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Response of Filler Tobacco Crop to Different Planting Dates

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INTRODUCTION

Filler tobacco has been grown commercially in Puerto Rico since the beginning of the seventeenth century and is at present a major agricultural enterprise in some sections of the Island. It is planted in the fall through early winter, a planting season arrived at by our early farmers after years of trial and error.

Usually, the seedbeds are sown from the latter half of August onward, and the field plantings are made from the end of September through the early days of January. The planting dates within this wide range vary with the particular climatic conditions of each locality, the prevailing weather, and the farmer's judgement. January plantings entail the risk of poor yields, since the months of January, February, and March are the driest of the year in Puerto Rico, and prolonged periods of deficient moisture are not uncommon.

With the coming of spring and the more abundant rainfall of April and May, planting can be resumed. However, there is a general opinion among farmers and those experienced in the business that spring and summer tobacco is of inferior quality because it yields a high proportion of strawy, thin, light-weight leaves. It is also claimed that insect pests are more numerous and destructive at this time of the year.

So far, little or no scientific investigation has been undertaken to determine the soundness of present beliefs and practices regarding the time of planting of tobacco. This paper presents the results of an experiment planted at fixed intervals throughout the year at the Gurabo Substation,

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Agricultural Experiment Station, University of Puerto Rico, with this purpose in mind.

MATERIALS AND METHODS

A series of 13 experiments was planted with 1 experiment every 28 days at the Gurabo farm, starting on September 13, 1960 and ending on August 15, 1961. The site chosen was a hilly portion of the farm where Juncos clays and Múcara silty clay loams[2] with moderate to steep slopes are relatively friable and well drained.

The four commercial varieties V-12, C-10, Olor, and P.R. 1-60 were compared in a complete randomized-block design with five replications. Two seedbeds were made for each experiment in the eighth and seventh weeks prior to transplanting in the field to ensure an adequate supply of seedlings. Seed was sown in 6-inch clay pots filled with a soil mixture of 1 part loam and 1 part filter-press cake. This mixture was sterilized with methyl bromide at the rate of 2 pounds per 100 square feet. Seedlings were transplanted when 3 to 4 weeks old to metal flats with Vitabands, filled with the same sterilized soil mixture. After 4 to 5 weeks in the flats they were transplanted to the field.

Land preparation was performed individually for each experiment from 1 month to 1 week ahead of planting time, as the prevailing weather conditions allowed. Rows were spaced 3½ feet apart, and plants 1½ feet within the row. Individual plots were 20 feet long × 18 feet wide, each with 5 rows of 12 plants for a total of 60 plants.

Fertilizer was applied in the hole at transplanting time at the rate of 4 ounces per plant of a 6-8-10 fertilizer. Irrigation was used when necessary to get plants started, but never beyond a period of 2 weeks after transplanting.

Plants were topped as soon as the inflorescence emerged; suckering was practiced when necessary; tobacco leaves were primed every week, hand-strung and tied to sticks; air-curing took place in a conventional barn. Cured tobacco was classified according to USDA standards and weighed after classification.

RESULTS AND DISCUSSION

The yields of the 13 experiments are given in table 1. The highest yields for the means of the four varieties occurred in the experiments of October

[2] The Juncos clay and Múcara silty clay loam are medium-deep soils of the humid hilly uplands of Puerto Rico. Both are derived from massive tuffs, tuffaceous shales, and other volcanic rocks which may lie within 1 to 2 feet below the surface. They range in color from black to light grayish brown and, in acidity, from slightly acid to acid. The steep phases of these soils are used predominantly for pasture but are also used extensively for tobacco, subsistence crops and sugar cane (*6*)[3].

[3] Italic numbers in parentheses refer to Literature Cited, p. 173.

11 and May 23, with 13.9 and 15.7 hundredweights of cured tobacco per *cuerda*,[1] respectively. After October 11, there was a gradual decline in production to 7.4 hundredweights for the January 3 and 31 and the February 28 experiments. After the peak in May, the yields again decreased to 9.2 hundredweights in July.

