (Birr/ha).

	2,4-D	Duplosan	Brittox	One hand weeding
Gross benefit	1359.89	1470.22	1459.51	1369.36
Costs that vary Cost of herbicide application (herbicide, labor, sprayer)				
gov't supplier	64.28	76.11	90.92	0
market	130.06	177.37	273.22	0
Cost of hand weeding	0	0	0	66.00
Total costs that vary				
gov't supplier	64.28	76.11	90.92	66.00
market	130.06	177.37	273.22	66.00
Net benefit				
gov't supplier	1295.61	1394.11	1368.59	1303.36
market	1229.83	1292.85	1186.29	1303.36
Marginal rate of return (%)	—	897.63	261.76	—

Table 4. Sensitivity analysis for on-farm herbicide verification on durum wheat, 1989/90 and 1990/91 (Birr/ha).

	2,4-D	Duplosan	Brittox	One hand weeding
Gross Benefit				
Old grain price (0.73 Birr/kg)	1359.89	1470.22	1459.51	1369.36
New grain price (1.35 Birr)	2304.77	2523.29	2501.42	2337.79
Net Benefit				
Old price	1229.83	1292.85	1186.29	1303.36
New price	2174.71	2345.92	2228.20	2271.79
Marginal rate of return (%) (with new price)	—	66.56	—	—

Appendix 1. Rainfall data for Ada and Akaki woredas for the crop growing months in 1989/90 and 1990/91 (mm).

		June	July	August	Sept.	Total	Average
1989/90	Ada	61.9	222.5	202.5	103.3	590.2	147.6
	Akaki	58.6	264.2	301.0	170.9	794.7	198.70
1990/91	Ada	61.8	208.6	146.0	141.6	558.0	139.5
	Akaki	78.9	280.7	222.9	117.3	699.8	174.9

Sources: Debre Zeit and Akaki Beseka weather stations.

Appendix 2. Average field prices for 1989/90 and 1990/91 in Ada and Akaki woredas.

Wheat grain	0.73 Birr/kg
Wheat straw	0.09 Birr/kg
2,4-D herbicide	
gov't supplier	17.38 Birr/l
market	70.01 Birr/l
Duplosan	
gov't supplier	22.37 Birr/l
market	89.88 Birr/l
Brittox	
gov't supplier	27.64 Birr/l
market	131.81 Birr/l
Sprayer service	0.70 Birr/l
Labor	3.00 Birr/work-day