Effect of staking on yield and quality of indeterminate beans[*]

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COMPENDIO

Frijoles trepadores (Phaseolus vulgaris L.) *se sembraron en lomos de surco de 91 cm. en tres campañas para comparar los efectos de estacado vertical y horizontal, y no estacado, sobre el rendimiento en semilla y la calidad de la semilla de los frijoles. Los rendimientos en grano, reunidos todas las campañas, para los métodos de no estacado, y estacado vertical y horizontal fueron 1178, 2069 y 2061 kg/ha, respectivamente, lo que indica que los métodos de estacado vertical y horizontal tuvieron resultados comparables. Fue más fácil que los tallos treparan en estacas rugosas que en lisas. El estacado también produjo granos de mejor calidad debido a que las vainas estuvieron más alejadas del suelo, lo que dio lugar a que menos vainas estuvieran en contacto con la tierra.*

Introduction

THE common bean, *Phaseolus vulgaris* L., is an important food crop in Malawi where the types grown are mostly the indeterminate (climbing) ones and are used as dry beans although the leaves are sometimes plucked before pod set and used as green vegetable. The indeterminate types are generally grown as intercrop with maize where the maize provides support for the bean. Bean yields from such a mixed cropping system are usually low presumably because of low plant population of the bean crop, 24,000- 36,000 plants/ha, in the mixture (4), poor planting pattern (3), shading of the beans by the associated crop (2), and competition for factors of production (1). The low bean yields in the mixed cropping system would suggest that the genetic potential of the existing cultivars is not exploited maximally. One method of exploiting these cultivars fully could be by planting them as a pure crop while substituting stakes for the maize crop.

The objective of this trial, was therefore, to compare the effects of staking methods on the seed yield and seed quality of indeterminate beans.

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Materials and methods

1971/72 experiments

Two indeterminate bean cultivars, one dry bean (cv. 336) and one canning bean (cv. 1200), were planted on 20th December, 1971, at Bunda College Farm (altitude 1,118 m, 33° 46' S and 14° 11' E) on sandy clay loam soil. The soil analysis date were: pH 6.5; total nitrogen 0.16; available phosphorus 5.8 μg; exchangeable potassium 0.70 meq/100 g soil; exchangeable calcium 6.6 meq/100 g soil; exchangeable magnesium 2.34 meq/100 g soil; C/N ratio, 10.7; and CEC, 11.3. Three staking methods were compared. These were 1) no stanking where bean plants were left prostrate on the ridge but with vines trained within plants on each other on the ridge 2) vertical staking, by using reeds 1.7 m tall which were spaced 30.0 cm apart with each reed (stake) providing support for 2 plants and 3) horizontal staking, these were reeds 1-m tall spaced 1 m apart and 4-m reeds were tied to the vertical stakes at 0.5 m apart to form four tiers. Compound B fertilizer (4-7.8-12.5; N-P-K) which also contains 9.0% S and 0.1% B was applied to all plots before planting. The design was a split plot with cultivars as the main plot and staking method as the subplots. Each treatment which was replicated 10 times consisted of 3 ridges 91 cm apart and 4 m long. The distance between plants within ridges was 15 cm Pests were controlled by spraying with rogor (dimethoate). Yield and other agronomic parameters were determined from 4 m of the middle ridge Seed yield was the weight of all seeds obtained on 3 9 mm circular screen All seeds retained on 3 9 mm circular screen were divided into two groups namely: saleable and unsaleable The unsaleable seeds were beans which were shrivelled and/or discoloured as a result of infection by fungal and bacterial pathogens in or on the seed coat as well as by contact with water or the soil. Pods/m² was calculated using seeded pods Pod length was the average length of ten pods per treatment and the number of seeds per pod was determined from the ten pods

