INFLUENCE OF RATE AND PLACEMENT OF SLOW-RELEASE FERTILIZER ON GROWTH AND QUALITY OF *SAINTPAULIA IONANTHA* Wend. POT PLANTS GROWN WITH CAPILLARY MAT WATERING

By

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CHAPTER I

INTRODUCTION AND REVIEW OF LITERATURE

Background

The African violet was discovered and collected by Baron Walter von Saint Paul in northeast Tanganyika (now Tanzania) in 1892. Several specimens which he sent to his father in northern Germany flowered the following year. After seeing these plants in flower, the director of the Royal Botanical Gardens at Herrenhausen realized that they were a new find in the plant world and named them Saintpaulia. Within a short time the African violet was being grown and offered for sale by several European firms (5).

African violets belong to the family Gesneriaceae, which includes a number of other popular, flowering house plants such as the florist gloxinia (*Sinningia speciosa*), lipstick plant (*Aeschynanthus* spp.), flame violets (*Episcia* spp.), and Cape primose (*Streptocarpus* spp.).

There are now 20 recognized species of Saintpaulia (9). However, almost all of the African violets commonly grown are offspring of *Saintpaulia ionantha*.

Commercial interest in the African violet in the United States started in 1927 when Armacost and Royston of Los Angeles imported seed from Europe and introduced the plants to the trade. Today the number of amateur growers in the U.S. is estimated to be in the millions (9).

African violets are asexually propagated from leaf cuttings. When placed in a loose growing medium, small plantlets form at the base of the petiole. These are removed and placed in 5-5.7 cm (2-2¼") pots. Next they are transplanted to a 7.6-11.4 cm (3-4½") pot. A 7.6 cm (3") flowering plant can be produced in 6-8 months from the time the cutting was taken. Often, specialists propagate the plants and sell the 5-5.7 cm (2-2¼") transplants to commercial growers who then produce a 10 cm (4") flowering plant in 10-12 weeks (2).

Renewed interest and demand for flowering house plants has stimulated the commercial production of African violets. Geo J. Ball, Inc. (1) states that African violets are easily the highest dollars-per-square-foot crop of any of their commercial pot plants, although market demands vary. Tremendous hobby interest stays constant and the African Violet Society is a large organization devoted to violet culture, breeding, and display (5,9).

The Development of Capillary Watering Systems

Hose-watering of greenhouse pot plants is a time consuming operation that adds greatly to the cost of production. Many automatic watering methods have been developed in an attempt to decrease the amount of labor devoted to watering.

In 1940, Kenneth Post and John Seeley worked on a method of watering plants from below, known as capillary watering. This system required a water-tight surface and a layer of sand on which the pots were set. When the sand was watered, the water moved by capillary action up from the sand through the hole in the bottom of the pot and into the soil surrounding the roots (16).

The method of subirrigation developed by Post and Seeley did not gain attention until the early 1960's when polyethylene films were in common use and as a result a water-tight surface was easier to produce. Due to the weight of the sand it was necessary to have a strong, level bench. In Denmark growers produced considerable acreages of pot plants by this method (16).

There were two disadvantages to a capillary system using sand; they were the necessity for absolutely level benches and the weight of the sand. Recently growers have substituted light-weight fibrous materials for the sand. This fibrous material is easy to install and can be cut to any dimension. Hammer and Langhans (12) have shown the capillary mat to be comparable to sand when growing 15 cm (6") pot mums. Capillary watering was also beneficial to Reiger begonias as shown by Hammer (11). There were fewer foliar disease problems with subirrigation than with conventional overhead watering since the foliage isn't wetted. Kiplinger et. al. (13), have grown Easter lilies, poinsettias, and pot mums on subirrigation mats. The lilies grew too tall due to the excess moisture but there were no essential differences between the pot mums and poinsettias grown on subirrigation mats as compared to overhead watering. Freeman (10) also found that a quality poinsettia crop could be produced using capillary mats. Production of foliage plants on capillary mats has also been successful (3). Research by Conover and Poole (8) indicated that soluble salt levels present in capillary mat grown plants will not present problems provided correct fertilization rates and methods are utilized.

A capillary mat should be placed on a flat surface. Underneath the mat should be a layer of polyethylene plastic to retain the moisture in the mat. Water can be applied to the surface of the mat through small openings along a plastic hose or chapin tubes can be used to irrigate the mat. As a result a more uniform level of moisture can be maintained as compared to other irrigation methods.

Algae growth on the mat is a disadvantage. However, moisture can still move into the pot even when large amounts of algae are present (3).

Many commercial growers are presently using the capillary method to water their African violets. In addition to the reduced time and labor devoted to watering, this method has other advantages over hand watering of African violets. It prevents wetting of the foliage which encourages disease. Also the water has time to reach room temperature before it comes in contact with the plant. When cold water is applied to the leaves in watering an African violet, light-colored rings or irregular mottlings develop on the leaf surfaces (15). This can reduce the salability of a plant. Also the relative humidity around the plants is increased when subirrigation mats are used.

Method of Fertilization in Relation to Capillary Watering

The fertilization program must be fitted to the requirements of capillary watering. Fertilizer can be added to the irrigation water to provide the necessary nutrients for plant growth. The fertilizer-water solution is absorbed from the mat. This method of fertilization is commonly used by commercial growers in conjunction with mat watering. The problem with this method is that the nutrients present in the water encourage the growth of algae (4).

A slow-release fertilizer can be incorporated into the growing medium when using mat watering (13). Few African violet growers, though, have been able to use slow-release fertilizers without burning the plant's delicate roots, especially in the summer. In addition, there appears to be a problem of the rate of fertilizer released associated with seasonal variation. One amount may be too much in the summer and yet not enough in the winter (18). It would be desirable to be able to use a slow-release fertilizer, such as Osmocote[1], while growing African violets on the mat. In addition to reduced algae growth, another reason given for its use is that the fertilizer is used more efficiently (7).

Rate and Placement of Osmocote

There appears to be a discrepancy over the amount of Osmocote that is recommended for African violets. Clarke (6) recommends 1.2 kg of Osmocote 14-14-14 per cubic meter of growing medium (2 lbs/cu. yd). Sierra Chemical Company (14), the manufacturer of Osmocote, recommends ½ of the regular rate of Osmocote 14-14-14. That is 2.97-3.56 kg/m^3 (5-6 lbs/cu. yd). Neither Clarke nor Sierra Chemical Company had research to support their recommendations.

The optimal placement of Osmocote in the pot while using subirrigation mats has not been determined. Coleman et al. (7), have shown that there is no difference in plant response due to placement of Osmocote on the surface, incorporated, or at some spot within the soil medium while using overhead irrigation. Simpson et al. (17), found that nutrient movement from surface application of Osmocote resembles liquid feed when using surface irrigation. The nutrients are slowly released and enter

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[1]Osmocote is a plastic encapsulated sphere of dry, water soluble fertilizers formulated from ammonium nitrate, ammonium phosphates, calcium phosphates, and sulfate of potash. It is a product of Sierra Chemical Co., Milpitas, California.

the growing medium evenly across the surface of the medium. The nutrients move downward to the root zone. The fertilizer release decreases as the soil surface dries between irrigations. Surface applications reduce leaching losses. By the time the nutrients are released from the capsule, most of the free water has drained from the pot.

Research Objectives

The objectives of this study were:

1. To determine the optimum rate and placement of Osmocote 14-14-14 in the production of Saintpaulia ionantha cultivars 'Ulli' and 'Lisa' for a period of 10-12 weeks while using capillary mat watering;
2. To observe the seasonal aspect of the rate and placement variables, i.e. grow a summer and winter crop to determine if different rates and/or placements of Osmocote 14-14-14 should be used during different seasons;
3. To observe the effect of the above variables on the different cultivars; and
4. In addition to the above, utilize liquid fertilizer rates at known commercial range as an empirical comparison with the Osmocote experimental rates.

CHAPTER II

MATERIALS AND METHODS

Experimental Treatments

The summer and winter crops were planted on July 15, 1978, and November 11, 1978, respectively. The same variables were used in both experiments. The major difference between the two experiments was the time of the year. The winter crop was subjected to shorter day-lengths, a greater number of overcast days, and unavoidably somewhat cooler temperatures.

'Lisa' and 'Ulli', two cultivars of the Fischer Ballet Series, were used.

The Osmocote 14-14-14 treatments were made up of four rates and three placements. The rates were:

1. 0.9 kg/cu. meter (1.5 lbs/cu. yd) - .624 g/11.43 cm pot
2. 1.8 kg/cu. meter (3.0 lbs/cu. yd) - 1.247 g/11.43 cm pot
3. 2.7 kg/cu. meter (4.5 lbs/cu. yd) - 1.870 g/11.43 cm pot
4. 3.6 kg/cu. meter (6.0 lbs/cu. yd) - 2.494 g/11.43 cm pot

The quantities of elemental nitrogen, phosphorus, and potassium received by each plant are listed in the Appendix (Table XXIV). The placements were:

1. Top dressed
2. Incorporated into the growing medium
3. Placed on the bottom of the pot

Listed below are the liquid fertilizer treatments:

1. Check (Irrigated with plain water).
2. 50 ppm N[1], 31 ppm P[2], 50 ppm K[3] (Placed in the irrigation water - constant liquid fertilizer).
3. 75 ppm N[1], 31 ppm P[2], 75 ppm K[3] (Placed in the irrigation water - constant liquid fertilizer).

The total amount of elemental nitrogen, phosphorus, and potassium placed on each individual capillary mat are shown in the Appendix (Table XXIV). The analysis of the liquid fertilizer treatments is in the Appendix.

Transplanting

Plantlets were obtained from Geo J. Ball, Inc., Chicago, Illinois. The plantlets came in trays of 36 cells. Each cell measured 4 x 4 cm (1.58 x 1.58 inches) and 4.5 cm (1.77 inches) deep. There were approximately 5-9 leaves on each plant (Figure 1).

The plantlets were transplanted into 11.43 cm (4½ inch) plastic pots. Each pot held 700 cu. cm of growing medium. The growing medium was Pro Mix_{B_x}[4]. The contents of Pro Mix_{B_x} are:

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[1]Nitrogen Source:
50 ppm: 50.43 g of KNO_3 and 79.93 g of $Ca(NO_3)_2$ per 378.5 liters of water.
75 ppm: 75.71 g of KNO_3 and 120.21 g of $Ca(NO_3)_2$ per 378.5 liters of water.

[2]Phosphorus Source:
31 ppm: 31 cc of 75% Food-Grade Phosphoric Acid per 378.5 liters of water.

[3]Potassium Source:
Provided by KNO_3. Amount used is given under nitrogen source.

[4]Pro Mix_{B_x} is a product of Premier Brands Peat Moss Corporation, New York, New York.

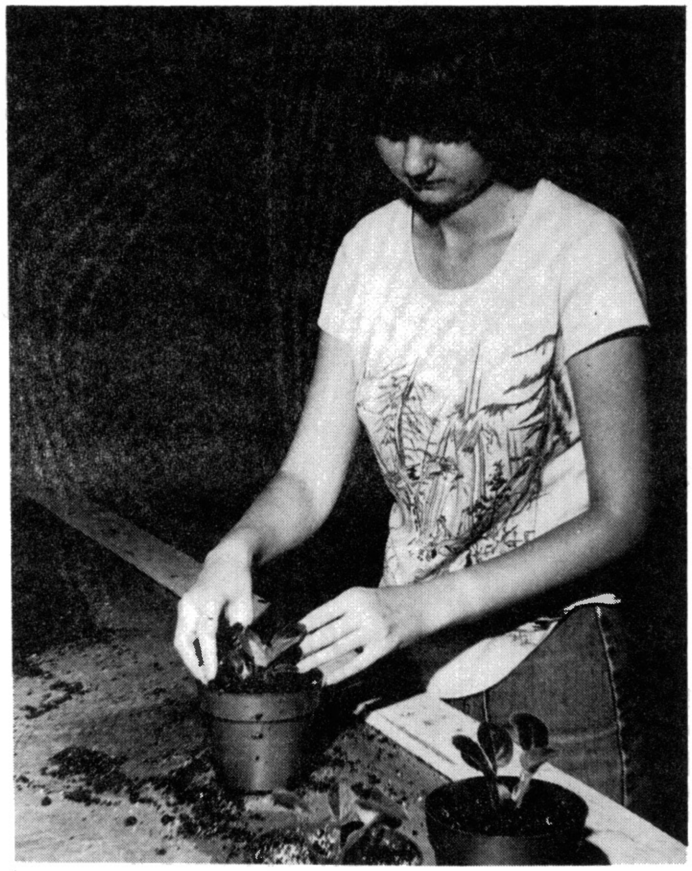

Figure 1. Size of Plantlets at the Start of the Summer Crop.

Sphagnum Peat	.465 cu. m. (13.2 bushels)
Vermiculite	.155 cu. m. (4.4 bushels)
Perlite	.155 cu. m. (4.4 bushels)
Dolomite	4.54 kg (10 lbs)
0-20-0	1.134 kg (2½ lbs)
KNO_3	680 g (1.5 lbs)
Fritted Trace Elements	85 g (3 oz)
Wetting Surfactant	142 g (5 oz)

In order to incorporate the Osmocote, the growing medium was placed in a jar with the proper amount of fertilizer. After mixing thoroughly, the mixture was placed in the pot.

Placing the Osmocote on the bottom of the pot required that a small amount of growing medium (approximately one cm deep) be placed in the pot before adding the fertilizer. This was done to prevent the Osmocote from seeping out the holes. The container was then filled with the rest of the growing medium.

In order to top dress a container with Osmocote, the proper amount was placed on the surface of the growing medium after the transplant was watered-in and drenched with Dexon(Lesan)-Benlate.

After transplanting each plant was watered-in with 120 ml of water and drenched with 120 ml of Dexon(Lesan)-Benlate at ½ rate.[1]

The plants were then placed on the bench and drenched with 120 ml of Peter's Soluble Trace Element Mixture[2] at ½ rate.[3] In addition to

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[1]One gram of Dexon(Lesan) 35 W.P. and one gram of Benlate 50 W.P. in 3.78 liters of water or 4 oz of each chemical/100 gallons of water.

[2]STEM is a product of Robert B. Peters Co., Inc., Allentown, PA.

[3]1.75 grams of STEM/5.9 liters of water or 1 oz/25 gal. of water.

providing trace elements, this established capillary action.

Experimental Design

Each experiment was placed in a Randomized Complete Block design with six replications of thirty experimental units each. Each experimental unit consisted of a pair of plants of the same treatment. Only one plant of each pair or experimental unit was used when the data was collected.

Physical Arrangement

The study was conducted in House 4 of the Oklahoma State University Horticulture Greenhouses. A 96.5 x 1412 cm bench was used for both crops. Each plant received a spacing of 15.25 x 21.6 cm (6 x 8½"). The blocks or replications ran from north to south along the length of the bench. Block one was closest to the cooling pads while block six was the greatest distance from the pads. Buffer rows were placed on the north and south ends of the bench. Each pot was placed on a 12.7 x 17.8 cm (5 x 7") subirrigation Vattex-P mat[1] placed on top of black polyethylene plastic cut to the same dimensions as the mat. Placing the containers on separate mats prevented the mixing of fertilizer from different treatments. Each mat was watered through a chapin tube which was attached to one of three main 1.9 cm (3/4") lines (Figure 2). The main lines extended from three separate barrels. One barrel held plain water. The other two contained the liquid fertilizer solution. Each mat received approximately 20 ml of water every 30 minutes from 7:00

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[1]Vattex-P is a product of U.S. Vattex, Center Moriches, New York. It contains natural and synthetic fibers with a stitched polyethylene backing.

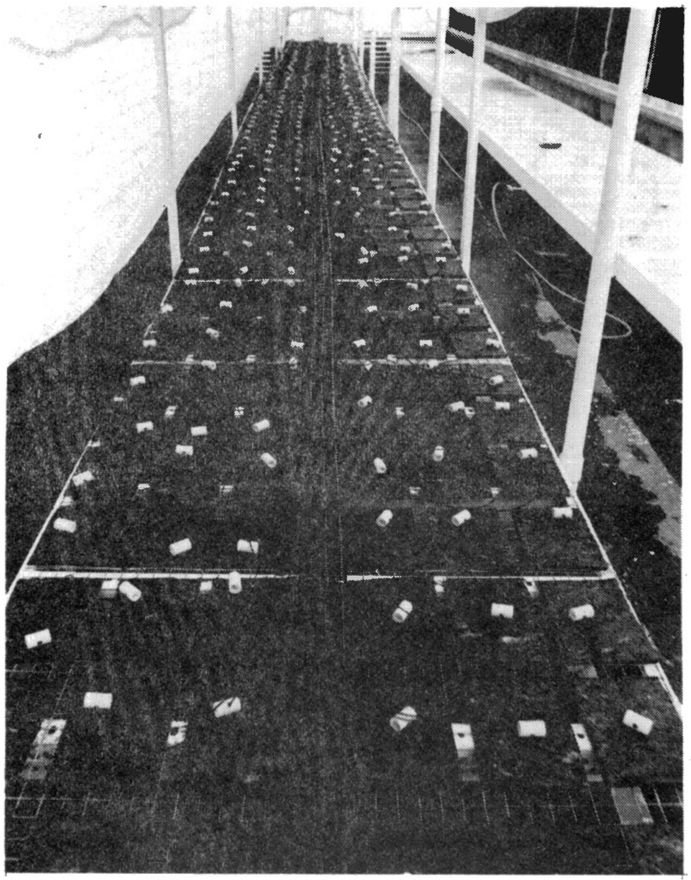

Figure 2. View of Bench and Irrigation System.

a.m. to 7:00 p.m.

Cultural Practices

The desired night temperature was 21°C (70°F). During the winter months, this temperature was difficult to maintain. Night temperatures sometimes fell to 18°C (64°F) and on a few occasions even dropped as low as 12°C (54°F).

The desired daytime temperature range was 24-29.4°C (75-85°F). During the summer months, the temperature occasionally exceeded this range. The temperatures often dropped below this range in the winter but generally stayed above 21°C (70°F).

Cheesecloth was used to reduce the light intensity to approximately 10,764 lumens/m^2 (1000 foot-candles) during the brightest part of the day.

Twice during the growth of each crop, the irrigation system was turned off to allow the subirrigation mats and the growing medium in the pots to dry somewhat. The plants are more susceptible to *Pythium* and other rot organisms when they are grown under very wet conditions. Growing medium was dried periodically to reduce potential problems with these pathogens. The irrigation system was turned off from July 31 to August 7, September 11 to September 18, November 22 to November 30, and December 22 to December 29. Each plant received 250 ml of water just prior to turning on the irrigation system each time.

Various measures were taken to control pests. On July 24, Sevin 50 W.P. was dusted around the legs of the bench and under the bench in an attempt to irradicate slugs and snails. The summer crop was drenched with Diazinon 50 W. at full rate[1] on August 4 to control fungus gnat larvae. Each pot received 120 ml of the solution. On December 18, the winter crop was sprayed with a solution of Ferban 76 W.P.-Captan 50 W.[2] in an attempt to control rot organisms.

Harvesting of the summer crop began September 25, seventy-three days after the start of the experiment. Harvesting was completed October 4. The winter crop was harvested from January 22 (73rd day of the crop) to January 31.

Data Recorded

Top Dry Weight

The above-ground plant parts were placed in paper sacks and dried in an oven at 71-82°C (160-180°F) until no moisture remained. After the plants were dried, the sacks and plants were weighed. The dry weight of each paper sack had been previously determined. The weight of the paper sack was then subtracted from the combined weight of the plant and paper sack to give the top dry weight of the plant.

Quality Rating

A scale of 1-10 was used, one being poorest quality and 10 being best quality. Features taken into consideration were: degree of chlorosis, bloom quality, amount of vegetative growth, number of flower stalks, and average number of flowers per stalk.

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[1]4.5 grams of Diazinon 50 W./3.8 liters of water.

[2]9 grams of each chemical/7.5 liters of water.

Tissue Analysis

Three blocks or replications were used for tissue analysis. The dried, above-ground tissues from each plant were ground and analyzed for % nitrogen, % phosphorus, and % potassium. The Kjeldahl method was used to find % nitrogen. The perchloric digestion procedure was used in the measurement of phosphorus and potassium. To determine % phosphorus the phospho-vano-molybdate color complex was used. Atomic absorption spectrophotometry was used to determine % potassium.

Width

Two measurements of width were taken at right angles to each other. These measurements were added together and then divided by two to give one measurement of width.

Leaf Area

A LI-COR Portable Area Meter[1] was used to determine the total square centimeters of leaf area (one side of each leaf only) of each plant.

Other Data Recorded

The following items were also observed: number of days to first bloom; number of leaves; number of flower stalks; and presence of necrotic areas on the leaves.

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[1]The LI-COR Portable Area Meter, Model LI-3000, is a product of Lambda Instruments Corporation, Lincoln, Nebraska.

CHAPTER III

RESULTS AND DISCUSSION

Statistical Analysis

For ease of interpretation, each crop was divided into four experiments, each one analyzed separately:

1. 'Lisa' - Osmocote treatments
2. 'Ulli' - Osmocote treatments
3. 'Lisa' - liquid fertilizer treatments
4. 'Ulli' - liquid fertilizer treatments

Fertilizer rates were analyzed for linear, quadratic, and cubic trends. Placement means (over all rates) were compared using a protected LSD. Interactions of rate and placement were graphed when significant. Also the placement means within each rate were compared using a protected LSD when the interaction of rate and placement was significant.

