gen source increases. If this assumption is correct, then it can be assumed that the already inadequate low potassium level was further decreased in availability to the plants as nitrogen levels were increased. Since there was no further flowering response above the third potassium level regardless of amount of nitrogen supplied, it is probable that carbohydrate manufacture reaches a peak in the 'Bluechip' variety of *Chrysanthemum morifolium* when potassium is supplied in amounts somewhere near the K_3 level of this experiment.

This research was conducted in a non-air-conditioned greenhouse when temperatures were extremely high and light intensity was at a maximum. These conditions greatly increase rate of respiration and favor high photosynthetic activity. During the fall and winter months these factors, particularly temperature, should vary which might result in lower requirements of nitrogen and potassium during these seasons than data from this phase of the work indicate, although the desirable ratios of these elements possibly could remain unchanged.

SUMMARY

A factorial experiment combining four levels of nitrogen and potassium (expressed as K_2O) – 50, 100, 200, and 400 ppm – was initiated on April 26, 1959. Sand solution culture in glazed crocks was employed with pots being subirrigated four times daily. The experiment was terminated on August 18, with the following growth measurements and flowering responses determined: stem length, stem diameter, number of days till bloom, flower and stem weight, and number, diameter, and yield of flowers.

Flowering responses were generally increased up to the third potassium level with no further differences occuring at the K_4 or high potassium source. However, the highest nitrogen treatment adversely affected most responses to flowering, and the only significant increases occurred between the N_1 and N_2 levels. The third and fourth levels of nitrogen delayed flowering as did the lowest potassium treatment.

Nitrogen had no effect on stem diameter but this measurement increased up to the third potassium level. Interactions favorably affecting stem length were evident at the K_1 and K_3 levels when N_1 was raised to N_2 and at K_4 with an increase of N_1 to N_3. Stem length was adversely affected at the low potassium-high nitrogen treatment.

Detrimental effects on growth and flowering were evident with a high nitrogen-low potassium ratio. In general the data indicate most favorable results for overall growth and flowering occurred at the second level of nitrogen and the third level of potassium.

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EFFECTS OF KINDS OF POTS AND FREQUENCIES OF WATERING ON SNAPDRAGONS, PETUNIAS AND CALENDULAS FROM SEEDLING STAGE TO MATURITY

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The production of seedling cut flowers and bedding plants for sale to homeowners and commercial concerns in the United States and especially in the South is increasing rapidly. Many containers have recently been introduced into the bedding plant trade, but there has been little research done to compare the advantages and disadvantages of these containers and the effect they have on plant growth.

Jones (3) tested house plants in porous and non-porous pots and found that under house conditions of relative humidity, up to one-half the water supplied was absorbed by porous pots or lost due to evaporation through the pot walls. Knight (4) found that type of containers used for plants had no effect on pot binding. Haber (1) stated that clay pots were superior to composition pots and paper bands as containers in work with several vegetables. Joiner and McFarlin (2) working with zinnias and chrysanthemums in six-inch clay pots under full light intensity and 50 percent shade found that the most desirable plants were produced when watered every four days, followed in descending order by those watered daily and every two days.

This experiment, therefore, was established to compare the results of using organic, clay and aluminum pots and asphalt plant bands on plant growth and the effect of these containers on the watering requirements of seedlings.

Methods and Materials

One-week old *Calendula officinalis* var. 'Lemon Queen', and two-week old *Antirrhinum majus*, var. 'Navajo', and *Petunia hybrida* var. 'White Velvet', were removed from flats, planted in 2¼-inch square jack organic pots, square Alumipots, round porous clay pots and asphalt plant bands, containing two parts sterilized compost and one part imported peat.

In addition to the four plant containers the experiment consisted of three watering frequencies—watered daily, every two days and every four days— in factorial combination, placed in randomized block design replicated four times and the experimental unit was 10 plants. The experiment was conducted on raised benches in a clear glass greenhouse at the University of Florida.

Three and one-half weeks after treatment initiation linear measurements were made of the seedlings, they were removed from the greenhouse, knocked out of Alumipots and clay pots and planted in the field. Plants in organic pots and plant bands were planted with the containers. The experimental design in the field was the same as the original design in the greenhouse, although variable treatments were not continued in the field since the objective of the experiment was to test effects of pots and hold-over effects of watering during the seedling stage. At the termination of the experiment the plants were harvested, weighed immediately and dried in a forced air oven at 70 degrees centigrade for approximately 72 hours and re-weighed to obtain fresh and dry weights.

Results

Data taken when the seedlings were removed from the greenhouse and planted in the field show identical trends among all three plant species i.e. linear growth of plants was equally good for those grown in organic pots and plant bands and both groups of plants were taller than those grown in clay and Alumipots (Tables 1, 2 and 3).

