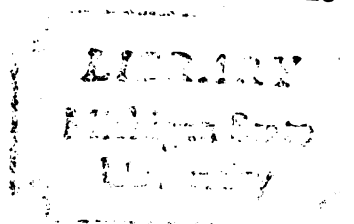




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THE RESPONSE OF CROPS TO SORGHUM RESIDUES

by

Gerardo V. Ruiz-Sifre

A THESIS

Submitted to

Michigan State University
in partial fulfillment of the requirements
for the degree of

MASTER OF SCIENCE

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1982

ABSTRACT

THE RESPONSE OF CROPS TO SORGHUM RESIDUES

by

Gerardo V. Ruiz-Sifre

Vegetable and field crops were grown on residues of several sorghum (Sorghum vulgare Pers.) cultivars in the greenhouse and field. The growth of snap beans (Phaseolus vulgaris L.) in the greenhouse was increased by 'Bird-a-Boo' sorghum depending on the potting soil used. The growth of field corn (Zea mays L.) seedlings in the greenhouse was consistently increased by residues of sorghum shoots, but not by residues of sorghum roots or whole plants. In contrast the growth of sweet corn in the field was always decreased by residues of 'Bird-a-Boo' sorghum roots and whole plants. The growth and yield of snap beans in the field was increased or decreased by sorghum residues depending on the sorghum plant part, quantity, cultivar, and soil environment. Although sorghum residues may stimulate crop growth, this stimulation was not easily controlled because the optimal range of sorghum residues and soil environment is too narrow.

I dedicate this thesis to the one who guided and inspired me during my trying times, to my Aunt Hilda Luz Mendoza.

ACKNOWLEDGEMENTS

I would like to thank Dr. S. K. Ries and Violet Wert, for their guidance during my research. I would also like to acknowledge Joseph DeFrank for his suggestions. I wish to express my appreciation to Dr. H. C. Price and Dr. W. F. Meggitt for serving on my committee. I also thank Jackie Schartzner for typing this thesis, and the other people who have helped me in my research.

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INTRODUCTION

Sorghum residues have been shown to affect the succeeding crop (17, 18). Sorghum residues may either stimulate or inhibit growth, depending on the cultivar and vegetable crop grown in the residue (8). The objective of this research was to determine if it is practical to utilize sorghum residues to increase the yield of vegetable crops.

The factors studied were sorghum cultivars, sowing rates, stages of killing, growth interval for planting the crop after killing and the response of different vegetable crops to sorghum.

LITERATURE REVIEW

The lowest yield of corn resulted when corn was planted in a rotation in which sorghum preceded the corn as compared to other small grain preceding the corn (17). Sorghum also debilitates the soil by exhausting the soil of moisture and killing microorganisms responsible for soil flocculation (18). The poor soil flocculation decreased the moisture retention capacity of the soil (4, 18).

Another hypothesis to explain the effects of sorghum was that high sugar concentrations in sorghum plants increased the number of soil microorganisms (6), which competed with the crop plants for nitrogen. Conrad (7) showed that this problem was partially corrected by planting legumes or applying nitrogen fertilizer.

Plants also exude chemicals into the environment which may either directly or indirectly affect the germination and growth of other plants (15, 16). Sorghum root exudates can be increased or decreased depending on application of foliar nutrients and on a change in metabolic activity at different stages of sorghum growth (1). Higher levels of exudates are produced during the early stages of sorghum growth than during the later stages (1).

Excretions of scopoletin from oat (Avena sativa L.) plants are minimal under optimum growing conditions, but increase with conditions unfavorable for growth of oats (11). In general, the direct action of the chemicals that are excreted from various plant species depends on the concentration, stability and physiological activity of the chemical substance released into the soil (3).

In 1964, Hoveland (10) found that small-seeded legumes were inhibited by sorghum root extracts. Patrick, et. al. (13) found that the chemicals most toxic in barley (Hordeum vulgare L.) were frequently present when the barley had decomposed in the soil for 10 to 25 days. After this period the toxicity declined and the growth of lettuce (Lactuca sativa L.) was frequently stimulated.

Environmental conditions such as soil moisture, temperature and microbial activity are involved in the release of chemical substances from crop residues (12). Depending on the decomposition condition of the crop residues, substances which are highly toxic, non-toxic or stimulative to another crop can be produced (13). During crop decomposition in the field, water soluble toxins are practically absent in sorghum residues after 22 to 28 weeks (9). The inhibitory effect of residues of wheat (Triticum aestivum L.) and oat straw disappear after 8 weeks in the soil. Wheat plants that have been grown on extracts of bluegrass (Poa pratensis L.) straw show a stimulative effect after the straw has been exposed to heavy precipitation indicating that the toxins may have been leached from the straw (5). It was believed that these growth stimulators in the bluegrass were less soluble in water than the inhibitors, thus compounds may have stimulated growth at low concentrations.