For the purpose of this discussion, the Osmocote rates will be shortened, e.g. simply 1.8 kg instead of 1.8 kg of Osmocote 14-14-14/cubic meter of growing medium. Results of the liquid fertilizer experiment, used as an empirical control, are in the Appendix. The liquid fertilizer treatments (50 ppm nitrogen, 31 ppm phosphorus, 50 ppm potassium and 75 ppm nitrogen, 31 ppm phosphorous, 75 ppm potassium) will be referred to as simply 50 ppm and 75 ppm respectively.

Summer Crop Growth and Quality Parameters

Dry Weight

The analysis of variance for the Osmocote treatments indicated that fertilizer rate had a significant effect on the dry weight of both cultivars. A linear trend was evident with 'Lisa' and a quadratic trend with 'Ulli'. Placement also had a significant effect upon the dry weight of 'Lisa' (Table I). The rate means (averaged across all placements) indicated that 3.6 kg and 2.7 kg produced the greatest amount of dry weight in 'Lisa' and 'Ulli' respectively (Figure 3). The placement means (Table I) suggested that top dressing the Osmocote produced the most dry weight in 'Lisa'. Placing the Osmocote on the bottom of the pot resulted in the lowest dry weight being produced, while incorporating it was intermediate in effect. These results suggest that top dressing resulted in the fertilizer being more available to the plant while placing it on the bottom of the pot restricted the availability of the nutrients to the plant. Incorporation was intermediate in effect.

Quality Rating

The analysis of variance for 'Lisa' indicated that the rate and placement of Osmocote had a definite effect on the quality of plant produced and that an interaction existed between rate and placement. An interaction between rate and placement was also evident with 'Ulli' even though the rate and placement main effects were not significant (Table II). This lack of significance in the main effects may be due to this interaction. Due to these interactions, the main effects of

TABLE I

ANALYSIS OF DRY WEIGHT (g) IN RELATION TO CULTIVAR, RATE, AND PLACEMENT OF OSMOCOTE IN THE SUMMER CROP[y]

Cultivar and Rate (kg/m^3)	Placement		
	Top Dressed	Incorporated	Bottom of Pot
'Lisa'			
0.9	4.65	3.64	3.59
1.8	4.97	4.51	4.12
2.7	5.03	5.09	4.31
3.6	5.34	5.14	4.87
Pooled Means[z]	5.00c	4.60b	4.22a
'Ulli'			
0.9	3.78	3.44	2.91
1.8	3.66	3.95	3.74
2.7	3.73	4.14	3.77
3.6	3.65	3.51	3.83
Pooled Means[z]	3.71a	3.76a	3.56a

[y]Significance of main effects, trends, and interactions:

	'Lisa'	'Ulli'
Rate	0.01	0.05
Linear	0.01	0.10
Quadratic	NS	0.05
Cubic	NS	NS
Placement	0.01	NS
Rate*Placement	NS	NS

[z]Means within rows (Left-to-Right) followed by different letters are significantly different at the 5% level. 'Lisa' - $LSD_{.05}$ = 0.313; 'Ulli' - $LSD_{.05}$ = 0.311. All Osmocote rates are pooled.

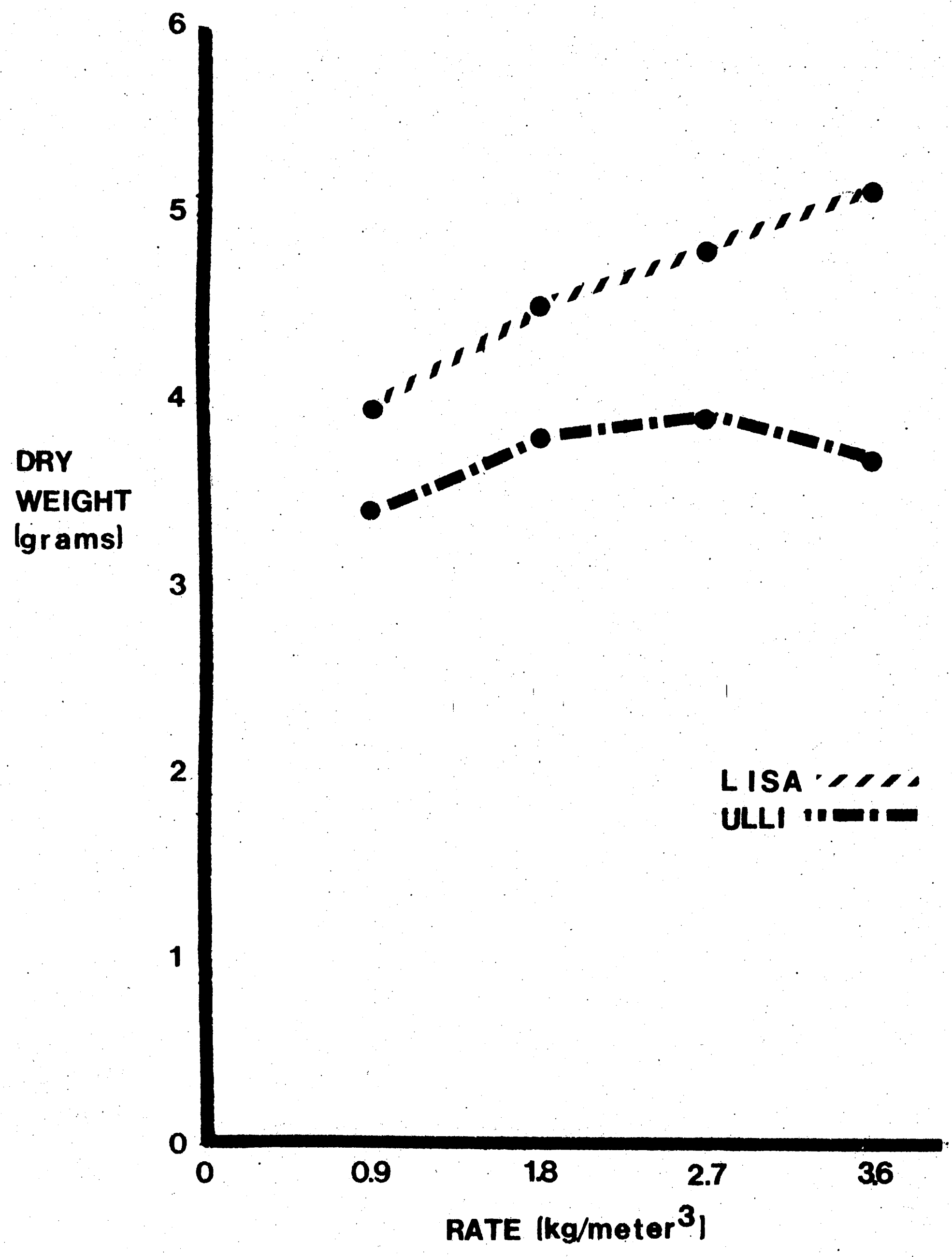

Figure 3. The Influence of Rate of Osmocote on Dry Weight in the Summer.

TABLE II

ANALYSIS OF QUALITY RATING IN RELATION TO CULTIVAR, RATE, AND PLACEMENT OF OSMOCOTE IN THE SUMMER CROP[y]

Cultivar and Rate (kg/m^3)	Placement: Top Dressed	Placement: Incorporated	Placement: Bottom of Pot
'Lisa'			
0.9	8.00b[z]	6.50a	6.00a
1.8	8.67b	8.33ab	7.50a
2.7	8.50ab	9.50b	8.33a
3.6	8.17a	9.17a	8.50a
'Ulli'			
0.9	7.83b	6.33ab	4.67a
1.8	6.50a	7.67a	6.67a
2.7	4.67a	7.83b	7.33b
3.6	4.50a	5.83ab	7.33b

[y]Significance of main effects, trends, and interactions:

	'Lisa'	'Ulli'
Rate	0.01	NS
Linear	0.01	NS
Quadratic	0.01	NS
Cubic	NS	NS
Placement	0.01	NS
Rate*Placement	0.05	0.01

[z]Means within rows (Left-to-Right) followed by different letters are significantly different at the 5% level. 'Lisa' - $LSD_{.05}$ = 1.10; 'Ulli' - $LSD_{.05}$ = 2.02.

rate or placement alone have little meaning since a different optimum rate was evident at each placement. When the Osmocote was top dressed, 1.8 and 2.7 kg produced the highest quality plants of 'Lisa', while 2.7 and 3.6 kg produced high quality plants when the Osmocote was incorporated or placed on the bottom of the pot (Figure 4). Overall, the highest quality plants of 'Lisa' resulted from incorporating 2.7 kg of Osmocote into the growing medium. With 'Ulli' the interaction of rate and placement indicated that it was more sensitive to over-fertilization than 'Lisa' (Figure 5). After the optimum rate for a particular placement (top dress or incorporation) was reached, quality rapidly declined. When the Osmocote was top dressed, the optimum rate was 0.9 kg. At higher rates, quality declined sharply. The rates of 1.8 and 2.7 kg produced the highest quality when incorporated. Quality was greatly decreased at 3.6 kg. The application of 2.7 and 3.6 kg of Osmocote to the bottom of the pot produced the optimum quality at that placement (Figure 5). These results again suggest that top dressing the Osmocote increases its availability to the plant while placing it on the bottom of the pot restricts this availability. Incorporation appears to be intermediate in effect.

Leaf Area

As one might expect, the analysis of variance and the mean comparisons for the Osmocote treatments showed results similar to those found in the dry weight analysis (Table III and Figure 6). The only exception to this is that with 'Lisa' top dressing the Osmocote was not significantly different from incorporating it (Table III).

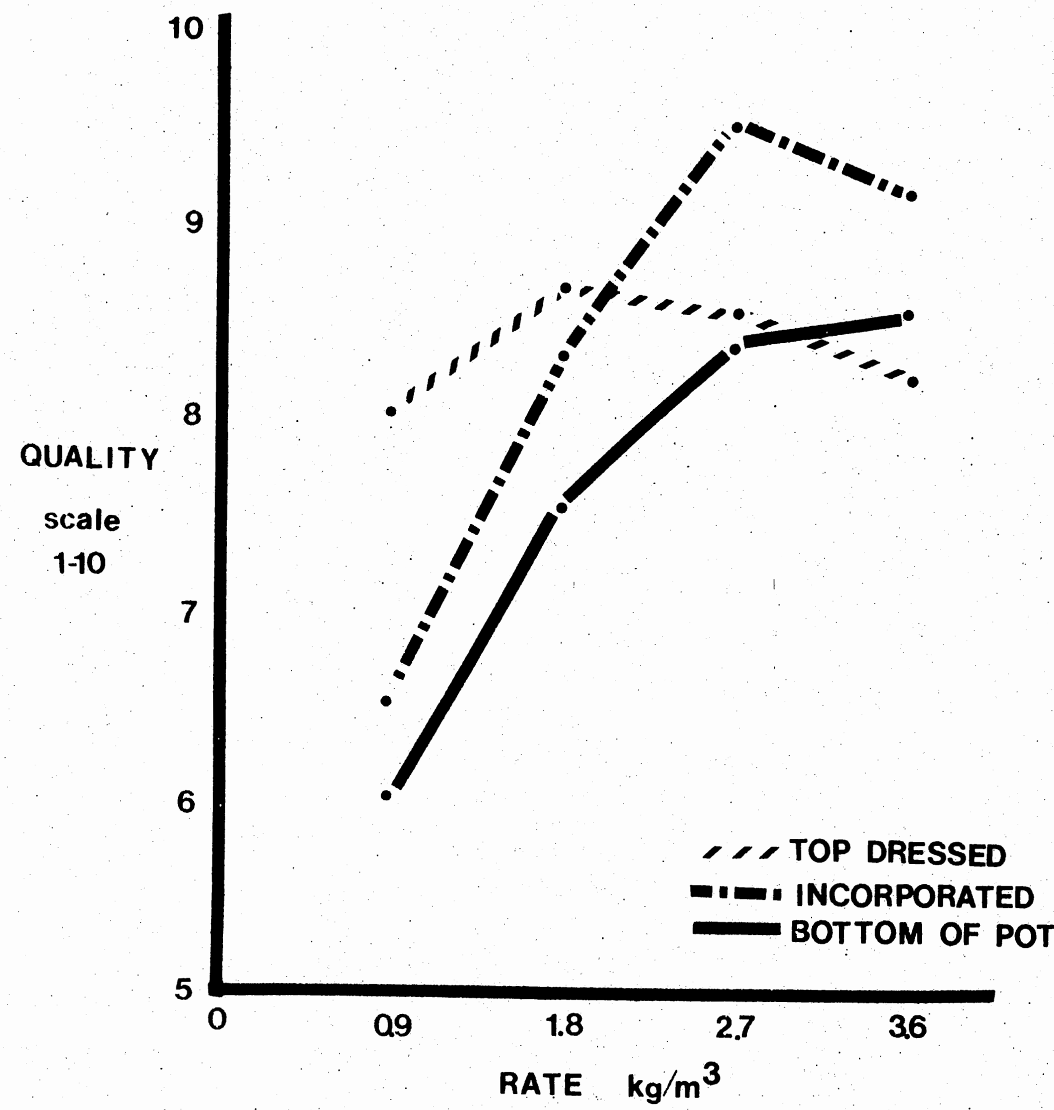

Figure 4. Influence of Osmocote Rate and Placement on the Quality Rating of 'Lisa' in the Summer.

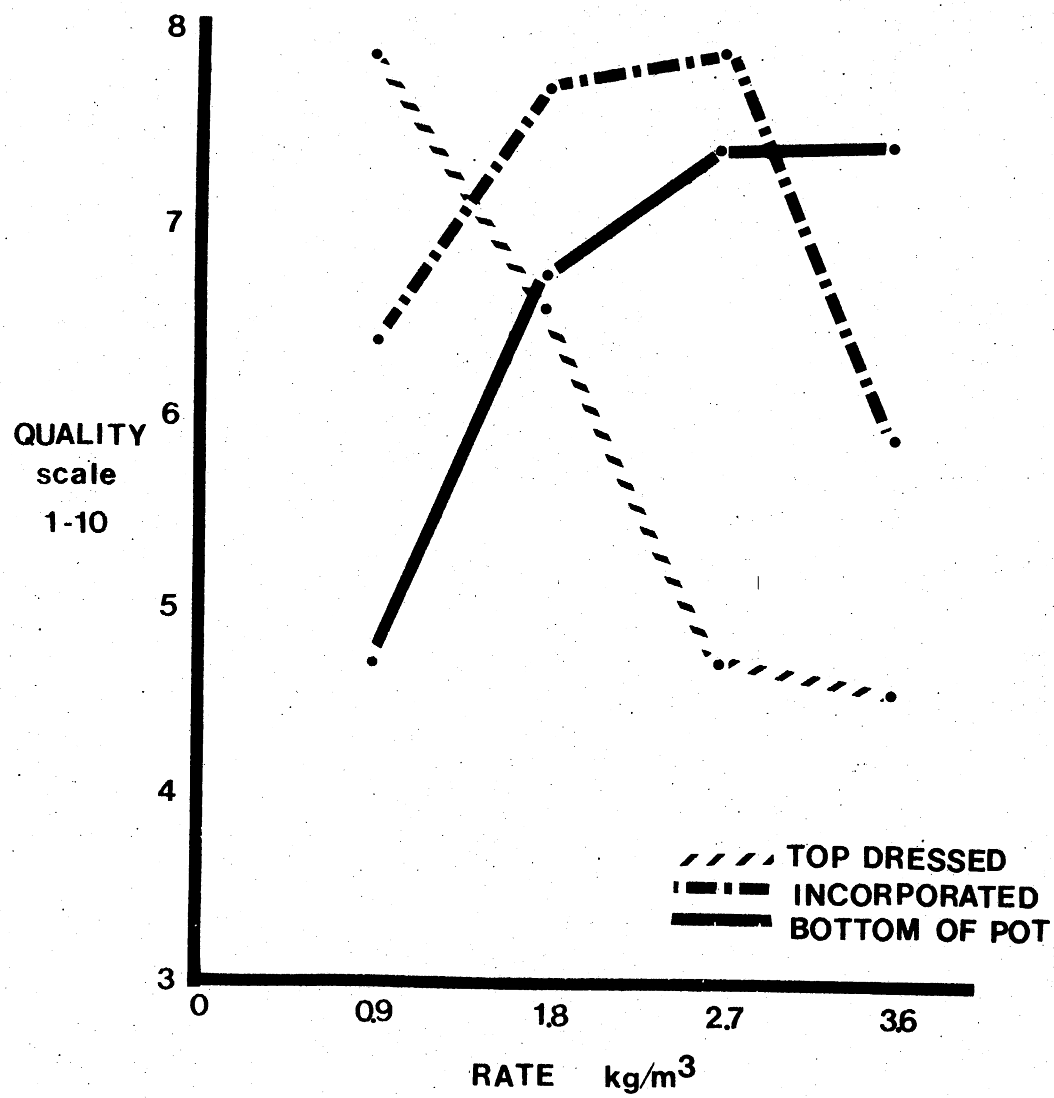

Figure 5. Influence of Osmocote Rate and Placement on the Quality Rating of 'Ulli' in the Summer.

TABLE III

ANALYSIS OF LEAF AREA (sq. cm) IN RELATION TO CULTIVAR, RATE, AND PLACEMENT OF OSMOCOTE IN THE SUMMER CROP[y]

Cultivar and Rate (kg/m^3)	Placement: Top Dressed	Placement: Incorporated	Placement: Bottom of Pot
'Lisa'			
0.9	649.2	522.2	539.5
1.8	771.0	668.0	597.8
2.7	714.3	763.3	632.5
3.6	818.3	802.0	750.5
Pooled Means[z]	738.2b	688.9b	630.1a
'Ulli'			
0.9	481.8	450.5	385.5
1.8	534.3	521.5	500.2
2.7	517.7	566.7	531.3
3.6	506.5	497.3	514.3
Pooled Means[z]	510.1a	509.0a	482.8a

[y]Significance of main effects, trends, and interactions:

	'Lisa'	'Ulli'
Rate	0.01	0.01
Linear	0.01	0.01
Quadratic	NS	0.01
Cubic	NS	NS
Placement	0.01	NS
Rate*Placement	NS	NS

[z]Means within rows (Left-to-Right) followed by different letters are significantly different at the 5% level. 'Lisa' - $LSD_{.05}$ = 52.2; 'Ulli' - $LSD_{.05}$ = 34.7. All Osmocote rates are pooled.

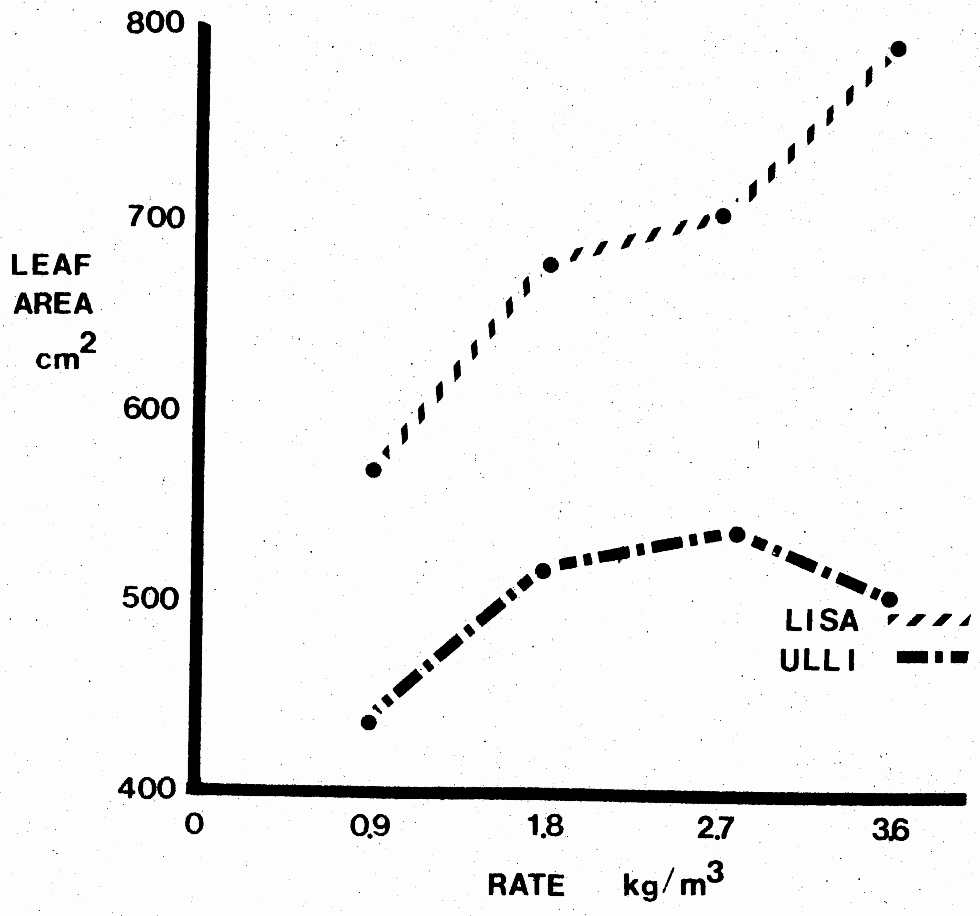

Figure 6. Leaf Area as Affected by Rate of Osmocote in the Summer.

Width

The analysis of variance of the Osmocote treatments suggested that rate is the only main effect that influenced plant width (Table IV). No interaction appeared to be present. The widest plants were produced when the rate was 2.7 kg (Figure 7).

Leaf Count

The analysis of variance of the Osmocote treatments indicated that rate alone had an effect on the number of leaves present (Table V). A quadratic trend was evident with 'Ulli' and a cubic trend with 'Lisa'. With 'Ulli' the greatest number of leaves was produced on those plants that received 1.8 kg of Osmocote. 'Lisa' peaked at 1.8 and 3.6 kg. These results are difficult to interpret (Figure 8). The value of this data is questionable since a large number of leaves does not necessarily imply a quality plant or visa versa. It does appear, with 'Ulli', however, that the lowest and highest fertilizer rates may have been detrimental.