TABLE 1. EFFECTS OF CONTAINERS AND WATERING FREQUENCIES ON LINEAR GROWTH IN CENTIMETERS OF CALENDULA OFFICINALIS, VAR. LEMON QUEEN

February 13, 1959

	Types of Pots						
Watering Frequency	Clay	Organic	Plant Bands		Alumipots		Watering Freq. Means
Daily	17.8	21.3	21.1		18.0		19.5
Every 2 days	19.2	20.7	20.6		18.5		19.8
Every 4 days	17.9	20.2	20.7		17.1		18.9
Pot Means	18.3	20.7	20.8	.05	17.9	.01	
L.S.D.				.05		.01	
Between Pot Means				1.14		1.54	

TABLE 2. EFFECTS OF CONTAINERS AND WATERING FREQUENCIES ON LONGITUDINAL GROWTH IN CENTIMETERS OF ANTIRRHINUM MAJUS, VAR. NAVAJO

February 13, 1959

	Types of Pots						
Watering Frequency	Clay	Organic	Plant Bands		Alumi		Watering Freq. Means
Daily	17.1	21.7	23.1		13.8		18.9
Every 2 days	17.0	22.0	21.7		17.5		19.5
Every 4 days	18.0	19.7	21.1		16.0		18.9
Pot Means	17.3	21.5	22.0		15.7		
L.S.D.				.05		.01	
Between Pot Means				1.41		1.90	

Final measurements were made on April 23, 1959. By this time snapdragons had overcome effect of watering treatment and there was no significant difference in either fresh or dry weight measurements resulting from pots. Differences still existed for calendulas on a fresh weight basis. Plants from organic pots and asphalt bands did not vary on the fresh weight basis and plant bands proved superior to clay and Alumipots in this respect (Table 4).

TABLE 3. EFFECTS OF CONTAINERS AND WATERING FREQUENCIES ON LONGITUDINAL GROWTH IN CENTIMETERS PETUNIA HYBRIDA, VAR. WHITE VELVET

February 13, 1959

	Types of Pots						
Watering Freq.	Clay	Organic	Plant Bands		Alumi		Watering Freq. Means
Daily	17.1	21.7	23.1		13.5		18.9
Every 2 days	17.0	22.1	21.8		17.6		19.6
Every 4 days	18.0	20.7	21.1		16.1		19.0
Pot Means	17.3	21.5	22.0		15.7		
L.S.D.				.05		.01	
Between Pot Means				1.46		1.96	

TABLE 4. EFFECTS OF CONTAINERS AND WATERING FREQUENCIES ON FRESH WEIGHT IN GRAMS OF CALENDULA OFFICINALIS, VAR. LEMON QUEEN

May 6, 1959

	Types of Pots				
Watering Freq.	Clay	Organic	Plant Bands	Alumi	Watering Freq. Means
Daily	144.0	128.9	154.4	189.0	158.1
Every 2 days	167.1	179.4	229.7	170.7	186.1
Every 4 days	222.1	234.6	201.6	177.1	208.8
Pot Means	177.7	189.3	195.3	175.9	
L.S.D.				.05	.01
Between Pot Means				13.62	N.S.

Petunias still exhibited a wide variation in fresh and dry weights as a result of the various pots at the final sampling date. Data of Tables 5 and 6 show that on a fresh weight basis organic pots produced the heaviest plants followed by plant bands and clay and Alumipots. On a dry weight basis there was no difference between plants grown in organic pots and plant bands, but organic pots produced heavier plants than did clay and Alumipots.

Actually a representative sample of plants was harvested monthly from the field and fresh and dry weight measurements taken. Snapdragons and calendulas did not overcome the differences in fresh and dry weight resulting from treatments until the final sampling date.

TABLE 5. EFFECTS OF CONTAINERS AND WATERING FREQUENCIES ON FRESH WEIGHT IN GRAMS OF PETUNIA HYBRIDA, VAR. WHITE VELVET

May 12, 1959

	Types of Pots				
Watering Freq.	Clay	Organic	Plant Bands	Alumi	Watering Freq. Means
Daily	57.4	65.3	69.7	50.1	60.6
Every 2 days	58.9	89.8	76.7	52.9	69.7
Every 4 days	59.3	82.3	61.3	54.3	64.3
Pot Means	58.6	79.1	69.3	52.5	
L.S.D.				.05	.01
Between Pot Means				9.86	13.25

TABLE 6. EFFECTS OF CONTAINERS AND WATERING FREQUENCIES ON DRY WEIGHT IN GRAMS OF PETUNIA HYBRIDA, VAR. NAVAJO

May 12, 1959

	Types of Pots				
Watering Freq.	Clay	Organic	Plant Bands	Alumi	Watering Freq. Means
Daily	13.8	16.5	18.0	15.0	15.9
Every 2 days	15.5	21.7	18.9	12.9	17.2
Every 4 days	16.6	20.2	16.7	15.3	17.2
Pot Means	15.4	19.5	17.8	14.4	
L.S.D.				0.05	0.01
Between Pot Means				2.05	2.75

Discussion

Post (5) and several other authors have stated that running plants "on the dry side" slows growth and prevents legginess. In this experiment there was noticeable wilting of many plants watered every four days on the third and fourth day without water, especially those plants in Alumipots. Data from this test show that this did not affect longitudinal growth of the seedlings and would therefore tend to disapprove the long-held belief that "running plants on the dry side," unless water is withheld to the point of permanent plant injury, effect linear growth. This is further substantiated with the work by Joiner et al (2).

