بسم الله الرحمن الرحيم

Response of Zinnia (*Zinnia elegans*), French Marigold (*Tagetes patula*) and Petunia (*Petunia hybrida*) to Planting Dates and Fertilizer Types

By
Samira Mohammed Abdulla Mukhtar
B.Sc. (Agric.) Honour
University of Khartoum
(1984)

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Supervisor
Professor Gaafar Mohamed El Hassan
Department of Horticulture
Faculty of Agriculture
University of Khartoum

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بسم الله الرحمن الرحيم

استجابة نباتات الزينيا والماريجولد الفرنسى والبتونيا لمواعيد الزراعة وأنواع الأسمدة

إعداد

سميرة محمد عبد الله مختار

بكالوريوس زراعة- مرتبة الشرف

جامعة الخرطوم

١٩٨٤

بحث تكميلي مقدم لنيل درجة ماجستير العلوم في البساتين

إشراف

بروفسير: جعفر محمد الحسن

قسم البساتين

كلية الزراعة

جامعة الخرطوم

ديسمبر ٢٠٠٢

DEDICATION

To my Husband Azhari

My kids Alaa, Eiman and Ahmed

And to my parents

With endless love

بسم الله الرحمن الرحيم

(سُبْحانكَ لا عِلْمَ لناَ إلا ما عَلّمْتَنا
إنَّك أنتَ العليمُ الحكيمُ)

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Key of Abbreviations in Figures

Fr_1 :	***Chicken Manure.***
Fr_2:	***Urea.***
Fr_3:	***Bayfolan (10-8-6).***
Fr_0:	***Control.***
PD_1:	***Planting Date 1 (October, 22).***
PD_2:	***Planting Date 2 (November, 22).***
PD_3:	***Planting Date 3 (December, 22).***

Abstract

Three field experiments were conducted at the Demonstration Farm of the Department of Horticulture, Faculty of Agriculture, University of Khartoum, Sudan, during Winter season (2000-2001) to study the response of Zinnia (*Zinnia elegans*), French Marigold (*Tagetes patula*) and Petunia (*Petunia hybrida*) to planting dates and fertilizer types. Each species was grown in a separate experiment.

The planting date treatments were, October, 22, November, 22, and December, 22. The fertilizer type treatments were, Chicken manure at the rate of 2.5 tons/ fed, Urea at the rate of 186.7 kg/ fed, Bayfolan (10-8-6) at the rate of 3 ml/liter and the control. The studied parameters included, number of flowers/ plant, number of branches/ plant, plant height and flower diameter. The collected data were statistically analyzed and the means were separated using Duncan's Multiple Range Test.

The results showed that the three species under study had responded to planting dates and fertilizer types. The response to planting dates varied with the species. Zinnia, can be grown successfully through out winter season of Shambat. However, planting on November 22, gave significantly higher values of growth parameters. Early sowing of French Marigold resulted in vigorous vegetative growth and higher flower yield than late sowing of November, 22 and December, 22. The favourable planting date for Petunia under conditions of the study was November, 22.

Significantly higher values of number of flowers per plant, number of branches/plant, plant height and flower diameter were associated with the fertilized plants compared to the control.

Application of chicken manure at the rate of 2.5 tons/fed was found to be superior to urea and Bayfolan (10-8-6) and gave higher values in the studied growth parameters. Urea and Bayfolan (10-8-6) gave significantly higher growth values compared to the control.

بسم الله الرحمن الرحيم

ملخص الاطروحة

أجريت ثلاث تجارب حقلية بالمزرعة الايضاحية لقسم البساتين – كلية الزراعة – جامعة الخرطوم بالسودان. في شتاء عام ٢٠٠٠-٢٠٠١م لدراسة استجابة نباتات الزينيـا والماريغولد الفرنسى والبتونيا لمواعيد الزراعة وأنواع الأسمدة. تمت زراعة كل نوع في تجربة منفردة وكانت معاملات مواعيد الزراعـة: ٢٢ أكتـوبر و ٢٢ نـوفمبر ثـم ٢٢ ديسمبر. كانت معاملات أنواع الأسمدة هي: سماد الزرق (مخلفات الدواجن) بمعدل ٥ر٢ طن للفدان واليوريا بمعدل ٧ر١٨٦ كجم للفدان والبايفولان (١٠-٨-٦) بمعدل ٣ مل للتر والشاهد. اشتملت المعايير التي تمت دراستها على عدد الازهار بالنبات، وعـدد الأفـرع بالنبات وطول النبات وقطر الزهرة. حللت البيانات إحصائياً وتـم فصـل المتوسـطات باستخدام اختبار دانكانز. أظهرت النتائج أن الأصناف الثلاث قيد الدراسة قـد اسـتجابت لمواعيد الزراعة ونوع السماد. اختلفت استجابة النباتات لمواعيد الزراعة باختلاف نـوع النبات.