Flower Stalk Count

According to the analysis of variance for the Osmocote treatments neither rate nor placement had an effect on the number of flower stalks produced. There does appear to be a cultivar difference; 'Lisa' producing slightly more stalks per plant than 'Ulli' (Table VI).

Number of Days to First Bloom

Rate and placement had an effect upon the number of days to the

TABLE IV

ANALYSIS OF WIDTH (cm) IN RELATION TO CULTIVAR, RATE, AND PLACEMENT OF OSMOCOTE IN THE SUMMER CROP[y]

Cultivar and Rate (kg/m^3)	Placement		
	Top Dressed	Incorporated	Bottom of Pot
'Lisa'			
0.9	28.50	26.17	26.50
1.8	29.67	29.08	28.92
2.7	31.75	30.58	31.50
3.6	31.08	30.83	31.33
Pooled Means[z]	30.25a	29.17a	29.56a
'Ulli'			
0.9	26.00	24.00	22.58
1.8	26.25	25.75	26.08
2.7	25.50	26.75	27.33
3.6	25.83	25.83	25.83
Pooled Means[z]	25.90a	25.58a	25.45a

[y]Significance of main effects, trends, and interactions:

	'Lisa'	'Ulli'
Rate	0.01	0.05
Linear	0.01	0.05
Quadratic	0.05	0.05
Cubic	NS	NS
Placement	NS	NS
Rate*Placement	NS	NS

[z]Means within rows (Left-to-Right) followed by different letters are significantly different at the 5% level. 'Lisa' - $LSD_{.05}$ = 1.340; 'Ulli' - $LSD_{.05}$ = 1.236. All Osmocote rates are pooled.

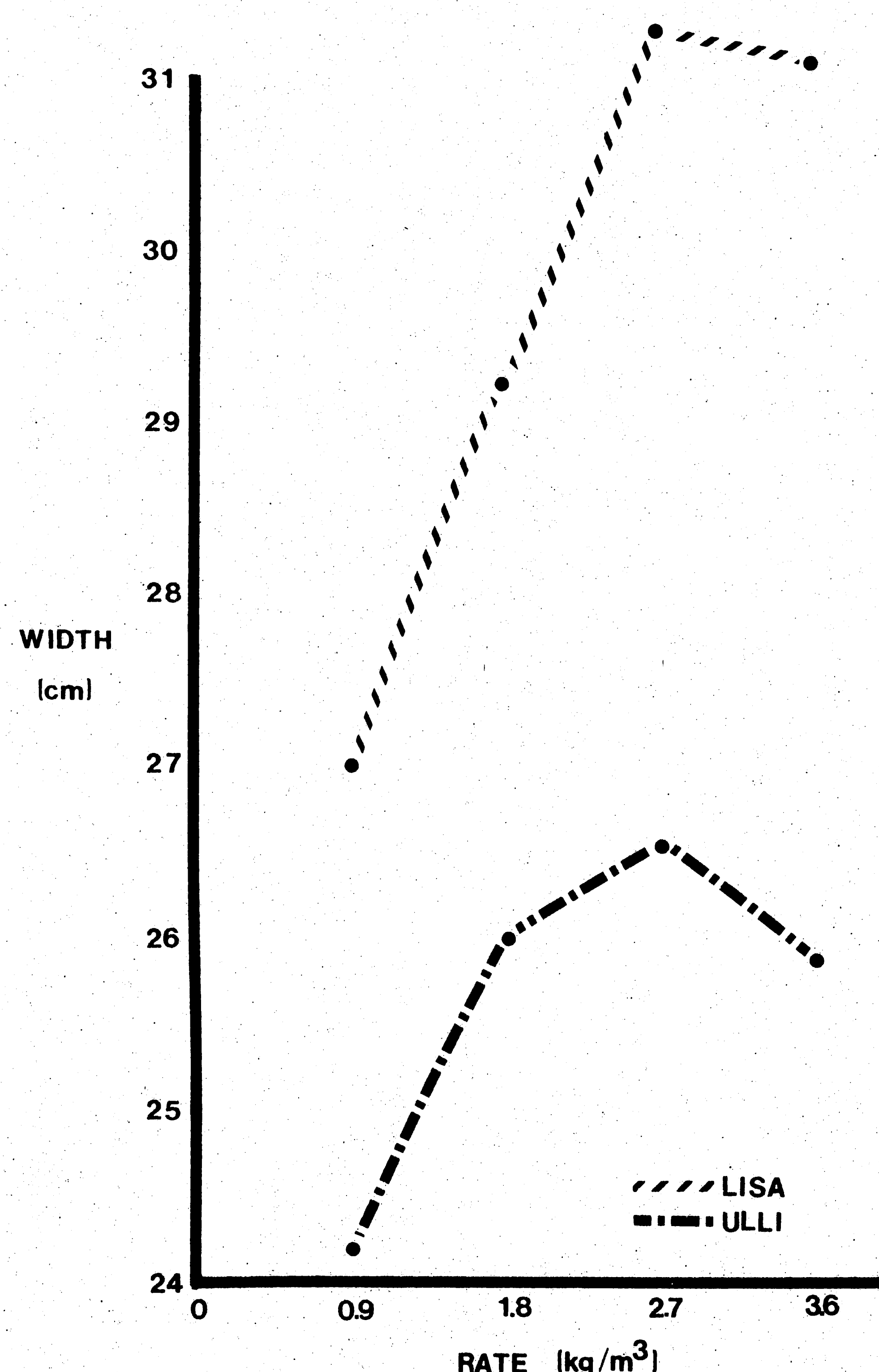

Figure 7. Plant Width as Affected by Rate of Osmocote in the Summer.

TABLE V

ANALYSIS OF LEAF COUNT IN RELATION TO CULTIVAR, RATE, AND PLACEMENT OF OSMOCOTE IN THE SUMMER CROP[y]

Cultivar and Rate (kg/m^3)	Placement		
	Top Dressed	Incorporated	Bottom of Pot
'Lisa'			
0.9	36.00	32.17	32.67
1.8	44.17	36.33	34.67
2.7	30.33	37.50	29.67
3.6	40.83	38.17	41.50
Pooled Means[z]	37.83a	36.04a	34.63a
'Ulli'			
0.9	32.17	32.67	29.33
1.8	38.00	38.83	40.67
2.7	41.33	33.50	39.50
3.6	39.00	36.50	33.50
Pooled Means[z]	37.63a	35.83a	35.75a

[y]Significance of main effects, trends, and interactions:

	'Lisa'	'Ulli'
Rate	0.05	0.05
Linear	NS	NS
Quadratic	NS	0.05
Cubic	0.01	NS
Placement	NS	NS
Rate*Placement	NS	NS

[z]Means within rows (Left-to-Right) followed by different letters are significantly different at the 5% level. 'Lisa' - $LSD_{.05}$ = 4.95; 'Ulli' - $LSD_{.05}$ = 4.92. All Osmocote rates are pooled.

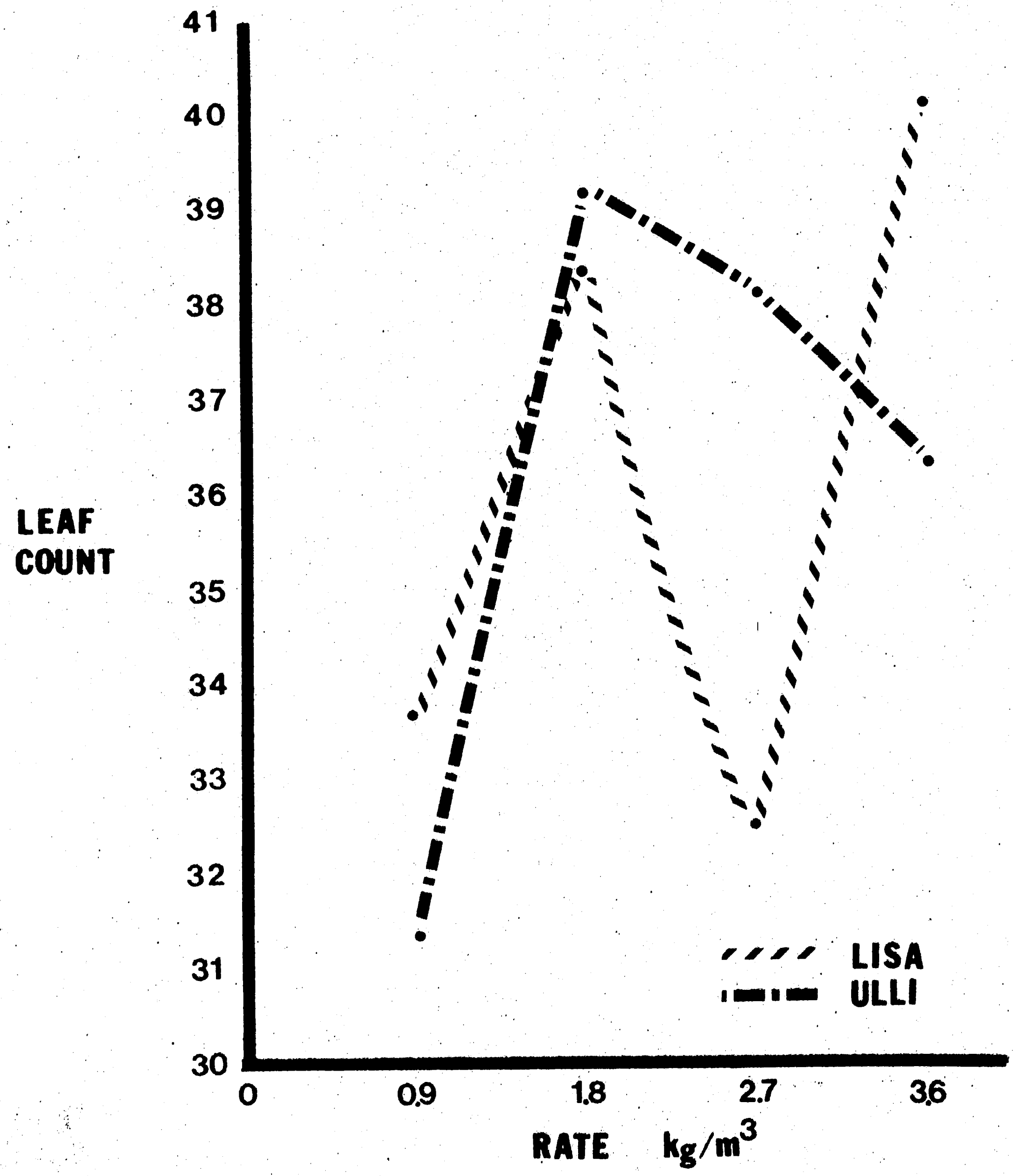

Figure 8. Influence of Osmocote Rate on Leaf Count in the Summer.

TABLE VI

ANALYSIS OF FLOWER STALK COUNT IN RELATION TO CULTIVAR, RATE, AND PLACEMENT OF OSMOCOTE IN THE SUMMER CROP[y]

Cultivar and Rate (kg/m^3)	Placement		
	Top Dressed	Incorporated	Bottom of Pot
'Lisa'			
0.9	5.33	5.33	5.00
1.8	5.67	5.33	5.67
2.7	5.67	6.33	6.17
3.6	4.67	5.50	5.50
Pooled Means[z]	5.34a	4.88a	5.59a
'Ulli'			
0.9	4.83	4.50	4.17
1.8	3.50	4.67	5.33
2.7	3.17	4.17	4.33
3.6	3.67	3.67	4.67
Pooled Means[z]	3.79a	4.25a	4.63a

[y]Significance of main effects, trends, and interactions:

	'Lisa'	'Ulli'
Rate	NS	NS
Linear	NS	NS
Quadratic	NS	NS
Cubic	NS	NS
Placement	NS	NS
Rate*Placement	NS	NS

[z]Means within rows (Left-to-Right) followed by different letters are significantly different at the 5% level. 'Lisa' - $LSD_{.05} = 0.89$; 'Ulli' - $LSD_{.05} = 0.86$. All Osmocote rates are pooled.

opening of the first bloom stalk on 'Lisa'. Placement alone had a significant effect upon 'Ulli' (Table VII). The rates of 0.9 and 2.7 kg brought about a shortened period to flowering in 'Lisa'. This may not be of any great importance to a commercial grower since flowering initiated only three days earlier on the average than at the other two rates (Figure 9). Placement in both 'Ulli' and 'Lisa' was only borderline significant. In both cases, the placement of Osmocote on the bottom of the pot resulted in the shortest number of days to first bloom while top dressing the Osmocote resulted in the longest number of days to first bloom. Incorporation was not significantly different from top dressing or bottom of the pot placement (Table VII).

Percent Nitrogen

The analysis of variance for the Osmocote treatments indicated that rate and placement were highly significant in their effect on the percent nitrogen in the plant tissues of both 'Lisa' and 'Ulli' (Table VIII). The nitrogen percentage in 'Ulli' increased directly with the increase in rate. The percent nitrogen in 'Lisa' also increased directly with the increase in rate up to a certain point (2.7 kg) where it then leveled off (Figure 10). The percent nitrogen in the plant tissues of 'Lisa' was less when the Osmocote was incorporated or placed on the bottom of the pot than when it was top dressed. With 'Ulli' the percent nitrogen in the tissues was the least with the bottom of the pot placement and greatest when top dressed. Incorporation was intermediate between the two (Table VIII). These results again suggest that top dressing the Osmocote brought about a greater availability of the nitrogen to the plant. The results of the dry weight analysis support

TABLE VII

ANALYSIS OF NUMBER OF DAYS TO FIRST BLOOM IN RELATION TO CULTIVAR, RATE, AND PLACEMENT OF OSMOCOTE IN THE SUMMER CROP[y]

Cultivar and Rate (kg/m^3)	Placement: Top Dressed	Placement: Incorporated	Placement: Bottom of Pot
'Lisa'			
0.9	51.33	49.00	51.17
1.8	55.33	54.00	50.50
2.7	51.83	51.33	49.33
3.6	56.17	53.00	52.67
Pooled Means[z]	53.67b	51.83ab	50.92a
'Ulli'			
0.9	57.00	57.00	55.83
1.8	60.83	55.83	59.50
2.7	62.00	57.33	57.00
3.6	62.00	60.67	55.67
Pooled Means[z]	60.46b	57.71ab	57.00a

[y]Significance of main effects, trends, and interactions:

	'Lisa'	'Ulli'
Rate	0.05	NS
Linear	0.10	NS
Quadratic	NS	NS
Cubic	0.05	NS
Placement	0.10	0.10
Rate*Placement	NS	NS

[z]Means within rows (Left-to-Right) followed by different letters are significantly different at the 5% level. 'Lisa' - $LSD_{.05}$ = 2.42; 'Ulli' - $LSD_{.05}$ = 3.03. All Osmocote rates are pooled.

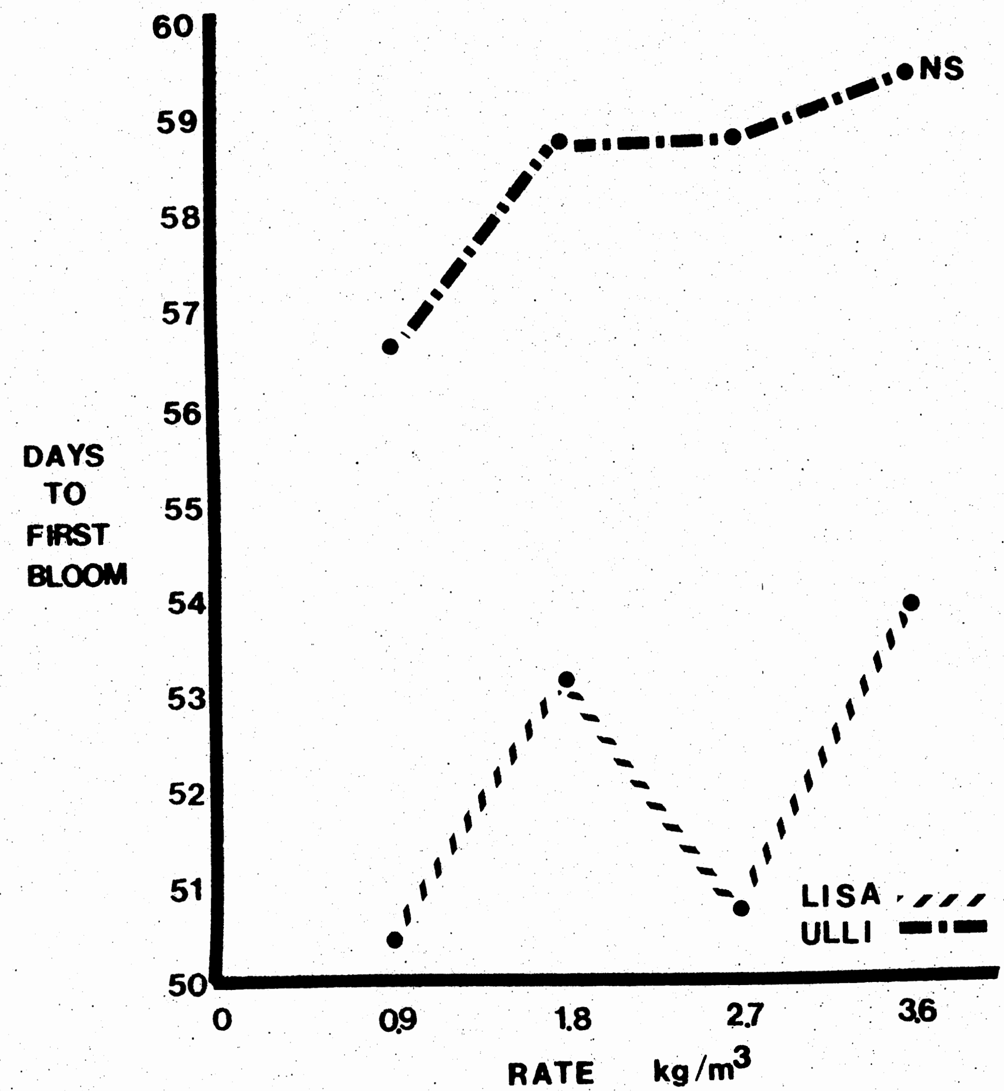

Figure 9. Influence of Osmocote Rate on the Number of Days to First Bloom in the Summer.

TABLE VIII

ANALYSIS OF NITROGEN (%) IN PLANT TISSUE IN RELATION TO CULTIVAR, RATE, AND PLACEMENT OF OSMOCOTE IN THE SUMMER CROP[y]

Cultivar and Rate (kg/m^3)	Placement: Top Dressed	Placement: Incorporated	Placement: Bottom of Pot
'Lisa'			
0.9	1.57	1.28	1.37
1.8	1.97	1.61	1.51
2.7	2.28	1.82	1.83
3.6	2.32	2.09	1.63
Pooled Means[z]	2.04b	1.70a	1.59a
'Ulli'			
0.9	1.66	1.43	1.42
1.8	2.23	1.88	1.62
2.7	2.40	2.20	1.61
3.6	2.50	2.44	1.78
Pooled Means[z]	2.20c	1.99b	1.61a

[y]Significance of main effects, trends, and interactions:

	'Lisa'	'Ulli'
Rate	0.01	0.01
Linear	0.01	0.01
Quadratic	NS	NS
Cubic	NS	NS
Placement	0.01	0.01
Rate*Placement	NS	NS

[z]Means within rows (Left-to-Right) followed by different letters are significantly different at the 5% level. 'Lisa' - $LSD_{.05}$ = 0.20; 'Ulli' - $LSD_{.05}$ = 0.18. All Osmocote rates are pooled.

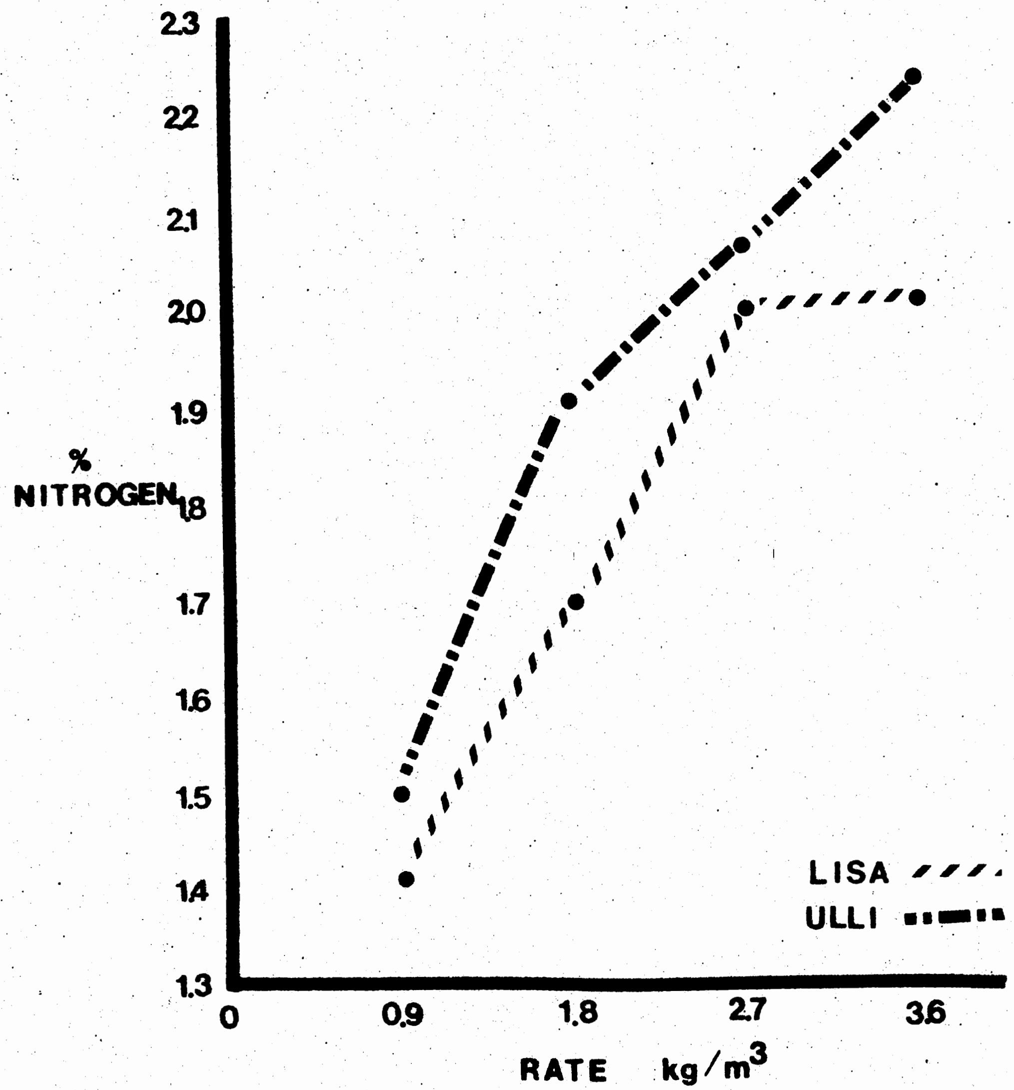

Figure 10. Influence of Osmocote Rate on Percent Nitrogen in Plant Tissues in the Summer.

this conclusion (Table I). Top dressing increased the amount of vegetation. Since nitrogen is an important element in vegetative growth, this perhaps explains why top dressing the Osmocote resulted in increased dry weight. Simply more nitrogen was available to the plant. The analysis of the number of days to first bloom also supports this finding (Table VII). Top dressing the Osmocote delayed blooming. Excess nitrogen is noted for delaying flowering.