The data generally indicate little difference in longitudinal growth and fresh and dry weights of plants grown in the organic pots and the asphalt plant bands and both containers produced taller and heavier plants than clay and Alumipots. In addition, the Alumipots produced plants either significantly shorter or less heavy than did clay and the other containers. Much of this difference in plant growth due to containers can probably be attributed to volume variation of the containers. Although commercially rated, 2¼-inch pots were used in every instance a volumetric measurement indicated considerable differences. The Alumipots held 80 cubic centimeters (cc) of water, the clay 85 and the organic pots 107. This variation in container volume undoubtedly resulted in differences in the volume of roots produced by plants growing therein. In addition to the larger volume area of the organic pots as compared to the clay and Alumipots, the roots of the seedlings growing in them had penetrated the sides and bottom of the container during the three weeks of treatment in the greenhouse prior to planting in the field. The plant bands offered the same lack of restriction to root development since they had no bottoms and the roots grew into and became massed in the bench soil.

Aeration could also have been a factor in growth differential inasmuch as air movement through the medium in clay and organic pots was undoubtedly increased by the porosity of their wall as compared with aluminum pots.

Except for snapdragons the restriction of the root system during the seedling stage affected the growth of the plants throughout their growth to maturity. The longer the plants grew after being removed from the clay and Alumipots the less difference in fresh and dry weight occurred as compared with plants growing in organic pots and plant bands.

Therefore there was a tendency for the plants to overcome the restriction of root system with time. By the final sampling date snapdragons had overcome the effect of root restriction caused by clay and Alumipots during the early stages, but three months of field growing was necessary to overcome the restrictive effects.

Students handling the plants in the various containers stated that plant bands and Alumipots were the most difficult to handle. It was difficult to prevent the soil from falling through the bottom of the bands and, to prevent this, considerable care and time was necessary. It was very difficult to knock plants from the Alumipots without seriously disrupting and knocking the soil from around the root system. At the end of three-week period in the greenhouse the organic pots were slightly spongy and broke along the top edges if not handled carefully, however, all students reported that they were still the easiest to work with and took less time in handling than other containers.

Summary

Three 3x4 factorial experiments were established to test the effects of clay, organic and aluminum pots and plant bands and three watering frequencies (daily, every 2 days and 4 days) on the growth of snapdragons, *Antirrhinum majus*, var. 'Navajo', and calendulas, *Calendula officinalis* var. 'Lemon Queen' and *Petunia hybrida*, var. 'White Velvet', from seedling stage to maturity. These plants were placed in randomize block design and replicated four times with 10 plants to the experimental unit. Three and one-half weeks after treatments began seedlings were removed from greenhouse, knocked out of Alumipots and clay pots and planted with the containers.

Generally frequencies of watering had no effect on the longitudinal growth of seedlings nor on the fresh or dry weight of the plants after they were removed to the field.

There was normally little variation between the plants grown in organic pots and asphalt plant bands as far as any of the growth measurements were concerned. However, plants in these two containers were generally taller in the seedling stage and had higher fresh and dry weights in later stages of growth than did plants growing in clay or Alumipots. In most instances plants in Alumipots were shorter and produced less fresh and dry weights than those growing in any of the other containers tested.

The organic pots and plant bands cost less than the other two containers and the organic pots could generally be handled more efficiently than the other containers.

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CONTROL OF GEOTROPIC BENDING IN SNAPDRAGON AND GLADIOLUS INFLORESCENCES

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Snapdragon and gladiolus flowers are some of the more difficult crops to ship because of their great sensitivity to gravity. These crops, if they are not shipped upright, usually have the upper portion of the spike bent and are thus unsaleable. Laboratory treatments confirm commercial experience in shipping problems by showing that after a few hours geotropic bends become fixed through hardening of the stem tissue.

Snapdragons are generally grown in greenhouses near metropolitan areas since they cannot be shipped great distances in a horizontal position and the crop is not of high enough value to afford special upright shipment. Yet this crop could be readily grown in the field in Florida during the winter months and sent to Northern markets if shipping were feasible. Thus the possibility of snapdragons becoming an important cut flower crop in Florida depends largely on development of an inexpen-