The two highest productions fell in the early autum (Oct. 11, see table 1) and in the spring (May 23) and compare favorably with the Island mean yield, which is around 11 hundredweights of cured tobacco. The growing periods of the three experiments with the lowest yields extended through January, February, and March, the driest months of the year, as evidenced

TABLE 1. *Yield of cured tobacco per* cuerda[1] *as obtained in 13 seasonal experiments at Gurabo, P.R., 1960-61*

Experiment of	Variety V-12	Variety C-10	Variety Olor	Variety P.R. 1-60	Means of 4 varieties
Sept. 13	9.1	9.0	11.0	12.6	10.4
Oct. 11	13.2	12.6	14.1	15.6	13.9
Nov. 8	11.4	11.7	11.3	13.4	12.0
Dec. 6	9.5	9.9	11.7	12.8	11.0
Jan. 3	7.1	6.7	6.6	9.0	7.4
Jan. 31	6.2	7.8	6.8	8.9	7.4
Feb. 28	6.7	5.9	6.6	10.4	7.4
Mar. 28	9.1	8.8	9.4	11.9	9.8
Apr. 25	10.8	11.4	12.9	14.5	12.4
May 23	14.6	14.2	16.6	17.5	15.7
June 20	11.3	10.5	11.3	12.0	11.3
July 18	7.6	8.9	10.1	10.4	9.2
Aug. 15	9.3	9.9	11.6	11.8	10.6
Mean yield	9.8	9.8	10.8	12.4	10.7

[1] A *cuerda* is the equivalent of 0.9712 acre.

by rainfall data of table 2. The slight decrease after May occurred in the warm summer months in which downpours are frequent. These results are illustrated graphically in figure 1 where the individual yields for the four varieties studied are plotted against the planting dates, and where it is clearly seen that the four curves obtained are very similar in trend.

Mean total production and rainfall are compared in graphic form in figure 2 by plotting each set of values from tables 1 and 3 against planting dates. The figure reveals no close correlation and, furthermore, the calculated r value of 0.43337 is not significant.

Some of the reasons for the difficulty in obtaining good correlation between rainfall and yield are well-known. They arise from the interaction of

[1] 1 *cuerda* = 0.9712 acre.

TABLE 2.—*Mean monthly and annual precipitation for the Gurabo, P.R., region from 1899 to 1964 as compared with the prevailing rainfall during the experimental period*[1]

Item	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
	Inches												
66-year average (1899-64)	3.64	2.46	2.46	3.75	6.11	6.00	6.47	7.25	7.65	6.73	5.92	4.57	63.00
	1961								*1960*				
Experiment (1960-61)	3.73	2.21	5.67	5.98	2.75	5.10	7.15	11.56	21.47	5.57	8.33	9.02	88.99

[1] Averaged from data obtained from the Weather Bureau of Puerto Rico and the Gurabo Weather Station.