Percent Phosphorus

The analysis of variance of the Osmocote treatments indicated that rate and placement were significant in their effect on the percent phosphorus in the plant tissues of both cultivars (Table IX). In the plant tissues of 'Lisa', the highest level of phosphorus was found at the rate of 2.7 kg. The rate of 3.6 kg brought a sharp decline in percent phosphorus. This is difficult to understand. In 'Ulli' the percent phosphorus in the plant tissues continued to rise with the increase in rate (Figure 11).

The results of the analysis of placement may coincide with the fact that phosphorus does not move or leach easily in the growing medium. The lowest percentage of phosphorus in 'Lisa' was found when the Osmocote was top dressed while in 'Ulli' it was when the Osmocote was placed on the bottom of the pot. In 'Lisa' the greatest phosphorus percentage was found when the Osmocote was incorporated (Table IX). The bottom of the pot application was not significantly different from either top dressing or incorporation with 'Lisa'. Incorporation and top dressing were equivalent in 'Ulli'. In both cultivars the highest percent phosphorus was found when the Osmocote was incorporated. This

TABLE IX

ANALYSIS OF PHOSPHORUS (%) IN PLANT TISSUE IN RELATION TO CULTIVAR, RATE, AND PLACEMENT OF OSMOCOTE IN THE SUMMER CROP[x]

Cultivar and Rate (kg/m^3)	Placement: Top Dressed	Placement: Incorporated	Placement: Bottom of Pot
'Lisa'			
0.9	0.872	1.083	0.960
1.8	0.884	1.050	0.930
2.7	1.066	1.245	1.160
3.6	0.998	1.064	1.039
Pooled Means[y]	0.955a	1.111b	1.022ab
'Ulli'			
0.9	1.043a[z]	1.239a	1.113a
1.8	1.229a	1.176a	1.062a
2.7	1.514b	1.452b	0.855a
3.6	1.269a	1.554b	1.095a

[x]Significance of main effects, trends, and interactions:

	'Lisa'	'Ulli'
Rate	0.05	0.01
Linear	NS	0.01
Quadratic	NS	NS
Cubic	0.05	NS
Placement	0.10	0.01
Rate*Placement	NS	0.01

[y]Means within rows (Left-to-Right) followed by different letters are significantly different at the 5% level. $LSD_{.05}$ = 0.136. All Osmocote rates are pooled.

[z]Means across rows (Left-to-Right) followed by different letters are significantly different at the 5% level. $LSD_{.05}$ for comparing placement means within the same rate = 0.197.

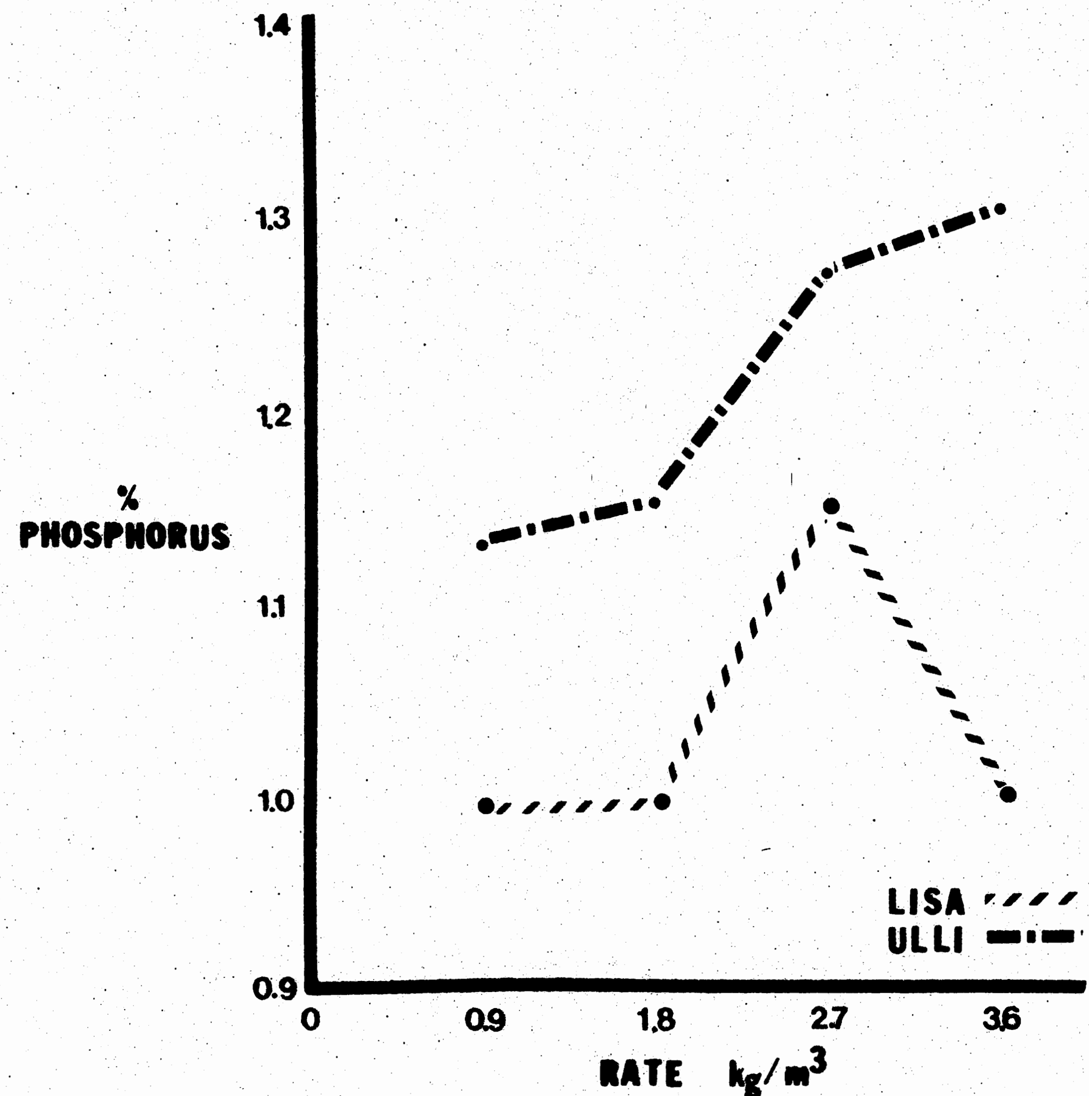

Figure 11. Influence of Osmocote Rate on Percent Phosphorus in the Plant Tissues in the Summer.

again suggests that since phosphorus is relatively immobile in the soil or growing medium that incorporation would lead to better access to the phosphorus than the other two methods of application.

Percent Potassium

No significant difference was found between treatments in the percent potassium in the plant tissues due to rate or placement of Osmocote (Table X). Since this does not correspond with the results from the winter crop, it is possible that errors were made in the laboratory analysis of the percent potassium found in the plant tissues, although seasonal differences could have existed.

Presence of Necrotic Areas

The presence of "characteristic banded necrotic areas on some leaves" of Osmocote-treated plants was evident in the summer particularly on the cultivar 'Ulli'. It appears that 'Ulli' is somewhat sensitive to Osmocote regardless of rate or placement (Table XI). On the whole these "burn" areas would probably not reduce the salability of the plants to any great degree. 'Lisa' appeared to be most sensitive to Osmocote when it received 3.6 kg as a top dressing. As discussed before top dressing appears to increase the availability of the nitrogen in the Osmocote. Therefore 3.6 kg as a top dressing was the highest rate with possibly the most effective application. The "burn" in this case may simply have been from over-fertilization. Twenty-five percent of those plants ('Lisa') that received a bottom of the pot placement were also "burned". This is difficult to interpret. Perhaps this is due to a concentrated layer of Osmocote in the root zone.

TABLE X

ANALYSIS OF POTASSIUM (%) IN PLANT TISSUE IN RELATION TO CULTIVAR, RATE, AND PLACEMENT OF OSMOCOTE IN THE SUMMER CROP[y]

Cultivar and Rate (kg/m^3)	Top Dressed	Placement Incorporated	Bottom of Pot
'Lisa'			
0.9	3.453	3.942	3.387
1.8	3.620	3.803	4.021
2.7	3.867	4.007	3.718
3.6	4.016	3.399	3.133
Pooled Means[z]	3.739a	3.788a	3.564a
'Ulli'			
0.9	3.483	3.746	3.480
1.8	3.866	3.782	3.695
2.7	4.001	3.884	3.098
3.6	3.540	3.392	3.162
Pooled Means[z]	3.723a	3.701a	3.359a

[y]Significance of main effects, trends, and interactions:

	'Lisa'	'Ulli'
Rate	NS	NS
Linear	NS	NS
Quadratic	NS	NS
Cubic	NS	NS
Placement	NS	NS
Rate*Placement	NS	NS

[z]Means within rows (Left-to-Right) followed by different letters are significantly different at the 5% level. 'Lisa' - $LSD_{.05}$ = 0.366; 'Ulli' - $LSD_{.05}$ = 0.390. All Osmocote rates are pooled.

TABLE XI

PERCENTAGE OF PLANTS WITH NECROTIC AREAS ON LEAVES IN RELATION TO CULTIVAR, RATE, AND PLACEMENT OF OSMOCOTE IN THE SUMMER CROP

Cultivar and Rate (kg/m^3)	Placement			Percentage at each rate
	Top Dressed	Incorporated	Bottom of Pot	
'Lisa'				
0.9	0	0	33	11
1.8	0	17	17	11
2.7	0	0	33	11
3.6	50	0	17	22
Percentage at each Placement	12.5	4	25	
'Ulli'				
0.9	33	100	50	61
1.8	100	67	83	83
2.7	100	50	83	78
3.6	100	67	83	83
Percentage at each Placement	83	71	75	

Winter Crop Growth and Quality Parameters

Dry Weight

The analysis of variance of the Osmocote treatments indicated that rate had a significant effect upon the dry weight of both 'Lisa' and 'Ulli'. A quadratic trend was evident (Table XII). A rate of 2.7 kg produced the greatest amount of dry weight in both cultivar (Figure 12). Placement was not significant in either cultivar.

The winter crop plants produced considerably less dry weight that in the summer (Tables I and XII). 'Ulli' showed quadratic trends in both crops for rate, whereas 'Lisa' showed a linear trend in the summer and a quadratic trend in the winter. If one rate was chosen for both seasons, it appears that 2.7 kg would be satisfactory.

Quality Rating

According to the analysis of variance for the Osmocote treatments, rate was significant but placement wasn't for the cultivar 'Lisa'. Since there is an interaction between rate and placement, the significance or lack of significance of rate and placement has little meaning (Table XIII). Due to this interaction, different rates were optimum at different placements. The rate of 1.8 kg was optimum when the Osmocote was top dressed. At higher rates quality dropped off sharply. When the Osmocote was incorporated into the growing medium, 1.8 and 2.7 kg produced the highest quality plants. With the bottom of the pot placement, 2.7 kg produced the highest quality plants (Figure 13).

The analysis of variance for 'Ulli' and the Osmocote treatments indicated that there was no significant difference between treatments

TABLE XII

ANALYSIS OF DRY WEIGHT (g) IN RELATION TO CULTIVAR, RATE, AND PLACEMENT OF OSMOCOTE IN THE WINTER CROP[y]

Cultivar and Rate (kg/m^3)	Placement		
	Top Dressed	Incorporated	Bottom of Pot
'Lisa'			
0.9	2.95	3.11	2.58
1.8	3.24	2.92	2.87
2.7	3.21	3.34	3.23
3.6	2.47	2.70	2.84
Pooled Means[z]	2.97a	3.02a	2.88a
'Ulli'			
0.9	2.85	2.48	2.25
1.8	2.89	2.79	2.46
2.7	3.01	3.01	3.03
3.6	2.49	2.39	3.03
Pooled Means[z]	2.81a	2.67a	2.69a

[y]Significance of main effects, trends, and interactions:

	'Lisa'	'Ulli'
Rate	0.01	0.05
Linear	NS	NS
Quadratic	0.01	0.05
Cubic	NS	NS
Placement	NS	NS
Rate*Placement	NS	NS

[z]Means within rows (Left-to-Right) followed by different letters are significantly different at the 5% level. 'Lisa' - $LSD_{.05}$ = 0.29; 'Ulli' - $LSD_{.05}$ = 0.29. All Osmocote rates are pooled.

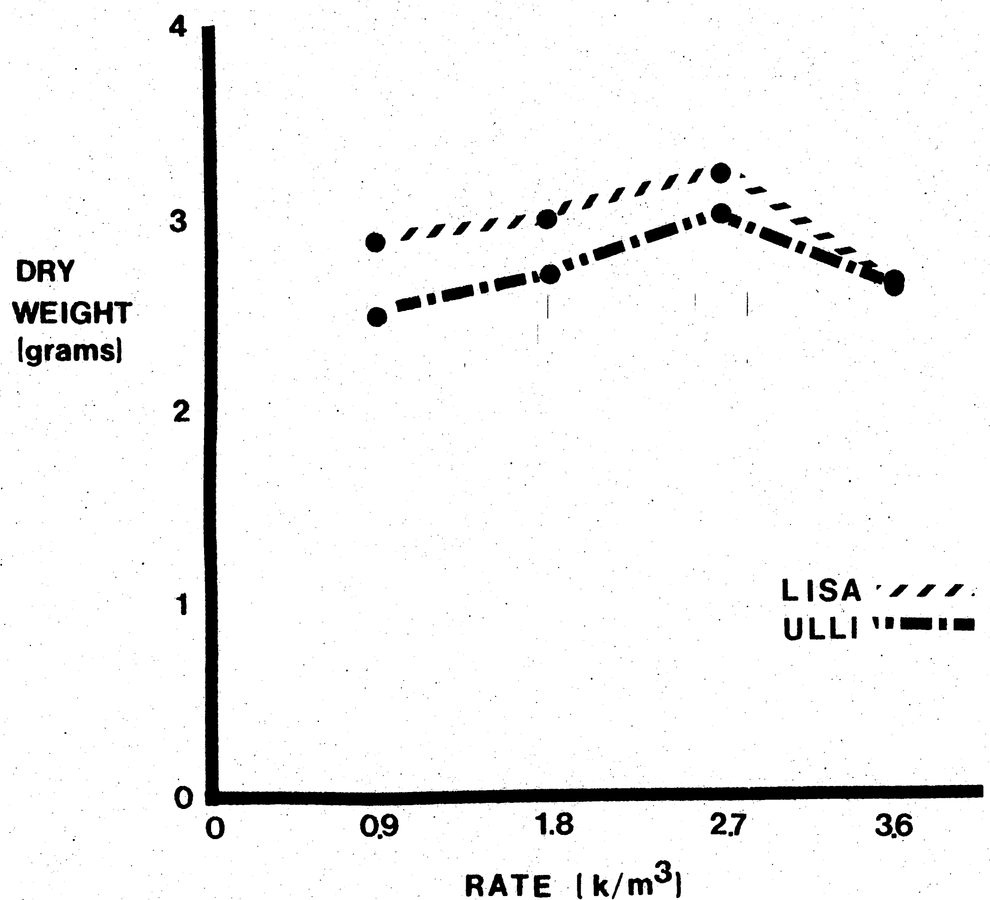

Figure 12. Dry Weight as Affected by Osmocote Rate in the Winter.

TABLE XIII

ANALYSIS OF QUALITY RATING IN RELATION TO CULTIVAR, RATE, AND PLACEMENT OF OSMOCOTE IN THE WINTER CROP[y]

Cultivar and Rate (kg/m^3)	Placement		
	Top Dressed	Incorporated	Bottom of Pot
'Lisa'			
0.9	7.83b[z]	7.50ab	5.83a
1.8	9.00a	8.33a	7.67a
2.7	7.67a	8.17a	8.67a
3.6	6.00a	6.50a	8.33b
'Ulli'			
0.9	7.00a[z]	7.33a	6.67a
1.8	7.00a	7.17a	7.33a
2.7	7.00a	8.50a	8.00a
3.6	5.33a	5.50a	9.00b

[y]Significance of main effects, trends, and interactions:

	'Lisa'	'Ulli'
Rate	0.05	NS
Linear	NS	NS
Quadratic	0.01	NS
Cubic	NS	NS
Placement	NS	NS
Rate*Placement	0.05	NS

[z]Means within rows (Left-to-Right) followed by different letters are significantly different at the 5% level. 'Lisa' - $LSD_{.05}$ = 0.93; 'Ulli' - $LSD_{.05}$ = 1.23.

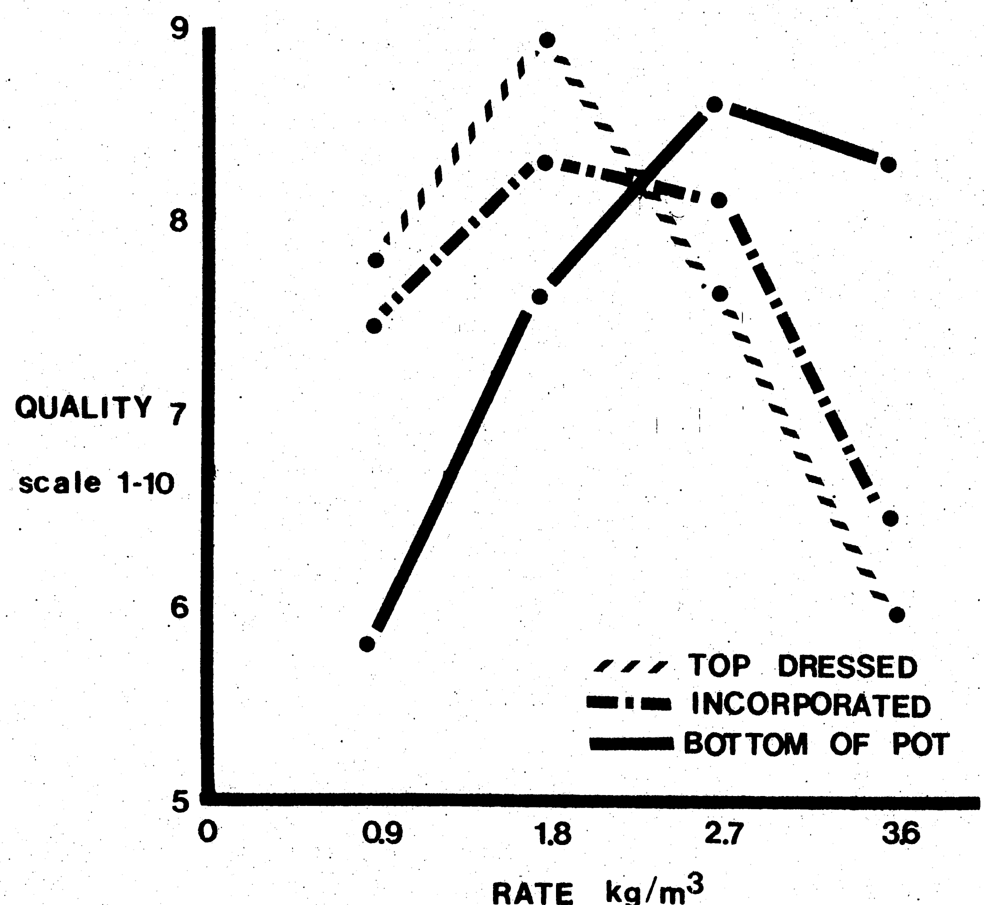

Figure 13. Influence of Osmocote Rate and Placement on the Quality Rating of 'Lisa' in the Winter.

(Table XIII). When the interaction of rate and placement was graphed, a different story was told (Figure 14). At the rate of 3.6 kg, top dressing or incorporating the Osmocote resulted in a sharp decrease in quality. But when this rate was placed on the bottom of the pot, quality continued to rise (Figure 15). The rate of 2.7 kg when incorporated or placed on the bottom of the pot produced plants with an average quality rating of eight or better.

