GROWTH AND YIELD OF SORGHUM AS INFLUENCED BY GREEN MANURE AND SOIL ORGANIC MATTER CONTENT

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ABSTRACT

Green manure increased the organic matter content of the soil. Soybeans, as green manure, provided the highest organic matter content (3.796%), followed by mungbean (3.268%) and bushbean (2.836%). The plot without green manure had the lowest organic matter content of 1.740%. The nutrients from the organic matter of the soil significantly increased plant height in the treated plots more than those in plots without green manure. This practice was not effective in increasing the panicle length, panicle weight, and the 100-grain weight of sorghum. Using mungbean as green manure significantly decreased the grain yield of sorghum although there was a significant increase in plant height. Highly significant differences were observed on the effects of the inorganic fertilizer treatments. Application of 30-30-30 kg/ha of N, P_2O_5, and K_2O markedly increased plant height, leaf area index, panicle length, panicle weight, and grain yield (2.24 t/ha). Plots where no fertilizer was applied yielded 1.12 t/ha of grain.

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INTRODUCTION

Because of improper cultivation, excessive use of contact herbicides, and continuous cropping which may lead to erosion, most of our lands have been seriously depleted of organic matter. To alleviate this condition, adequate organic matter, in the form of green manure should be incorporated into the soil at every cropping period. Green manure is any plant or crop, usually a legume, grown in the field and plowed into the soil to augment the existing organic matter and to make soil conditions more favorable for the growth of the succeeding crops

(Mercado, 1954). It is incorporated into the soil at flowering stage, or when formation of nodules is at its peak, as in the case of legumes. This study presents (a) the effects of green manuring using different legume crops on the organic matter content of the soil and (b) the effects of different green manure and inorganic fertilizers on the growth and yield of sorghum.

MATERIALS AND METHODS

An experimental area of 630 sq m was prepared by plowing and harrowing alternately. Three plowing operations each followed by harrowing were done to allow the weed seeds to germinate and to level and pulverize the soil. A split-plot arranged in randomized complete block design with three replications was used. The experimental area was divided into four main plots with an area of 45 sq m (10 x 4.5 m) each. These four main plots were further sub-divided into 2.5 x 4.5 m sub-plots for the fertilizer treatments in combination with green manuring. Each main plot was separated by 1.0 m alleyway. The main plots (green manure) were designated as follows:

T_0 – control (no green manure)
T_1 – bushbean
T_2 – mungbean
T_3 – soybean

The sub-plots (inorganic fertilizers) were designated as follows:

F_0 – 0-0-0 F_2 – 30-30-30
F_1 – 0-30-30 F_3 – 60-30-30

Bushbeans, mungbeans and soybeans as green manure were planted simultaneously since they flower at about the same time. They were planted at a distance of 75 cm between rows and 25 cm between hills with plant population of 110,000 plants/ha for each crop. Sorghum, the main crop, was planted one month after plowing-under the green manure crops. Enough seeds were drilled in the ridges to have 15 plants per linear meter or a plant population of 200,000 plants/ha.

The legume plants were plowed under at flowering stage by using an animal-drawn moldboard plow. The green manure plants were allowed to decompose for about a month before the sorghum crop was planted.

Before planting the main crop, all the plots (including the control) were applied with the specific treatments in the rows. Urea (45-0-0), single superphosphate (0-20-0), and muriate of potash (0-0-60) were used as the inorganic fertilizers. Sorghum was harvested when 90% of the heads were fully ripened.

To minimize weed competition for plant nutrients, sunlight, space and moisture, hand weeding was done whenever necessary. Other cultural practices such as pest control, irrigation and drainage, etc. were also done.

To determine the initial and final organic matter contents of the soil, sampling was done three times: (a) after the first land preparation, (b) before planting sorghum, and (c) shortly after harvesting sorghum. The Walkley-Black method of determining the organic matter content

of the soil was used (Jackson, 1958).