1972/73 experiment

During the 1972/73 growing season, cultivars 336 and 1200 were also grown at Bunda College Farm on 1st December, 1972, on a sandy clay soil The soil analysis results were pH, 6 0; total nitrogen 0 9%; available phosphorus, 4 0 μg; exchangeable potassium 1.16 meq/100 g soil; exchangeable calcium 8 80 meq/100 g soil; exchangeable magnesium 2 70 meq/100 g soil; C/N ratio, 10.4; and CEC, 15 24 The staking methods were essentially the same as the 1971/72 experiment except that sticks, with fairly rough surface, were used for staking instead of reeds This was because reeds were too smooth for easy training of bean vines The sticks used for the vertical and those vertical sticks used for the horizontal support were 2.0 and 1 2 m long, respectively, instead of 1 7 and 1.2 m long as in the previous year The design was a split plot with cultivars as the main plot and staking methods as the sub-plot. Compound L (8 0-6 5-8 3; N-P-K) fertilizer which also contaings 9 0% S and 0.1% B was applied at the rate of 400 kg/ha Each treatment, which was replicated 8 times, consisted of 4 ridges 91 cm apart and 4 m long and the distance between plants within ridges was 15.0 cm which gave a plant population of 73,260 plants/ha Yield and other agronomic characteristics were determined as for the 1971/72 experiment However, pods were divided into seeded and non-seeded (empty)

1973/74 experiment

Cultivar 1200 was planted at Bunda College on 5th January, 1973, on a sandy clay loam soil The soil analysis data were: pH, 6 3; total nitrogen, 0 15%; available phosphorus, 13 2 μg; exchangeable potassium 0 70 meq/100 g soil; exchangeable calcium, 6.8 meq/100 g soil; exchangeable magnesium, 0 71 meq/100 g soil; C/N ratio, 14 0; and CEC, 10 3

Four staking methods were compared The first one was no staking in which plants were left prostrate on the ground and the vines were not trained within the ridge The last three of these were essentially the same as for the 1971/72 and 1972/73 experiments The design was a randomized block and each treatment, which was replicated five times, consisted of three ridges each 10 m long Ridges were 91 cm apart and the distance between plants on the ridge was 15 cm producing a plant population of 73,260 plants/ha Each treatment received 400 kg/ha of compound L (8 0-6.5-8.3; N-P-K) fertilizer before planting Yield and yield components were determined from 10 m of the middle ridge and only yield of saleable seeds was determined Pods were separated into pod frequency from 0 (empty), to 9-seeded pods/m² Seed/pod ratio was the weight of saleable seed expressed as a percentage of saleable seeds plus shell weight

Results

1971/72 Season

Yield and yield components

Stanking increased seed (saleable) yield significantly at P = 0 05 (Table 1) For instance, the vertical and horizontal methods of staking yielded 46 1 and 38 2%, respectively, over the control (no staking) However, there was no significant difference between the vertical and the horizontal methods of staking Cultivar 336 yielded consistently higher (6.4%) than 1200; but the difference was not significant The yield of *cv.* 1200 was lower than expected This might have been due to an attack of bean fly, *Agromyza (Melanogromyza) phaseoli* Cop which caused the stem of such tender plants to break during training

Staking improved seed quality significantly (P=0 05) with vertical and horizontal staking methods producing 65 4 and 68.9%, respectively, higher quality seed than the control. Staking also increased the number of pods/m² with the vertical and the horizontal staking methods producing 22 3 and 19 3% more pods/m², respectively, than the unstaked treatment Neither seeds/pod nor pod length was significantly affected by staking method

1972/73 Season

Yield and yield components

As in the 1971/72 season, staking increased seed (saleable) yield significantly (P = 0.05) with control, vertical and horizontal staking methods (pooled over cultivars) producing 1,296, 1,784 and 1,968 kg/ha, respectively (Table 2) The yield difference between vertical and unstaked; and horizontal and unstaked plants were 37 7 and 51 8%, respectively However, the weights of unsaleable seeds, pooled over cultivars, were 139, 18 and 34 kg/ha, respectively, indicating that vertical and horizontal staking methods produced 86.8 and 75 6% higher quality seed than the unstaked plants Vertical and horizontal staking methods produced 6 9 and 10.0% more seeded pods/m² than the plants that were left prostrate on the ridge The number of empty