The quality of 'Lisa' was slightly lower in the winter than it was in the summer (Figures 4 and 13). In the summer 'Lisa' appeared to tolerate higher rates without adverse effects on quality. The quality of 'Ulli' was slightly higher in the winter than in the summer (Figures 5 and 14). These differences in quality may be due to a cultivar difference in temperature preference. Temperatures were unavoidably cooler in the winter. 'Lisa' may prefer a higher temperature range than 'Ulli' and likewise 'Ulli' may prefer somewhat cooler temperatures than normal for African violets. Another possibility is that since the environment was more conducive to rapid growth in the summer and 'Lisa' being a vigorous cultivar was able to utilize the fertilizer as quickly as it was released. 'Ulli' being somewhat less vigorous than 'Lisa' was probably unable to tolerate the faster release rate of the Osmocote in the summer. In the winter the environment was not as conducive to vigorous growth and the reduced quality of 'Lisa' simply may have been due to slower growth and likewise not as much fertilizer was needed or could be tolerated. The slower release of the Osmocote was probably the cause of the higher quality of 'Ulli' in the winter.

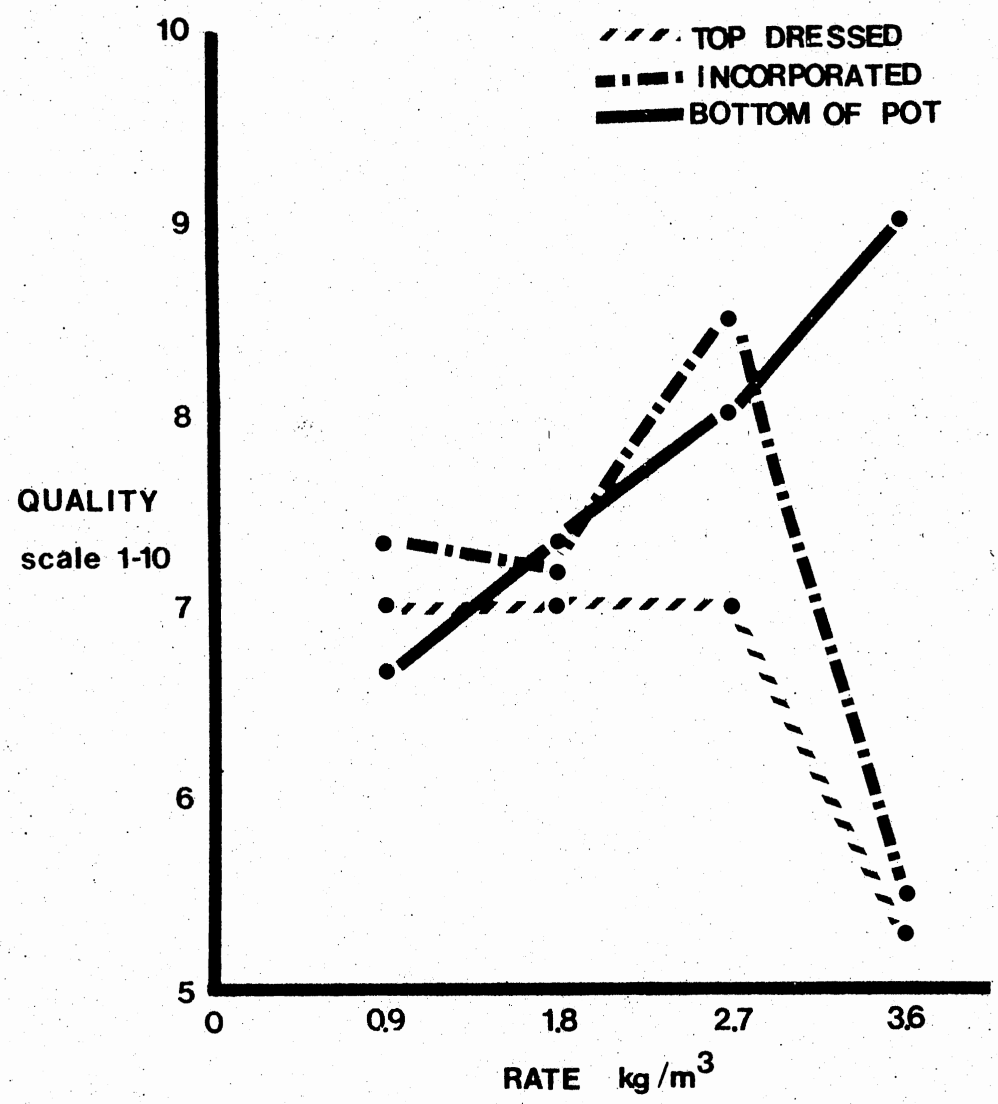

Figure 14. Influence of Osmocote Rate and Placement on the Quality Rating of 'Ulli' in the Winter.

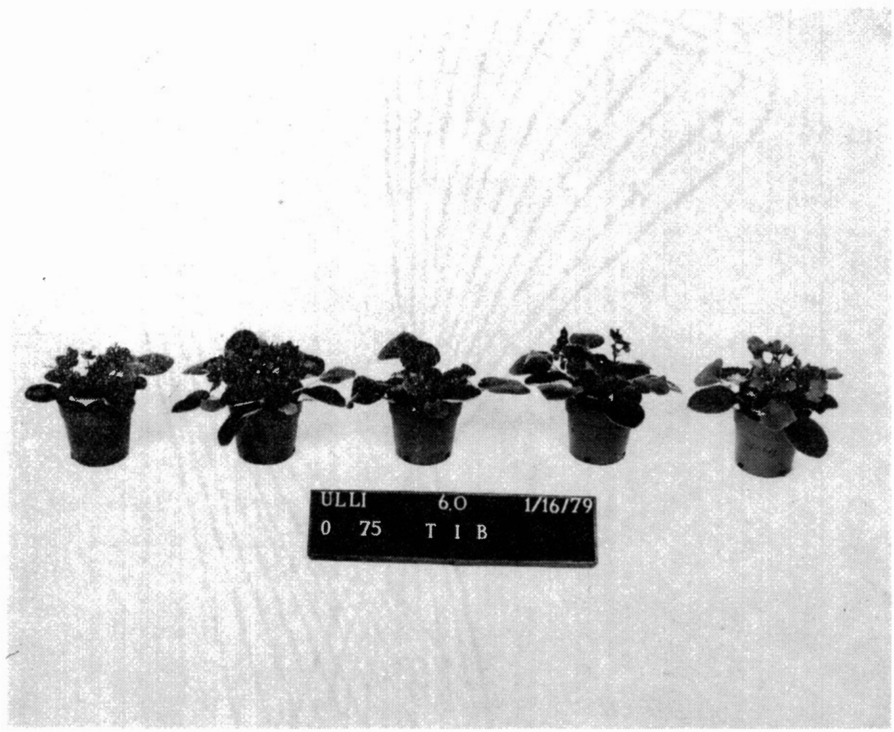

Figure 15. Comparison of Quality as Influenced by Rate and Placement of Osmocote in the Winter. (Left-to-Right: Check, 75 ppm, 3.6 kg/m^3 - Top Dressed, 3.6 kg/m^3 - Incorporated, and 3.6 kg/m^3 - Bottom of the Pot).

Leaf Area

The analysis of variance for the Osmocote treatments indicated that rate was significant and that there was a quadratic trend in both cultivars (Table XIV). The greatest total leaf area area in both cultivars resulted from the application of the rate of 2.7 kg/m^3 (Figure 16). Placement was not significant (Table XIV).

The above results coincide with the results of the dry weight data.

Width

Again rate had a definite effect upon the width of the plant but placement did not (Table XV). The rates of 1.8 and 2.7 kg, produced the largest width in 'Lisa' and the greatest width in 'Ulli' resulted from the application of 2.7 kg (Figure 17).

Leaf Count

During the winter, neither rate or placement had a significant efect upon the number of leaves present on the Osmocote treated plants (Table XVI).

Flower Stalk Count

According to the analysis of variance for the Osmocote treatments, rate had a significant effect upon the flower stalk count of 'Lisa' but not 'Ulli' (Table XVII). With the cultivar 'Lisa' the flower stalk count was greatest at the rates of 1.8 and 2.7 kg. The rate of 3.6 kg reduced the number of flower stalks significantly (Figure 18). Placement affected the number of flower stalks produced by 'Ulli' but not

TABLE XIV

ANALYSIS OF LEAF AREA (sq. cm) IN RELATION TO CULTIVAR, RATE, AND PLACEMENT OF OSMOCOTE IN THE WINTER CROP[y]

Cultivar and Rate (kg/m^3)	Placement: Top Dressed	Placement: Incorporated	Placement: Bottom of Pot
'Lisa'			
0.9	496.0	530.3	445.5
1.8	544.4	522.3	488.2
2.7	530.3	571.5	538.3
3.6	420.8	470.2	508.3
Pooled Means[z]	497.9a	523.6a	495.1a
'Ulli'			
0.9	467.3	396.5	352.2
1.8	459.2	441.0	398.3
2.7	454.7	478.5	465.2
3.6	418.0	394.0	463.2
Pooled Means[z]	449.8a	427.5a	413.0a

[y]Significance of main effects, trends, and interactions:

	'Lisa'	'Ulli'
Rate	0.01	0.10
Linear	NS	NS
Quadratic	0.01	0.05
Cubic	NS	NS
Placement	NS	NS
Rate*Placement	NS	NS

[z]Means within rows (Left-to-Right) followed by different letters are significantly different at the 5% level. 'Lisa' - $LSD_{.05}$ = 41.4; 'Ulli' - $LSD_{.05}$ = 39.3. All Osmocote rates are pooled.

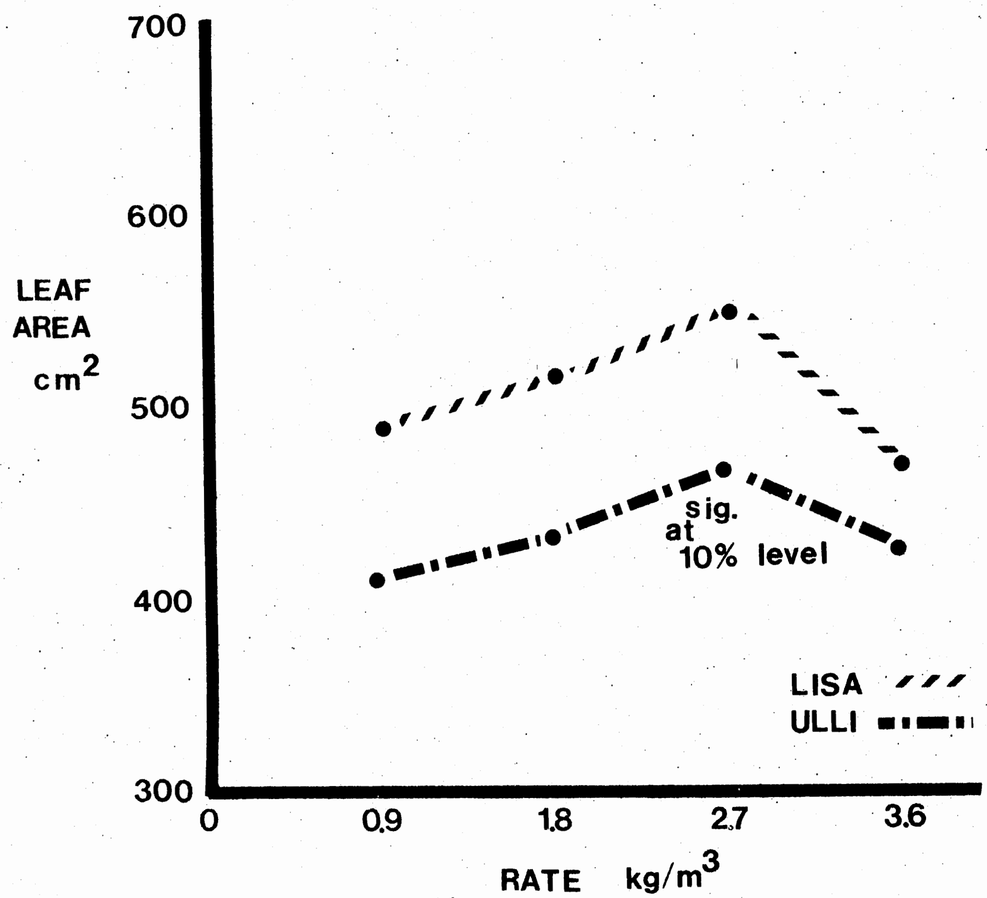

Figure 16. Leaf Area as Affected by Osmocote Rate in the Winter.

TABLE XV

ANALYSIS OF WIDTH (cm) IN RELATION TO CULTIVAR, RATE, AND PLACEMENT OF OSMOCOTE IN THE WINTER CROP[y]

Cultivar and Rate (kg/m^3)	Placement: Top Dressed	Placement: Incorporated	Placement: Bottom of Pot
'Lisa'			
0.9	28.58	28.00	27.58
1.8	30.33	30.33	28.42
2.7	27.92	31.08	30.17
3.6	27.25	26.92	28.42
Pooled Means[z]	28.52a	29.08a	28.65a
'Ulli'			
0.9	27.58	25.75	26.25
1.8	27.83	27.58	25.58
2.7	27.75	28.25	30.33
3.6	27.00	26.92	29.17
Pooled Means[z]	27.54a	27.13a	27.83a

[y]Significance of main effects, trends, and interactions:

	'Lisa'	'Ulli'
Rate	0.05	0.10
Linear	NS	0.10
Quadratic	0.01	NS
Cubic	NS	NS
Placement	NS	NS
Rate*Placement	NS	NS

[z]Means within rows (Left-to-Right) followed by different letters are significantly different at the 5% level. 'Lisa' - $LSD_{.05}$ = 1.37; 'Ulli' - $LSD_{.05}$ = 1.54. All Osmocote rates are pooled.

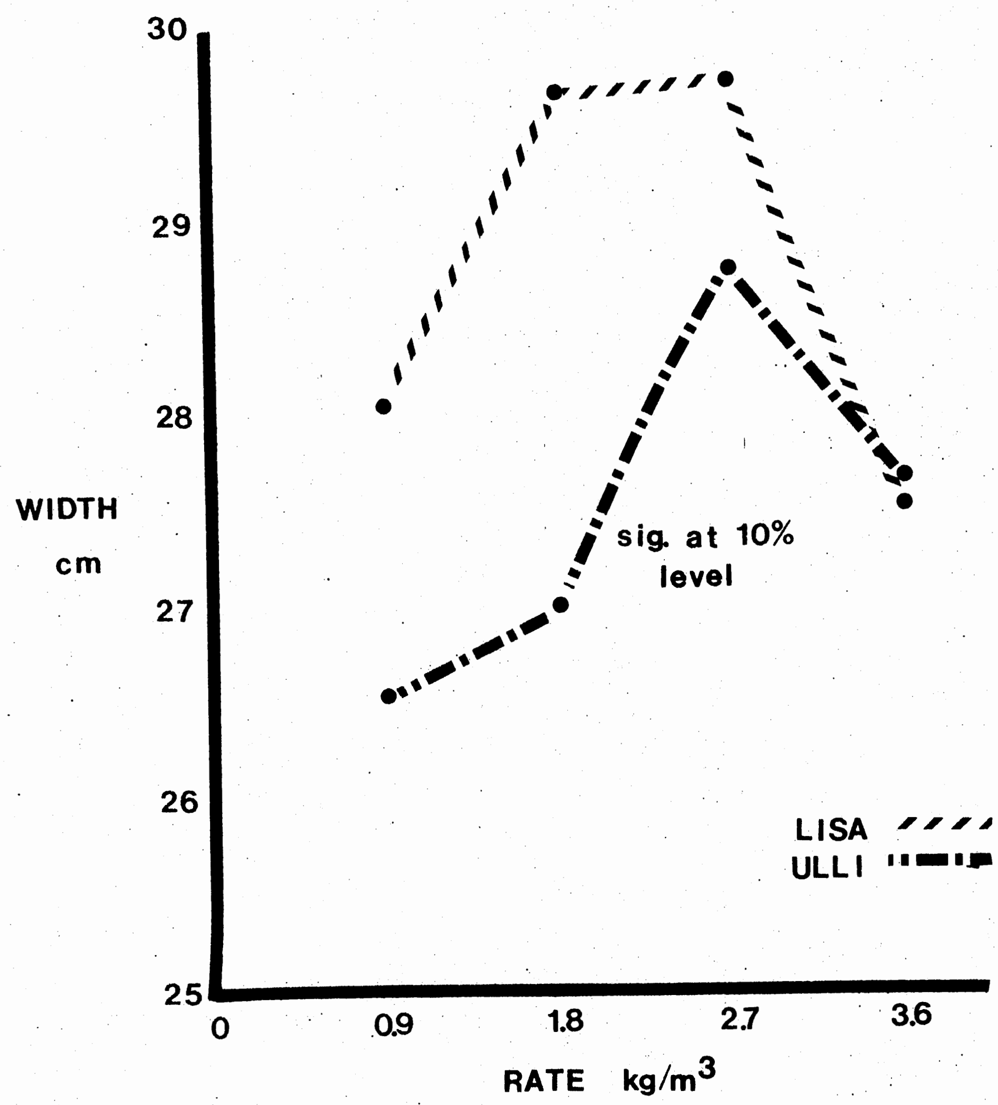

Figure 17. Plant Width as Affected by Osmocote Rate in the Winter.

TABLE XVI

ANALYSIS OF LEAF COUNT IN RELATION TO CULTIVAR, RATE, AND PLACEMENT OF OSMOCOTE IN THE WINTER CROP[y]

Cultivar and Rate (kg/m^3)	Placement: Top Dressed	Incorporated	Bottom of Pot
'Lisa'			
0.9	30.50	28.00	25.33
1.8	29.67	26.00	26.83
2.7	27.83	29.67	28.67
3.6	21.33	28.50	28.17
Pooled Means[z]	27.33a	28.04a	27.25a
'Ulli'			
0.9	28.17	23.00	22.50
1.8	24.33	25.00	26.33
2.7	26.83	24.83	25.83
3.6	23.17	25.83	23.33
Pooled Means[z]	25.63a	24.67a	24.50a

[y]Significance of main effects, trends, and interactions:

	'Lisa'	'Ulli'
Rate	NS	NS
Linear	NS	NS
Quadratic	NS	NS
Cubic	NS	NS
Placement	NS	NS
Rate*Placement	NS	NS

[z]Means within rows (Left-to-Right) followed by different letters are significantly different at the 5% level. 'Lisa' - $LSD_{.05}$ = 3.13; 'Ulli' - $LSD_{.05}$ = 2.33. All Osmocote rates are pooled.

TABLE XVII

ANALYSIS OF FLOWER STALK COUNT IN RELATION TO CULTIVAR, RATE, AND PLACEMENT OF OSMOCOTE IN THE WINTER CROP[y]

Cultivar and Rate (kg/m^3)	Placement		
	Top Dressed	Incorporated	Bottom of Pot
'Lisa'			
0.9	5.17	5.17	5.17
1.8	5.83	5.50	6.17
2.7	5.83	5.17	6.50
3.6	5.00	4.33	5.17
Pooled Means[z]	5.46a	5.04a	5.75a
'Ulli'			
0.9	4.50	5.83	5.33
1.8	4.50	5.33	5.17
2.7	4.83	5.00	5.50
3.6	3.67	4.17	6.17
Pooled Means[z]	4.38a	5.08ab	5.54b

[y]Significance of main effects, trends, and interactions:

	'Lisa'	'Ulli'
Rate	NS	NS
Linear	NS	NS
Quadratic	0.05	NS
Cubic	NS	NS
Placement	NS	0.10
Rate*Placement	NS	NS

[z]Means within rows (Left-to-Right) followed by different letters are significantly different at the 5% level. 'Lisa' - $LSD_{.05}$ = 0.95; 'Ulli' - $LSD_{.05}$ = 0.98. All Osmocote rates are pooled.