There is a possibility that crop stimulation can be obtained by advantageous association between crop plant species (14). DeFrank (8) reported that plant populations of sweet corn and snap beans were increased by 'F.S. 24' sorghum residues. It was also reported that the plant population of cucumbers (Cucumis sativus L.) was increased by

'Bird-a-Boo' sorghum (8). Higher yields of sweet corn, lima beans (Phaseolus limensis Macf.) and watermelon (Citrullus vulgaris Schrad.) were obtained when rye (Secale cereale L.) was used as mulch in a no-till study (2).

In the future, man should strive to understand the natural relationships and interactions between crop plant species. These relationships should be taken into consideration for improving crop culture and food production.

MATERIALS AND METHODS

Greenhouse experiments. The response of 'Pioneer 3780' corn seedlings to different parts of 'Bird-a-Boo' sorghum plants, was measured in the greenhouse. The sorghum plants were grown in cedar flats (35 x 50 cm) and clay pots (18 x 17 cm). Seventy-two and 14 sorghum seeds were planted in each flat and pot respectively.

Sorghum shoots, roots and whole plants were compared with controls consisting of paper strips or vermiculite for their influence in the growth of corn. The sorghum was killed either with 1.7 kg/ha of glyphosate or by freezing. The shoots were cut from one series of flats for the shoot treatment and the remaining roots were used to test the effect of sorghum roots on growth.

One week after the sorghum was killed, 2 rows of corn with 12 seeds per row were planted per flat, and 8 seeds were planted per pot at a depth of 2.5 cm. Eight days after planting, the corn seedlings were thinned to 10 per row in the flats and 4 per row in the pots. The corn shoots were harvested and dried at 70°C for at least one day prior to dry weight determinations. Three successive plantings of corn were made on the same soil at intervals after the first planting.

The influence of sorghum residues and time of planting after killing the sorghum was studied by establishing 10 sorghum plants in (18 x 17 cm) clay pots. The sorghum plants were killed with glyphosate, and 8 snap bean seeds planted per pot at a depth of 1.3 cm. Eleven days after the planting, the snap bean seedlings were thinned to 4 plants per pot. After approximately 8 days, the snap bean shoots were harvested and dried at 70°C for at least one day.

'Spartan Arrow' snap beans were planted on sorghum plants that were killed 1, 3 and 6 weeks after planting. The controls consisted of pots containing vermiculite at approximately the same volume as the sorghum.

'Spartan Arrow' snap beans were seeded in pots which contained residues of 3, 6 and 9 sorghum plants. Three controls (no sorghum) were included; one with no mulch and the other 2 with excelsior applied at a rate equal to the weight of sorghum used.

'Spartan Arrow' snap beans were planted on sorghum residues 1, 2, and 4 weeks after the sorghum was killed. Controls consisted of vermiculite applied at approximately the same volume as the sorghum. There was a control for each planting interval. The pots containing sorghum residues were watered during the interval between when the sorghum was killed and when the crop was planted.

The soil used in all the experiments was a loam, sand and peat mix in a 1:1:1 proportion, except in one experiment concerned with the age of sorghum at time of killing and one test on the rate of sorghum plant residues. In these cases the same soil described above was used and combined with Sunshine mix (Tisor Western Pear Corporation, Vancouver, B. C., Canada) in a 1:1 proportion. Sorghum, corn and snap bean plants were fertilized twice a week with 1 g/liter of a soluble 20N-20P-20K fertilizer, at a rate of 250 and 750 ml per pot and flat respectively.

Field experiments. The cultural practices used such as fertilization, planting method and spacing are shown in Table 1. The sweet corn test planted in sorghum residues also received 112 kg N/ha, 17

TABLE 1:
Cultural conditions for crops tested on sorghum residue and cultivare in 1980 and 1981.

Experiment	Location	Year	Soil Type	Fertilizer N-P-K (kg/ha)	Planting Method Sorghum	Spacing					
						Cucumber		Snap Bean		Sweet Corn	
						between row (m)	in row (cm)	between row (m)	in row (cm)	between row (m)	in row (cm)
Sorghum Residues	Clarksville Experimental Station	1980	Bixby Sandy Loam	134 (k)	Unidrill Ballymoney BT336 PP Co. Antrim, N. Ireland	-	-	0.5	8-12	0.5	20
	East Lansing Hort. Farm	1981	Conover Loam	336(10-20-20)	Planet Jr. Cole Manufacturing Company. Charlotte, N.C.	-	-	0.6	5-6	0.6	20
Sorghum Cultivare	East Lansing Hort. Farm	1980	Spinks Sandy Loam	448(16-16-16)	Unidrill	1	15	1	8-10	1	20
	East Lansing Hort. Farm	1981	Spinks Sandy Loam	560(12-12-12)	Planet Jr.	0.6	30	.0.6	10-11		

days after planting in 1981. Four rows of the crops were planted in all the experiments, except in the 1980 sorghum cultivar experiment in which 3 rows were planted. The 2 outside rows in each experiment were considered guard rows. The plots were 3 x 6 m in all the experiments except in the 1980 sorghum cultivar experiment in which the plots were 3 x 3 m. Weeds were controlled in the sorghum and crops by hand hoeing. Water was applied with overhead irrigation on all the plots as needed.

