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EVALUATION OF SEAWEED PRODUCTS UPON THE VARIOUS GROWTH RESPONSES OF THREE TYPES OF TOBACCO

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The continuous development of new tobacco types and manufacturers' demand for better quality makes it essential to test and evaluate any materials which show promise in crop development in this field of work. Some years ago Martin and Senn (unpublished data) found some evidence that applications of seaweed meal to the soil prior to planting produced tobacco with significantly higher nicotine content, a prime factor in cigarette manufacturers' requirement. Along with this factor it appeared that seaweed products when applied to the soil or as foliar sprays might have potential applications in producing other desirable effects on the growth and development of tobacco plants. Seaweed is a natural and an organic source of trace elements, amino acids, and varying amounts of many elements. Since results of seaweed work at Clemson have shown some unusual and enlightening factors, tests were conducted in a plastic greenhouse at the Simpson Experiment Station at Clemson, S. C., during the winter and spring of 1969-1970 and in the field during the summer of 1970 to study the effects of various seaweed products and of rates of application on three types of tobacco.

I. Methods Used in Plastic Greenhouse

Types of tobacco selected for testing were those considered to be the best varieties of each type; namely, Coker 258 - flue cure, Connecticut Shade - wrapper and Kentucky Dark Fire - cigar. Seed were planted on January 1, 1970, and transplanted to the containers on February 7, 1970, using one plant to a container.

Experiments were conducted in a plastic greenhouse, 110 feet long by 29 feet wide. The greenhouse was equipped with automatic venting, cooling, and heating units for maintaining optimum environmental conditions. A night temperature of 65 degrees F. and a day temperature of 75 to 85 degrees F. were maintained throughout the experiment. The greenhouse contained benches on which the container grown tobacco plants were placed.

The growing media consisted of two parts loamy soil, one part Canadian peat moss, one part sand, one and one-half parts well rotted chicken compost, and one-half part sawdust. These ingredients plus a conventional 5-10-5 tobacco fertilizer and dolomitic lime were thoroughly mixed to provide a fertile media (304 grams of fertilizer per bushel) and a pH of 6.0 to 6.5.

No. 10 tin cans were used with holes punched in the bottoms for drainage. A uniform granite gravel was placed in the bottom of each can and five pounds of the growing media.

SEABORN dehydrated seaweed (fine grade) and SEABORN liquid concentrate were used in prescribed treatments as follows:

Treatment	Description of Treatment
1. Check	No seaweed used of any kind
2. Foliar Spray	1 part liquid concentrate: 25 parts of water applied March 2, 9, 16, 23, 30, and April 6, 1970
3. Foliar Spray	1 part liquid concentrate: 50 parts of water applied March 2, 9, 16, 23, 30, and April 6, 1970

Treatment	Description of Treatment
4. Liquid Feed	1 part liquid concentrate: 25 parts of water applied February 27, March 5, 13, 20, 27, April 3, and April 10, 1970
5. Liquid Feed	1 part liquid concentrate: 50 parts of water applied February 27, March 5, 13, 20, 27, April 3, and April 10, 1970
6. Seaweed Meal	Mixed in soil at rate of 400 pounds per acre on November 17, 1969
7. Seaweed Meal	Mixed in soil at rate of 800 pounds per acre on November 17, 1969

8. Treatment No. 2 above plus Treatment 4 above

9. Treatment No. 3 above plus Treatment 4 above

10. Treatment No. 2 above plus Treatment 5 above

11. Treatment No. 3 above plus Treatment 5 above

12. Treatment No. 2 above plus Treatment 6 above

13. Treatment No. 3 above plus Treatment 6 above

14. Treatment No. 2 above plus Treatment 7 above

15. Treatment No. 3 above plus Treatment 7 above

Each treatment consisted of four replications, each having four plants, and the treatments of four plants were randomized for statistical treatment on the benches. Spacings of approximately 18 inches by 18 inches were used between cans.