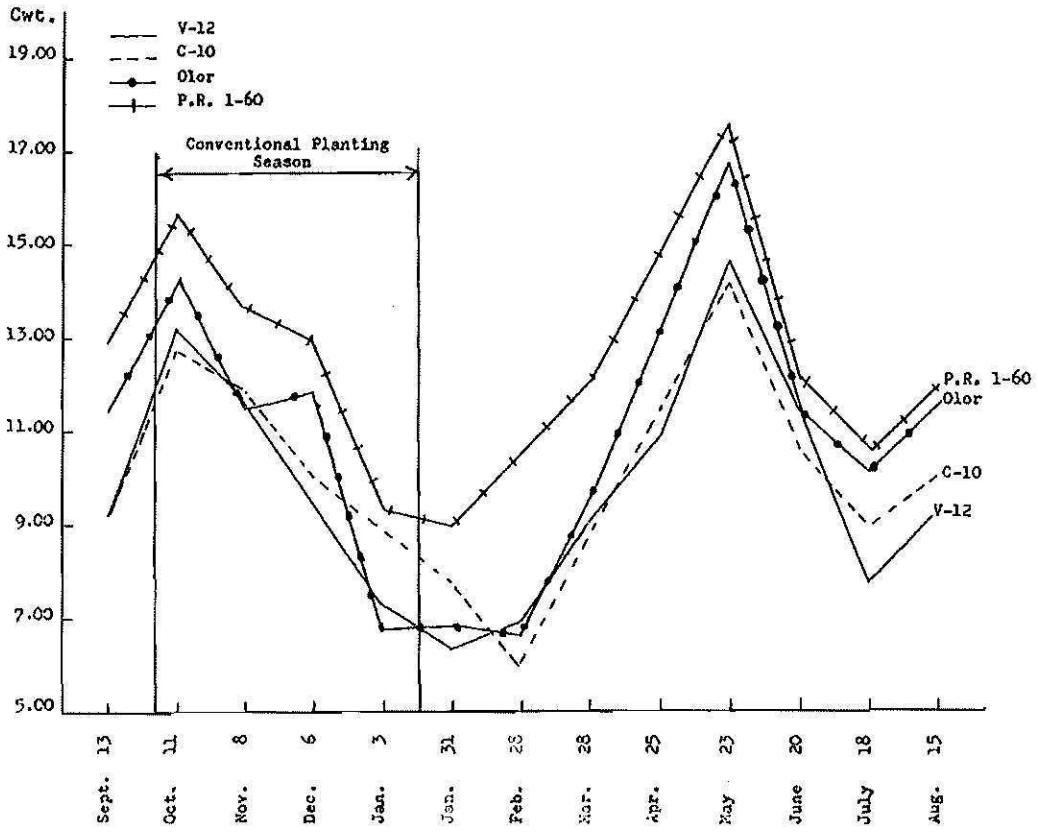

FIG. 1.—Yield in hundredweights of cured tobacco per *cuerda* for 4 varieties planted in 13 seasonal experiments at Gurabo, P.R., 1960-61.

multiple factors, the study of which is beyond the scope of the present experiment. However, two of these are worth mentioning here: The detrimental effect of excessive rainfall, and the favorable effect of mists, dews, and fogs during dry weather.

According to Kramer (*4,5*), who has made an extensive study of the subject, tobacco is one of the most susceptible crop plants to injury from flooding or saturation of the soil, which results in the wilting of leaves or in the death of leaves and roots, in severe cases. Because the tobacco plant is very slow in developing adventitious roots, the chances for recuperation are less than those of other crop plants such as sunflower and tomato.