The response of 'Spartan Arrow' snap bean and 'Gold Cup' sweet corn to 'Bird-a-Boo' sorghum plant residues was studied in 1980 and 1981. The treatments consisted of sorghum roots, shoots, whole plants and a control with no sorghum.

'Gold Cup' sweet corn, 'Spartan Arrow' snap beans and 'Greenstar' cucumber, were tested in sorghum cultivars in 1980 and 1981. In 1980, the treatments consisted of a control (no sorghum) and 2 sorghum cultivars 'Milkmaker' and 'Haygrazer'. In 1981, snap beans, and cucumber were tested on 3 different sorghum cultivars ('Milkmaker', 'Haygrazer', and 'Bird-a-Boo'). The snap beans were planted at 2 dates with 2 weeks between plantings. The cucumbers however, were planted 2 different times, 1 and 2 weeks after the sorghum was killed.

Statistical procedures. Randomized complete block designs were used in all greenhouse and field studies. For convenience, different crops were included in the same randomized block design in the field, but the data for each crop was analyzed separately. Six blocks were used in the greenhouse studies and 4 blocks in the field research, except for the 1981 sorghum cultivar experiments, which utilized only 2 blocks.

Analysis of variance was conducted and the F test used if appropriate. In the other tests the means were compared with the L.S.D. when the F value for the factor was significant.

RESULTS AND DISCUSSION

Greenhouse experiments. The response of the corn seedlings to sorghum residues was similar when the sorghum plants were killed with glyphosate or by freezing. Thus, the data for the different methods of killing was combined and analyzed as a percentage of the controls for the 4 planting times.

The dry weight of corn seedlings was increased 28% and 32% by the residues or sorghum shoots and whole sorghum plants respectively compared to controls (Table 2). There was no significant difference between the dry weight of corn seedlings grown in the residues of sorghum roots and controls.

The data from another experiment with pots and flats was also combined and analyzed as a percentage of the controls for the 4 planting times. The residues from sorghum shoots consistently increased the dry weight of corn seedlings over a 14 week period (Figure 1). In contrast to this stimulation the residues from sorghum roots inhibited corn for 7 weeks and then the effect was lost. Whole plants had no effect on growth during the period that the roots alone were causing inhibition. However, after the inhibitory effect of roots was lost whole plant residues stimulated growth. This response occurred regardless of how the sorghum was killed and in both pots and flats.

The corn seedlings response to the sorghum residues suggests the presence of a growth inhibitor in the sorghum roots and the presence of a growth stimulator in the sorghum shoots. It is also possible that the same chemical or chemicals inhibits growth at high levels and stimulates growth at low levels (5).

TABLE 2:

Growth of 'Pioneer 3780' corn seedlings planted in residues of 'Bird-a-Boo' sorghum from whole plants, shoots and roots.