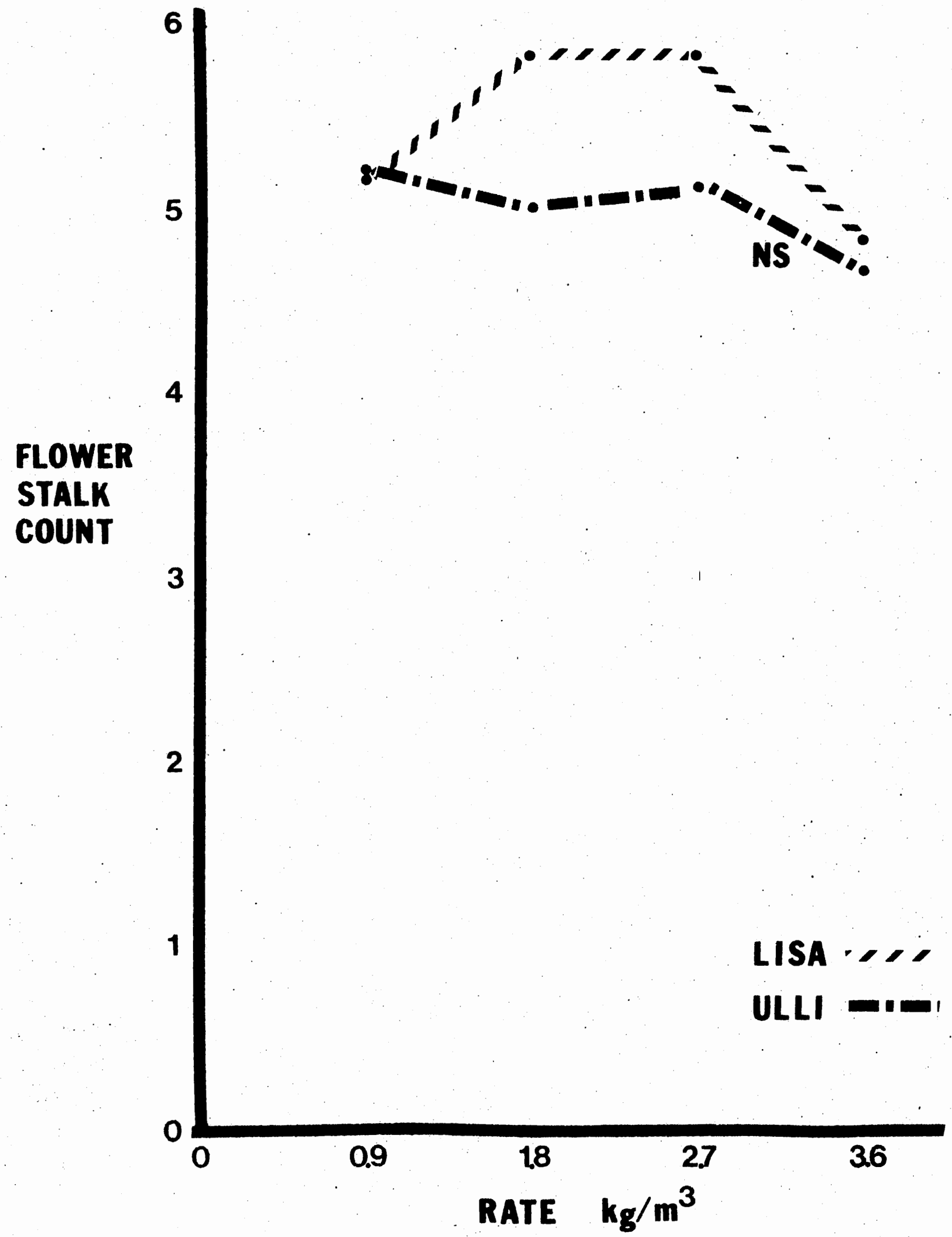

Figure 18. Influence of Osmocote Rate on Flower Stalk Count in the Winter.

'Lisa' (Table XVII). With 'Ulli', the bottom of the pot placement resulted in the greatest number of flower stalks being produced while top dressing the Osmocote significantly reduced the flower stalk count. Incorporation was not significantly different from either top dressing or the bottom of the pot placement (Table XVII).

Number of Days to First Bloom

The rate of Osmocote applied had a significant effect upon the number of days to first bloom (Table XVIII). Placement did not appear to have an effect. The rates of 0.9 and 1.8 kg brought about the shortest number of days to first bloom in 'Lisa' but 2.7 kg was only one day later on the average. A reduction of approximately four days was brought about by the rate of 2.7 kg on 'Ulli' (Figure 19).

Percent Nitrogen

The rate and placement of the Osmocote had a significant effect on the percent nitrogen found in the above-ground portions of the plants (Table XIX). The percent nitrogen increased proportionately with an increase in rate (Figure 20). Top dressing the Osmocote resulted in the highest percent nitrogen in both cultivars and the bottom of the pot placement resulted in the lowest percent nitrogen. Incorporation was intermediate in effect (Table XIX). These results again support the idea that top dressing the Osmocote increases the amount of nitrogen available to the plant while the bottom of the pot placement restricts the amount of nitrogen available to the plant. This suggests that even though the plants are watered from below there still is some downward movement of nitrogen. Some of the nitrogen from the Osmocote that is

TABLE XVIII

ANALYSIS OF NUMBER OF DAYS TO FIRST BLOOM IN RELATION TO CULTIVAR, RATE, AND PLACEMENT OF OSMOCOTE IN THE WINTER CROP[y]

Cultivar and Rate (kg/m^3)	Placement Top Dressed	Incorporated	Bottom of Pot
'Lisa'			
0.9	51.50	51.33	51.00
1.8	49.17	53.17	51.50
2.7	54.67	54.50	48.83
3.6	54.83	57.17	54.83
Pooled Means[z]	52.54a	54.04a	51.42a
'Ulli'			
0.9	56.33	58.33	54.83
1.8	53.67	54.50	57.50
2.7	49.33	54.17	52.67
3.6	61.83	57.17	53.50
Pooled Means[z]	55.29a	56.40a	54.63a

[y]Significance of main effects, trends, and interactions:

	'Lisa'	'Ulli'
Rate	0.10	0.10
Linear	0.05	NS
Quadratic	NS	0.05
Cubic	NS	NS
Placement	NS	NS
Rate*Placement	NS	NS

[z]Means within rows (Left-to-Right) followed by different letters are significantly different at the 5% level. 'Lisa' - $LSD_{.05}$ = 3.40; 'Ulli' - $LSD_{.05}$ = 3.62. All Osmocote rates are pooled.

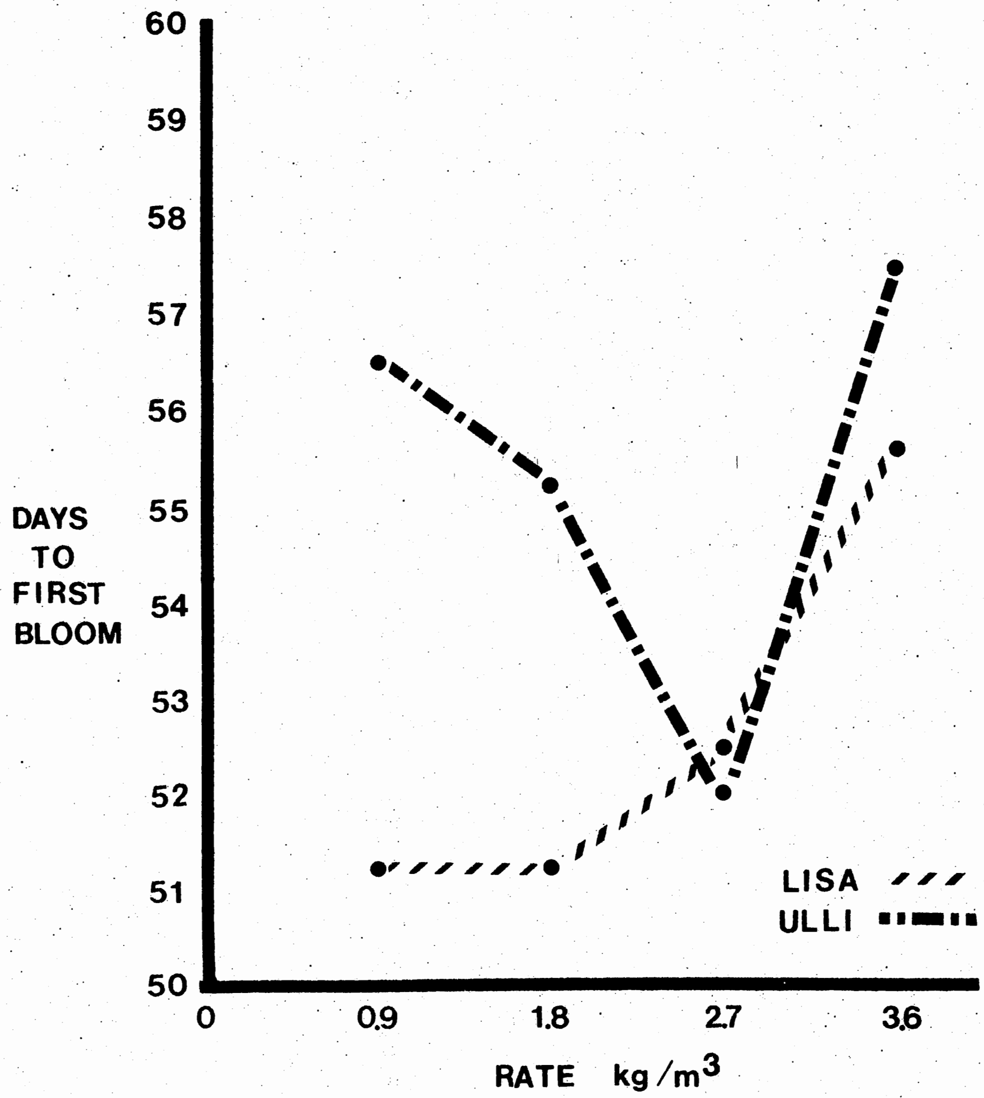

Figure 19. Number of Days to First Bloom as Influence by Osmocote Rate in the Winter.

TABLE XIX

ANALYSIS OF NITROGEN (%) IN PLANT TISSUE IN RELATION TO CULTIVAR, RATE, AND PLACEMENT OF OSMOCOTE IN THE WINTER CROP[y]

Cultivar and Rate (kg/m^3)	Placement		
	Top Dressed	Incorporated	Bottom of Pot
'Lisa'			
0.9	1.98	1.69	1.43
1.8	2.16	2.12	1.68
2.7	2.48	2.20	1.94
3.6	2.65	2.30	2.21
Pooled Means[z]	2.32c	2.08b	1.82a
'Ulli'			
0.9	1.97	1.68	1.55
1.8	2.19	2.01	1.67
2.7	2.34	2.13	1.88
3.6	2.48	2.38	2.01
Pooled Means[z]	2.25c	2.05b	1.78a

[y]Significance of main effects, trends, and interactions:

	'Lisa'	'Ulli'
Rate	0.01	0.01
Linear	0.01	0.01
Quadratic	NS	NS
Cubic	NS	NS
Placement	0.01	0.01
Rate*Placement	NS	NS

[z]Means within rows (Left-to-Right) followed by different letters are significantly different at the 5% level. 'Lisa' - $LSD_{.05}$ = 0.08; 'Ulli' - $LSD_{.05}$ = 0.11. All Osmocote rates are pooled.

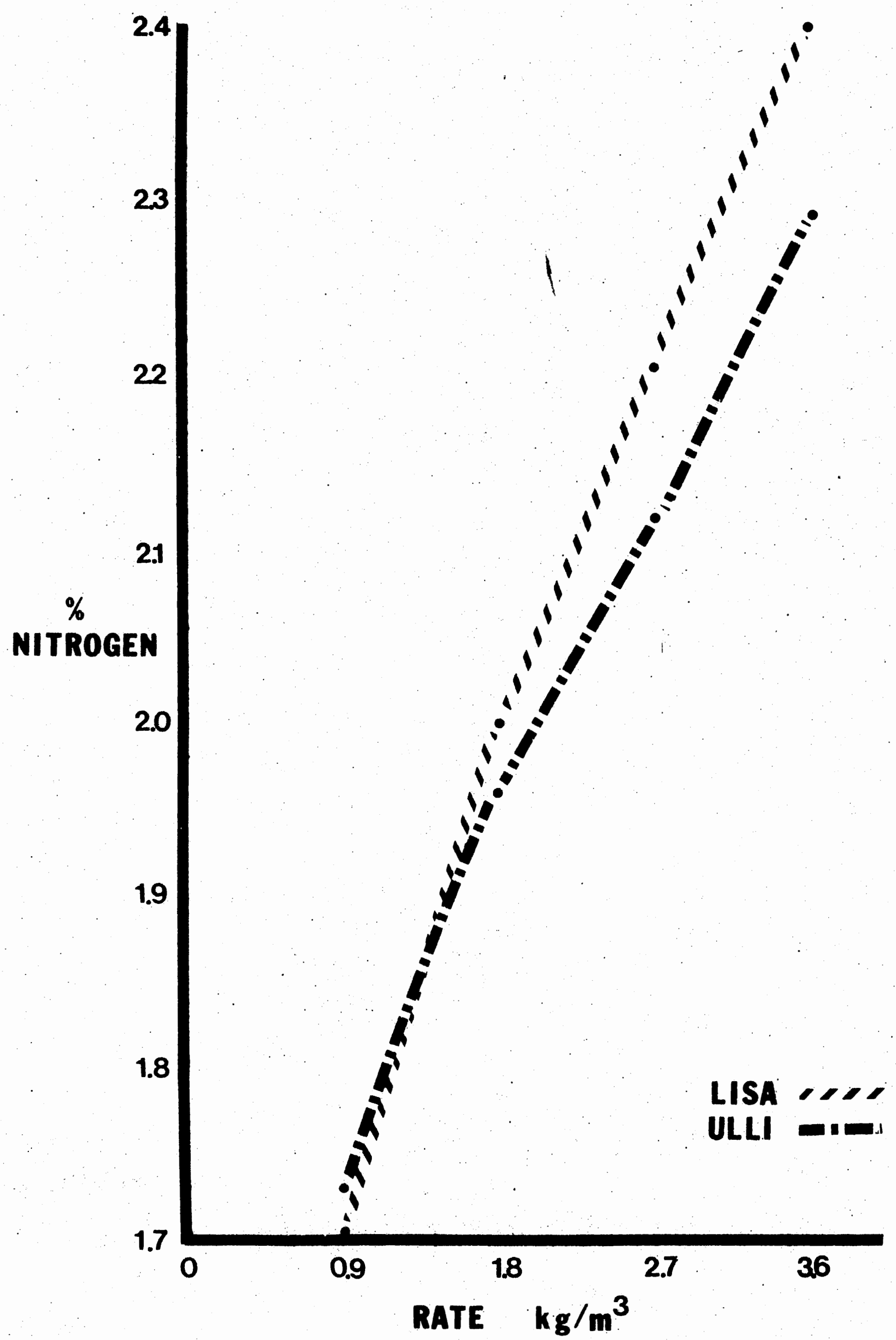

Figure 20. Influence of Osmocote Rate on the Percent Nitrogen in the Plant Tissues in the Winter.

placed on the bottom of the pot is probably lost or leached out of the pot.

The percent nitrogen in the plant tissues of the winter crop was slightly higher on the average than in the summer crop (Tables VIII and XIX, Figures 10 and 20). This may have been due to the fact that vegetative growth was greater in the summer than in the winter (Tables I and XII). This may have caused a dilution in the level of nitrogen in the plant tissues of the summer crop.

Percent Phosphorus

The analysis of variance for the Osmocote treatments indicated that rate and placement were significant in their effect upon the percent phosphorus present in the plant tissues (Table XX). Both cultivars showed only a slight increase in percent phosphorus between 0.9 and 2.7 kg but between 2.7 and 3.6 kg a sharp increase in percent phosphorus was evident (Figure 21). Incorporation and the bottom of the pot placement brought about the highest level of phosphorus in 'Lisa' while with 'Ulli' incorporation alone resulted in the highest percentage of phosphorus. Top dressing and the bottom of the pot placement were not significantly different with 'Ulli' (Table XX). As with the summer crop, incorporation of the Osmocote resulted in the highest level of phosphorus in the plant. Since phosphorus is relatively immobile in the soil or growing medium, incorporation of the Osmocote would probably lead to better access by the plant to the phosphorus than the other two methods of application.

The percent phosphorus in the plant tissues of both crops was in the range that is considered toxic to most plants (Tables IX and XX).

TABLE XX

ANALYSIS OF PHOSPHORUS (%) IN PLANT TISSUE IN RELATION TO CULTIVAR, RATE, AND PLACEMENT OF OSMOCOTE IN THE WINTER CROP[y]

Cultivar and Rate (kg/m^3)	Placement: Top Dressed	Incorporated	Bottom of Pot
'Lisa'			
0.9	0.430	0.469	0.567
1.8	0.489	0.563	0.507
2.7	0.549	0.623	0.539
3.6	0.576	0.867	1.012
Pooled Means[z]	0.511a	0.631b	0.659b
'Ulli'			
0.9	0.535	0.788	0.494
1.8	0.525	0.598	0.683
2.7	0.666	0.655	0.591
3.6	0.732	1.010	0.949
Pooled Means[z]	0.615a	0.763b	0.589a

[y]Significance of main effects, trends, and interactions:

	'Lisa'	'Ulli'
Rate	0.01	0.01
Linear	0.01	0.01
Quadratic	0.01	0.01
Cubic	NS	NS
Placement	0.01	0.05
Rate*Placement	0.05	NS

[z]Means within rows (Left-to-Right) followed by different letters are significantly different at the 5% level. 'Lisa' - $LSD_{.05}$ = 0.085; 'Ulli' - $LSD_{.05}$ = 0.107. All Osmocote rates are pooled.

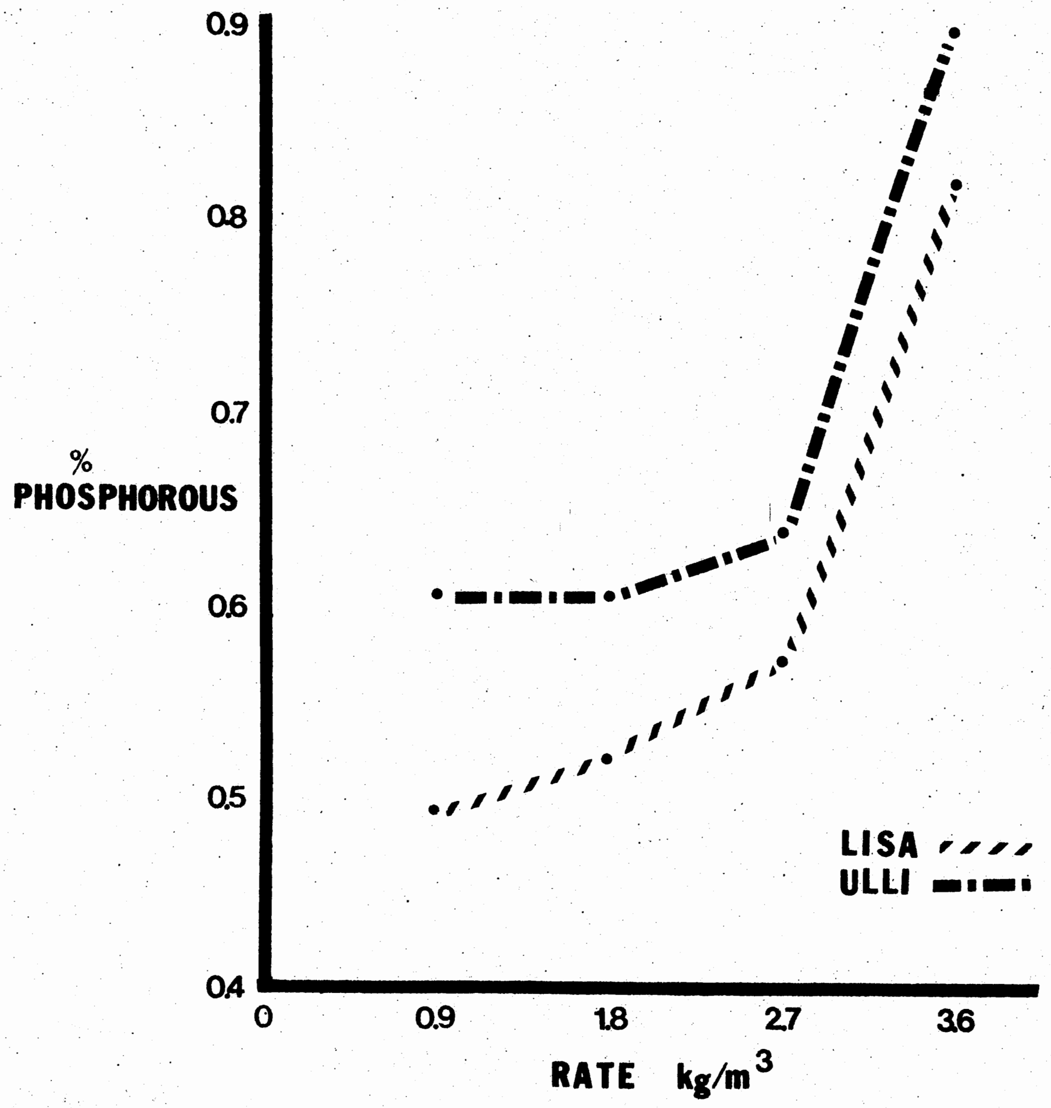

Figure 21. Influence of Osmocote Rate on the Percent Phosphorus in the Plant Tissues in the Winter.

This high level of phosphorus might have been the result of using the whole plant (including flowers) for tissue analysis instead of only the leaves as is customary.

Percent Potassium

Only rate was significant in its effect upon the percent potassium in the Osmocote treated plants (Table XXI). A linear trend was evident for both cultivars (Figure 22).

Presence of Necrotic Areas

This was not a problem with the winter crop. The reason for this may have been the cooler temperatures that were present in the winter. The rate of Osmocote release is correlated with temperature, e.g. the higher the temperature the faster the release. Likewise the faster the release, the more ammonium nitrogen in the growing medium. This may have been the cause of the "burn" that was so evident in the summer.

The burn can't be explained on the basis of percent nitrogen in the plant tissue alone. In winter, percent nitrogen was greater (at a given Osmocote rate) than in the summer, but lower percent nitrogen in the summer may have been due to more total growth causing a dilution effect. The burn could possibly be associated, as stated above, with rate of release of ammonium nitrogen coupled with higher transpiration in the summer, or there could be some other unknown factor associated with Osmocote in hot weather.

Another possibility could be excess phosphorous. Most of the foliage burn was present on the leaves of 'Ulli' in the summer crop. Phosphorus levels were also highest in this cultivar and season (Table XI)

TABLE XXI

ANALYSIS OF POTASSIUM (%) IN PLANT TISSUE IN RELATION TO CULTIVAR, RATE, AND PLACEMENT OF OSMOCOTE IN THE WINTER CROP[y]

Cultivar and Rate (kg/m^3)	Placement: Top Dressed	Placement: Incorporated	Placement: Bottom of Pot
'Lisa'			
0.9	3.963	4.390	4.036
1.8	4.382	4.808	4.193
2.7	5.290	5.217	4.505
3.6	4.670	4.693	4.952
Pooled Means[z]	4.578a	4.777a	4.422a
'Ulli'			
0.9	4.124	4.206	3.695
1.8	4.079	4.421	4.217
2.7	4.395	4.748	4.400
3.6	5.217	5.091	4.837
Pooled Means[z]	4.454a	4.616a	4.297a

[y]Significance of main effects, trends, and interactions:

	'Lisa'	'Ulli'
Rate	0.05	0.01
Linear	0.01	0.01
Quadratic	NS	NS
Cubic	NS	NS
Placement	NS	NS
Rate*Placement	NS	NS

[z]Means within rows (Left-to-Right) followed by different letters are significantly different at the 5% level. 'Lisa' - $LSD_{.05}$ = 0.90; 'Ulli' - $LSD_{.05}$ = 0.936. All Osmocote rates are pooled.