The damage is more severe in poorly drained clay soils and under warm

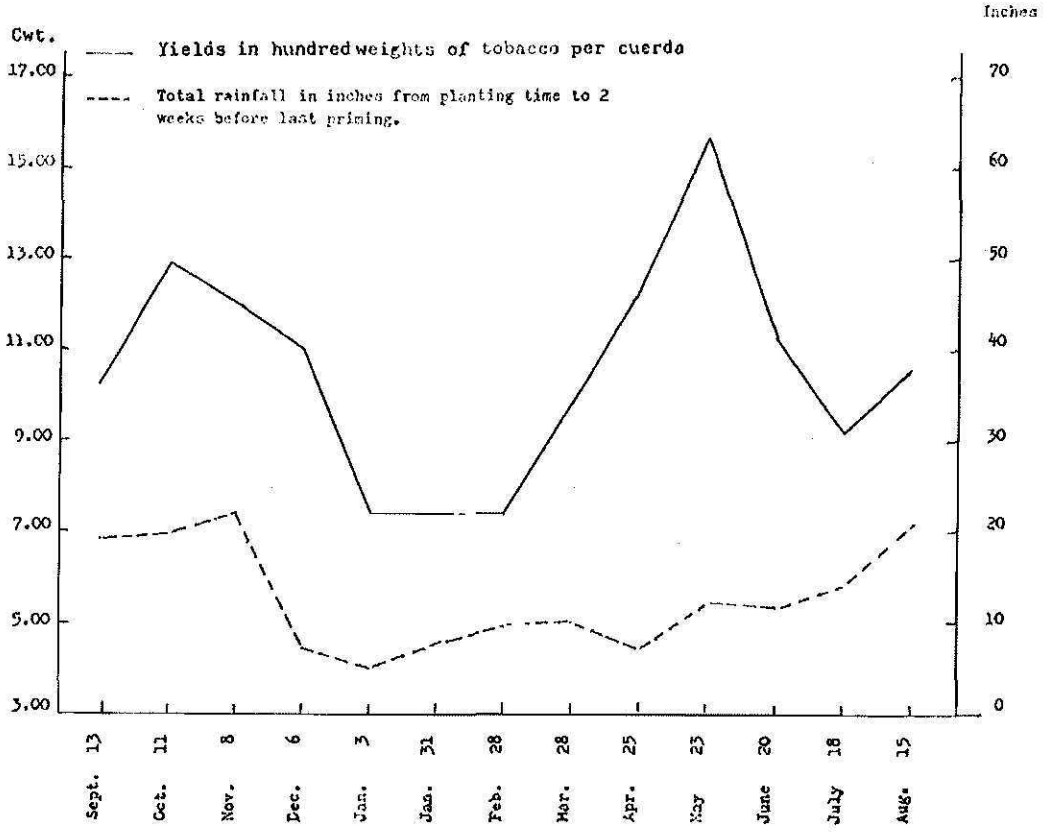

FIG. 2.—Yield per *cuerda* and total rainfall for 13 seasonal experiments planted at Gurabo, P.R., 1960-61.

soil temperatures. It is accentuated when the plant tissues are soft and succulent as a result of rapid growth, and when bright suns follow heavy rains. All these conditions prevail frequently in Puerto Rico. Our farmers have long been aware of the danger to their crops from saturated soils, as evidenced by their insistence on planting with steep-sloped draining ditches, contrary to the best soil conservation practices.

As other consequences of excessive rainfall Garner (*3*) mentioned reduction in yield from the production of thin light-weight leaves, which are also more susceptible to wind and hail damage, and the loss of nutrients from light soils. Prolonged periods of drought, on the other hand, reduce yields

by stunting the plants and causing the firing of the leaf-tips. Moderate drought, however, does not materially reduce yields, for the reduction in leaf size is compensated by greater weight per cubic area.

In Puerto Rico, mists, dews, and fogs constitute an important secondary source of water for the tobacco crop, especially during the drier, cool, late-autumn and winter months.

The potential source of water from fogs, mists, and dews has been pointed out by Went (*9*). On the other hand Balcar (*1*) has demonstrated the ability

TABLE 3.– *Temperature, rainfall, and evaporation for the growing periods of 13 seasonal tobacco experiments at Gurabo, P.R., 1960-61*[1]

Experiments		Temperature				Rainfall[2]	Evaporation
Planted	Last picking	Maximum	Minimum	Difference	Average	Total	
		°F.	°F.	°F.	°F.	*Inches*	*Inches*
Sept. 13	Dec. 7	88.6	66.4	22.2	77.5	19.20	14.83
Oct. 11	Dec. 28	87.2	65.0	22.2	76.1	19.52	13.98
Nov. 8	Feb. 6	84.9	64.2	20.7	74.6	22.01	12.13
Dec. 6	Feb. 21	84.2	60.9	23.3	72.6	7.34	12.39
Jan. 3	Mar. 27	84.8	61.5	23.3	73.2	5.03	15.07
Jan. 31	Apr. 10	85.4	62.0	23.4	73.7	7.57	18.07
Feb. 28	May 12	86.2	62.0	24.2	74.1	9.62	20.42
Mar. 28	June 15	86.6	66.8	19.8	76.7	9.92	20.94
Apr. 25	July 3	87.1	68.0	19.1	77.6	7.08	21.23
May 23	Aug. 3	87.9	68.8	19.1	78.4	12.08	20.34
June 20	Aug. 21	88.3	68.9	19.4	78.6	11.89	19.72
July 18	Sept. 28	89.1	68.8	20.3	79.0	14.13	19.75
Aug. 15	Oct. 24	88.8	68.4	20.4	78.6	20.93	17.25

[1] Based on data obtained at the Gurabo Substation. Figures are taken from planting date to 2 weeks before last picking.

[2] Adjusted for runoff by discarding precipitation in excess of 2 inches per 24-hour period of rainfall and adding 0.50 inches for every 3 hours of overhead irrigation.

of the tobacco plant to absorb much water directly and through the leaves. Although no data are available as to the extent of dews and fogs in the interior part of Puerto Rico, their common occurrence, even in dry weather, is well known. They enable the crop to make growth under conditions of sparce rainfall, and thus partly offset the positive correlation between rainfall and yield.

