Research Note

TOMATO YIELDS AND ECONOMIC BENEFITS OF MUCUNA DEERINGIANA *INCORPORATION INTO THE SOIL*[1]

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Mucuna deeringiana (Bort) Merr, commonly known as velvet bean, is highly resistant to root-knot nematodes; in addition, it is valuable as green manure and as a forage legume. It also controls weeds, some fungi species, and fixes nitrogen (Grainage and Saleem, 1988). In Puerto Rico, velvet bean has proven effective in reducing losses caused by nematodes, especially *Meloidogyne* spp. and *Rotylenchulus reniformis* in tomato, thus increasing tomato yields. *Mucuna*-tomato rotation systems have increased tomato yields over 100% (Acosta, 1991, 1995; Acosta et al., 1991, 1995). In the above mentioned experiments the best results were obtained with velvet bean incorporated into the soil a month after having been cut and left in the row until deteriorated. In order to determine the profitability of the incorporation of the velvet bean residues vs. non-incorporation (cut and removed from the field), a cost-benefit analysis was performed in a commercial planting.

A field experiment was established at the Isabela Experiment Station in 1995. The soil was a Coto clay (Typic Hapludox), with 6.4 pH and 2% organic matter, heavily infested with reniform and root-knot nematodes [4,000 juveniles (J2)/250 cm^3 of soil]. The purpose of the experiment was to compare velvet bean incorporation into the soil (cut and plowed under) three months after being planted, followed by tomato, and velvet bean non-incorporated (cut and removed from the field), followed by tomato. In the comparison, an economic analysis (Kay and Edwards, 1994) was used to determine the feasibility of each of these cultural practices.

The area of the commercial planting was 1977 m^2 (0.1012 ha), formed by 63 rows each 30.48 m long, with 0.91 m between rows. The area was divided into two plots formed by 30 rows. There was a 2.74-m space between plots. Both plots were planted to velvet bean seeds sown 0.46 m apart. Weeds were controlled with paraquat (Gramoxone[4]—2.92 L/ha). Three months later velvet bean was cut and pulled out from one of the plots, whereas in the other it was cut, then chopped and left in the plot for deterioration. A month later, it was plowed into the soil at tomato planting. Diazinon (Diazinon AG500®—1.17 L/ha) was applied once to control the mole cricket (*Scapteriscus* sp.). Plots were planted with five-week-old cv. Duke tomato seedlings from a commercial nursery. Planting distance was 31.25 cm apart. Fertilizer was applied once to all plots. Fungi were controlled with chlorothalonil (Bravo R500®). Plants were irrigated when necessary. Cul-

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[4]Trade names in this publication are used only to provide specific information. Mention of a trade name does not constitute a warranty of equipment or materials by the Agricultural Experiment Station of the University of Puerto Rico, nor is this mention a statement of preference over other equipments or materials.

tural practices were conducted as recommended for the crop by the Agricultural Experiment Station (Anonymous, 1992).

Harvest was 90 days after planting. The tomatoes were classified as commercial or non-commercial. Commercial fruits were at least 6.25 cm in diameter, free from mechanical damage or genetic malformations.

A budget for tomato production was prepared to determine the revenue, expenses and profit of two *Mucuna*-tomato rotation systems. The revenue section included all cash and non-cash revenue from the crop, as well as yield, net yield, farm price, and gross income. Tomato yields were adjusted to 10% less because of the optimum management of the experimental plots. The price of high quality tomatoes was $0.66 per kilogram. The gross income was calculated by multiplying the net yield by the farm price (Myrna Comas, Marketing Specialist, Agricultural Extension Service, UPR, Mayagüez, PR, personal communication).

The variable costs were determined by adding all operating or variable costs, such as cost of velvet bean seeds, tomato seedlings, fertilizers, chemicals (herbicides, fungicides, insecticides), labor, machinery and weeding. All costs were similar in the two treatments, except for the cost of weeding.