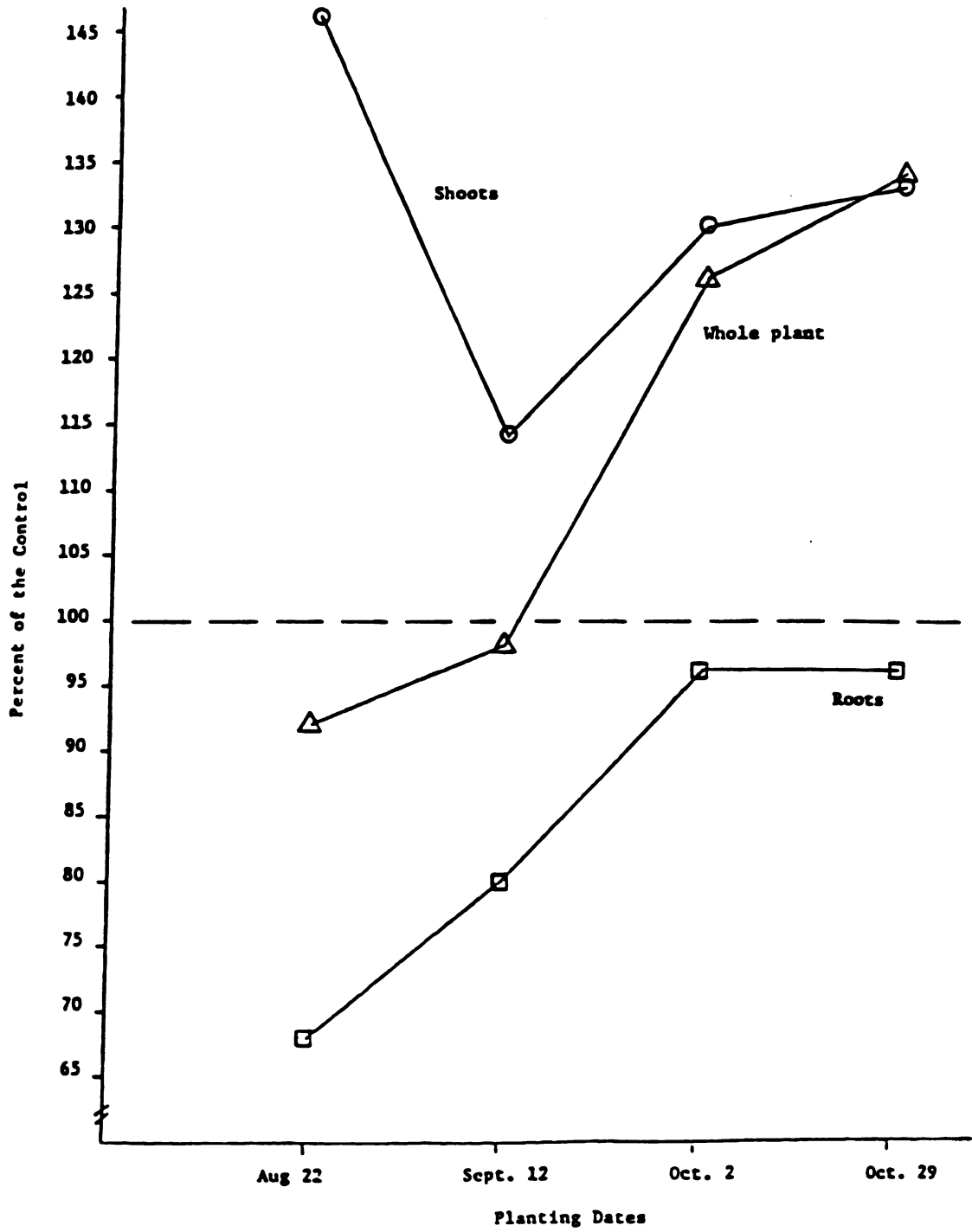
Forty-nine day-old sorghum plants were killed on November 30, 1979. Corn seed were planted in flats on December 13, 1979, January 8, February 3 and February 26, 1980. Corn plants were harvested 20 days after planting. Each observation is the average of 2 killing methods of 4 planting dates.

Sorghum Residue	% of Control
Whole Plants	132
Shoots	128
Roots	102
L.S.D. at .05 level	14
L.S.D. at .01 level	19

FIGURE 1:

Response in the greenhouse of 'Pioneer 3780' corn seeded at different times to residues of whole plants, shoots, and roots of 'Bird-a-Boo' sorghum.

Thirty-two day-old sorghum was killed on August 13, 1980. Corn seeds were planted in flats and pots on August 22, September 11, October 1 and October 21, 1980. Corn shoots were harvested 20 days after planting. Each observation is the average of 2 tests of 6 replications. The F value of the difference in growth on the different residues at the 4 planting dates was significant at .01 level.



The dry weight of snap beans was increased 24% when grown on residues from 6-week-old sorghum plants (Table 3). There was no significant difference between the dry weight of snap beans grown on residues of 1 and 3 week-old sorghum plants. However, in another test the dry weight of snap beans was increased 22% when grown in residues of 1 week-old sorghum plants and decreased 16% and 31% by the residues of the 3 and 6 week-old sorghum plants respectively.

The difference in response of the snap beans between the first and second test may have been due to the difference in organic material in the 2 soil mixes and in the amount of sorghum residues present. In the first test the amount of sorghum residues for the 1 and 3 week-old sorghum was low, so that the stimulating chemical may have leached out. However, when there was a high concentration of the stimulating chemical in the 6-week-old sorghum, an increase in the snap bean growth occurred (Table 3). In the test with a soil mixture relatively high in organic matter, the active chemical or chemicals may have been partially inactivated by the organic matter allowing the remainder of the chemical from the 1-week-old sorghum residues to stimulate growth. However, growth was inhibited when higher amounts of residues were available to the snap bean seedlings because the capacity of the soil organic matter to inactivate the active material had been exceeded.

The dry weight of the snap bean seedlings was increased by all the rates of sorghum residues compared to control treatments (Table 4). An increase in sorghum plant population did not increase the stimulatory effect that the sorghum residues had on the snap bean growth. There was no difference in snap bean growth between treatments with excelsior mulch and no excelsior or sorghum mulch.