RESULTS AND DISCUSSION

Organic Matter Content.

After incorporating the green manure into the soil, the organic matter content of the soil increased from an initial content of 1.401% to 3.300% (Table 1). This result corroborated with the findings of Bavaskar and Zende (1972) and Beckman (1977) that green manuring tends to increase the organic matter content of the soil thus improving its physical as well as chemical properties. After harvesting the sorghum crop, the organic matter content of the soil declined by about 23.8% (Table 1). This reduction was due to the utilization of the available nutrients, especially N, P, and K from the decomposing organic matter by the sorghum crop. It was also possible that some of the decomposed organic matter leached to the lower soil horizon or were washed away.

Agronomic Characteristics of Sorghum.

Number of Days from Seeding to Emergence. — Plants in T_1 emerged earlier compared to the rest of the treatments (Table 2). Statistical analysis revealed that an application of 30 kg N/ha significantly enhanced the emergence of sorghum, while 60 kg N/ha delayed its emergence (Table 2). Salisbury (1969) stated that higher nitrogen application caused some inhibitory effects on germination because nitrogen release ammonia. He also stated that nitrate is also one of the germination promoters to a certain extent. This study shows that an application of 30 kg N/ha was

Table 1. Organic matter content of the soil before and after green manuring and after harvesting the sorghum crop.

Legume Crop	Organic Matter Convent (%)		
	A_1	B_2	C_3
Control	**1.401**	**1.740**	**1.572**
Bushbean	**1.401**	**2.836**	**2.350**
Mungbean	**1.401**	**3.268**	**2.689**
Soybean	**1.401**	**3.796**	**2.505**
Mean[1]	**1.401**	**3.3004**	**2.5144**
t-computed	**3.36**	**5.796**	
t-tabulated =	**1.943**		

A_1 Analysis using the Walkley-Black method was made before manuring was applied.
B_2 Analysis made after green manuring and before planting the sorghum crop.
C_3 Analysis made after harvesting the sorghum crop.
[1] Mean organic matter content of the soil excluding the control.

enough to enhance sorghum emergence.

Number of Days from Emergence to Flowering. — Green manure treatments and different levels of inorganic fertilizer did not significantly affect the number of days from emergence to flowering of sorghum. There were also no significant interaction effects observed between green manuring and fertilizer treatments. However, manuring slightly delayed the flowering of sorghum by 1-2 days (Table 2).

Number of Days from Emergence to Maturity. — The different green manure and fertilizer treatments did not significantly affect the number of days from emergence to maturity of the sorghum crop although there were slight differences among the means. Likewise, an application of 30 kg N/ha enhanced crop maturity by about 3 days compared to the control (Table 2).

Leaf Area Index (LAI). — Leaf area index is an important factor that influences light interception, crop growth, and consequently crop yield. High leaf area allows interception of more light, thereby enhancing greater photosynthetic activity. While photosynthesis is actively going on, more photosynthates are manufactured in the leaves and translocated to the grains. However, extremely high LAI may also have some detrimental affects because of mutual shading which consequently results in competition for light.

Green manure did not significantly affect the LAI of sorghum. However, plots treated with bushbeans as green manure had the highest LAI (2.02), while the control had the lowest (1.86). The addition of inorganic fertilizer (30-30-30) increased the LAI of sorghum significantly. Table 2 shows that an application of 30-30-30 markedly increased LAI (2.26) while the control plot had the lowest LAI (1.458).

Plant Height. — Data on plant height was taken bi-weekly starting one month after planting. Plant height increased rapidly from 6-10 weeks after emergence; beyond this period, the increase was gradual. This might be due to the maximum utilization of nutrients from the added organic matter and inorganic fertilizer during the active vegetative growth stage of the crop. Plants in plots manured with soybeans grew tallest (147.48 cm) while those in the control plots, grew shortest (114.48 cm). Plant height was also affected significantly by the varying levels of inorganic fertilizers. The addition of nitrogen fertilizer at 60 kg/ha increased plant height significantly from 6-10 weeks after planting, the plant growth slowing down beyond this period (Table 2). Statistically, plants treated with 30 and 60 kg N/ha were significantly taller than those that did not receive inorganic N fertilizer. This shows that plants need ample supply of nitrogen especially during their active vegetative stage. No significant interaction was observed between manuring and inorganic fertilizer levels.