Table 1.—Yield and yield components of two bean cultivars at three staking methods (1971/72)

Cultivar	Staking Method	Yield (kg/ha)		Seeded pods/m²	Seeds/pod	Pod length (cm)
		Saleable	Unsaleable			
336	No staking	1,560	90	148.0	6.2	10.5
	Vertical staking	2,310	28	180.0	6.4	10.7
	Horizontal staking	2,090	19	157.0	6.4	10.8
	Mean	1,990	46	161.7	6.3	10.7
1200	No staking	1,150	83	234.0	5.5	8.0
	Vertical staking	2,090	32	312.0	5.6	8.3
	Horizontal staking	2,070	35	298.0	5.8	8.3
	Mean	1,870	50	281.3	5.6	8.2
	S.E. ±	187	12	14.7	0.13	0.1
	Means: No staking	1,505	87	191.0	5.9	9.3
	Vertical staking	2,200	30	246.0	6.0	9.5
	Horizontal staking	2,080	27	228.0	6.1	9.6
	S.E. ±	132	9	10.4	0.09	0.07

Table 2.—Yield and yield components of two bean cultivars at three staking methods (1972/73).

Cultivar	Staking Method	Yield (kg/ha)		Pods/m²		Seeds/pod	Pod length (cm)
		Saleable	Unsaleable	Seeded	Empty		
336	No staking	1,239	201	161.3	6.7	6.0	10.2
	Vertical staking	1,952	23	180.1	11.1	5.9	10.4
	Horizontal staking	2,029	50	168.2	11.0	6.2	10.9
	Mean	1,763	91	169.9	9.6	6.0	10.5
1200	No staking	1,356	76	231.8	14.0	5.1	8.3
	Vertical staking	1,618	13	245.6	15.7	5.1	7.8
	Horizontal staking	1,837	18	267.7	15.1	5.6	8.3
	Mean	1,605	36	249.4	14.9	5.3	8.1
	S.E. ±	205	47	10.4	1.4	0.14	0.20
	Means: No staking	1,296	139	198.1	10.4	5.6	9.3
	Vertical staking	1,785	18	213.0	13.4	5.5	9.1
	Horizontal staking	1,968	34	218.0	13.1	5.9	9.6
	S.E. ±	115	33	7.4	1.0	0.08	0.14

pods/m² also followed the same pattern of response as that of the seeded pods/m². As in the previous year, staking method had no significant effect on the number of seeds/pod and pod length

1973/74 Season

Seed Yield

Seed yield (kg/ha) increased significantly (P=0 05) with staking methods and vertical method of staking, which had the highest yield (2,223 kg/ha), produced 143% more than the control (no staking and no vine training). Yield (g/plant) also increased significantly (P=0 05) with staking method with the vertical and horizontal staking methods yielding 50 3 and 45 6% more g/plant, respectively, than the control (Table 3)

Components of yield

The effects of staking method on pod characteristics are presented in Table 4 Plants trained on stakes produced more pods/m² than unstaked plants with vertical and horizontal methods of support producing 58.7 and 34.0% more pods/m², respectively, than control The number of pods/m² for no staking and no vine training and no staking but vine training more comparable Pods with six seeds occurred more frequently with unstaked plants while seven-seeded pods occurred more frequently with staked plants Staking increased pod length with vertical and horizontal staking methods producing 17.4 and 44.9% longer pods, respectively, than the control.

