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INTRODUCTION: In Durango, forest plantations with woody species reached 1,866 ha in 2013 (SEMARNAT, 2013). Forest plantations have been recommended under irrigation and agricultural lands for the intensive production of wood, pulp and firewood, as well as for Christmas trees cultivation. In 2015, intensive production of forest biomass was supported using different pine species such as *Pinus greggii*, *P. cembroides* and *P. engelmannii*. High yield potential has been also detected in the same production areas for agricultural crops such as common bean (*Phaseolus vulgaris*), which is considered as a productive and profitable option by farmers in order to obtain food and economic benefits during pine timber production. Decrements have been observed in grains per pod, grains per plant and harvest index, as percentage of shade increased (Hadi *et al*., 2006). The objective of this study was to evaluate shade effects on yield of Pinto Saltillo common bean cultivar grown under two cropping systems in Durango, México.

MATERIALS AND METHODS: From 2014 to 2016, an agroforestry (alley cropping) system was implemented at INIFAP´s experiment station located in Durango, México. The agroforestry system included an 8 to 10 year old *Pinus greggii* plantation and a common bean cultivar (Pinto Saltillo), showing intermediate maturity (96 days after planting: DAP). Common bean cultivar was sown when the rainy season started (June 24th to August 4th) using strips between pine tree lines, which was planted 3 m apart and 1.5 m between plants. In 2014, pine trees showed average values of 3.3 m for plant height, 11.0 cm of stem basal diameter and 2.0 m of crown diameter.

Pinto Saltillo, common bean cultivar was sown in alternate strips using two rows, 130 m in length and 0.81 m apart. A traditional cropping system was established in an adjacent plot without pine plantings to be used as a control. Fertilizer was applied by hand at the dose of 25-35-00 (N-P_2O_5-K_2O). Weed control included two mechanical weeding complemented with one chemical application (Fomesafen) and two hand weeding. Supplemental irrigation was applied in order to avoid crop loss caused by intermittent drought registered across years during the cropping season, which was associated with low rainfall. In 2014, two pyranometers (Kipp & Zonen SP Lite 2) were installed over 80 cm from the soil surface in order to evaluate global solar radiation (watts/m^2) and the shade effect in common bean plants. In 2015 and 2016, readings were taken during the reproductive period using an AccuPAR (Decagon LP-80, Decagon Devices, Inc.) ceptometer for light interception measurements in both cropping systems.

The experimental plot consisted in one strip with two rows and three (2014 and 2015) to five (2016) replications. Phenological data were registered for days to flowering and physiological maturity. At maturity, three equidistant plant samples were taken from each crop strip for yield determination. Samples consisted of two rows with 5 m in length by 0.81 m in width (8.1 m^2). Analysis of variance was obtained under randomized complete block design combined over years with six to 15 replications (samples) and mean comparisons were performed by Tukey´s test ($P \leq 0.05$).

RESULTS AND DISCUSSION: Increments in light interception (shade) were registered across years averaging 24 % in 2014 to 33 % in 2016 (Figure 1). Variation was observed for days to flowering and maturity across years. Early flowering (33 DAP) and maturity (82 DAP) was observed in 2016, mainly due to delayed plantings and photoperiod sensitivity registered in Pinto Saltillo. A significant reduction of seed yield was observed between cropping systems. The highest seed yield was observed at traditional

system during 2016 (2,647.4 kg ha^{-1}). Highest yield reduction (67 %) was registered under the highest shade level (33 %) observed in 2016 (Figure 1). Lowest yield average was also observed in the agroforestry system (880.3 kg ha^{-1}) compared to traditional system (2,647.4 kg ha^{-1}).

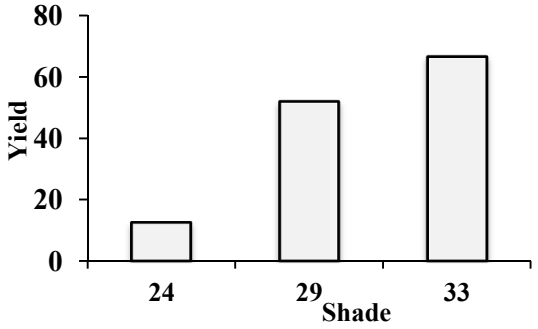

Figure 1. Shade effect on common bean seed yield registered in an agroforestry system implemented in Durango, México. (2014-2016).

Effect on yield reduction was related to increments in light interception (shade) caused by tree growth and the lack of tree pruning. Similar values for 100 seeds weight (32.6 to 34.0 g/100 seeds) were observed across cropping systems. Higher yield and low reduction in seed weight are desired traits in common bean cultivars grown under pine-common bean intercropping system. In despite of yield reduction, common bean represents an important option in agroforestry systems and the farmers would have food production and an additional income during the early growth of the trees.

Table 1. Traits evaluated in Pinto Saltillo common bean cultivar grown under two cropping systems.

Year	Days to Flowering	Days to Maturity	Yield kg ha^{-1}	100 seeds Wt (g)
		Agroforestry System		
2014	46	105	1,577.5^{b}	33.5
2015	40	105	754.8^{b}	32.9
2016	33	82	880.3^{b}	34.9
Average	**40**	**105**	**1,070.9^{B}**	**33.7**
		Traditional System		
2014	45	104	1,804.0^{a}	34.3
2015	40	104	1,463.6^{a}	32.7
2016	34	82	2,647.4^{a}	32.6
Average	**40**	**105**	**1,971.7^{A}**	**33.2**

Letters in columns indicate significant differences according to Tukey´s test ($P \leq 0.05$) between cropping systems ($^{A-B}$) and years^{a-b}.

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