Liquid fertilizer (20-20-20) was used at the rate of one pound per fifty gallons of water and applied in sufficient quantities to fill the head of each can on each of the following dates: March 5, 16, 23, 26, 30, April 2, and 6, 1970. These liquid feedings plus the necessary applications of water resulted in vigorous and healthy plants with near field sized leaves.

Data were collected on nitrogen-alkaloid contents; number and weight of the leaves per plant; weight of stalks; soil analyses of each treatment for phosphorus, potassium, calcium, magnesium, and pH; and dry matter of the leaf samples.

Foliar Analysis:

Leaf samples for foliar analysis were collected on April 7. Two of the most recently matured leaves were randomly selected from each plant. The leaf samples were taken from approximately the lower one-quarter of the plant, excluding the bottom leaves.

After collection, the leaves were washed in distilled water to remove any spray residue. After the leaves were washed, they were dried at 70°C. in a gravity flow oven for 48 hours and ground in a Wiley mill equipped with a 40-mesh screen.

The nitrogen content of the ground leaf samples was determined by a modified semi-micro Kjeldahl method in the Tobacco Division of the Commodity Stabilization Service, U.S.D.A., Raleigh, N. C. Phosphorus was determined colorimetrically by the use of a Bausch and Lomb Spectronic 20. Potassium, calcium, magnesium, sodium, manganese, iron, boron, copper, zinc, aluminum, and molybdenum were determined by the Perkin-Almer 303 Atomic Absorption Spectrophotometer. Phosphorus, potassium, calcium, magnesium, and sodium were expressed on a percent dry weight basis. The remaining elements were expressed on a parts-per-million basis (Table 5).

II. Methods Used in Field Plots

Two types of tobacco were selected for this test; namely, Coker 258 and Kentucky Dark Fire.

A tobacco plant bed was used to grow the plants of Coker 258. Three treatments were used; namely, Check, 400, and 800 pounds per acre of Seaborn dehydrated seaweed (fine grade). The tobacco seed was planted in the plant beds on March 5 and the plants were transplanted to the field plots on May 20.

The plants of Kentucky Dark Fire were obtained from Tennessee and they were transplanted to the field plots on May 21. These plants were not grown in seaweed treated plant beds as for Coker 258.

The field plots were set up in randomized quadruplicate single row plots which were twenty feet long and three and one-half feet wide. A regular tobacco fertilizer, 5-10-5, was used at the rate of 1,000 pounds per acre in the furrow and bedded up. The seaweed treatments were as follows:

Coker 258:

Treatment No.	Untreated Plants Used
1	Check
2	Foliar Spray
3	Foliar Spray
4	400 pounds seaweed meal applied - furrow
5	600 pounds seaweed meal applied - furrow

Coker 258 Cont.

Treatment No.	Seaweed Treated Plants Used at 400 lbs. Rate
6	Check
7	Foliar Spray
8	Foliar Spray
9	400 pounds seaweed meal applied in furrow
10	600 pounds seaweed meal applied in furrow

	Seaweed Treated Plants Used From Bed at 800 lbs. Rate
11	Check
12	Foliar Spray
13	Foliar Spray
14	400 pounds seaweed meal applied in furrow
15	600 pounds seaweed meal applied in furrow

Kentucky Dark Fire:

Treatment No.	
1	Check
2	Foliar Spray
3	Foliar Spray
4	400 pounds seaweed meal applied in furrow
5	600 pounds seaweed meal applied in furrow

Leaf samples were taken from each plant in each replication for alkaloid and nitrogen analyses, micro- and macro-elements, and dry matter.

Actual insect counts were made for the horn worm and degrees of injury or damage by horn worms, bud worms, and flea beetles was recorded.

No insecticides nor fungicides were used on the tobacco in the greenhouse or in the field.

Normal procedures were used for hoeing and cultivating to keep down weeds.