كان أنسب وقت لزراعة البتونيا هو ٢٢ نوفمبر تحت ظروف التجربة. يمكـن زراعة نبات الزينيا (*Zinnia elegans*) بنجاح طوال موسم الشـتاء بشـمبات، إلا أنـه الزراعة في ٢٢ نوفمبر أعطت معنوياً أعلى قيم لمعايير النمو. أعطت الزراعة المبكـرة للماريغولد الفرنسى (*Tageter patula*) في ٢٢ أكتوبر نمواً خضرياً قوياً وإنتاجية عالية للأزهار مقارنة بالزراعة المتأخرة في ٢٢ نوفمبر و ٢٢ ديسمبر.

ارتبطت أعلى قيم لعدد الأزهار بالنبات وعدد الأفرع بالنبات وطول النبات وقطر الزهرة معنوياً بالنباتات التي تم تسميدها مقارنة بنباتات الشاهد. كانت إضافة سماد الزرق بمعدل ٥ر٢ طن للفدان أفضل من اليوريا والبايفولان (١٠-٨-٦) من حيث زيادة إنتـاج الأزهار وجودتها. أعطى التسميد باليوريا والبايفولان (١٠-٨-٦) إنتاجية عالية معنويـاً مقارنة بالشاهد.

1. Introduction

Annual flowering ornamental plants have high esthetic value. They are widely grown in green-houses, commercially purchased as potted flowering plants or grown in home gardens and public parks for landscape purposes.

In the Sudan Zinnia, Marigold and Petunia are the most popular annual ornamental plants grown mainly in Winter. They are easily propagated by seeds.

Recently, the demand for ornamental plants has been increasing. More nurseries have been established especially in Khartoum State. This may be due to urbanization and change in the life style of people, as they became more aware of the value of ornamental plants.

In the Sudan research on annual ornamental plants has been megre, if any. Nursery men and garden owners depend mainly on their experience in plant management. Therefore, a reliable scientific study on cultural practices such as planting dates, planting methods, irrigation and fertilization to improve production in terms of quantity and quality is an urgent need. The objectives of this study were therefore:

1. To investigate the response of Zinnia (*Zinnia elegans*), French Marigold (*Tagetes patula*) cultivar oxadis and Petunia (*Petunia hybrida*) cultivar pendula to different planting dates during Winter season.
2. To investigate the response of these three cultivars to fertilizer types.

2. Literature Review

In the Sudan inspite of increasing trend towards growing ornamental plants, limited research works were carried out. Annual ornamental plants have received no attention concerning the scientific study. Therefore, no available literature was found in this field.

So this study is considered one of the pioneering trials to highlight this group of economically and esthetically important plants.

2.1 Zinnia (*Zinnia elegans*)

2.1.1 Botany

Zinnia is a member of family: Asteraceae (Compositae) (Aster/daisy family). Zinnia is a relatively small genus comprising 17 species, native to North and South America and Originated in Mexico (Boyle, 1986). The wild flower is a single daisy with pale lavender colour. New colours appear through hybridization, ranging from sunny orange, gold, yellow, scarlet rose, cream and white with some bicolours or strips but no blues. Plant height ranges from 13.5 cm up to 120 cm and flower diameter is 4-13 cm. Foliage is rough textured. Flowers may be single, semi-double or double and dahlia-like (pompon) flowers (Faust, 1980).

Creeping zinnias are grown as ground cover and reach up to 13.5 cm high, hang from window boxes. Zinnia is also grown as a bedding plant. (Russ and Polomski, 2002).

2.1.2 Environment and Culture

Zinnia is easy to grow from seeds in rich loamy soil in the open with full sun. Zinnia is drought tolerant, grows in warm weather and is

a frost sensitive annual plant. (Russ and Polomski, 2002). Seeds germinate outdoor in one week at 20-30°C. Sometimes seeds respond to light. (Hartmann and Kester, 1984 and Abu EL Dahab.1994).

Six to eight weeks seedlings are ready to be set out. Plants flower within 6-8 weeks from seed sowing. They require deep watering as frequent light watering will encourage shallow rooting (Cox.1997).

Ground watering is better than over head sprinkling because high humidity on foliage encourages mildew which is the most important disease of Zinnia (Faust, 1980). Spacing is 9-25 cm. Zinnia is sensitive to root disturbance (Faust, 1980). Pinching (removal of the terminal flower bud) induces branching. Zinnia requires fertilization several times during growing season. In Europe, it is grown as a Summer annual bedding plant from May to October.

(*Zinnia elegans)* can be produced year-round in green houses as a cut flower in addition to its use as a bedding plant (Dennis *et al*, 1987).

2.2 Marigold (*Tagetes spp*.)

2.2.1 Botany

Marigold belongs to family Asteraceae (compositae). The plant is a tender, herbaceous, rapidly growing annual. Originated in South America, Argentina and New Mexico. It is also a native of South Europe. The leaves are feather-like, finely dissected and oppositely arranged. The leaves often have pungent odor secreted by glands on the lower surface of the leaves (Bearce, 2002). Flowers are usually scented due to presence of Quercetagetrin 5-methyl ether and patulitin oil (Bahrdwaj, *et al.* 1980).