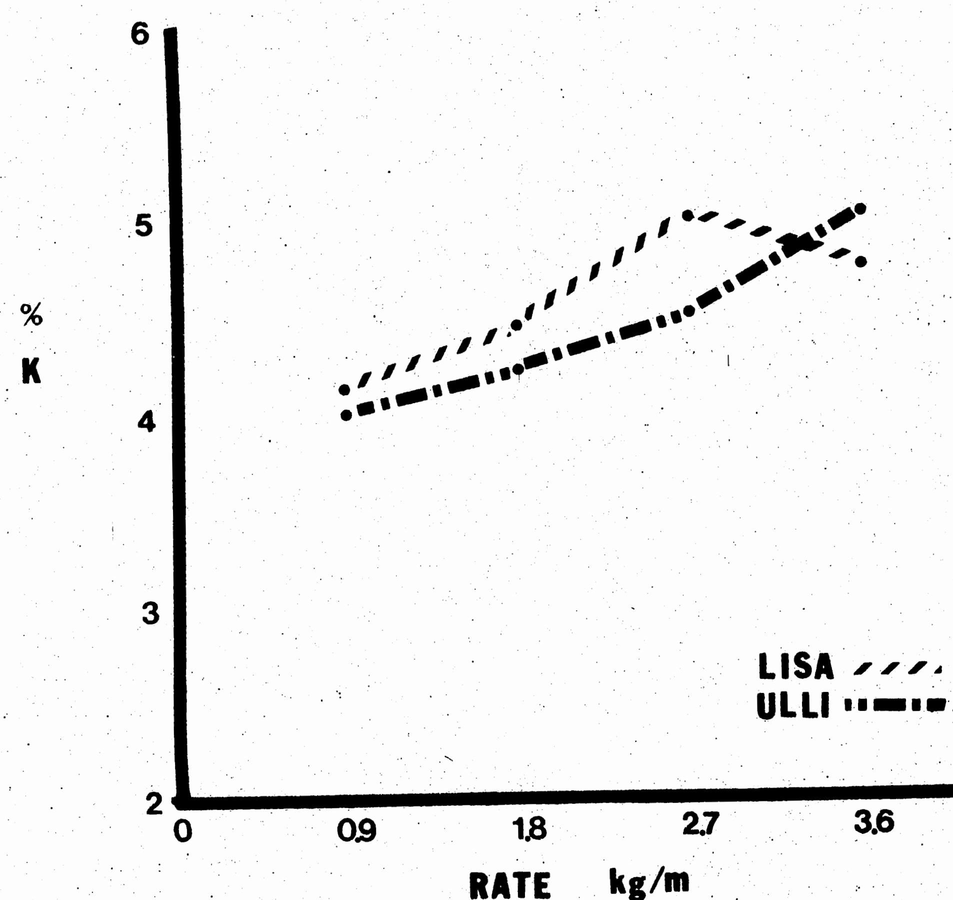

Figure 22. Influence of Osmocote Rate on the Percent Potassium in the Plant Tissues in the Winter.

and the levels were very high. Winter phosphorus levels were lower (Table XXI). 'Ulli' showed higher phosphorus levels in summer and winter. It would be of interest to observe excess phosphorus symptoms in African violets.

CHAPTER IV

PRINCIPAL CONSLUSIONS

In the summer, the cultivars varied in vegetative growth (dry weight and leaf area) due to the rate of Osmocote applied. The rate of 3.6 kg/m^3 resulted in the most vegetative growth with 'Lisa' while 2.7 kg/m^3 was optimum for 'Ulli'. In the winter, there was little cultivar difference in vegetative growth due to the rate of Osmocote applied. The rate of 2.7 kg/m^3 was optimum for both cultivars (Figure 23).

The quality rating took into account the whole plant. When this was considered, an interaction between rate and placement was evident. In general, top dressing the Osmocote produced a quality plant at lower rates. If the Osmocote was placed on the bottom of the pot, a higher rate of application was necessary to produce a quality plant. With 'Lisa', 1.8 kg/m^3 appeared to be the optimum rate when top dressing the Osmocote. A slightly lower rate of 0.9 kg/m^3 was desired for 'Ulli' when top dressing. A rate of 3.6 kg/m^3 generally produced a quality plant of both cultivars when a bottom of the pot placement was used. For both cultivars the rate of 2.7 kg/m^3 consistently produced a high quality plant when it was incorporated.

The presence of necrotic areas on the leaves of the Osmocote-treated plants was evident in the summer particularly on the cultivar 'Ulli'. 'Ulli' appears to be sensitive to Osmocote regardless of rate or place-

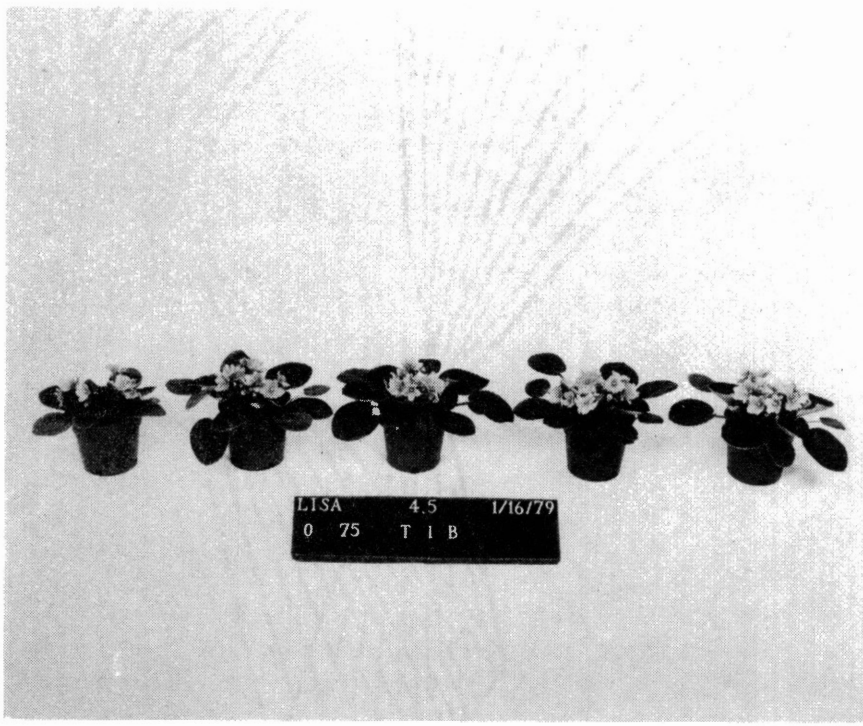

Figure 23. Comparison of Quality as Influenced by Rate and Placement of Osmocote in the Winter. (Left-to-Right: Check, 75 ppm, 2.7 kg/m^3-Top Dressed, 2.7 kg/m^3-Incorporated, and 2.7 kg/m^3-Bottom of the Pot).

ment. 'Lisa' was most sensitive when the rates were high and when the Osmocote was placed on the bottom of the pot.

In general, the percent nitrogen in the above-ground portions of the plant increased as the rate of fertilizer increased. Top dressing the Osmocote brought about an increase in the level of nitrogen in the plants. This suggests that top dressing increases the availability of the nitrogen or decreases the leaching of the nitrogen.

Incorporation of the Osmocote appears to give the plants greater access to the phosphorus in it. The percent phosphorus in the plants that received this placement were consistently high.

In general, a commerical grower would probably find the incorporation of the Osmocote to be the most practical and efficient method of application. The bottom of the pot placement would be time-consuming and the results showed no obvious benefits from using this method. Top dressing the Osmocote would require the use of an extremely small amount per pot and it would be easy to accidentally apply too much. Again no obvious benefits were observed when using this method as compared to incorporation. In fact, the increased availability of the nitrogen and the decreased availability of the phosphorus could be considered a deterrent to using this method. In some cases top dressing the Osmocote decreased the number of flower stalks and increased the number of days to first bloom possibly due to this imbalance of nitrogen and phosphorus. Incorporation of the Osmocote appears to have several advantages over the other two methods of application. If a grower is blending his own growing medium, it is the simplest and least time-consuming method. The Osmocote can be applied to a large quantity of growing medium instead of applying to each individual pot. Also nitrogen appears to be slightly less available to the plant than when the Osmocote is top dressed. This decreases the chance of over-fertilization and also helps keep the nitrogen in balance with the other nutrients. This method of application also appears to give the plants greater access to the phosphorus perhaps since the phosphorus is relatively immobile. Also the incorporation of the rate of 2.7 kg/m^3 consistently produced a high quality plant, usually equal to the 50-75 ppm liquid fertilizer treatments except for 'Ulli' in the summer.

If a grower uses a bagged, commercial growing medium and has not invested in soil mixing equipment, top dressing at the rate of 1.8 kg/m^3 would be satisfactory (though not as desirable as incorporation of 2.7 kg/m^3) if the rate was carefully calculated and application was accurately done.

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APPENDIX

ANALYSIS OF LIQUID FERTILIZER TREATMENTS

The liquid fertilizer rate of 50 ppm nitrogen, 31 ppm phosphorus, 50 ppm potassium was adequate to produce a quality plant in either season or cultivar. The rate of 75 ppm nitrogen, 31 ppm phosphorus, 75 ppm potassium was also satisfactory and generally produced a slightly higher quality plant. In some instances, the 75 ppm rate appeared to reduce the number of days to first bloom and slightly increased the number of flower stalks.

TABLE XXII

STATISTICAL SIGNIFICANCE OF MAIN EFFECTS AND TRENDS OF VARIOUS GROWTH AND QUALITY PARAMETERS OF LIQUID FERTILIZER TREATMENTS IN THE SUMMER CROP

	Dry Weight		Quality Rating	
	'Lisa'	'Ulli'	'Lisa'	'Ulli'
Rate	0.01	0.01	0.01	0.01
Linear	0.01	0.01	0.01	0.01
Quadratic	0.01	0.01	0.01	0.01
	Leaf Area		**Width**	
	'Lisa'	'Ulli'	'Lisa'	'Ulli'
Rate	0.01	0.01	0.01	0.01
Linear	0.01	0.01	0.01	0.01
Quadratic	0.05	0.01	0.01	0.05
	Leaf Count		**Stalk Count**	
	'Lisa'	'Ulli'	'Lisa'	'Ulli'
Rate	0.10	0.01	NS	0.01
Linear	0.05	NS	NS	0.01
Quadratic	NS	0.01	NS	NS
	Days to First Bloom		**Nitrogen (%)**	
	'Lisa'	'Ulli'	'Lisa'	'Ulli'
Rate	NS	0.01	0.10[z]	0.01
Linear	NS	0.01	0.10[z]	0.01
Quadratic	NS	0.05	NS	0.05
	Phosphorus (%)		**Potassium (%)**	
	'Lisa'	'Ulli'	'Lisa'	'Ulli'
Rate	NS	NS	NS	NS
Linear	NS	NS	NS	NS
Quadratic	NS	NS	NS	NS

[z]Due to missing data, the degrees of freedom were extremely low. This brought about an increase in probability level.

TABLE XXIII

MEANS OF GROWTH AND QUALITY PARAMETERS IN RELATION TO CULTIVAR AND RATE OF LIQUID FERTILIZER IN THE SUMMER

Cultivar and Rate (ppm)	Dry Wt. (g)	Growth Parameters Quality	Leaf Area (cm^2)	Width (cm)
'Lisa'				
0	2.66	3.50	371.33	21.25
50	4.93	9.00	752.17	31.58
75	5.27	8.50	831.67	32.00
'Ulli'				
0	2.31	3.67	312.50	20.75
50	4.23	8.33	612.17	27.33
75	3.81	8.33	506.67	28.33
	Leaf Count	Stalk Count	Days to First Bloom	
'Lisa'				
0	25.67	4.17	52.00	
50	35.50	5.00	52.83	
75	38.17	5.50	54.83	
'Ulli'				
0	26.33	4.00	58.67	
50	46.00	4.50	59.00	
75	28.17	6.33	53.17	
	Nitrogen (%)	Phosphorus (%)	Potassium (%)	
'Lisa'				
0	0.857	0.877	2.843	
50	1.807	1.281	3.743	
75	1.930	1.232	3.836	
'Ulli'				
0	0.660	1.242	3.819	
50	1.877	1.358	3.814	
75	1.840	1.263	3.402	

TABLE XXIV

QUANTITIES OF N, P, AND K APPLIED TO THE CAPILLARY MAT FOR LIQUID FERTILIZER TREATMENTS OR PLACED IN THE POT OF OSMOCOTE TREATMENTS[y]

Fertilizer Type and Rate	Nitrogen (mg)	Phosphorus (mg)	Potassium (mg)
Liquid Fertilizer			
50 ppm	1416	878	1416
75 ppm	2124	878	2124
Osmocote 14-14-14			
0.9 kg/m^3	87	38	72
1.8 kg/m^3	175	75	143
2.7 kg/m^3	262	112	215
3.6 kg/m^3	350	150	287

[y]Liquid fertilizer treatments - Quantity applied to each individual 12.7 x 17.8 cm subirrigation mat. Osmocote treatments - quantity placed in each pot.

TABLE XXV

PERCENTAGE OF PLANTS WITH NECROTIC AREAS ON LEAVES IN RELATION TO CULTIVAR AND RATE OF LIQUID FERTILIZER IN THE SUMMER CROP[z]

	'Lisa'	'Ulli'
0 ppm	83	83
50 ppm	0	0
75 ppm	0	17

[z]This necrosis differed from that noted in the Osmocote treatments in that it was typical of a nutrient deficiency (perhaps nitrogen and/or potassium). Plants were chlorotic with marginal necrosis.

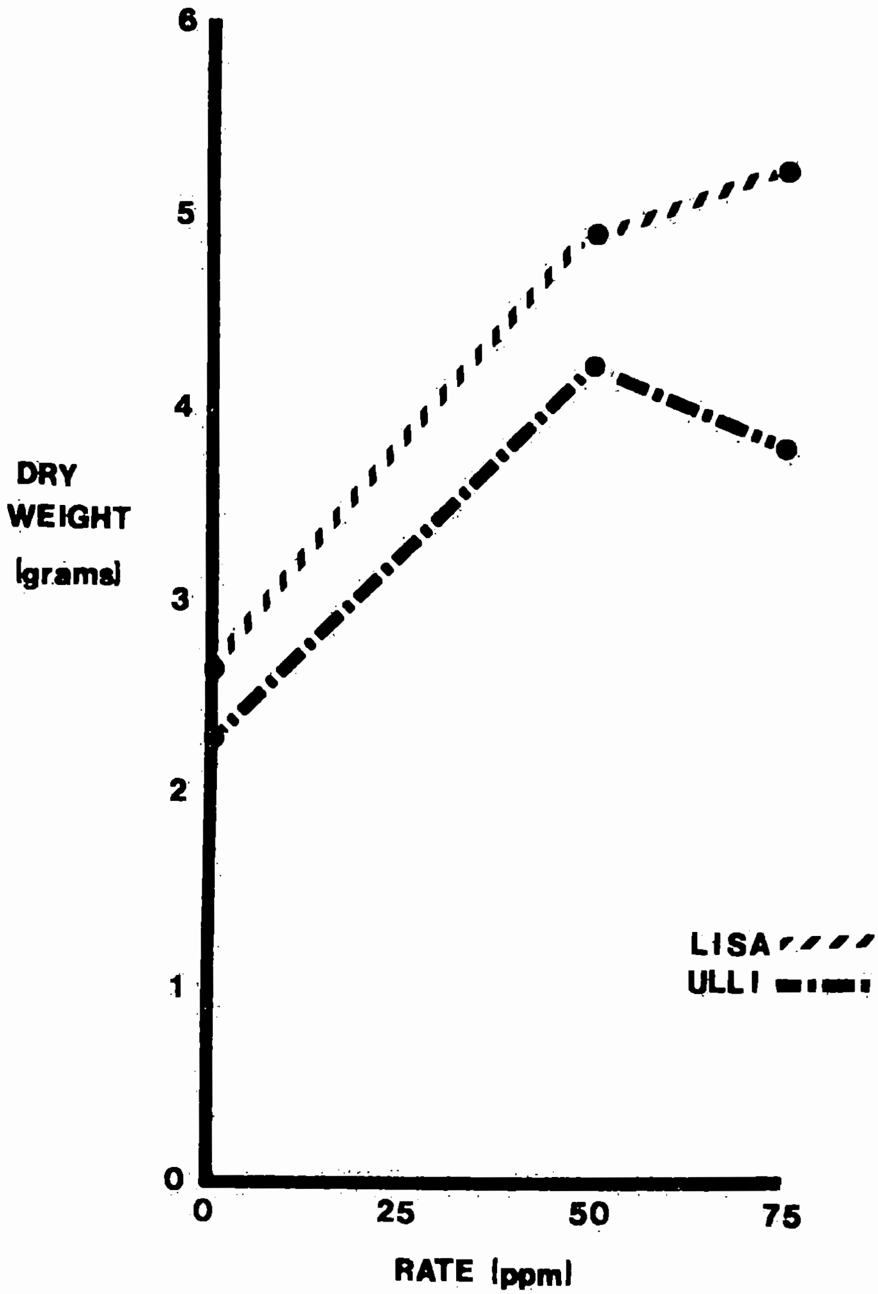

Figure 24. The Influence of Liquid Fertilizer Rate on Dry Weight in the Summer.

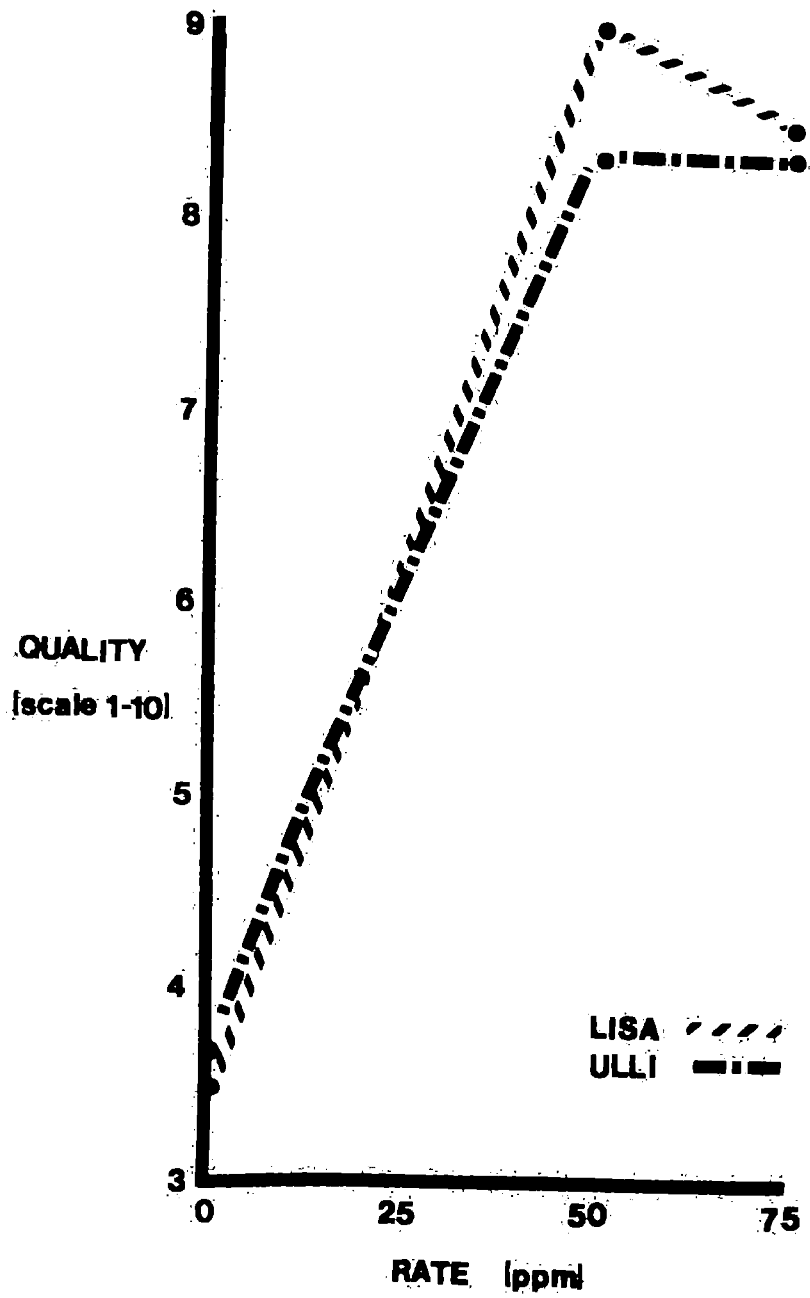

Figure 25. The Influence of Liquid Fertilizer Rate on the Quality Rating in the Summer.