TABLE 3:

Growth of 'Spartan Arrow' snap bean seedlings after being grown on 'Bird-a-Boo' sorghum residues of different ages.

One, 3 and 6 week-old sorghum plants were killed on May 13, 1981 in test 1 and on August 26, 1981 in test 2. Snap bean seeds were planted on May 27, 1981 in test 1 and on September 2, 1981 in test 2. Snap bean shoots were harvested 21 and 19 days after planted in test 1 and 2 respectively.

Dry Weight of Snap Beans				
Age (Weeks)	Sorghum Residues (kg/ha)	6% Organic Matter (g/pot)	Sorghum Residues (kg/ha)	12% Organic Matter (g/pot)
0	0	4.2	0	5.8
1	22	3.8	84	7.1
3	950	4.4	4605	4.9
6	8791	5.2	17016	4.0
L.S.D. at .05 level		0.5		0.9
L.S.D. at .01 level		0.7		1.3

TABLE 4:

Growth of 'Spartan Arrow' snap bean seedlings in different quantities of 'Bird-a-Boo' sorghum residues.

Ten day-old sorghum plants were killed with glyphosate on November 6, 1981. Snap bean seeds were planted on November 13 and the seedling shoots harvested on November 30, 1981.

Treatments			
Sorghum plants		Mulch	Dry Weight ^a
(kg/ha)	(No.)		
-	-	None	3.02
113	-	Excelsior	3.04
113	3	Sorghum	3.30
218	6	Sorghum	3.16
323	-	Excelsior	3.02
323	9	Sorghum	3.28

^aF value for sorghum vs no sorghum treatments was significant at .05 level.

The dry weight of snap beans were increased an average of 24% when the snap beans were planted 1, 2, and 4 weeks after about 5000 kg/ha of sorghum was applied. The increase in the dry weight of the snap beans was obtained regardless of the time interval for planting the snap beans after the sorghum application. The F value for their comparison was significant at the .01 level.

Field experiments. In the summer of 1980 the early yield of snap beans in the field was increased 89% by residues of sorghum roots (Table 5).

Whole plants and roots of sorghum decreased the dry weight of sweet corn seedlings 47% and 53% respectively. The growth of the older corn plants was only inhibited 22% and 19% by the whole sorghum plant and roots respectively (Table 5).

In 1981, the weight per pod of the snap beans was increased by the residues of the sorghum shoots and whole plants in the first harvest, but this difference was not reflected by a higher snap bean yield (Table 6). The second harvest and total yield of the snap beans was decreased by residues from sorghum roots and whole plants. These reductions in yield were due to fewer pods per m² from smaller plants in the treatments.

In the sweet corn experiment the treatments consisting of residues from whole sorghum plants were eliminated due to animal damage to the sweet corn plants during the seeding stage. The animal did not injure any corn seedling plants from the other treatments. The dry weight of sweet corn seedlings was decreased 36% by the residues of sorghum roots, but later the corn forage was only decreased 16% by the same treatment (Table 7).

TABLE 5:

Growth and yield of 'Spartan Arrow' snap beans and 'Gold Cup' sweet corn after growing in 'Bird-a-Boo' sorghum residues at Clarksville, Michigan in 1980.

Twenty-nine day-old sorghum was killed with glyphosate on July 14. The dry weight of the residues of the sorghum shoots was 2420 kg/ha. Sweet corn and snap beans were planted on July 24.

Sorghum Residues	Snap Beans (kg/ha)		Sweet Corn (kg/ha)	
	Seedling Dry Weight	Yield	Shoot Dry Weight	
	Aug. 7	Sept. 11	Aug. 7	Oct. 2
None	102	2647	12.8	3839
Whole Plant	108	2938	6.8	2981
Roots	96	5014	6.0	3117
Shoots	104	3049	11.3	3930
L.S.D. at .05 level	N.S.	1190	2.5	793
L.S.D. at .01 level	N.S.	1710	3.6	N.S.

TABLE 6:

Growth and yield of 'Spartan Arrow' snap beans after growing in 'Bird-a-Boo' sorghum residues at the Michigan State University Horticultural farm in 1981.

Forty-day-old sorghum was killed with glyphosate on July 9. The dry weight of the sorghum shoot residues was 3930 kg/ha. Snap bean seeds were planted on July 17.

Sorghum	Yield kg/ha		g/pod		Pods/m ²	
	Sept. 8	Sept. 18	Sept. 8	Sept. 18	Sept. 8	Sept. 8
Residues						
None	9229	9324	5.22	5.17	177	181
Whole	7700	7146	5.46	5.69	141	125
Roots	8694	8694	5.25	5.21	166	134
Shoots	9477	9286	5.75	5.16	164	180
L.S.D. at .05 level	N.S.	1350	0.21	N.S.	N.S.	23
L.S.D. at .01 level	N.S.	1939	0.30	N.S.	N.S.	33

TABLE 7 :

Growth of 'Gold Cup' sweet corn after growing in 'Bird-a-Boo' sorghum residues at the Michigan State University Horticultural farm in 1981.