2.2.2 Species and Cultivars

There are many cultivars of Marigold. They differ in size and flower shape. For simplification Marigolds are divided into four basic species:

- African Marigold (*Tagetes erecta*), 30 cm high.
- French Marigold (*Tagetes patula*) 15-27 cm.
- Triploid: A hybrid between African and French Marigold

  (*Tagetes erecta*×*Tagetes patula*) 18-30 cm.
- Single Marigolds eg. (*Tagetes tenuifolia)* (signata) pumila (Bearce, 2002).

French Marigolds (*Tagetes patula*) are of two types:

- Large flowered French Marigold used as a divider or bedding. Plant medium height 27-32 cm.
- Dwarf French Marigold: small plant up to 27 cm high. Flowers are small 2 ¼ - 3 ½ cm across and continuous flowering.

African Marigolds are of two types:

- Large flowered African Marigold: plants are compact, erect, 27-30 cm tall flowers and 7 cm across. They bloom three weeks earlier than tall cultivars, and have double flowers with flat or ball-like head. Flower colour is yellow to pumkin orange with no bicolour (Bearce, 2002).

Tall African Marigolds or “Aztec Marigolds” are large, and flower in late Summer to fall (short days determine flowering). Colours are

orange or yellow. Plant height is about 90 cm or more. Spacing is 30 cm. Plants need staking, and used primarily as cut flowers. Tall African Marigold have unpleasant odor. Cultivar Hawaii is odorless (Bearce, 2002).

(*Calendula officinalis*) is another type of Marigold (pot Marigold), it is a shrub-like herbaceous annual.

2.2.3 Environment and Culture

Marigolds grow quickly from seeds planted directly in warm light well-drained soil rich in organic matter. Seeds germinate within a week. The temperature should be 20-30°C. (Hartmann and Kester, 1984). Full sun is best but they can tolerate some shade. Spacing is 9 cm for dwarf-sized seedlings and about 30 cm apart for tall kinds. (Kelly, 1977).

The seeds can also be sown indoor and transplanted after 4-6 weeks into garden beds or containers. Flowering starts 6-8 weeks from seed sowing. Marigolds can also be propagated by cuttings. Watering is once a week and over watering causes roots decay (Faust, 1980).

2.2.4 Uses of Marigolds

Marigolds are used for colour massing in borders, as edgers, hedges, in pots, window boxes and as cut flowers. Marigolds are used as a biocontrol of root-knot nematodes. Chemicals secreted by the roots were effective in controlling soil nematodes (Faust, 1980). Not all Marigolds are effective against nematodes.

In a greenhouse experiment Ploeg, (1999) grew four cultivars of French Marigold (*Tagetes patula)* “Bonnita Mixed”, “Gypsy

sunshine", "Scarlet sophia", "single gold" and "Tangerine" and two African Marigold cultivars namely "Crackerjack" and "flor de Muer" were used to control root-knot nematodes (*Meloidogyne incognita)* and (*M.Javanica)*. He used Marigolds in rotation with vegetables. He grew nematode-susceptible plants after Marigold and marigolds were planted where vegetables were planted the previous year. Only the common deep orange-flowered variety is of medicinal value. Parts used are leaves and flowers. Leaves are gathered in the morning after the dew and dried by sun. The ray florets are used and quickly dried in the shade in a good current of warm air, spread out on sheets of paper loosely to avoid discolouration (Annonymous, 2002[(3)]).

Marigold is chiefly used as local remedy. Its action is stimulant and diphoretic, given internally. It is useful in chronic ulcer and varicose veins. Calendula oil is used as an excellent base for salves, facial creams as carrier oil in perfumes (Annonymous, 2002[(3)]).

Marigold flowers rubbed on affected part is effective against sting of wasp and bee.

A yellow dye has been extracted from flowers by boiling. Flowers were used to give cheese a yellow colour.

In Dutch land yellow petals are dried and used as spice in broth. Leaves eaten as salad are useful in scrotula of children (Annonymous, 2002[(3)]).

2.3 Petunia (*Petunia hybrida*)

2.3.1 Botany

Petunia,a member of family Solanaceae (nightshade family), originated in South America. It is a tender perennial often grown as annual. Flowers are funnel-shaped with mild fragrance, leaves are oblong, smooth-edged and sticky. Plants are more than 30 cm high. Flowers have different colours, ranging from deep purple, lavender to all shades of red, in addition to yellow and white (Faust, 1980). White and lavender cultivars have very sweet fragrance.

2.3.2 Landscape Uses

Petunia is the number one bedding plant. It is the most popular flowering annual which has long flowering period (Spring till frost). It is used for colour masses, borders, containers, hanging baskets or seasonal ground cover. Petunia is also sown in patio tubs along walkways (Hartmann and Kester, 1984).