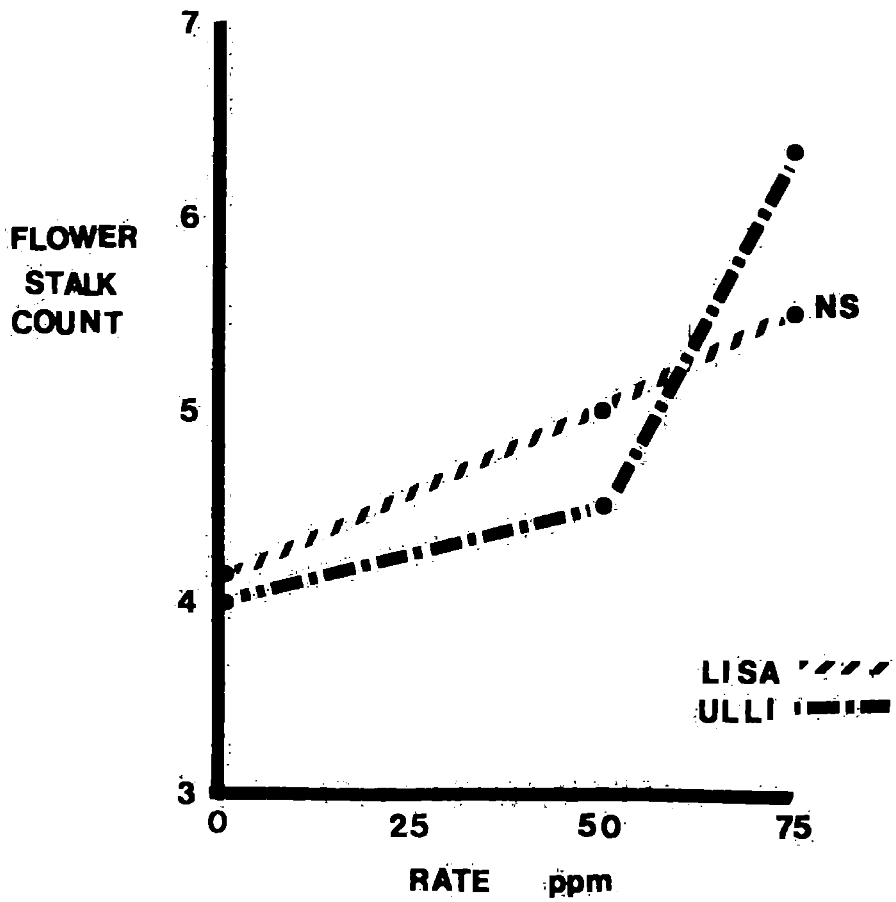

Figure 26. Influence of Liquid Fertilizer Rate on Flower Stalk Count in the Summer.

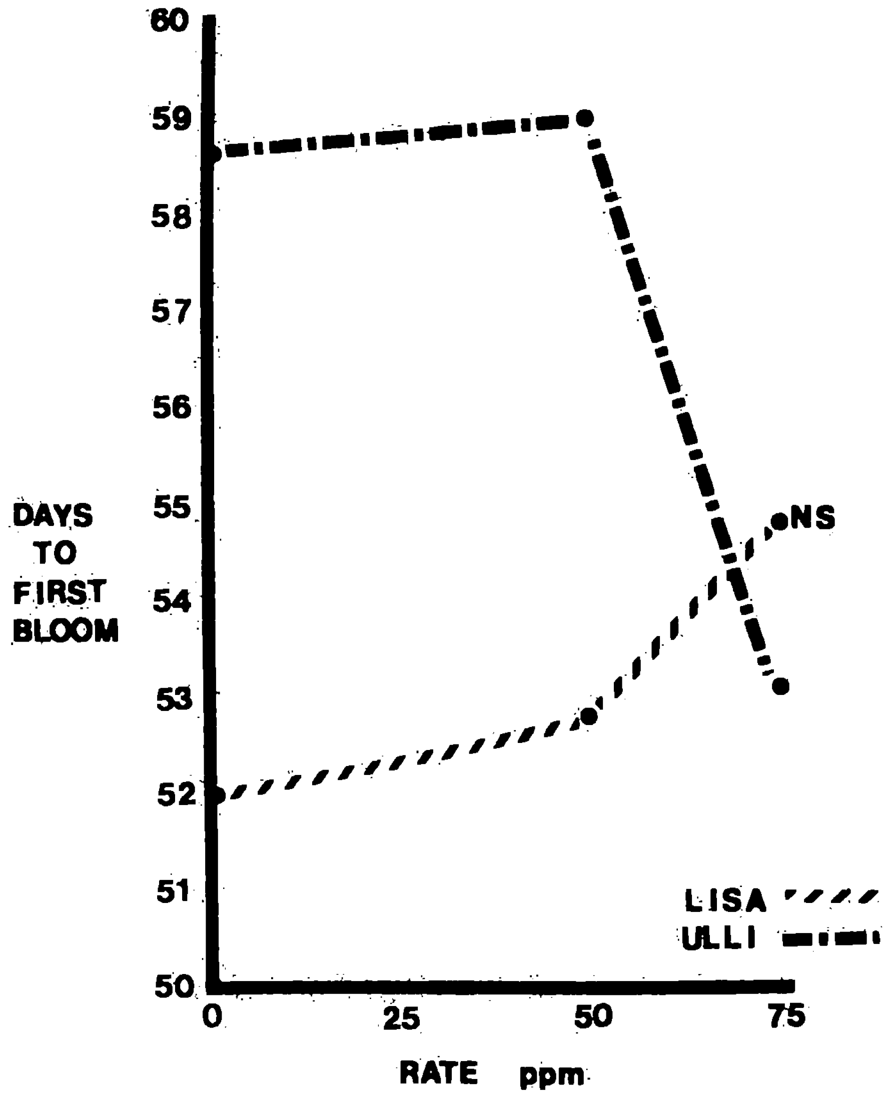

Figure 27. Number of Days to First Bloom as Influenced by Liquid Fertilizer Rate in the Summer.

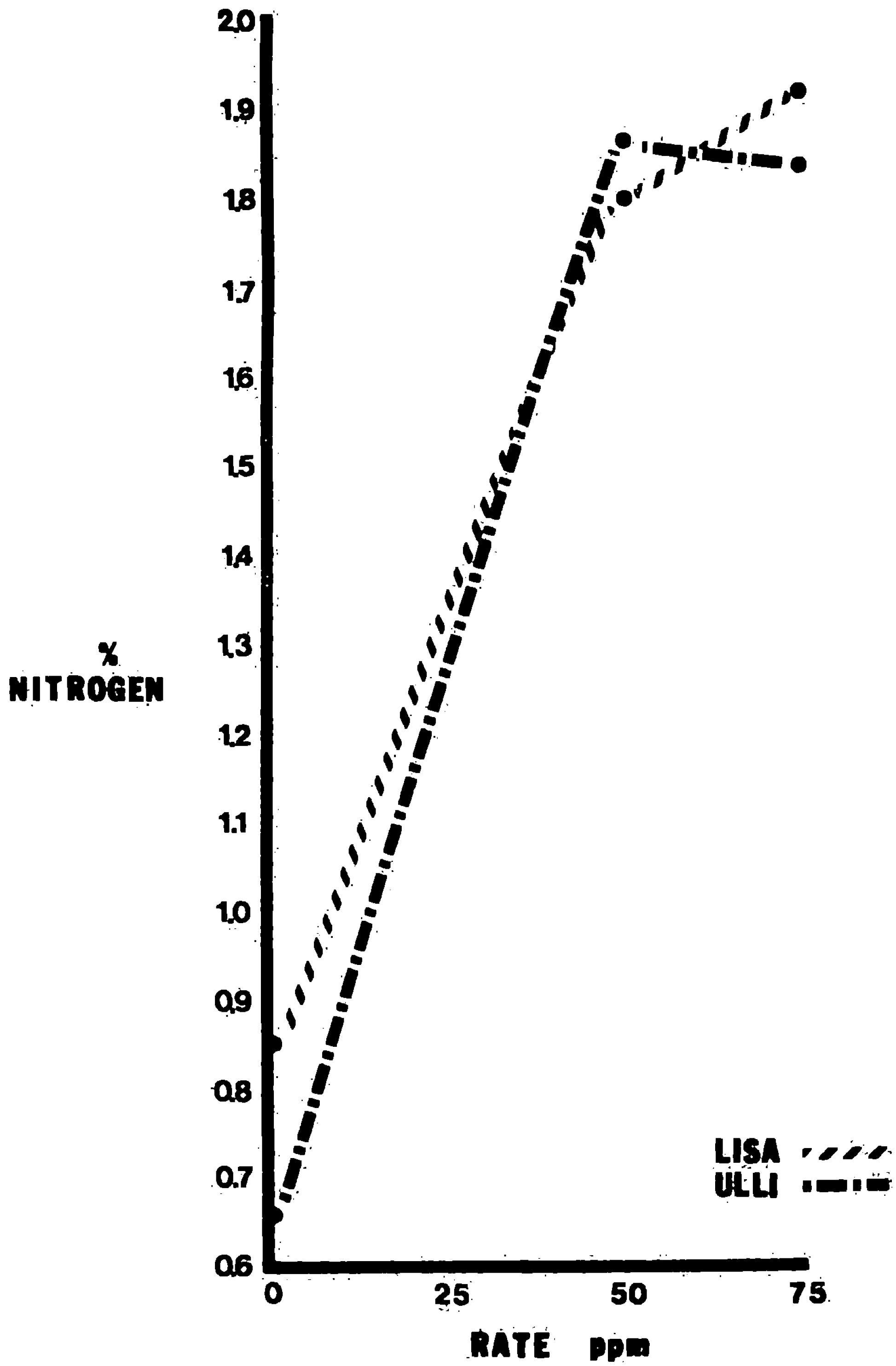

Figure 28. Influence of Liquid Fertilizer Rate on Percent Nitrogen in the Plant Tissues in the Summer.

TABLE XXVI

STATISTICAL SIGNIFICANCE OF MAIN EFFECTS AND TRENDS OF VARIOUS GROWTH AND QUALITY PARAMETERS OF LIQUID FERTILIZER TREATMENTS IN THE WINTER CROP[y]

	Dry Weight		Quality Rating	
	'Lisa'	'Ulli'	'Lisa'	'Ulli'
Rate	0.01	0.01	0.01	0.01
Linear	0.01	0.01	0.01	0.01
Quadratic	NS	NS	0.01	0.01
	Leaf Area		**Width**	
	'Lisa'	'Ulli'	'Lisa'	'Ulli'
Rate	0.01	0.01	0.01	0.01
Linear	0.01	0.01	0.01	0.01
Quadratic	0.05	0.05	0.01	0.10
	Leaf Count		**Stalk Count**	
	'Lisa'	'Ulli'	'Lisa'	'Ulli'
Rate	0.05	0.05	0.01	NS
Linear	0.05	0.01	0.01	NS
Quadratic	0.05	NS	NS	NS
	Days to First Bloom		**Nitrogen (%)**	
	'Lisa'	'Ulli'	'Lisa'	'Ulli'
Rate	NS	NS	0.01	0.01
Linear	NS	NS	0.01	0.01
Quadratic	NS	NS	0.01	0.01
	Phosphorus (%)		**Potassium (%)**	
	'Lisa'	'Ulli'	'Lisa'	'Ulli'
Rate	0.10	0.10	0.01	0.05
Linear	0.05	NS	0.01	0.05
Quadratic	NS	0.10	NS	NS

TABLE XXVII

MEANS OF GROWTH AND QUALITY PARAMETERS IN RELATION TO CULTIVAR AND RATE OF LIQUID FERTILIZER IN THE WINTER CROP

Cultivar and Rate (ppm)	Growth Parameters		
	Dry Weight (g)	Quality	Leaf Area (sq. cm.)
'Lisa'			
0	1.93	4.00	352.83
50	3.06	8.33	550.83
75	3.32	8.83	584.33
'Ulli'			
0	1.67	4.00	276.00
50	2.76	8.50	448.33
75	3.07	8.67	471.33

Cultivar and Rate (ppm)	Width (cm)	Leaf Count	Stalk Count	First Bloom
'Lisa'				
0	23.08	24.83	4.67	50.33
50	29.75	23.83	5.83	54.67
75	30.92	29.67	6.00	50.33
'Ulli'				
0	22.92	18.83	5.17	53.00
50	28.42	23.00	5.67	54.17
75	29.08	26.83	5.33	54.83

Cultivar and Rate (ppm)	Nitrogen (%)	Phosphorus (%)	Potassium (%)
'Lisa'			
0	1.170	0.301	3.489
50	2.130	0.838	4.575
75	2.217	0.911	5.365
'Ulli'			
0	1.203	0.490	3.698
50	2.050	0.876	5.123
75	2.090	0.725	5.587

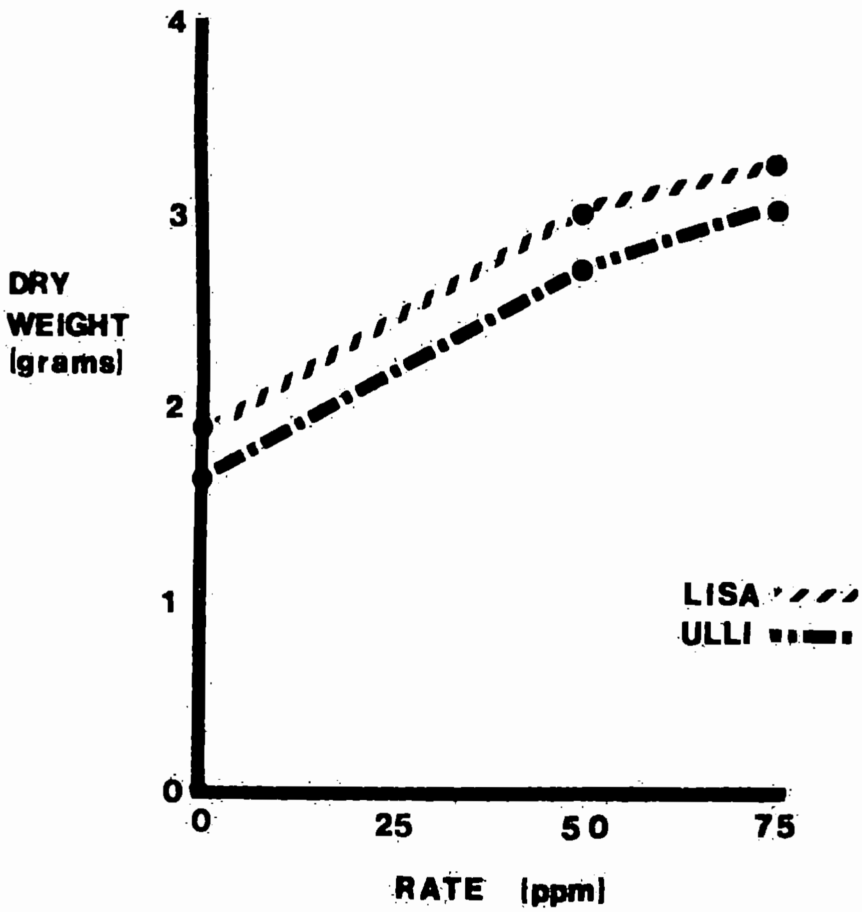

Figure 29. Dry Weight as Influenced by Liquid Fertilizer Rate in the Winter.

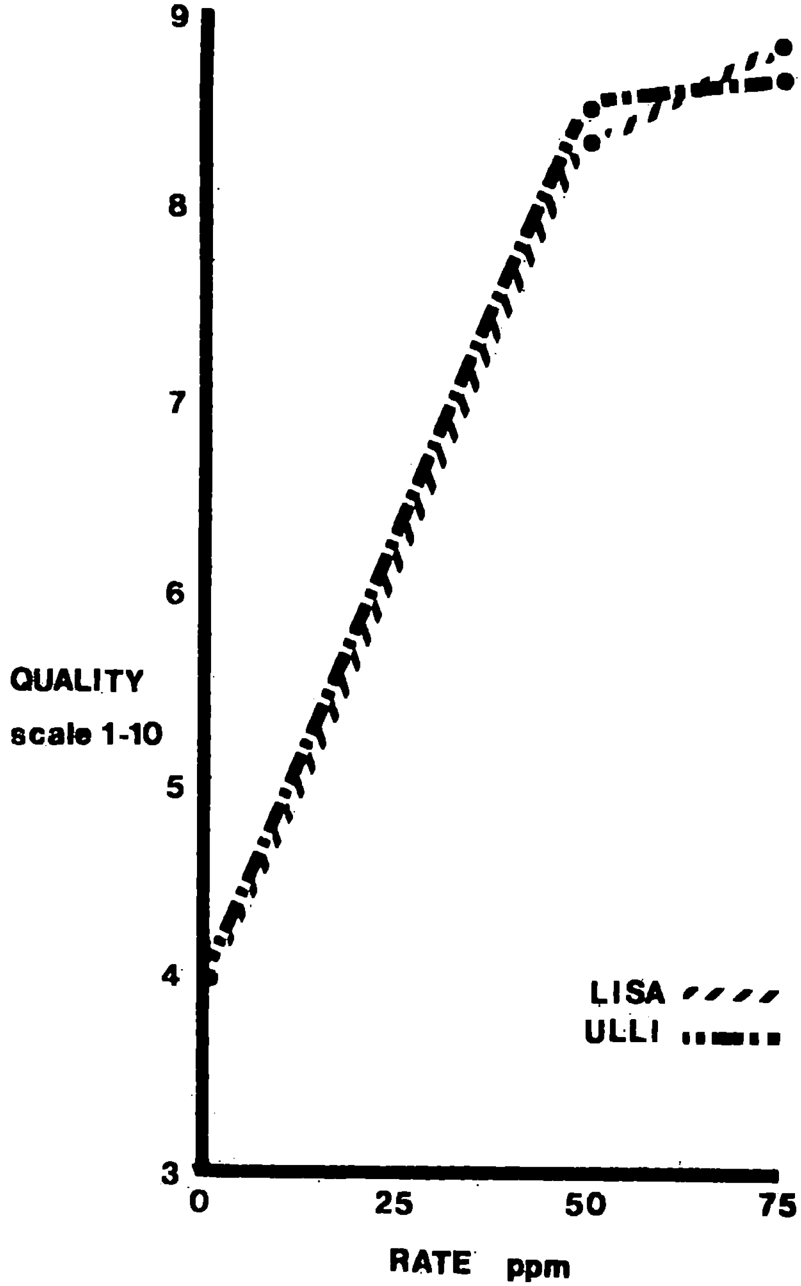

Figure 30. Influence of Liquid Fertilizer Rate on the Quality Rating in the Winter.

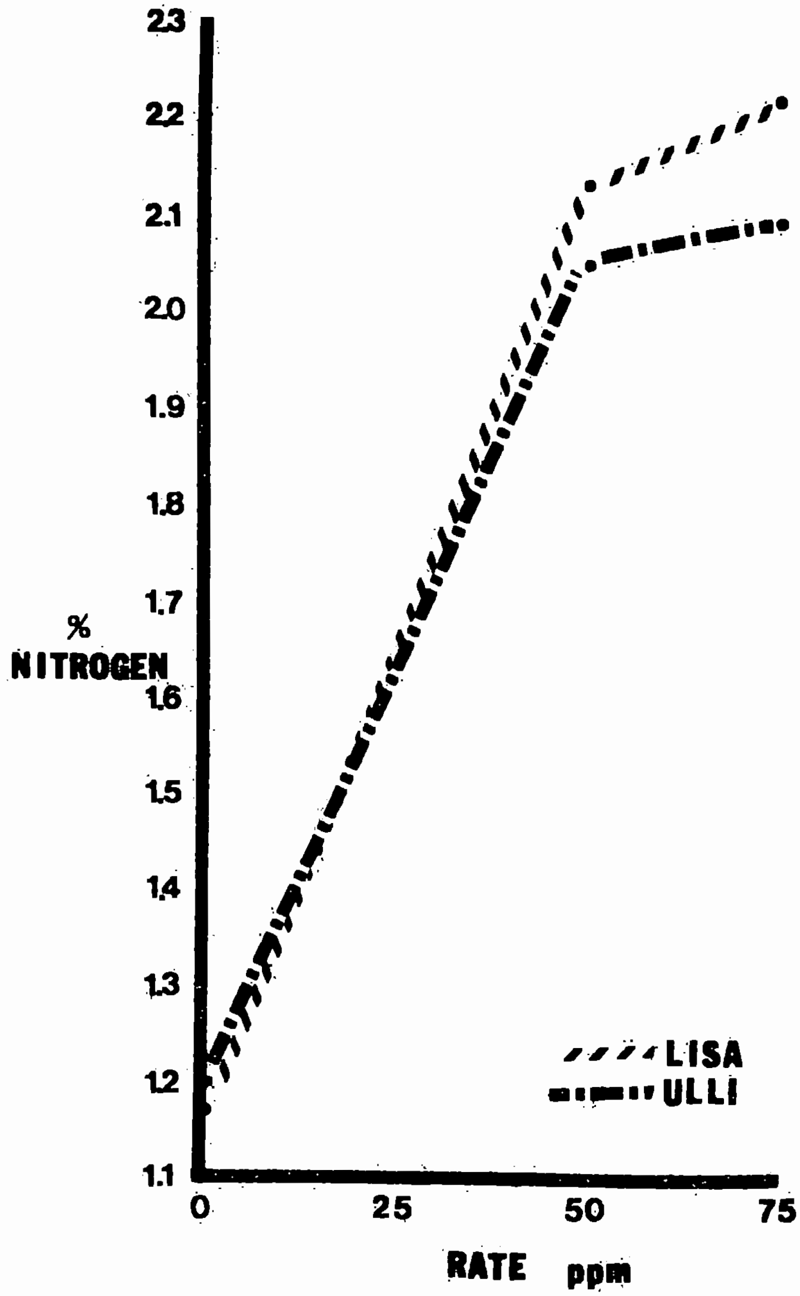

Figure 31. Influence of Liquid Fertilizer Rate on the Percent Nitrogen in the Plant Tissues in the Winter.

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