Forty-day-old sorghum was killed with glyphosate on July 9. The dry weight of the sorghum shoot residues was 3930 kg/ha. The sweet corn was planted July 17.

Sorghum Residues	Seedling Dry Weight		Forage Fresh Weight
	Aug. 3	kg/ha	Sept. 24
None	21.9		40814
Roots	14.0		34432
Shoots	22.0		41158
L.S.D. at .05 level	4.2		5484
L.S.D. at .01 level	6.4		N.S.

In general the snap bean yield was increased by the residues of the sorghum roots in 1980 and decreased by the whole sorghum plant and the roots in 1981. The sweet corn was inhibited by the residues of the sorghum roots during both years and by the whole sorghum plant in 1980. These results suggest an apparent sensitivity of the crops to a chemical or chemicals that were present in the sorghum roots and which may either stimulate growth at low concentration or inhibit plant growth at high concentrations. In 1981, the sorghum residue applied to the crops was 62% (1510 kg/ha) more than the residues in 1980 which may explain the snap beans inhibition in 1981, compared to the stimulation the previous year. There is also the possibility that soil microorganism may produce bioactive chemicals from the sorghum residues.

In 1980, the cucumber and sweet corn plants were harvested instead of the marketable products, because the crops were planted too late for normal maturity. The dry weight of the cucumber plants was increased 37% by the 'Milkmaker' sorghum as compared to control (Table 8). The snap bean yield was not significantly different which may have been due to the high coefficient of variation (24%). In this 1980 study, the dry weight of the sweet corn shoots was decreased 25% by 'Milkmaker' and 38% by 'Haygrazer' sorghum residues.

The data for the snap bean experiment was analyzed as a percentage of the control for the 2 harvests. Increases and decreases in the snap bean yield were found between 2 harvests but there was no difference when the 2 harvests were combined. The residues from 39-day-old 'Bird-a-Boo' sorghum decreased the snap bean yield in the first harvest, followed by an increase in yield during the second harvest (Figure 2). In contrast the residues from the 25-day-old 'Milkmaker' sorghum only

TABLE 8 :

Dry weight of 'Greenstar' cucumber and 'Gold Cup' sweet corn, and yield of 'Spartan Arrow' snap beans when grown in 'Milkmaker' and 'Haygrazer' sorghum residues at Michigan State University Horticultural farm in 1980.

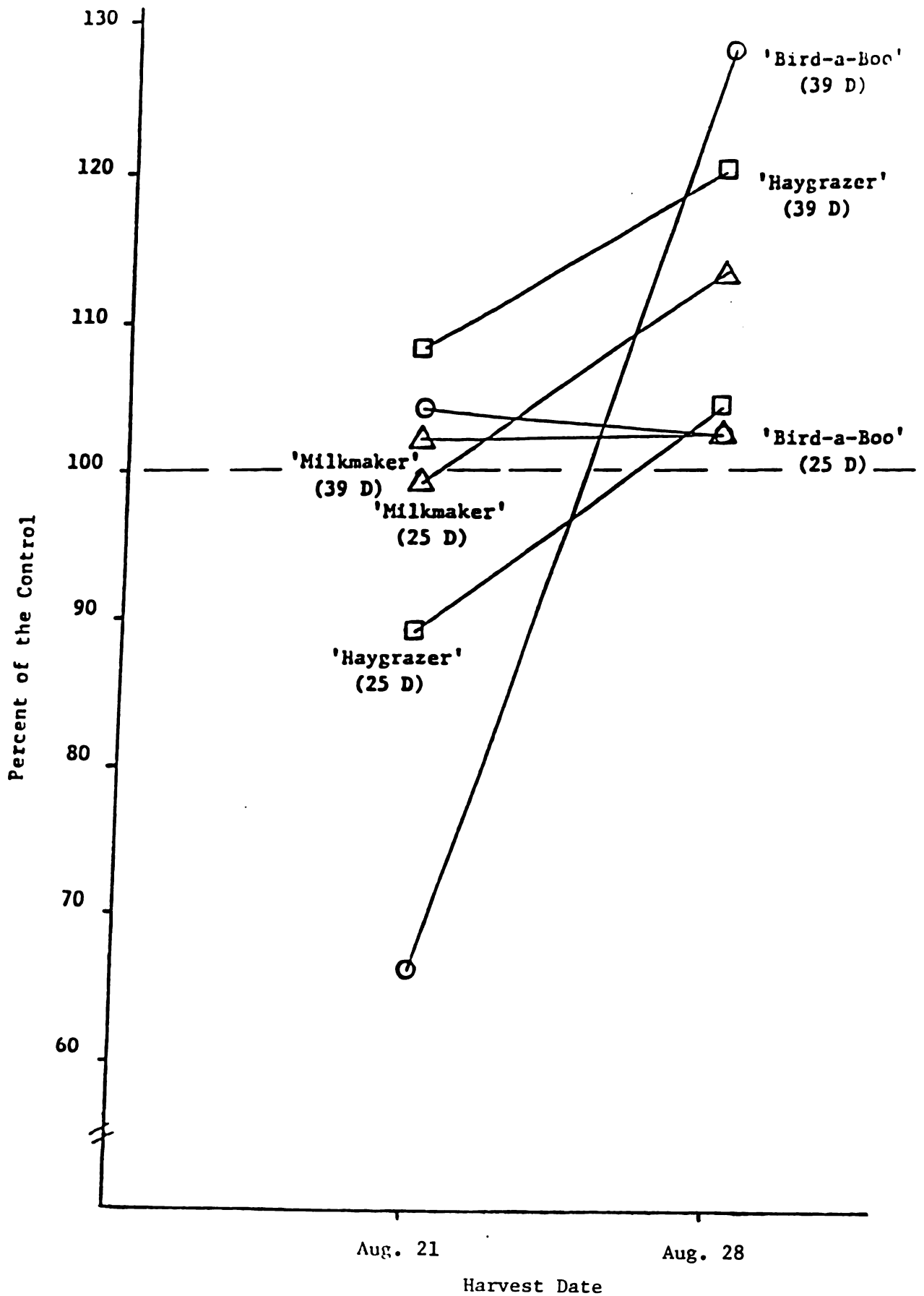
Thirty-one day-old sorghum was killed with glyphosate on July 20. Snap beans, cucumbers and sweet corn were planted on July 17.