III. Results and Discussion

The overall results of this experiment have been very disappointing because everything was done to carry out each step of the experiment as perfectly as possible. However, from the tables presented herewith, the data show no real statistical differences between treatments. Therefore, it is clear that a number of facts have been ascertained from the results of the experiments; namely,

1. Seaweed meal, liquid seaweed feeding, and foliar sprays used singularly or in combination with one another have no significant effects on the control of horn worms, bud worms, nor flea beetles. These pests were present in a high population and they were causing severe damage to the tobacco leaves. Root knot nematodes attacked the roots of the plants. Observations of the root systems of the various types of tobacco show Coker 258 possessed high resistance to the root knot nematodes. Kentucky Dark Fire was very susceptible to the root knot nematodes as all treatments were severely affected and there was no difference between treatments as the root systems of plants in all treatments were severely attacked and heavily galled.
2. Seaweed products and methods of application have had little or no effects on dry matter content of leaves, yield of leaves and stalks, carry-over effects of seaweed treated plants from plant bed to field plots, number of leaves, and alkaloid and nitrogen ratios.

Table 1 . Mean Weight in Grams of the Leaves of Three Types of Tobacco Grown Under Various Seaweed Treatments in a Plastic Greenhouse. Spring 1970.

Treatment No.	Types of Tobacco		
	Coker 258	Connecticut Shade	Kentucky Dark Fire
1	2,255	3,597	1,868
2	2,286	3,358	1,783
3	2,286	3,359	1,747
4	2,396	3,049	1,595
5	2,547	3,388	1,682
6	2,895	3,309	1,939
7	2,274	3,611	1,776
8	2,351	3,412	1,814
9	2,137	3,369	1,824
10	2,097	3,789	1,757
11	1,999	3,735	1,646
12	2,559	3,507	1,891
13	2,247	3,149	1,652
14	2,850	3,240	2,024
15	2,501	3,482	1,742
L.S.D. - 5% Level	N.S.	N.S.	N.S.

Table 2 . Mean Green Weight in Grams of the Stalks of Three Types of Tobacco Grown Under Various Seaweed Treatments in a Plastic Greenhouse. Spring 1970.

Treatment No.	Types of Tobacco		
	Coker 258	Connecticut Shade	Kentucky Dark Fire
1	748	1,059	636
2	748	1,078	555
3	729	1,124	583
4	688	1,052	567
5	727	1,042	593
6	756	1,010	608
7	740	1,093	635
8	722	1,035	620
9	708	1,063	596
10	699	986	608
11	704	1,114	569
12	748	1,070	585
13	700	1,017	590
14	669	987	595
15	724	1,010	596
L.S.D. - 5% Level	N.S.	N.S.	N.S.

Table 3 . Mean Number of Leaves Per Plant of Three Types of Tobacco Grown Under Various Seaweed Treatments in a Plastic Greenhouse. Spring 1970.

Treatment No.	Types of Tobacco		
	Coker 258	Connecticut Shade	Kentucky Dark Fire
1	25	67	20
2	26	63	19
3	24	68	19
4	26	67	19
5	26	68	24
6	29	65	19
7	24	71	20
8	29	62	21
9	24	69	21
10	27	68	19
11	26	72	20
12	26	67	21
13	25	65	18
14	29	63	21
15	26	64	18
L.S.D. - 5% Level	N.S.	N.S.	N.S.

Table 4 . Mean Nitrogen - Alkaloid Ratios From Samples of Three Types of Tobacco Grown Under Various Seaweed Treatments in a Plastic Greenhouse. Spring 1970.

Treatment No.	Types of Tobacco		
	Coker 258	Connecticut Shade	Kentucky Dark Fire
1	1.7681	2.6278	2.1179
2	2.0215	3.5514	2.4122
3	2.0496	2.8729	2.3309
4	1.7718	2.8938	2.1071
5	2.1806	3.5261	2.0406
6	2.2721	2.5772	2.0635
7	1.9243	3.2135	1.8387
8	2.6842	3.0558	2.3522
9	2.6464	3.2933	2.7496
10	2.3762	2.6949	2.6325
11	2.5681	3.2964	2.3041
12	2.3087	3.4989	2.0186
13	2.2960	3.0402	2.0612
14	2.6609	2.9628	1.9858
15	1.8633	3.4937	2.0518
L.S.D. - 5% Level	N.S.	N.S.	N.S.