Garner (*3*) considered that, in spite of being rather drought-resistant, the tobacco plant requires liberal well-distributed rainfall for rapid growth and attainment of large size. It may be added that the need for water is critical at the time of setting out the plants after transplanting. According to rainfall data recorded during the years 1899 to 1958 for the Gurabo area,

critical soil moisture-deficient periods of 15 or more consecutive days are more likely to occur between January and April, particularly in February and March (*2*). Planting in these months without irrigation facilities will add the risk of heavy loss after transplanting to that of poor yield at harvesttime. Thus it becomes apparent that, when comparing yield with rainfall data, poor correlation is to be expected, as is illustrated in figure 2, if total values only are used, without taking into consideration rainfall distribution.

TABLE 1. *Cash value (dollars) of cured tobacco per* cuerda[1] *obtained with 4 commercial varieties in 13 seasonal experiments at Gurabo, P.R., 1960–61*

Experiment of	Cash value per *cuerda* of variety				Mean of 4 varieties	Significant differences at 5-percent level
	A (V-12)	B (C-10)	C (Olor)	D (P.R. 1-60)		
Sept. 13	264	265	320	380	307	D > ABC, C > AB
Oct. 11	392	377	416	464	412	D > BA
Nov. 8	347	366	337	414	366	D > CAB
Dec. 6	287	302	356	394	335	D > AB, C > AB
Jan. 3	211	200	196	275	221	D > CBA
Jan. 31	186	233	204	268	223	D > AC
Feb. 28	218	185	212	337	238	D > BCA, A > BC
Mar. 28	279	275	294	361	303	D > BAC
Apr 25	360	393	447	500	425	D > AB
May 23	524	533	572	605	558	No significant differences
June 20	358	344	364	383	362	No significant differences
July 18	241	284	328	345	299	D > A, C > A
Aug. 15	287	311	350	369	329	D > A
Mean total	304	313	338	392	337	

[1] A *cuerda* is the equivalent of 0.9712 acre.

The cash values of cured tobacco per *cuerda* were calculated for each variety on the basis of yield and the scale of prices received by farmers during the 1960–61 crop year for the different USDA grades of tobacco and are presented in table 4.

It will be seen at a glance that variety P.R. 1–60, developed from native material by selection at the Experiment Station, proved superior in all the experiments. The last column of the table shows that the varietal differences obtained between P.R. 1–60 and all or some of the other varieties were significant at the 5-percent level in 11 out of the 13 experiments.

A study of the grade indices revealed no consistent differences between

the four varieties. Since the grade index is a measure of quality, it follows that yield is the preponderant factor responsible for the significant differences observed between varieties when measured in terms of cash value. The close correlation between yield and cash value may be further appreciated by looking at figure 3, where the means for the four varieties have been plotted against planting dates.

Under the present USDA system of grades for Puerto Rican tobacco, the thin and the heavy-bodied leaves are equally priced, so that the proportion of the two kinds is not reflected in either the grade index or the cash