	Cucumber Vines	Corn Shoots	Bean Yield
Sorghum	kg/ha	kg/ha	kg/ha
Cultivars	Sept. 29	Sept. 26	Sept. 29
None	462	1290	1091
'Milkmaker'	631	967	1290
'Haygrazer'	417	799	1024
L.S.D. at .05 level	124	366	N.S.

FIGURE 2:

Yield of 'Spartan Arrow' snap beans grown on residues of 3 sorghum cultivars of 2 different ages. The beans were harvested twice at Michigan State University Horticultural farm in 1981.

Thirty-nine and 25 day-old sorghum cultivars were killed with glyphosate on June 23. The dry weight of the sorghum shoots, was 914 and 576 kg/ha for 'Bird-a-Boo', 586 and 907 kg/ha for 'Milkmaker'; and 974 and 1036 kg/ha for 'Haygrazer' for the first and second sorghum plantings respectively. Snap bean seed was planted on June 30. The F value for the difference in yield on the different sorghum cultivar residues at the 2 harvests was significant at .05 level.



increased the snap beans yield in the second harvest. The residues from the 25-day-old 'Haygrazer' sorghum decreased the snap bean yield in the first harvest and then the effect was lost. However, the residues from the 39-day-old 'Haygrazer' sorghum increased the snap bean yields in the second harvest. These decreases or increases in snap beans yield were due to differences in snap bean pods per m².

Most of the sorghum residues increased the snap bean yield during the second harvest. This suggests that the chemical present in the residues of the sorghum plant may have delayed the early growth of snap beans, but did not affect total production.

In the cucumber experiment during the second harvest, the cucumber yield was decreased by the residues of the 'Milkmaid' and 'Haygrazer' sorghums when the crop was planted one week after the sorghum application (Table 9). The cucumber yield was not significantly different from the control when the crop was planted 2 weeks after the sorghum application.

In general, cucumbers were stimulated by 'Milkmaid' sorghum in 1980 and the yield decreased by 'Milkmaid' and 'Haygrazer' sorghums in 1981. The snap bean yield was increased or decreased by 'Haygrazer' and 'Bird-a-Boo' sorghums, and increased by 'Milkmaid' sorghum in 1981. The sweet corn growth was decreased by 'Milkmaid' and 'Haygrazer' sorghum in 1980. These results suggest that crops have a differential sensitivity to the residues of different sorghum cultivars. The chemical or chemicals and their concentration may vary depending on the sorghum cultivar.

TABLE 9:

Growth and yield of 'Greenstar' cucumbers when planted at different intervals after application of 'Bird-a-Boo', 'Milkmaker' and 'Haygrazer' sorghum residues at Michigan State University Horticulture farm in 1981.

Fourty-two day-old sorghum cultivars were killed with glyphosate on July 1. Cucumber seed was planted on July 8 and July 15. The seedlings were harvested on July 21 and July 28 for dry weight determination. An early cucumber harvest was conducted on August 26 and September 1, and a late harvest on September 1 and September 8.

