EFFECTS OF INDENTATION, TIDE RIDGING AND TILLAGE SYSTEMS ON SEED YIELD OF DRY BEAN IN THE SEMIARID HIGHLAND OF MEXICO

E. S. Osuna-Ceja[2], J.S. Padilla-Ramírez[2], M.A. Martínez-Gamiño[2], E. Martinez Meza and J.A. Acosta-Gallegos[2]
[1]Research partially financed through the project 2003/175 (SAGARPA-CONACYT-COFUPRO).
[2]INIFAP Bean Research Group. Apartado Postal 20, Pabellón de Arteaga, Aguascalientes, México. C.P. 20660. esosuna@yahoo.com.mx

Introduction. Limited and erratic rainfall in the semiarid highlands of Mexico often results in low dry bean yield and sometimes in total crop failures. Soil water conservation practices can greatly improve the potential success in many dry land farming systems. Conservation tillage systems that contribute to minimize soil erosion and retain crop residues on the soil surface have generally increased water conservation. Seed yield of dry beans under rainfed conditions may be enhanced by utilizing improved dry bean cultivars in conjunction with cultural practices such as in situ rainwater catchments techniques, combined with reduced tillage (1). Also, furrow ridges, which are small dikes or micro-catchments along the rows at 3-m intervals throughout the length of the field and the "Aqueel", which is the trade name for a unique means of creating indentations in a loose soil surface. These ridges along the rows and the indentations, act as water reservoirs to store rainwater. Both dry land conservation technologies have increased dry bean yield, reduced runoff and control soil erosion (2). In a semiarid environment, the efficient use of precipitation is necessary to reduce production risks. The purpose of this study was to validate an integral dry bean production strategy by including several technological components in combination with improved cultivars.

Material and Methods. The study was conducted at different sites located in the region known as "El Llano" in the northeast of the state in Aguascalientes (21° 54' N; 102° 04' W) during summer 2005 and 2006. This area is characterized as semiarid with an annual rainfall average < 450 mm at an altitude of 2000 m.a.s.l. The soil is sandy clay loam with a pH value of 7.9 and < 1% organic matter; it is superficial with 1% slope. Trials were conducted in four sites in 2005 and five in 2006. Plots of one ha each were planted after the onset of the rainy season on July 5th in 2005 and on July 15 and 27th in 2006. Three technological components were validated: 1) Improved bean cultivars (Flor de Mayo Bajío and Flor de Mayo Sol); 2) Tillage methods (disc plowing (DP) and "Multiarado" (Mult), chisels that break the ground without turning the soil) and 3) In situ water catchments and conservation (Aqueel "Aq" and Ridges "R"). The Aqueel wheel makes continuous rows of indentations; it was attached to the rear of the planter at the time of sowing. Tide ridges were 0.15 to 0.20 m high and were form in each furrow at spacing of 3-m with hoe like devices attached to the cultivator (35 days after planting). Treatments were established on strips of six to eight rows 0.76 m wide and 100 to 150 m long. Seed yield was determined on four samples of 6.08 m^2 (2 x 0.76 x 4) per treatment.

Results and Discussion. In 2005 total rainfall from June to October was similar to the long-term average and above it in 2006 (Table 1). Within each growing season there were dry and wet spills; in 2005 early in the season (June) rainfall was below average, considerably above average during July and August, and below average in September and October. Rainfall in 2006 was above average from July to September and below average in October. Rainfall distribution is important when water catchments are built during the crop season since they will have a positive impact only if it rains after they are form.

TABLE 1. Average long-term rainfall (30 yr) and rainfall occurred in 2005 and 2006 at "El Llano", Aguascalientes, Mexico.

MONTH	*Rainfall (mm)*		
	2005	2006	30-yr avg
June	25	34	96
July†	105	156.4	100
August	167	195.2	84
September	14	67.4	61
October	3.8	4.0	30
Total	**314.8**	**457**	**371**

† Total growing season rainfall was 273 mm in 2005 and 343 mm in 2006.

TABLE 2. Average seed yield (ton ha^{-1}) of two dry bean cultivars grown under four technological components in five sites at "El Llano", Aguascalientes, Mexico during 2005 and 2006

Technological Component	**Experimental Sites** Tildio I	Tildio II	Copetillo	Sandovales	Sta. Rosa	**Average**
Cultivar:			**2005**			
Flor de Mayo Bajio	1.035	0.416	0.527	0.782	-	0.690
Flor de Mayo Sol	0.957	0.365	0.581	0.980	-	0.721
Tillage methods:						
Disc plowing	1.028	0.333	0.560	0.893	-	0.703
Multiarado	0.964	0.447	0.547	0.868	-	0.707
Water catchment:						
Ridges	1.061	0.428	0.554	0.942	-	0.746
Without Ridges	0.931	0.353	0.554	0.789	-	0.657
Cultivar:			**2006**			
Flor de Mayo Bajio	626.8	156.2	0.476	1.014	0.567	0.568
Flor de Mayo Sol	866.6	115.3	0.627	1.012	0.717	0.668
Tillage methods:						
Disc plowing	690.7	142.5	0.457	1.123	0.597	0.602
Multiarado	802.7	129.0	0.646	1.170	0.679	0.685
Water catchment:						
Aqueel	-	-	0.612	1.203	0.639	0.819
Without aqueel	-	-	0.491	0.902	0.634	0.676
Ridges	757.6	153.4	0.558	1.163	0.745	0.675
Without Ridges	735.8	118.1	0.545	1.023	0.546	0.594

In 2005 and 2006 cv Flor de Mayo Sol outperformed Flor de Mayo Bajio by 4% and 15%, respectively. Both tillage methods had a similar yield in 2005 and the 'Multiarado' had 12% higher yield than disc plowing; this is important since the 'Multiarado' uses have the time and energy to prepare one ha than the traditional disc plowing. As for the Aqueel, an implement that was tested in 2006, this was the component with the higher yield, 17% higher than the control. The use of ridges also improved yield by 12%. The implement for building ridges costs less than the aqueel, although the aqueel can further increase seed yields. The introduction of technological components in the semiarid highlands of Mexico can greatly reduce the risks of producing rainfed dry beans.

References. 1) Padilla-Ramírez, J.S. *et al.*, 2006. Bean Improvement Cooperative. 49:261-262. 2) Osuna-Ceja, E.S. *et al.*, 2006. Bean Improvement Cooperative. 49:251-252.