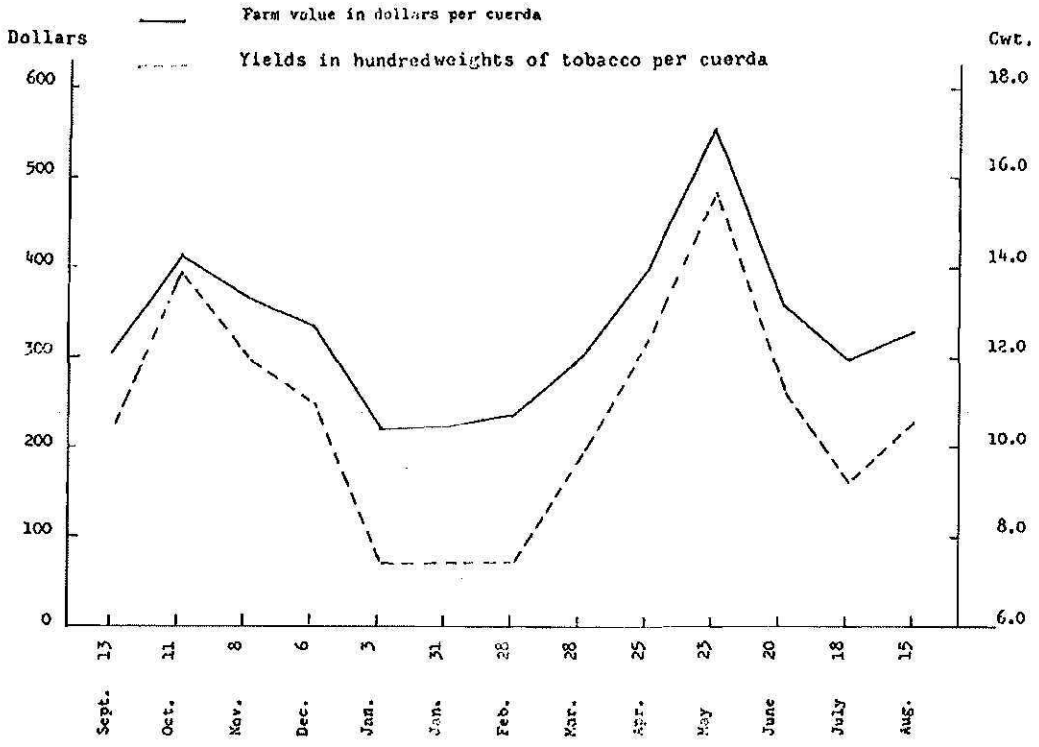

FIG. 3.—Yield and farm value per *cuerda* for 13 seasonal experiments planted at Gurabo, P.R., 1960-61.

value. However, this proportion could have an important bearing on the cigar industry where the two types of tobacco are blended in predetermined amounts for the manufacture of cigars. Table 5 shows the percentage of heavy-bodied leaves produced by each variety per experiment. The varietal differences observed are unimportant and inconsistent, but the differences between experiments are sometimes great. A high percentage of heavy-bodied leaves is closely associated with reduced rainfall, as demonstrated in figure 4, where both values have been plotted against planting dates, and by a highly significant negative correlation coefficient of -0.82254.

On the other hand, the possibility exists that the lower night temperatures which prevail in Puerto Rico during the dry winter months may also

TABLE 5.—*Percentage of heavy-bodied leaves produced in 13 seasonal experiments at Gurabo, P.R., 1960–61*

Experiment of—	Data for variety—				Mean of 4 varieties
	V-12	C-10	Olor	P.R. 1-60	
Sept. 13	37	33	29	32	33
Oct. 11	0	0	0	0	0
Nov. 8	10	11	6	13	10
Dec. 6	26	27	31	38	31
Jan. 3	91	91	90	93	91
Jan. 31	87	88	88	89	88
Feb. 28	44	60	45	66	56
Mar. 28	58	50	52	52	53
Apr. 25	74	74	77	80	77
May 23	17	34	20	25	24
June 20	38	36	46	44	41
July 18	32	44	43	45	41
Aug. 15	13	21	19	17	17
Mean total	37	41	38	43	40