Table 5 . Soil Analyses of Soil Samples From Which Three Types of Tobacco Were Grown Under Various Seaweed Treatments in Containers in a Plastic Greenhouse in PPM. April 24, 1970.

Treatment Number	Types of Tobacco														
	Coker 258					Connecticut Shade					Kentucky Dark Fire				
	P	K	Ca	Mg	pH	P	K	Ca	Mg	pH	P	K	Ca	Mg	pH
1	100	92	1000	50	6.6	100	81	1000	50	6.7	100	105	1000	50	6.8
2	100	96	1000	50	6.6	100	84	1000	50	6.7	100	115	1000	50	6.8
3	100	95	1000	50	6.6	100	81	1000	50	6.7	100	117	1000	50	6.8
4	100	105	1000	50	6.9	100	100	1000	50	7.2	100	117	1000	50	7.1
5	100	113	1000	50	7.1	100	93	1000	50	7.0	100	117	1000	50	7.0
6	100	95	1000	50	6.7	100	80	1000	50	6.8	100	117	1000	50	6.8
7	100	96	1000	50	6.7	100	75	1000	50	6.8	100	117	1000	50	6.7
8	100	115	1000	50	7.0	100	102	1000	50	7.2	100	117	1000	50	7.2
9	100	116	1000	50	7.1	100	100	1000	50	7.2	100	117	1000	50	7.1
10	100	115	1000	50	7.0	100	95	1000	50	7.1	100	117	1000	50	7.0
11	100	115	1000	50	6.9	100	94	1000	50	7.0	100	117	1000	50	7.1
12	100	101	1000	50	6.7	100	79	1000	50	6.8	100	117	1000	50	6.9
13	100	92	1000	50	6.7	100	73	1000	50	6.8	100	117	1000	50	6.8
14	100	90	1000	50	6.7	100	79	1000	50	6.7	100	117	1000	50	6.9
15	100	103	1000	50	6.6	100	81	1000	50	6.8	100	117	1000	50	6.8

Table 6 . Treatment Means Obtained by Leaf Nutrient Analysis From Three Types of Tobacco Grown Unver Various Seaweed Treatments in a Plastic Greenhouse. Spring 1970

Treatment Number	TREATMENT MEANS OF FOLIAR NUTRIENT LEVELS Percent				
	P*	K	Ca	Mg	Na
1	0.40 cd	2.85 f	1.97abcd	0.70ab	0.01 g
2	0.44ab	3.54 d	2.07ab	0.68ab	0.22 bc
3	0.46a	3.68 cd	2.12a	0.69ab	0.14 e
4	0.34 e	2.78 f	1.64 f	0.62 b	0.05 f
5	0.40 cd	3.04 ef	1.93abcde	0.72ab	0.02 fg
6	0.43abc	3.38 de	2.04abc	0.66ab	0.01 g
7	0.39 d	3.12 ef	1.75 ef	0.64ab	0.02 fg
8	0.40 cd	3.68 cd	1.89 bcde	0.68ab	0.26a
9	0.39 d	3.52 d	1.85 cde	0.62 b	0.18 d
10	0.42 bcd	3.60 cd	1.91 bcde	0.67ab	0.25ab
11	0.43abc	3.55 cd	1.98abcd	0.67ab	0.16 de
12	0.45ab	3.69 cd	2.05abc	0.74a	0.24abc
13	0.46a	4.10ab	1.78 def	0.66ab	0.16 de
14	0.45ab	4.38a	1.93abcde	0.71ab	0.21 c
15	0.44ab	3.94 bc	1.93abcde	0.66ab	0.16 de

*All means followed by the same small case letter are not significantly different from each other at the 5 percent level.