Generally, pods with six or seven seeds had a higher yield contribution to total yield than others Six-seeded pods produced 26 5% of the total seed yield of unstaked plants while pods with seven seeds had 35.2% of the total yield of staked plants The shelling percentage (seed/pod ratio × 100) increased with additional seeds/pod with the one- and the nine-seeded pods having 49 9 and 79 4 shelling percentage, respectively

Discussion

Yield and yield components

The seed yields, pooled over three years for unstaked, vertical and horizontal staking were 1,178, 2,069 and 2,061 kg/ha, respectively, thereby indicating that staking, either vertical or horizontal methods increased, seed yield when compared with the control treatment However, vertical and horizontal staking methods had comparable results. The increase in yield with staking could be attributed to, among other factors, better exposure of leaves to solar radiation, and of more vigorus growth and development of the staked than the unstaked plants. The staked plants which grew much taller might have had more area for pod set as compared to the unstaked plants which were much shorter and the concentration of pods on a relatively, smaller area might have increased competition for "sink" site Consequently, there were fewer pods/plant and per m² for the unstaked than the staked plants. For instance, the number of seeded pods/m², pooled over the three years ,were 169.2, 231 4 and 221 6 for unstaked, vertical and horizontal staking, respectively, and the correlation coefficient between seeded pods/m² and saleable yield was 0 673 ($r^2 \times 100 = 45.3$) indicating that 45 3% of the variation in seed yield could be accounted for by difference in pods/m²

It was easier to train vines on stakes with rough than on stakes with smooth surfaces and in vertical than in horizontal supports. In vertical method of staking, once the stakes were set in position and the vines trained early in the season before they coiled, vine training was not a problem and needed little or no attention thereafter because the vines were able to "train" themselves on the stakes. However, with the horizontal staking, much attention and care were needed to ensure that the vines were trained along the appropriate tier and with least damage Delay in vine training meant unwinding the vines from the tier and training them on the upper one which resulted in stem breakage.

Despite these limitations, the results showed that with care, comparable results could be obtained from both methods. This would suggest that a camallholder who has no difficulty in obtaining stakes would use the vertical methods However, in areas where stakes are scarce, the horizontal method would be preferred. Here the farmer could use a few strong vertical stakes with dried maize or sorghum stalks forming the horizontal tiers

Staked plants produced higher quality seeds than unstaked plants The increase in seed quality with staking was mainly due to higher pod clearance above the ground and less denser canopy which made the microclimate around the staked plants less humid. Consequently, there were fewer pods resting on the damp soil thereby reducing the number of pods and seeds discoloured by microbial growth.

Table 3.—Yield of one bean cultivar at four staking methods (1973/74).

Staking Method	Yield			
	kg/ha	Increase (%) over control	g/plant	Increase (%) over control
No staking and no vine training (control)	916	—	21 1	—
No staking but vine training	993	8	22 8	8
Vertical staking	2,223	143	50 3	138
Horizontal staking	2,136	134	45 6	116
Mean	1,567	—	35 0	—
S E ±	182	—	4 0	—

Table 4.—Number of pods/m², pod length, percentage yield contribution of seeded pods and shelling percentage of a bean cultivar at four staking methods.