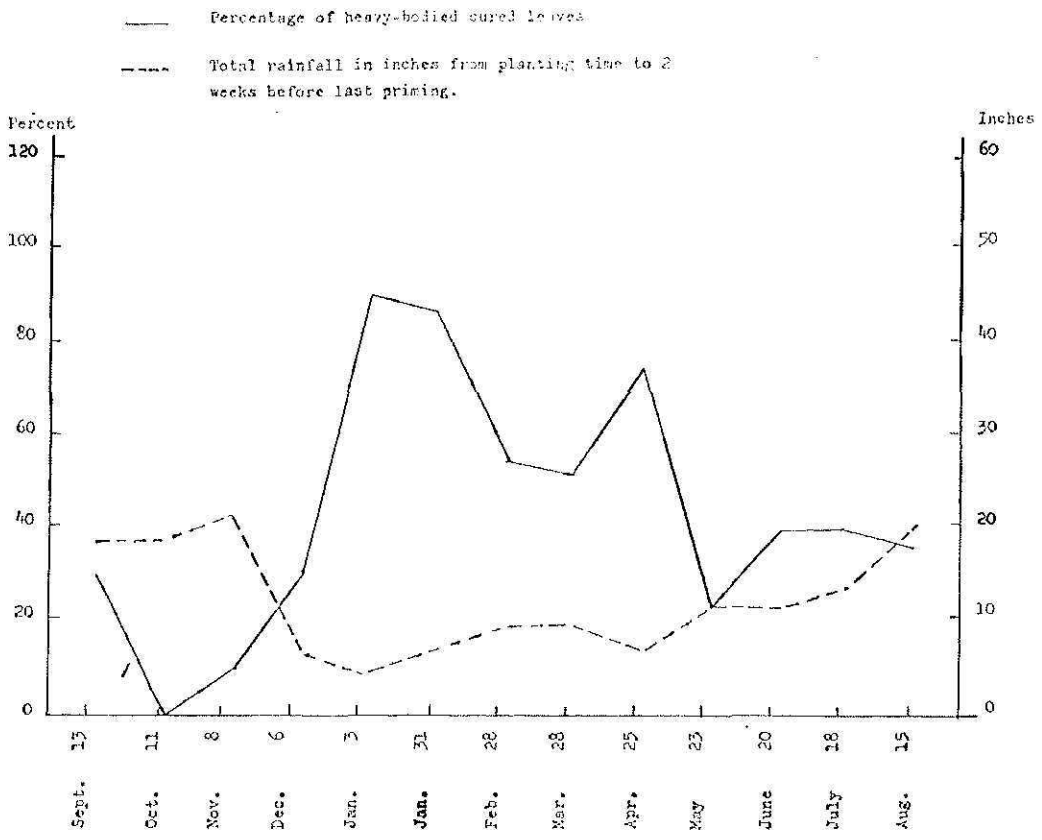

FIG. 4.—Percentage of heavy-bodied cured leaves and total rainfall for 13 seasonal experiments at Gurabo, P.R., 1960–61.

contribute to the production of heavier-bodied leaves with higher carbohydrate and lower nitrogen content, as suggested by the work of Pearse (*7,8*) in South Africa.

We deem it pertinent to mention here that, in the present experiments, tobacco cured best and offered the least problems during the normally drier months of the year in Puerto Rico, that is, from January through April, a circumstance which favors the conventional planting season.

TABLE 6.—*Labor in man-hours employed in 13 seasonal tobacco experiments planted at Gurabo, P.R., 1960-61*[1]

Experiment of—	Land preparation[2]	Planting and fertilization	Cultivation[2]	Priming of leaves	Stringing of leaves	Hanging of leaves	Felling, tying, and baling	Total
Sept. 13	18	28	85	30	63	20	20	264
Oct. 11	7	26	66	25	61	23	16	224
Nov. 8	28	18	63	18	54	14	16	211
Dec. 6	7	18	50	16	43	12	9	155
Jan. 3	20	25	39	16	43	12	12	167
Jan. 31	7	14	47	12	28	6	6	120
Feb. 28	7	25	30	15	23	7	9	116
Mar. 28	7	28	42	18	49	12	12	168
Apr. 25	11	16	38	20	59	14	12	170
May 23	7	20	41	19	52	16	12	167
June 20	7	16	41	15	41	10	10	140
July 18	7	18	60	13	45	11	11	165
Aug. 15	7	15	44	22	58	12	16	174
Total	140	267	646	239	619	169	161	2,241
Average	11	21	50	18	48	13	12	172
Percent of total	6	12	29	10	28	8	7	100

[1] Does not include man-hours in seedbeds and barn management.

[2] Land preparation, soil fumigation, and overhead irrigation are estimates, based on actual performance of equipment and personnel used.

The temperature, rainfall, and evaporation figures given in table 5 are totalled for the growing period of each experiment up to 2 weeks prior to the last priming, since the final 2 weeks are regarded as having little effect upon total production. The mean growth-period temperatures varied from 72.6° to 79.0° F. for the experiments of December 6 and July 18, respectively, and the two highest productions were obtained with mean temperatures 76.1° and 78.4° F. Garner (*3*) held that temperatures above 60° F. are necessary for the adequate growth of the tobacco plant, while prolonged temperatures of 95° to 100° F. may be injurious; a temperature of 80° F.

is about optimum for the crop. Thus, temperatures generally remained within an adequate range during the whole year.

Table 6 refers to the man-hours utilized in the various tasks performed in the different experiments. As expected, the lowest total man-hour values correspond to the experiments with the lowest yields. It is of interest to note at the bottom of the table that the labor requirements prior to harvesting accounted for 47 percent of the total, while stringing of the leaves accounted for more than half of the remaining 53 percent.

The use of modern chlorinated and organic-phosphorous insecticides permitted the effective control of insect pests throughout the year.