2.3.3 Cultivars or Types

According to Kelly (1975), the most important petunia types are:

- Grandifloras: which are large flowered 7-9 cm bloom (flower diameter).
- Multifloras: prolific, produce masses of colour 3-7 cm bloom.
- Floribundas: produce medium-sized flowers 5-7 cm wide and free flowering.

- Milliflora: much smaller than any other petunia. Flowers are 2-3.5 cm wide and compact. Plants are excellent for containers.
- Spreading petunias: low growing, spread as much as 90-120cm. They form a beautiful colourfull ground cover. They can be used in window boxes and hanging baskets (Russ and Palomosk, 2002).

2.3.4 Environment and Culture

Petunia requires light, well-drained soil of medium fertility. It takes 8-10 weeks from seed sowing to transplanting. It requires full sun and can tolerate some shade. Seeds of petunia are very minute, slow starting and slow growing; germinate within 1-2 weeks at 20°C. Seeds require light for germination (Abudahab, 1994). Spacing should be about 30cm. It needs to be fertilized several times during the growing season. Seedlings require hardening before transplanting into exposed beds. Direct seeding of many nursery stock species is more economical, since less handling and green-house space is required (Daniel, 1979). Seeds of double-flowered cultivars and some F_1 hybrids may need light and high temperature (27-29°C) for good germination. After emergence the seedlings need low temperature about 15°C for establishment before transplanting. Soft wood cuttings taken in late Summer from side shoots root easily (Hartmann and Kester, 1984). Aphids and slugs are the main problems of petunia.

2.4 Effect of Planting Date

Planting date is the most important cultural practice in production of annual ornamental plants. Petunia flowering time was greatly influenced by photoperiod, as long days promoted flowering. Duration of the final phase of flower development was influenced primarily by temperature (Adams *et al*., 1993).

A study carried out in Seoul, to investigate the effect of light intensity (sun, half-sun or shade) and sowing dates (30 March, May or July) on flowering of six petunia cultivars, revealed that plants which flowered early had the highest number of flowers and this was observed in May sowing grown in the sun irrespective of cultivar. The duration of flowering was promoted by growth in half-sun and sowing date in March. Total carbohydrate contents were influenced by growth condition of the plants being higher at high light intensity of May (Kwack and Lee 1999).

Adams *et al*., (1993) investigated the effects of temperature and planting date on time to first flowering of *Petunia hybrida* cv. “Express Blush Pink”. Seeds were sown on three separate sowing dates (8 Februray, 1 and 22 March). Flowering was earlier under high temperature when planting was on 22 March.

The rate of progress to first flowering increased linearly with lengthening photoperiod up to critical photoperiod (14.4 h/day). The rate of progress to flowering increased linearly with increasing temperature. However, the optimun temperature (at which the rate of progress to flowering was maximal) was lower under short days compared to long days. Delay in sowing annuals generally shortened

the time to flower and flowering period of Petunia and Marigold under Korean conditions (Jeon and Hong, 1987).

Reekie *et al*., (1997) found that day length controled plant response to carbon dioxide enrichment under green house condition. The growth and flowering responses of plants kept in short days (9 hrs) to carbon dioxide enrichment were greater than those kept under long days (13 hrs), CO_2 from 350-1000 ml/litre) in growth chamber. Flowering of petunia was delayed by 12 days by treatment of seedlings with Cupper hydroxide.

In comparison trial between grandiflora and multiflora group of petunia, the date of start of flowering was recorded in grandiflora hybrids (four single colour and 12 mixed colour cultivars) and multiflora hybrids (three mixed-colour cultivar). In the latter group the mean date of flowering for each cultivar ranged from 10 May to 16 May, but in grandiflora group the date ranged from 5 May to 18 May. The multiflora flowers were less damaged by rain than large grandiflora flowers. Also multiflora bore more flowers (Loeser, 1988).

In the greenhouse, raising temperature (air temperature) for most bedding plants increases growth rates but temperature above 30°C has detrimental effects. High temperature stimulates soft growth resulting in taller, thin-stemmed plants.The build up of protein and amino acids is predominant. The higher the temperature the higher the need for fertilizer and water. On the other hand, low temperatures cause slow plant growth with build up of carbohydrates (Larson,

1980). The optimum temperature for bedding plants varies between 16-21°C depending on the plant species.

Leaf and flower colour can also be influenced by temperature. At low temperature starch is converted into sugar.Accumulation of carbohydrates results in increased anthocyanin, thus redish colour on the edges of leaves and stem may be a symptom of low temperature and flower colour is usually more intense. At high temperatures the plant may have faded flower colour and lighter green leaves (Larson, 1980).

French Marigold, Balsam and Vinca were reported to have no photoperiodic preferences, therefore, they will flower in about the same number of days whether under long-or short-day regimes.