Sorghum Cultivars	Planting Interval (weeks)	Sorghum Residues kg/ha	Seedling Dry weight (kg/ha)	Yield (\$/ha)		
				Early	Late	Total
None	1	-	11.78	299	367	665
None	2	-	9.41	187	151	339
'Bird-a-Boo'	1	1074	8.01	201	290	491
'Bird-a-Boo'	2	1526	8.40	164	173	338
'Milkmaker'	1	878	7.81	143	249	392
'Milkmaker'	2	1296	8.22	195	159	354
'Haygrazer'	1	1715	7.61	208	263	471
'Haygrazer'	2	1588	7.46	163	130	294
L.S.D. at .05 level			N.S.	N.S.	89	N.S.
L.S.D. at .01 level			N.S.	N.S.	131	N.S.

CONCLUSIONS

In the greenhouse, greater stimulation of crop growth was obtained when the sorghum plants were killed 1 week after planting on soil relatively high in organic matter (12%) and 6 weeks in a soil relatively low in organic matter (6%). The best time for planting the crop was 1 week after killing the sorghum.

In the field, 'Bird-a-Boo' and 'Milkmaker' sorghum cultivars stimulated snap bean growth and yield more than 'Haygrazer'. All 3 sorghum cultivars inhibited sweet corn growth.

In the greenhouse and field, the residues of 4 to 6 week old sorghum shoots stimulated the growth and yield of crops more often than whole plants or roots. The residues of whole plants and roots may either stimulate or inhibit crop growth. The optimum amount of sorghum shoot residues needed to stimulate snap bean growth and yield was about 2600 kg/ha.

Environmental factors such as soil type, moisture, soil micro-organisms and temperature affected the release of chemicals from the sorghum residues. These substances either stimulated or inhibited crop growth, depending on environmental factors and the crops planted in the residues. Although sorghum residues may stimulate crop growth, this stimulation was not easily controlled, because the optimal range of sorghum residue and soil environment is too narrow.

LITERATURE CITED

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1. Balasubramanian, A. and G. Rangawami. 1969. Studies on the influence of foliar nutrient sprays on the root exudation pattern in four crop plants. *Plant and Soil* 30(2):210-220.
2. Beste, C. E. and S. J. Olson. 1978. Interim report on no-tillage studies with vegetables. (unpublished report) Dept. of Horticulture, University of Maryland.
3. Borner, H. 1980. Liberation of organic substances from higher plants and their role in the soil sickness problem. *Bot. Rev.* 26:393-424.
4. Breazeale, J. B. 1924. The injurious after effects of sorghum. *Agron. J.* 16(11):689-700.
5. Cochran, J. P., C. L. Elliot and R. I. Papendick. 1977. The production of phytotoxins from surface crop residues. *Soil Sci. Soc. Am.* 14:903-908.
6. Conrad, J. P. 1927. Some causes of the injurious after effects of sorghum and suggested remedies. *J. Am. Soc. Agron.* 19:1091-1111.
7. Conrad, J. P. 1928. Fertilizer and legume experiments following sorghum. *J. Am. Soc. Agron.* 20:1211-1234.
8. DeFrank, J. 1979. Weed and vegetable response to allelopathic influences in no-tillage plantings. M.S. Thesis, Mich. State Univ., East Lansing.

9. Guenzi, W. E. and F. M. McCalla. 1967. Presence and persistence of phytotoxic substances in wheat, corn and sorghum residues. Agron. J. 59:163-165.
10. Hoveland, C. S. 1964. Germination and seedling vigor of clovers as affected by grass root extracts. Crop Sci. 4(2):211-213.
11. Martin, P. 1956. Qualitative and quantitative untersuchungen über die ausscheidung organischer verbindungen aus den keimwurzeln des hafers (Avena sativa L.). Naturwiss. 43:277-228.
12. McCalla, T. M. and F. A. Haskins. 1964. Phytotoxic substances from soil microorganism and crop residues. Bac. Rev. 28:181-207.
13. Patrick, Z. A., T. A. Toussoun and W. L. Snyder. 1963. Phytotoxic substances in arable soils associated with decomposition of plant residues. Phytopathol. 53:752-761.
14. Putnam, A. R. and W. B. Duke. 1978. Allelopathy in agroecosystems. Ann. Rev. Phytopathol. 16:431-451.
15. Rice, E. L. 1974. Allelopathy. Academic Press, New York.
16. Schreiner, O. and H. S. Reed. 1907. The production of deleterious excretions by roots. Bull. Tor. Bot. Club 34:279-301.
17. Ten Eyck, A. M. and V. M. Shoesmith. 1906. Indian corn. Kan. Exp. Sta. Re. Bul. 147:256-262.
18. Vinall, H. N. and R. E. Getty. 1921. Growing and utilizing sorghums. U.S.D.A. Far. Bul. 1158.

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