Dry Matter Partitioning in No-Tillage Tropical Corn in Florida

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Abstract

The long frost-free period in Florida could allow numerous multiple croping alternatives to farmers. This study was conducted 1) to determine the best plant population for highest yield of tropical open pollenated corn (Zea *mays* L.) when planted as a second crop in the late summer in north central Florida and 2) to determine the partitioning of dry matter among the corn parts. Six populations were studied in increments of 4,000 plants A ' and ranged from 12,000 to 32,000 plants A^{-1}. The study was conducted at two locations on the Green Acres Agronomy Farm on an Arredondo loamy sand (Grossarenic Paleudult) in 1987. Treatments were replicated six times in a randomized complete block design. Corn was harvested at black layer formation. Plants were separated into leaves, stalks, shucks, cobs, and grain and dried at 70 C for estimation of dry matter production. Maximum yield was obtained at the 32,000 plants A^{-1} population.

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INTRODUCTION

Florida is on the border line of the 30 degree latitude, it is not a large corn *(Zea mays* L.) producer and its corn yield average is about 62 bu A^{-1} On the other hand, the dairy and *beef* cattle farmers of north Florida, have a need of high quality forage in the fall and winter months. At present their choices of a summer annual forage crop that will grow in the fall are limited to crop species such as forage sorghum *(Sorghum bicolor* L. Moench), grain sorghum *(Sorghum bicolor* L. Moench), sudangrass *(Sorghum sudanese)* and corn.

Corn is the most commonly ensiled crop in the USA, preferred for its better quality and yield of digestible nutrients over the other choices. Corn grain is over 90% digestible and corn silage is about 70%. while sundangrass silage is about 46% (Wright et al., 1983). However, there had been limited success with fall grown corn due to the lack of adapted genotypes which can withstand the environmental stress.

During the past 6-yr, field research has been conducted to develop an open pollenated variety selected for the hot humid summer and cool fall climate of north Florida. This material originated in the hot humid tropics of Costa Rica and was allowed to cross with selected tropical and temperate hybrids in Florida. The experimental population FLOPUP (Florida open pollenated upright ear) has been selected for testing. FLOPUP has been developed for planting in August and harvest in the late fall in north and central Florida. However, the low fall temperatures and short day-length, during the critical stage from silking to maturity, may severely reduce dry matter accumulation and final grain yield. Several authors (Breuer et al., 1976; Hunter et al., 1977), have established that many corn genotypes are photoperiodically sensitive. Roberts and Struckmeyer (1938) were among the first to report the effects of temperature on the response of corn to photoperiod. Corn genotypes also differ in their response to temperature (Breuer et al., 1976).

Numerous research studies have dealt with determining the optimum plant population for a given hybrid under a certain environment. The majority of results show that optimum plant population may vary from about 16,000 to over 40,000 plant A^{-1} (Larson and Hanway, 1977). In Georgia, optimum plant populations for two hybrids over a 2-yr period varied from 17,000 to 41,000 plants A^{-1} under irrigated conditions (Brown et al., 1970).

The objectives of this research were: 1) to determine the best plant population for highest yield of FLOPUP when planted as a second crop in the late summer in north central Florida, and 2) to determine the distribution of dry matter among the corn parts.

Materials and Methods

FLOPUP (Florida open pollenated upright ear experimental population of the 7th cycle of mass selection) was planted in early August, 1987 at the Green Acres Agronomy Farm, near Gainesville. The randomized complete block design had six replications with six plant populations as treatments of four rows, 20 ft long and 2.5 ft wide. The population treatments were 12,000, 16,000, 20,000, 24,000, 28,000 and 32,000 plants A^{-1}.

Planting was done with a Brown-Harden in-row-subsoil no-tillage planter. Fertilizer was applied according to soil test. About 40,000 seed A^{-1} were planted and the populations were fixed by thinning when corn reached an average of about 4 in. in height.

Preemergence herbicides such as Atrazine (2 lb a.i. A^{-1}), Sencor (Metribuzin) (0.4 lb A^{-1}), Lasso (Alachlor) (2 lb a.i. A^{-1}), and Paraquat (0.4 lb a.i. A^{-1} plus recommended surfactant, were sprayed over the plots. It was necessary to apply paraquat as postdirected to control weed problems in certain areas. Small areas of weeds were also controlled mechanically by hand.

Irrigation was applied by overhead sprinkler and guns as needed, depending on natural rainfall. The insects were controlled as needed by use of Lannate (Methomy) (2 lb a.i. A^{-1}) and granulated Furadan (Carbofuran) (2 lb a.i. A^{-1}). Lannate was sprayed over the plants and furadan was applied in the row at planting.

At black layer formation on the grain, data was collected on whole plant yield, grain yield and grain shelling percent, to determine the effects of plant population on these factors and the best population required to optimize yield under the prevailing conditions. Silage yield was estimated from dry matter data.

Statistical analysis was done using a Tandy model 1000 SX microcomputer using the MSTAT program for the ANOVA of a randomized complete block design and mean separation by Fisher protected (LSD) test. Regression analysis of the dependent variables dry matter of grain and whole plant yield, were tested against the independent variable plant population.

Results and Discussion

In general all yield variables responded to increased plant populations (Table I). For the lowest treatment of 12,000 plants A^{-1} to 32,000 plants A^{-1}, the maximum treatment, the grain yield obtained went from 24 bu A^{-1}, 40 bu A^{-1}, respectively. This represented a proportional increase of up to 60% over the lowest yield for the lowest population treatment. These yields were low compared with yields of tropical hybrids, such as Pioneer brand X304C, with a yield of 124 bu A^{-1} (Gallaher and Baldwin, 1985), grown at the same location during a previous year but planted in March rather than August.