African Marigold (*Tagetes erecta)* and Zinnia will flower faster under short day condition. Therefore, early Winter sowing will flower earlier than late Spring sowing (Larson, 1980).

Petunia though growing better at 13°C and 21°C responds as along day plant but photoperiodic effects depend on the specific variety (Larson, 1980).

According to Harka (1983), seed of 8 large – flowered petunia cultivars were sown on 21 January, 10 February or second March and grown with warm temperature, cool or cold green-house temperature. The later the sowing and higher the temperature, the shorter the growing period needed to produce salable plants. Short days delayed plant growth, particularly with early sowings. Seasonal variation in

vegetative and reproductive development was observed when (*Zinnia elegans*) cultivars

were grown in the green-house during Spring, Summer, Fall and Winter. All cultivars flowered earliest in Summer and latest in Winter.

Days to flowering of (*Zinnia elegans*) and number of nodes were influenced principally by season, where variation in height and flower diameter was due mainly to cultivar differences (Dennis, 1987).

Zinnia elegans grown in green-house during Spring, Summer, Fall and Winter, the cultivars flowered earliest in Summer and latest in Winter. Summer grown plants required about 45 days from seed sowing to flowering, where as Winter-grown plants required about 78 days to flower (Boyle, *et al.*, 1986).

Both duration and time of application of photoperiodic lightening were found to affect vegetative and reproductive development of (*Zinnia elegans).* Plants grown under long days (14-24hr/24) provided by eight hr of solar irradiation and supplementary incandescent irradiation were greater in height, leaf size, flower diameter and number of nodes, and flowered later than plants grown under short days of 8-12 hr duration. High quality cut flowers of *Zinnia elegans* (i.e. rigid stems, large flower diameter and maximum petalage) can be produced during natural short days of winter and spring by controlling photoperiod (Boyle and Stimart, 1983). According to Pinto, *et al.* (1996), leaf area of *Zinnia elegans* was affected by sowing date at the stages before and full flowering.

2.5 Fertilizers

Fertilization is necessary as a nutrient supplementation of natural supply of the nutrients and replacement of nutrients removed by plants.

Therefore efficient and balanced use of fertilizers and manures, which are essential for obtaining maximum potential yield and success of flowering based on modern technology should be developed

The efficient production of high quality herbaceous ornamental plants required a nutrition regime which will supply a constant uniform level of nutrition throughout the growth cycle (Janick, 1979). Two- year trails on the effect of nitrogen at 60, 120 or 180 kg/ ha and P_2O_5 at 60, 120 or 180 kg/ha in all possible combination,revealed that the best results in terms of flower yield and quality of china aster were obtained with highest rates of both elements (Reddy, 1978).

2.5.1 Organic Fertilizers

Organic fertilizers are used intensively in horticulture. These are plant residue and animal waste products. They are rich source of nitrogen and phosphorous. The nitrogen present is not water- soluble. They may be slowly released in soil as the fertilizer decays. They contain less soluble salts, so they can be used at large rates without the risk of damage to the root system due to high dose. They are safer and more friendly to the environment (Coats, 1975).

Animal manure generally affects crop yield directly or indirectly.

Directly by supplying the plant with both macro and micro nutrients, and indirectly, by changing the physical and chemical properties.

Physically, it improves soil structure there by improving tilth, aeration, water movement and retention. Chemically, it acts as an ion exchanger and store-house of N, P and S (Steavenson,1982).

Biologically organic matter provides carbon, energy and nutrients source for micro-organism which in turn perform a variety of indispensable interaction of soil fertility (Prakash and Maec Grer, 1983).

El Hassan (1993) found that the organic matter improved soil physical and chemical properties through increasing water holding capacity.

Nitrogen content of the manure depends on various factors. The greater the urine proportion together with appropriate quantity of water added, the higher the content of ammonia nitrogen (Elamin, 1991).

A compost product consists of lumber sawdust + sea food processing residue + sea bird manure was used as organic fertilizer in *Zinnia elegans* and was found to increase flower growth of *Zinnia elegans* (Chang, *et al*., 1999).

Combination of both organic manure and urea treatments with compositae plants was found to be most effective in suppressing plant parasitic nematodes (Akhtar, 1998). Chicken manure was found to be one of the most promising sources of organic matter.Recent studies in Faculty of Agriculture, University of Khartoum, showed that this material is quite helpful as a soil amendment in reclamation of salinity (Malik, 1983; Dahab, 1984; Gabir, 1984 and Abdulla, 1989).

Biscoff (1989) reported that application of organic manure for many years increased yields of potatoes. Positive effects of chicken

manure on plant height and dry weight of leaves in okra (*Abelmoschus esculentus*) was reported by Eltilib et al., (1993). Application of chicken manure at the rate of 2.5 was found to increase yield of leaves, stems and growth rate of (*Cathoranthus roseus*) (Ahmed, 2002).