Table 2. Means for the different parameters for sorghum as affected by different manure and fertilizer treatments.

Treatments	Number of Days			Leaf Area Index	Plant Height at Harvest (cm)	Panicle Length (cm)	Panicle Weight (g)	100-grain Weight (g)	Grain Yield (t/ha)
	Seeding to emergence	Emergence to flowering	Emergence to maturity						
(Green Manure)									
Control	7.58	63.74	101.90	1.86	114.48a	12.25	0.21	2.58	2.32c
Bushbean	6.75	64.16	98.90	2.02	137.80b	12.96	0.22	2.37	1.62a
Mungbean	7.25	65.08	99.24	1.86	143.88bc	11.52	0.17	2.39	1.15a
Soybean	6.92	65.40	99.49	1.93	147.48c	12.66	0.21	2.67	2.13
Mean	7.12	64.60	99.90	1.92	135.86	12.42	0.20	2.50	1.80
(Fertilizer)									
Control	7.33b	65.33	101.16	1.58a	126.67a	11.29a	0.16	2.42	1.22a
0-30-30	7.33b	64.50	100.00	1.77b	133.33a	12.26b	0.19b	2.54	1.64b
30-30-30	6.66a	64.42	98.58	2.26d	140.59b	13.33c	0.24c	2.68	2.24c
60-30-30	7.16b	64.20	99.92	2.05c	142.86b	12.81bc	0.20b	2.46	2.20c
Mean	7.12	64.60	99.90	1.92	135.86	12.42	0.20	2.50	1.80
Grand Mean	7.12	64.60	99.90	1.92	135.86	12.42	0.20	2.50	30.83
CV (a) %	15.38	3.46	2.66	36.70	4.36	16.60	29.58	12.62	30.83
CV (b) %	7.02	3.01	3.41	9.60	5.57	5.15	13.66	14.09	23.60

Treatment means within a column and within treatments not designated by letters are not significantly different in the F-test.

Treatment means within a column and within treatments followed by a common letter are not significantly different at 0.05 probability (DMRT).

Yield and Yield Components of Sorghum.

Statistical analysis revealed that the length and weight of panicle, and the 100-grain weight were not significantly affected by green manuring. No significant interaction between green manuring and inorganic fertilizer treatments was noted. However, significant differences were observed on panicle length and panicle weight among inorganic fertilizer treatments (Table 2). Plants in plots treated with 30 kg N/ha produced the longest panicle, while those in the control, the shortest. In this study, the average length of the panicles was shorter than normal (<20 cm), which was probably due to the poor stand of the crop brought about by unfavorable climatic conditions during its development period. The excessive rainfall during the period of the study affected panicle formation and development because the crop grew luxuriantly.

Plants treated with 30 kg N/ha developed panicles weighing 0.24 kg/plant, while those in the control plots developed light panicles (0.17 kg/plant). The greater supply of nutrients from the fertilizer application could have made the difference.

Grain Yield. — Application of green manure did not increase grain yield as was expected. The plants in the control plots produced the highest grain yield (2.32 t/ha) while those in the mungbean-treated plots the lowest yield (1.15 t/ha) (Table 2). The decrease in yield of mungbean-treated plots was probably caused by the toxic substances

excreted by the mungbean plants which are detrimental to the succeeding crop (Gabon, 1977). The damage caused by birds which fed on the grains added further to the reduction in grain yield. Application of inorganic fertilizer increased the grain yield of sorghum significantly, especially at 30 and 60 kg/ha levels of nitrogen (Table 2). These levels yielded the highest values for all he parameters.

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