Linear regression was positive for grain and plant dry matter yield as a function of plant population, with an equation of y grain dry matter yield (lb A^{-1}) 790 0.034X for grain, and y dry matter yield (lb A^{-1}) 2315 0.144X for plant dry

Table 1. Yield variable of August planted corn affected by plant population (Two location average in 1987 at Gainesville, FL.)

Density	Grain		Cob	Shuck	Shelling
plants A^{-1}	Bu A^{-1}	............Ton DM A^{-1}	....		%
12,000	24 c	0.57 c	0.18 b	0.29 c	76a
16,000	27 c	0.64 c	0.21 b	0.36 b	75a
20,000	35ab	0.84ab	0.27a	0.41ab	76a
24,000	32 b	0.77 b	0.25a	0.40ab	75a
28,000	36ab	0.85ab	0.28a	0.43ab	76a
32,000	40a	0.94a	0.31a	0.45a	75a

Density	ear	Leaf	Stalk	Plant	Silage[a]
Plants A^{-1}	----------- Ton DM A^{-1}		------------		Ton A^{-1}
12,000	1.04 c	0.29 c	0.61 c	1.94 c	5.5 c
16,000	1.21 c	0.30 c	0.74 c	2.25 c	6.4 c
20,000	1.52ab	0.37 bc	0.95 b	2.84 b	8.1 b
24,000	1.42 b	0.46ab	1.02 b	2.90 b	8.3 b
28,000	1.56ab	0.49a	1.03 b	3.08ab	8.8ab
32,000	1.70a	0.53a	1.24a	3.47a	9.9a

a = Estimate is at 35% dry matter. Values in columns not followed by the same letter are significantly different at the 0.05 level of probability according to LSD test.

matter. The coefficient of determination was R2 0.85 for grain and R2 0.94 for plant dry matter. The conclusion from this was that the highest plant populaton used in this study resulted in the highest yield.

Table 2. Temperature date in 1987 for Gainesville, Florida and day-length for Florida 30^{o}-latitude).

Month	Temperature Max	Temperature Min	Day-length 7th day	Day-length 22nd day	Rainfall
	..........Deg. F.....		........Hours........		In.
Jan	66.9	42.6	10.9	11.2	4.2
Feb	70.5	47.0	11.5	11.9	5.4
March	74.0	52.5	12.3	12.7	10.3
April	79.8	50.0	13.3	13.7	0.5
May	86.2	64.3	14.1	14.5	4.3
June	91.4	70.0	14.7	14.7	2.9
July	92.8	72.1	14.7	14.4	3.9
August	93.0	72.7	14.1	13.7	5.4
Sept	89.7	69.4	13.1	12.7	3.7
Oct	79.7	55.5	12.3	11.8	0.3
Nov	75.8	54.3	11.5	11.1	4.3
Dec	72.2	45.7	10.9	10.8	1.2

Table 2 shows the temperatures and day-lengths registered during the year 1987, and in particular during the growing period from August to December. Low day and night temperatures during the ear filling period is one of the major critical limiting factors in the fall in order to obtain high grain yield, in north Florida. This is consistent with Breuer, et al (1976) who reported that during the grain filling period, temperature and photoperiod interact to reduce the number of grain filling days. Most of the dry matter of corn is produced during the 50 to 60 day period from tasseling to maturity (Hanway, 1963; Wright et al., 1983). In our experiment, the last 50 to 60 days of growth was characterized by decreasing day-length and temperature (Table 2).

The date of planting has an effect on the total number of days required to reach 50% tassel. According to Wright et al, (1983), the later we plant in the season in north Florida conditions (February to May), the sooner 50% tasseling and 50% moisture is reached. The flowering date of corn has been advanced by increasing temperature or decreasing photoperiod (Allison and Daynard, 1979; Tollenaar et al., 1979). The photoperiod and temperature affects the number of days to tassel, and this is different for each corn genotype (Hunter et a]., 1977). It is likely that dry matter yield of the whole corn plant, planted in midsummer as a second crop, will be affected, because the time from emergence to tasseling is shortened by short day-lengths and dropping temperatures from August to December. We observed that during the later part of the growth, after silking, certain disuniformity in the number of green and drying leaves occurred, this could be explained by the effect that low day and night temperatures have on the leaves of different ages. According to Alberda (1969), day temperature is the important factor in influencing the chlorophyll concentration in growing leaf parts. Parts subjected to low night temperatures remain fully green and their growth is virtually unaffected. This is an important factor for silage purposes. Nevertheless, FLOPUP shows promising results as a fall crop (Table 1).

Conclusions

All yield variables responded to increased plant population. The maximum grain and who plant dry matter yield of 40 bu A^{-1} and 3.43 ton A^{-1},respectively were obtained at the highest population of 32,000 plants A^{-1}. The ear size and shelling percent were not affected by plant population density. The effect was only in the number of ears. FLOPUP showed promising results as a fall silage crop if well managed. Temperature during the grain filling period is one of the major critical limiting factors in the fall to obtain high grain yield. The short day-length correlated with low temperature, and high insect damage perhaps, will affect the final grain yield. Insect control needs futher research, to determine the most effective and economical control program.

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