The use of chicken manure is more efficient than farm yard manure (FYM) on sunflower (*Helianthus annus* L.) particularly in seed yield and head diameter. High values of plant height and number of leaves per plant of sunflower (*Helianthus annus* L.) were obtained by using chicken manure at the rate of 5 tons/fed + nitrogen at the rate of 150.5 kg/fed (Ibrahim, 1999).

The value of chicken manure as a source of plant nutrient was tested by Perkin and Parker (1971). They recorded that broiler (chicken used to produce meat) manure contained 2.27, 1.07 and 1.7% nitrogen, phosphorous and potassium respectively.

2.5.2 Foliar Fertilizer

Foliar application of mineral nutrients by means of sprays offers a method of supplying nutrients to plants more rapidly as a new technique when some elements are deficient (Hassan, 1996).

Foliar fertilizer is a quick remedy of nutrient deficiency. Different foliar fertilizers gave greater increase in plant height, number of leaves, leaf area, relative growth rate, fresh and dry weight of banana over the control (Hassan, 1996).

Dawoud (1991) examined the response of foster grapefruit seedlings grown under nursery condition using different foliar fertilizers namely, Bayfolan (10-8-6) NPK, Wuxal (10-10-7) and Nitrofoska (10-2-6). He found that the foliar fertilizer materials gave greater increase in plant height compared to the control. Bayfolan (10-8-6) gave greater increase in plant height, scion diameter, fresh and dry weights compared to the control.

AL Amin (1993), working on banana suckers grown under nursery conditions, studied the influence of four different foliar fertilizers namely, Bayfolan (10-8-6), Wuxal (7-14-7), Nitrogfoska (10-2-6) and Foliar-x (10-7-8). He found that all fertilizer materials showed greater increases in plant height, pseudostem diameter, number of leaves, relative growth rate, fresh and dry weights than the control.

In an experiment on *Graptophyllum pictum* (a foliage ornamental plant) using foliar fertilizer materials namely: Bayfolan, Nitrafoska, Wuxal and Foliar-x were applied at concentration of 2.5 ml/l, the results revealed that the plants responded to all foliar fertilizer materials. Total fresh and dry weight, relative growth rate and root volume were higher in treated plants compared to control (Osman, 1995).

3. Materials and Methods

3.1 Experimental Site

The study was carried out in the Demonstration Farm of the Department of Horticulture, Faculty of Agriculture, University of Khartoum, at Shambat, (latitude 15° 40′ N, longitude 32° 32′ E) in Winter season (2001-2002).

The climate is semi-arid, tropical, with seasonal annual rainfall of 150-180 mm during Summer. Meteorological data during the growing season are shown in Appendix (1).

3.1.1 Soil Type

The soil physicochemical analysis reported by Abdulla (1989) showed that, "Shambat" soil was of clay loamy type slightly alkaline with pH range 7.5-7.7.

3.1.2 Seed Source

Seeds of French Marigold (*Tagets patula*) var. (oxadis) were imported from Italy. Seeds of Zinnia (*Zinnia elegans*) and petunia (*Petunia hybrida*) var. (Pendula) were imported from Holland.

3.1.3 Experimentation

The following three experiment were carried out to achieve the reported objectives:

Experiment One: Response of Zinnia (*Zinnia elegans*) to Planting Dates and Fertilizer Types

The experiment was laid out in a split-plot design with three replications. Fertilizer types were assigned to the main plots and

planting dates to the sub-plots. The experimental unit was a plot 100 cm ×50 cm.

The main plot treatments (fertilizers) (Fr) were:

1. Chicken manure: (Fr_1).
2. Urea: (45% N_2) (Fr_2).
3. Bayfolan 10-8-6 (NPK) as foliar fertilizer (Fr_3).
4. Control (Fr_0).

The sub-plot treatments (planting dates) (PD) were:

1. October, 22. 2001 (PD_1).
2. November, 22. 2001 (PD_2).
3. December, 22. 2001 (PD_3).

The planting date was refered to the time of seed sowing in the nursery

3.2 Cultural Practices

3.2.1 Production of Seedlings

Seeds were sown in the nursery in river silt in plastic trays with dimensions of 35×28×7 cm with perforated holes for drainage. The soil was well-irrigated before sowing. The seeds were evenly broadcasted on the soil surface at the rate of about hundred seeds per tray. Then the seeds were covered with a thin layer of sand. The trays were covered with a clean transparent polyethylene cover and left without irrigation until seedling emergence. The trays were kept in a partially-shaded area until full germination. Then they were transferred to beds in sunny area for four weeks, when the seedlings were ready for transplanting.

The seedlings were irrigated twice by flooding the beds with water. The water reached the seedlings after rising up by capilarity (sub irrigation).

When Zinnia seedlings became more stronger they received a weekly careful direct watering by a hose.

The seedlings were hardened by exposure to water shortage a week before transplanting out in the field by increasing the irrigation interval.

3.2.2 Land Preparation

The land was ploughed, disc-harrowed, leveled and then divided into plots 100cm×50cm. Each fertilizer treatment was 150 cm apart from the adjacent one to avoid inter-plot interference.