CONCLUSIONS

Because the experiments reported upon herein were restricted to one particular locality, the Caguas Valley, and to one year, 1960–61, conclusions are, of necessity, limited in scope, the more so because of the considerable variations in topography, soils, and annual weather that prevail in the tobacco-growing regions of the Island. However, certain definite trends seem apparent.

Tobacco grown from early January to early spring is likely to suffer from insufficient rainfall which usually endangers the setting of the plants after transplanting, particularly when irrigation facilities are wanting, and at the same time affects yield adversely.

Tobacco planted in the spring with the initiation of more abundant rainfall, may produce high yields of satisfactory grades, but the farmer will be confronted with the following disadvantages: 1, Preparation of seedbeds during the months of February and March when irrigation is essential; 2, curing during the warm and humid summer months when conditions inside the barn are less favorable; 3, harvesting and curing extending into the tropical hurricane season when the crop stands in danger of total loss.

Tobacco planted in the summer will suffer from most of the disadvantages outlined above, in addition to that of lower yields resulting from the adverse effect of excessive rainfall.

Autumn- and winter-grown tobaccos generally produce good yields and good grades. Although planting in this season also involves some disadvantages, in our opinion they are outweighed by the advantages. On the negative side, excessive rainfall may cause damage to the seedbeds by encouraging root diseases, and a hurricane may cause heavy if not complete loss to the seedbed. At the same time prolonged, cool, rainy weather at the beginning of the harvest may impair curing in the barns. On the positive side, seedbeds planted in the autumn will require a minimum of irrigation, hurricanes will not threaten the growing and harvested crop, and curing will be favored by the drier weather associated with the months of January, February, and March.

SUMMARY

With the purpose of evaluating the seasonal variations obtained with the tobacco crop in Puerto Rico, a series of 13 experiments was planted with 4 commercial varieties of tobacco at 28-day intervals, at Gurabo, P.R., from September 13, 1960 to August 15, 1961.

Equally good or better grades and yields were obtained from tobacco planted in the early spring as compared with that planted in the regular autumn-winter season.

Rainfall was found to be the most important factor affecting yield, but, because its effect was modified by numerous other conditions, it was not possible to obtain a satisfactory correlation between the two. The lowest yields were obtained when tobacco was planted during the normally drier months of January, February, and March. Weight per unit area of leaf was also observed to be closely related to rainfall, the drier the weather the higher the percentage of heavy-bodied leaves.

Yield was the preponderant factor affecting cash values. Variety P.R. 1–60 proved superior to V-12, C-10, and Olor or when statistically compared from this standpoint, although the four varieties studied responded similarly to changes in weather conditions.

Temperatures prevailing in Puerto Rico were adequate for the growing of tobacco throughout the year.

Insect pests were effectively controlled at all times with the modern insecticides employed.

RESUMEN

En este estudio se evaluó el efecto de las variaciones climatológicas estacionales que prevalecen en Puerto Rico sobre cuatro variedades comerciales de tabaco. Con tal propósito, se establecieron 13 experimentos con estas 4 variedades, haciéndose la siembra a intervalos de 28 días, durante un año, desde el 13 de septiembre de 1960 al 15 de agosto de 1961.

El tabaco que se sembró temprano en la primavera produjo tan buenos o mejores resultados, en cuanto a rendimiento y calidad, que el que se sembró durante la época tradicional de otoño a invierno.

La lluvia fue el factor que más afectó el rendimiento, pero debido a las muchas otras condiciones que modifican su efecto, no fue posible obtener una correlación satisfactoria entre ambos factores. Los rendimientos más bajos coincidieron con las siembras hechas en los meses de enero, febrero y marzo, los más secos del año. La densidad-peso del tejido foliar también parece depender estrechamente del factor humedad: a menor lluvia, mayor el porcentaje de hojas gruesas y pesadas.

Con respecto al valor de la cosecha, el rendimiento fue el factor preponderante. Aunque las cuatro variedades estudiadas respondieron en

forma similar a los cambios de clima, mantuvieron, sin embargo, diferencias de rendimiento entre sí, resultando la variedad P.R. 1–60 significativamente superior a las variedades V-12, C-10 y Olor, según el análisis estadístico.

Las temperaturas que prevalecen en Puerto Rico fueron adecuadas para la siembra del tabaco durante todo el año.

La aplicación de los insecticidas más modernos permitió un control efectivo de los insectos que atacan esta cosecha durante todo el año.

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