Staking Method	Pod description (number of seeds/pod)											
	0	1	2	3	4	5	6	7	8	9	Total	Mean
	Pods/m²											
No staking and no vine training	15.4	6.4	14.3	20.6	26.2	27.9	29.2	16.0	1.2	—	157.2	—
No staking but vine training	15.5	7.1	14.6	22.4	26.9	25.5	28.5	19.6	1.1	—	161.3	—
Vertical staking	14.2	5.9	10.1	34.6	24.0	35.2	50.3	60.0	15.1	0.1	249.5	—
Horizontal staking	19.6	6.9	12.1	19.8	26.4	38.0	48.9	56.4	10.1	0.1	238.3	—
Mean	16.2	6.6	12.8	24.4	25.9	31.7	39.2	38.0	6.9	0.1	—	
	Pod length (cm)											
No staking and no vine training	6.6	6.6	6.3	6.9	7.6	7.8	8.1	8.7	9.1	—	—	7.5
No staking but vine training	6.2	6.7	6.4	7.0	7.2	7.6	8.2	8.2	9.0	—	—	7.4
Vertical training	6.3	7.0	7.2	7.6	8.0	8.4	8.6	9.0	9.3	10.0	—	8.1
Horizontal training	6.9	7.3	7.7	8.3	8.2	8.5	8.8	9.7	9.7	9.9	—	8.5
Mean	6.5	6.9	6.9	7.5	7.8	8.1	8.4	8.9	9.3	10.0	—	—
	Yield contribution (%) by each pod characteristic											
No staking and no vine training	—	0.9	3.8	9.0	15.9	22.6	26.8	19.4	1.6	—	—	—
No staking but vine training	—	0.9	4.0	9.0	16.8	23.6	26.1	18.2	1.4	—	—	—
Vertical training	—	0.4	1.6	4.0	7.8	14.6	25.6	35.9	10.0	0.1	—	—
Horizontal training	—	0.5	1.9	4.8	8.4	16.2	26.7	34.4	7.0	0.1	—	—
Mean	—	0.6	2.8	6.7	12.2	19.3	26.3	27.0	5.0	0.1	—	—
	Shelling percentage (Seed/pod) ratio X 100											
No staking and no vine training	—	48.9	61.8	61.9	71.2	75.9	77.0	78.2	79.3	—	—	69.7
No staking but vine training	—	50.3	65.7	69.2	74.2	76.5	78.0	78.3	78.5	—	—	71.3
Vertical training	—	49.7	62.3	69.0	72.1	74.3	73.9	76.7	77.4	81.0	—	70.7
Horizontal training	—	50.8	64.9	68.9	72.5	75.0	76.6	77.8	77.8	77.7	—	71.3
Mean	—	49.9	63.7	67.3	73.3	75.4	76.4	77.8	78.3	79.4	—	—

Summary

Indeterminate beans (*Phaseolus vulgaris* L.) were grown on 91-cm ridges in three seasons to compare the effects of no staking, vertical and horizontal staking on the seed yield and seed quality of beans. The seed yields, pooled over years, for no staking, vertical and horizontal staking methods were 1,178, 2,069 and 2,061 kg/ha, respectively, indicating that both vertical and horizontal methods of staking had comparable results. It was easier to train vines on rougher than on smoother stakes and on vertical than on horizontal stakes.

Staking also produced higher quality seeds because of higher pod clearance above the ground which resulted in fewer pods resting on the ground with staked than with unstaked plants.

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Reseña de Libros

EHRLICH, PAUL R , EHRLICH, ANNE, H y HOLDREN, JOHN P Ecoscience: population, resources, environment San Francisco, W H Freeman, 1977. 1051 p

Esta edición considerablemente revisada de la obra del mismo título (pero sin la palabra Ecosciente), es posiblemente en la actualidad el mejor y más completo libro sobre la interrelación entre población, recursos, energía y el medio ambiente.

Aunque son bien conocidos los puntos de vista del autor principal sobre el impacto devastador del aumento acelerado de población sobre recursos y sobre la deterioración del ambiente, el libro está escrito en forma moderada, con un esfuerzo real de ofrecer un punto de vista tan objetivo como posible, presentando a veces los diferentes enfoques que existen sobre un mismo tema.

El libro se ha dividido en diferentes secciones, todas con un planteamiento eminentemente ecológico del sistema "planeta tierra" y sus numerosos subsistemas Sobre todo se ofrecen datos, gráficos, y numerosísimas tablas; en fin, una amplia información de base, complementada por una admirable cantidad de referencias e índices de materias y de autores citados (varios miles)

En un libro de esta envergadura con un campo tan amplio de "interacciones" es difícil apuntar fallas sin caer en opiniones subjetivas Una impresión general es que la base es demasiado norteamericana y que las inevitables generalizaciones para los trópicos en general no toman suficientemente en cuenta las regiones de mediana elevación donde en muchos países se encuentra concentrada la mayor parte de la población y donde se encuentran a menudo las zonas más productivas para agricultura Hay una gran diferencia entre trópicos de altura y de bajura y ésto no se destaca suficientemente

Los capítulos sobre los futuros prospectos de la producción de alimentos, la discusión sobre revolución verde y sus limitaciones, el actual y futuro uso de energía, la disrupción de sistemas ecológicos (incluyendo las contaminaciones) son particularmente sobrios y deberán ser material de estudio para todos los que se interesan en estos temas Es inescapable la conclusión de que el futuro de planeta tierra está en serio peligro.