3.2.3 Fertilizer Application

Chicken manure was obtained from a nearby poultry farm. The manure was added to the plots and mixed thoroughly with the soil at the rate of 2.5 tons/fed. Then pre-transplanting irrigation was applied to all plots.

Chicken manure was chemically analyzed in the Laboratories of the Department of Soil Science, Faculty of Agriculture University of Khartoum and the results were shown in appendix (2).

Urea was broadcasted before irrigation at the rate of 186.7 kg/fed (recommended level) two weeks after transplanting applied once throughout the growing season.

Bayfolan (10-8-6) was sprayed at the recommended level, three ml/liter at two weeks intervals starting on the third week from transplanting, three times through out the growing season. The plants were sprayed early in the morning using 1.5liter hand sprayer. Both upper and lower surfaces of the leaves were thoroughly sprayed to

ensure complete coverage of the leaves. The control was left without fertilizer.

3.2.4 Transplanting and Spacing

One month old seedlings were transplanted out in the field .The spacing was 25 cm between plants. The plants were irrigated once a week during cool weather, and every five days during hot weather. Weeding was done as needed.

Zinnia plants were sprayed with Malathion every two weeks at the rate of 2ml/liter to control aphids and white flies.

3.3 Collected Data

Data for growth parameters was taken every two weeks starting at 50% flowering, where a sample of five plants was selected randomly from each plot and the selected plants were tagged. Growth parameters were measured and evaluated in terms of:

1) Mean number of flowers per plant.
2) Number of branches per plant.
3) Plant height.
4) Flower diameter.

Plant height was measured from the soil surface up to the tip of the terminal flower, using a tape meter. Average number of days from seed sowing to flowering was counted for each treatment.

Duncan's multiple range test was used to separate the treatment means (at 5% level of significance).

Experiment Two: Response of French Marigold (*Tagetes patula*) var. (oxadis) to Planting Dates and Fertilizer Types

The experiment was the same as experiment I with respect to the design, the treatments, cultural practices and fertilizer application,

except for the spacing between plants, which was 20 cm and the plants were not sprayed with any insecticide as Marigold is repellent to insects except bees. Data collection was the same as in Experiment I.

Experiment Three: Response of Petunia (*Petunia hybrida*) to Planting Dates and Fertilizer Types

The same as experiment One and Two with the exceptions of,

The experimental design

The experiment was laid in a randomized complete block design with four treatments and three replications. The differential treatments were fertilizers which were:

1. Chicken manure at the rate of 2.5 tons/fed (Fr_1).
2. Urea: (45% N_2) at the rate of 186.7 kg/fed (Fr_2).
3. Bayfolan (10-8-6) (Fr_3) at the rate of 3 ml/litre.
4. Control (Fr_0).

All the three fertilizers were applied in the same way as in experiment I. The plants were sprayed with Malathion every 2 weeks at the rate of 2 ml/litre to control insects (aphids and white flies).

Data were collected as in experiment I and II. All the cultural practices were similar to experiment I and II. Spacing was 25 cm between plants. Petunia seedlings were covered with a plastic mesh to avoid bird attack in the nursery.

Petunia seedlings received irrigation water by capilarity (indirectly), by flooding the beds in which the perforated trays of the seedlings were put, because the seedlings were very small and tender. This irrigation method continued till transplanting time.

4. Results

4.1 Experiment One: Response of Zinnia (*Zinnia elegans*) to Planting Dates and Fertilizer Types

4.1.1 Number of Flowers Per Plant

There were significant differences in number of flowers per plant among fertilizer treatments in the third reading (Table 1 and figure 1). Although there were no significant differences in number of flowers per plant between fertilizer types in the first reading, chicken manure treatment gave the highest values followed by the control,Bayfolan (10-8-6) and urea.

The second reading of number of flowers per plant showed significant differences among fertilizer treatments (Table 1 and Figure 1). The highest number of flowers per plant was obtained by chicken manure treatment followed by urea, Bayfolan (10-8-6) then the control (Table 1 and Figure 1).

With respect to planting dates, there were significant, differences among planting dates in number of flowers per plant in the three readings. The highest number of flowers per plant of (*Zinnia elegans*) was obtained by November, 22 planting date followed by December, 22 then October, 22 (Table 5 and Figure 5).

The interaction between fertilizer types and planting dates was not significant in the first and the second reading, but the third reading showed significant differences regarding number of flowers per plant (Table 9 and Figure 9).

4.1.2 Number of Branches Per Plant

Data for the effect of fertilizer types on number of branches per plant of (*Zinnia elegans*) was shown in (Table 2). The three readings showed statistically significant differences between fertilizers. The highest number of branches per plant was obtained by chicken manure followed by Bayfolan (10-8-6), urea and the lowest number of flowers per plant was given by the control (Table 2 and Figure 2).