Table 7 . Treatment Means Obtained by Leaf Nutrient Analysis From Three Types of Tobacco Grown Under Various Seaweed Treatments in a Plastic Greenhouse Cont. Spring 1970.

Treatment Number	TREATMENT MEANS OF FOLIAR NUTRIENT LEVELS PPM						
	Mn*	Fe	B	Cu	Zn	Al	Mo
1	96.0 h	44.0 bc	28.3 cdef	3.42a	53.8 c	51.3abc	4.13ab
2	103.1 gh	37.5 d	33.2ab	3.67ab	65.6ab	44.5 cde	4.12ab
3	103.6 gh	38.0 d	34.5a	5.08ab	60.3abc	41.7 d	4.15ab
4	103.4 gh	43.8 bc	26.8 ef	4.33ab	54.2 c	50.0 bc	4.25ab
5	109.3 fgh	46.5ab	30.1 bcde	4.33ab	61.1abc	55.3ab	4.43a
6	113.3 efg	48.9a	27.3 def	3.50ab	58.0 bc	57.5a	4.03ab
7	120.0 cdef	43.8 bc	25.8 f	4.42ab	54.7 c	50.8abcd	4.03ab
8	124.8 cde	35.7 d	32.0ab	2.25 b	59.8abc	37.5 e	3.92ab
9	113.9 efg	35.2 d	33.0ab	2.33 b	53.6 c	36.5 e	3.77 b
10	109.2 fgh	36.3 d	32.9ab	2.17 b	56.6 c	36.8 e	3.98ab
11	116.5 defg	36.3 d	34.6a	2.67ab	61.3abc	37.5 de	3.83ab
12	142.3ab	39.1 cd	31.5abc	3.58ab	67.3a	40.9 de	4.29ab
13	133.3abc	39.3 cd	31.8abc	4.08ab	55.7 c	36.9 e	4.08ab
14	129.2 bcd	38.2 d	31.1abc	4.33ab	62.6abc	35.1 e	4.16ab
15	144.1a	39.6 cd	30.4 bcd	4.58ab	62.4abc	37.5 de	4.11ab

*All means followed by the same small case letter are not significantly different from each other at the 5 percent level.

Table 8 . Summary - Number of Horn Worms on Tobacco Plants

Coker 258

	Check	Foliar Spray 1-25	Foliar Spray 1-12 1/2	Meal 400 lbs/A	Meal 600 lbs/A
No. Seaweed Meal in Plant Bed	.9	1.2	1.2	1.1	1.2
400 lbs. Seaweed Meal in Plant Bed	1.6	1.5	1.1	1.5	1.1
600 lbs. Seaweed Meal in Plant Bed	1.3	.8	1.4	1.0	1.0

Kentucky Dark Fire

	.7	.8	.9	.8	.8

Table 9 . Percent Dry Weight of Coker 258 and Kentucky Dark Fire Tobacco Leaves from Various Seaweed Treatments from Field Plots.

Coker 258

Treatment No.	Rep. 1	Rep. 2	Rep. 3	Rep. 4	Total	Mean
1	15.497	19.697	13.131	14.379	62.704	15.676
2	17.605	16.393	12.941	15.050	61.989	15.497
3	14.503	20.000	14.583	17.969	67.055	16.764
4	17.034	19.477	14.015	13.994	64.520	16.130
5	13.490	19.614	12.462	13.151	58.717	14.679
6	16.423	20.339	10.354	18.241	65.357	16.339
7	16.092	19.149	13.793	13.223	62.257	15.564
8	14.341	18.039	14.953	12.979	60.312	15.078
9	18.881	20.950	15.572	12.054	67.457	16.864
10	21.409	21.186	14.027	17.344	73.966	18.492
11	17.470	17.825	15.415	14.286	64.996	16.249
12	12.406	18.983	15.226	13.291	59.906	14.977
13	17.647	19.863	15.517	17.339	70.366	17.592
14	14.865	23.476	14.789	15.143	68.273	17.068
15	17.048	20.000	15.161	18.060	70.269	17.567