Se trata pues de un libro que no sólo es excelente como referencia, sino también prácticamente una enciclopedia de la ecología moderna Cómo es posible abarcar tanto y en forma relativamente tan concisa, no es fácilmente explicable y los autores merecen nuestra gratitud por acopiar, sintetizar, analizar y correlacionar la abundante y dispersa información disponible

GERARDO BUDOWSKI
CENTRO AGRONOMICO TROPICAL DE INVESTIGACION Y ENSEÑANZA (CATIE)
TURRIALBA, COSTA RICA

BLASCO LAMENCA, MARIO y SALINAS BARRETO, LUIS, eds Reunión Técnica Regional sobre Transferencia de Tecnología Agrícola a los Productores, Maracay, Venezuela, 26-30 mayo 1975 Lima, IICA Zona Andina, 1977, 231 p (Informes de Conferencias, Cursos y Reuniones Nº 83)

Después de algún tiempo de haber prácticamente abandonado los programas de extensión agrícola, los gobiernos latinoamericanos han vuelto la mirada nuevamente a los agentes de cambio y han reanudado sus esfuerzos en la acción más cercana al agricultor, esta vez con el nombre de transferencia de tecnología agrícola

Una de las reuniones más importantes sobre este tema se realizó en Maracay, Venezuela, en 1975. Los trabajos que allí se presentaron están contenidos en este volumen, publicado en Lima por la Zona Andina del IICA.

Lo que distingue este volumen de otros similares es la preponderancia de trabajos que examinan la realidad actual y estudian casos, frente a discusiones "conceptuales" que no miran al agro sino a las ideas de lo que Joan Robinson llama "ideólogos urbanos", que hasta hace poco eran muy visibles en este tipo de reuniones. Los trabajos se agrupan en dos tipos: a) informes sobre la transferencia de tecnología en países individuales; aquí hay información de valor sobre los éxitos y fracasos de las estrategias y tácticas empleadas en los planes de mejoramiento de la agricultura, los que deben ser estudiados para evaluar y aprovechar experiencias; y b) trabajos de especialistas en investigación, sistemas de producción, política económica, comunicación y educación, los que en gran parte exponen ideas, producto de observaciones en el mismo terreno, sobre la forma como funciona en los países andinos la transferencia de tecnología agrícola. Destaca en este grupo el trabajo de los organizadores del certamen, Mario Blasco y Guillermo Guerra, quienes en forma clara y ordenada presentan las relaciones de la investigación con la transferencia tecnológica, su situación en la región, los problemas de la transferencia, y las soluciones propuestas

Contrastan con estos trabajos, aquellos pocos que se han limitado a especulaciones teóricas y no a los problemas del agro de América Latina. Un caso típico es el que trata de la educación y transferencia, (pp 197-225) Difunde las ideas contenidas en libros de gente como Max Weber (sobre la ética protestante), Marcusse (sobre el hombre unidimensional), Bloch (el principio de la esperanza), cuya pertinencia con los problemas de nuestros campesinos no es fácil discernir Más que la relación entre la educación y el desarrollo rural, al autor aparentemente le interesa la formación de un nuevo hombre, que piense según modelos teóricos y que actúe condicionado a un marco ideal. Este es, aun en el mejor de los casos, un programa a muy largo plazo Pero los problemas de nuestro agro son urgentes; no hay tiempo para esperar esta nueva creación