Data presented in Table 6 shows the effect of planting date on number of branches per plant. There were significant differences between planting dates in the three readings. The highest values of number of branches per plant was obtained by December, 22 planting followed by November 22, then October 22 planting.

The interaction between planting dates and fertilizer types showed no significant differences regarding number of branches per plant in the first and the second reading, while the third reading gave statistically significant differences, with December. 22, planting date found to have the highest value followed by November. 22, then October. 22, planting date (Table 10 and Figure 10).

4.1.3 Plant Height (cm)

Data for plant height in the first and the third reading showed statistically significant differences between fertilizer types, while the second reading gave no significant differences among fertilizer types. The highest value of plant height was obtained with chicken manure (Table 3 and Figure 3). No significant differences were detected between planting dates in the first reading, however, October, 22

planting gave the highest value of plant height followed by, November, 22 and December, 22 planting.

Data of the second and the third reading showed significant differences between planting dates (Table 7). The highest values of plant height were obtained by December, 22. Planting, followed by November, 22 then October, 22 (Table 7 and Figure 7).

The interaction between planting dates and fertilizer types had significant effect on plant height in the second reading. The highest values of plant height were observed inNovember,22 planting followed byDecember, 22 then October, 22 planting, but the first and the third reading of the interaction showed no significant effect on plant height (Table 11).

4.1.4 Flower Diameter (cm)

Differences in flower diameter were not statistically significant among fertilizer types in the first and the third reading. The second reading showed significant differences between fertilizers. The highest flower diameter was detected with chicken manure fertilizer (Table 4 and Figure 4). Data presented in Table 8, show that the flower diameter was not significantly different in the first and the second reading, while the third reading gave significant differences among planting dates with the highest values being obtained by November, 22 planting followed by December, 22 then October, 22 planting.

No significant interaction was observedbetween planting dates and fertilizer types (Table 12).

Plate 1. A Flower of Zinnia (*Zinnia elegans*).

Table 1. Effect of Fertilizer Type on Number of Flowers/ Plant of Zinnia (*Zinnia elegans*)

Reading / Fertilizer	First Reading	Second Reading	Third Reading
Fr_1	2.48	21.74^{a}	29.96^{a}
Fr_2	1.47	16.46^{b}	24.67^{ab}
Fr_3	1.56	15.26^{b}	20.23^{ab}
Fr_0	1.68	13.03^{b}	20.62^{b}
C.V (%)	52.3	26.5	12.40
SE ±	0.277	1.18	1.72

Fr_1 = Chicken manure

Fr_2 = Urea

Fr_3 = Bayfolan (10-8-6)

Fr_0 = Control

Means bearing similar letter(s) within the same column are not significantly different (P<0.05) as determined by Duancan's Multiple Range Test.

Table 2. Effect of Fertilizer Type on Number of Branches/ Plant of Zinnia (*Zinnia elegans*)

Reading / Fertilizer	First Reading	Second Reading	Third Reading
Fr_1	8.96^a	31.34^a	52.65^a
Fr_2	6.07^b	23.03^b	34.62^b
Fr_3	6.29^b	24.62^b	37.78^b
Fr_0	5.87^b	21.92^b	31.33^b
C.V (%)	31.65	16.31	11.86
SE ±	0.408	0.88	2.078

Fr_1 = Chicken manure

Fr_2 = Urea

Fr_3 = Bayfolan (10-8-6)

Fr_0 = Control

Means bearing similar letter(s) within the same column are not significantly different (P<0.05) as determined by Duancan's Multiple Range Test.

Table 3. Effect of Fertilizer Type on Plant Height (cm) of Zinnia (*Zinnia elegans*)

Reading / Fertilizer	First Reading	Second Reading	Third Reading
Fr_1	21.81[a]	35.52	43.52[a]
Fr_2	15.12[b]	31.47	35.48[b]
Fr_3	16.27[b]	35.01	38.44[b]
Fr_0	16.42[b]	32.86	39.63[ab]
C.V (%)	24.15	11.06	9.78
SE ±	0.44	1.8237	1.39

Fr_1 = Chicken manure

Fr_2 = Urea

Fr_3 = Bayfolan (10-8-6)

Fr_0 = Control

Means bearing similar letter(s) within the same column are not significantly different (P<0.05) as determined by Duancan's Multiple Range Test.

Table 4. Effect of Fertilizer Type on Flower Diameter (cm) of Zinnia (*Zinnia elegans*)

Reading / Fertilizer	First Reading	Second Reading	Third Reading
Fr_1	2.33	3.80[a]	3.98
Fr_2	1.88	3.40[b]	3.57
Fr_3	2.06	3.52[b]	3.65
Fr_0	1.11	3.48[b]	3.51
C.V (%)	74.04	10.28	7.47
SE ±	0.113	0.081	0.103

Fr_1 = Chicken manure

Fr_2 = Urea

Fr_3 = Bayfolan (10-8-6)

Fr_0 = Control