Kentucky Dark Fire

Treatment No.	Rep. 1	Rep. 2	Rep. 3	Rep. 4	Total	Mean
1	18.584	22.008	17.200	17.241	75.033	18.758
2	23.019	20.415	15.979	17.085	76.498	19.125
3	20.000	20.611	18.333	16.818	75.762	18.941
4	18.341	20.816	19.204	17.671	76.032	19.008
5	20.476	20.245	22.170	13.675	76.566	19.142

Coker 258

Table 10. Summary of Bud Worm Damage to Leaves, 9-8-70

Treatment No.	1	2	3	4	Total	Mean
1	2.7	2.8	3.0	2.9	11.4	2.9
2	2.9	3.0	3.0	3.0	11.9	3.0
3	2.9	3.0	2.9	3.0	11.8	3.0
4	2.8	3.0	3.0	3.0	11.8	3.0
5	2.8	2.9	2.9	2.8	11.4	2.9
6	2.9	2.7	3.0	3.0	11.6	2.9
7	2.6	3.0	3.0	3.0	11.6	2.9
8	2.8	2.8	3.0	3.0	11.6	2.9
9	2.7	2.9	2.9	3.0	11.5	2.9
10	2.8	2.9	3.0	2.9	11.6	2.9
11	2.8	3.0	3.0	3.0	11.8	3.0
12	3.0	2.8	3.0	2.9	11.7	2.9
13	3.0	2.9	3.0	3.0	11.9	3.0
14	2.8	2.8	2.9	2.9	11.4	2.9
15	2.8	2.9	2.9	2.8	11.4	2.9

Kentucky Dark Fire

Treatment No.	1	2	3	4	Total	Mean
1	3.0	3.0	3.0	3.0	12.0	3.0
2	2.8	2.8	3.0	3.0	11.6	2.9
3	2.9	3.0	2.8	3.0	11.7	2.9
4	2.9	3.0	2.9	3.0	11.8	3.0
5	3.0	2.8	3.0	2.9	11.7	2.9

Degrees of Damage to Leaves:

0 = None
1 = Slight
2 = Moderate
3 = Heavy

Coker 258

Table 11. Summary - Horn Worm Damage to Leaves, 9-8-70.

Treatment No.	1	2	3	4	Total	Mean
1	2.2	2.6	2.8	2.6	10.2	2.55
2	2.3	2.9	2.8	2.8	10.8	2.70
3	2.5	2.7	2.8	2.9	10.9	2.73
4	2.2	2.8	2.6	2.5	10.1	2.53
5	1.8	2.5	2.7	2.6	9.6	2.40
6	2.6	2.5	2.9	2.1	10.1	2.53
7	2.6	2.7	2.9	3.0	11.2	2.80
8	2.8	2.8	2.9	2.6	11.1	2.78
9	2.6	2.8	2.8	2.9	11.1	2.78
10	2.5	2.9	2.8	2.0	10.2	2.55
11	2.5	2.5	2.6	3.0	10.6	2.65
12	2.5	2.6	2.8	2.4	10.3	2.58
13	2.9	2.7	3.0	2.5	11.1	2.78
14	2.6	2.8	2.6	2.5	10.5	2.63
15	2.6	2.9	3.0	2.4	10.9	2.73

Kentucky Dark Fire

Treatment No.	1	2	3	4	Total	Mean
1	2.7	2.8	2.7	2.3	10.5	2.6
2	2.3	2.2	2.9	2.7	10.1	2.5
3	2.5	2.7	2.8	2.7	10.7	2.7
4	2.4	2.1	2.8	2.9	10.2	2.6
5	3.0	2.4	2.5	2.8	10.7	2.7

Degrees of Damage to Leaves:

0 = None
1 = Slight
2 = Moderate
3 = Heavy