The profit or net benefits for each treatment were determined by subtracting the total variable costs of the particular treatment from the gross income. The cost of production of a kilogram of tomatoes was calculated for each of the two velvet bean-tomato treatments by using the Kay and Edwards (1994) equation:

$$\text{Cost of production/kg} = \frac{\text{total variable costs}}{\text{Yield}}$$

The percentage profit increase was calculated by subtracting the profit obtained in the implantation of the non-incorporation treatment from the profit in the velvet bean incorporation treatment, then divided by the profit of velvet bean incorporation multiplied by 100 as follows:

$$\%\ \text{profit increase} = \frac{\text{profit from velvet been incorporated} - \text{profit from velvet bean non-incorporated}}{\text{profit from velvet bean incorporated}} \times 100$$

Higher tomato yields (19,941 kg/ha) were obtained from plots with velvet bean incorporated into the soil (three months after being planted and prior to tomato transplanting), than from the plots with no velvet bean incorporation (7,744 kg/ha) (Table 1). Yields were 157% higher in the velvet bean incorporated treatment than in the non-incorporated. Acosta (1991, 1995) and Acosta et al. (1991, 1995) obtained similar results.

Table 2 presents the costs and profit of tomato production in each treatment. Variable costs were considerably less with velvet bean-incorporated plots than with non-incorporated. Cost reductions were obtained in the implementation of the treatment itself, and in less weeding. As demonstrated in previous work (Acosta et al., 1995), yield increases are attributed to various factors: nematode control due to the nematicidal effects of velvet bean roots (Acosta et al., 1995; Vargas et al., 1996), the improvement of soil fertility (Acosta et al., 1997), and weed control properties (Baryeh, 1987).

The cost of producing a kilogram of tomato from plots with velvet bean incorporated prior to tomato planting was $0.11, whereas it cost $0.33 to produce the same amount of tomatoes from plots with non-incorporated velvet bean. It has been demonstrated that velvet bean incorporation is an effective alternative for increasing tomato production in Puerto Rico.

TABLE 1.—*Tomato yields in five harvests after a crop sequence rotation with velvet bean at Isabela, P.R.*

	Harvest					
	Yield (kg/ha)[1]					
Treatments[2]	1	2	3	4	5	Total
MI	1,389.35	2,935.87	6,585.47	7,683.60	1,346.94	19,941.41
MNI	224.11	800.10	1,045.65	2,691.60	2,982.91	7,744.37
Total	1,613.46	3,735.97	7,631.12	10,375.20	4,329.85	27,685.78

[1]Yield = weight of all commercial fruits with ≥6.25 cm diameter, free from mechanical damage or genetic malformations.

[2]MI = *Mucuna* incorporated, MNI = *Mucuna* non incorporated.

TABLE 2.—*Budget to compare the profitability of producing tomatoes in two* Mucuna-*tomato rotation systems in Puerto Rico.*

	Treatments[1]	
Items[2]	*Mucuna* incorporated-tomato	*Mucuna* non-incorporated-tomato
Revenues		
average yield (kg/ha)	19,941.41	7,744.37
adjusted average yield (10%) (kg/ha) = Net yield	17,947.27	6,969.93
farm price ($/kg)	0.66	0.66
gross income ($/ha)	11,845.20	4,600.15
Variable costs		
Mucuna seeds	$ 16.30	$ 16.30
tomato seedlings	239.59	239.59
fertilizer	130.91	130.91
chemicals	217.36	217.36
labor	1,038.98	1,038.98
Mucuna incorporation	217.36	—
Mucuna non-incorporation	—	477.03
weeding	50.88	190.83
irrigation water (0.123 ha-m)	15.44	15.44
Total variable costs	$ 1,926.82	$2,326.44
Profit	$ 9,918.38	$2,273.71

[1]*Mucuna* incorporated = velvet bean plowed into soil three months after being planted, followed by tomato; *Mucuna* non-incorporated = velvet bean cut and pulled out from the field three months after being planted, followed by tomato.

[2]Revenue = income; gross income = income without deductions of production costs; variable costs; operating costs (preharvest, harvest) and machinery costs; profit = final value found by subtracting total variable costs from total revenue or gross income.

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