University of Jordan
Faculty of Graduate Studies
Graduate Department of Biological and Agricultural Science
and Natural Resources

Studies on (Hyacinthus orientalis) bulb production

By
Hassna Othman Aggad

Supervision
Dr. Jamal Sawwan

Submitted in partial fulfilment of the requirments for the degree of Master of Science in Plant Production

Faculty of Graduate Studies
University of Jordan

1990

All Rights Reserved - Library of University of Jordan - Center of Thesis Deposit

University of Jordan

Faculty of Graduate Studies

Graduate Department of Biological and Agricultural Science

and Natural Resources

I hereby recommend that this thesis under my direction by :

Hassna Othman Abd-El Fattah Aggad

Entitled :

Studies on (Hyacinthus orientalis) bulb production

be accepted as fulfilling the thesis requirement for the degree of MASTER OF SCIENCE.

Dr. J. S. Sawwan ..... December, 1990

As members of the final examination commitee, we certify that we have read this thesis and consider it satisfactory and acceptable for the award of MASTER OF SCIENCE DEGREE.

Dr. J. S. Sawwan, Assistant Prof .....

Dr. M.M. Qrunfleh, Associate Prof .....

Dr. N.A. Hadidi, Assistant Prof .....

Dr. H.A. Abu-Qaoud, Assistant Prof .....

Final approval and acceptance of this thesis is contingent on the candidate adequate performance and therof at the final oral examination.

All Rights Reserved - Library of University of Jordan - Center of Thesis Deposit

بسم الله الرحمن الرحيم

TO MY BELOVED

MOTHER, FATHER

AND HUSBAND

All Rights Reserved - Library of University of Jordan - Center of Thesis Deposit

ACKNOWLEDGEMENT

I wish to express my sincere gratitude and appreciation to my advisor Dr.Jamal Sawwan for his patience, continuous supervision, encouragement and generous help throughout this study.

Sincere appreciation is also extended to Dr. M.M. Qrunfleh, Dr. N.A. Hadidi, and Dr. H.A. Abu-Qaoud, members of the examination commitee, for reviewing this thesis.

Sincere gratitude is also extended to the staff of Plant Production Department. Special thanks are offered to Mr. Faddel Ismail for his great help and concern.

Finally, I would like to thank my friends and all who have contributed in bringing out this work .

All Rights Reserved - Library of University of Jordan - Center of Thesis Deposit

TABLE OF CONTENTS

All Rights Reserved - Library of University of Jordan - Center of Thesis Deposit

All Rights Reserved - Library of University of Jordan - Center of Thesis Deposit

All Rights Reserved - Library of University of Jordan - Center of Thesis Deposit

LIST OF TABLES

All Rights Reserved - Library of University of Jordan - Center of Thesis Deposit

LIST OF FIGURES

All Rights Reserved - Library of University of Jordan - Center of Thesis Deposit

ABSTRACT

Five experiments were conducted to evaluate some vegetative methods of Hyacinthus orientalis propagation .

Two growth regulators daminozide (100, 250, 500 ppm) and promaline (25, 50, 100 ppm) as sub treatments were combined with three vegetative main treatments, namely intact, scooping and scoring.

In another study the following methods were evaluated, control, scooping, scoring , divisions and hot water treatment.

Scooping gave the highest number of bulblets per bulb and in general the largest total weight of bulblets per bulb.

There was a significant interaction between the main treatments (scooping, scoring, intact) and the sub treatments (daminozide 100, 250, 500 ppm and promaline 25, 50, 100 ppm). Scooping combined with 250 ppm daminozide and scoring combined with 25 ppm promaline gave significantly the highest number of bulblets per bulb when compared to many treatment combinations.

For twin scaling, the highest numbers of bulblets per bulb and the largest total weight was obtained from twin scales that were incubated under temperatures of 0 - 5°C, then transplanted into the green house where temperatures were 20-25°C.

All Rights Reserved - Library of University of Jordan - Center of Thesis Deposit

INTRODUCTION

The hyacinth, a member of the faimly Liliaceae, a genus of around 25 species, and native of the Mediterrranean counteries (Genders 1973).

The Hyacinthus orientalis which flowers in spring is the parent from which all the large florists hyacinths have been derived.

The hyacinth can be grown under varied conditions and its handling for ornamental purposes is simple.

The multiplication of stock is by artifitial means, which requires skill and a lot of practice for good performance, so that only skillful growers atempt the culture. Production of the crop on a commercial scale also demands a considerable outlay of capital, some equipment and a wait of four to six years for returns on the investment. These facts coupled with the inherent risk obtaining in the continued culture of the same individual bulbs over a period of three to five years, make the hyacinth a crop one in which only a few skillful and persistant growers can afford to engage.

The industry of bulb production is still considerably new to many counteries, so that it seams that the leading counteries in this field hold a monopolly over the industry and the science behind it. Modern technology and very advanced laboratories along with well organized and equiped green-houses and plantation sites are employed in the business of bulb production.

Jordan, along with other developing counterise, lacks local production of

All Rights Reserved - Library of University of Jordan - Center of Thesis Deposit

flowering bulbs, and so depends entierly on import, thus loosing valuable amounts of hard currency.

Of the most important obstacles facing Jordan in this respect is lack of qualified and well trained people in addition to the scarcity of adequate and detailed information about the methods and techniques used in bulb propagation as most of these are kept as classified information for the producing companies.

This stady was worked upon to open a new frontier in Jordans agricultural sector. The choice of hyacinth bulbs as experimental material was due to their very high price and appeal to the Jordanian consumer because of their ease of handling and wide uses in gardens and pots, not forgetting the adorable fragrance of the flowers.

The study looks upon several conventional propagation methods that may result in high numbers of bulblets produced with large sizes, in order to come up with the best, cheapest and easiest way of hyacinth bulb production that can be easily adapted by the Jordanian grower.

All Rights Reserved - Library of University of Jordan - Center of Thesis Deposit

LITERATURE REVIEW

The term bulb has been applied to all bulb-like organs because their function is identicl, they contain a fleshy underground storage organ capable of carrying the plants through seasonal cold/warm or dry /wet periods. All have common factors such as quick growth under suitable conditions and same life-cycle, in that during growth and flowering, the following year's flower is formed in miniature, the foliage soon reaching maturity and dying away, as do the roots in most cases when the plant enters its period of rest.

Bulbous plants include the following :

Corms:

A corm is the undergroud base of the stem with distinct nodes and internodes. It is enclosed by the dry, scale like leaves. At the apex of the corm is a terminal shoot that will develop into the leaves and the flowering shoot. Axillary buds are produced at each of the nodes. (Genders,1973).

Propagation is mainly by the natural increase of new corms, large corms can be cut into sections, retaining a bud with each section. Each of these then develops a new corm. Cormels are also used in propagation. They are miniature corms that develop between the old and the new corms. One or two year's growth is required for them to reach flowering size. (Hartmann, and Kester 1983).

All Rights Reserved - Library of University of Jordan - Center of Thesis Deposit

Tubers:

A tuber is a special kind of swollen, modified stem structure that functions as an underground storage organ. Externally, the eyes present in a regular order over the surface represent nodes, each consisting of one or more small buds.

Propagation by tubers can be done either by planting the tubers whole or by cutting them into sections, each containing one or more buds. (Hartmann, and kester 1983).

Tuberous Roots and Stems:

Tuberous roots are enlargments of secondary roots. No nodes or internodes are present and the buds are produced only on the crown or stem end . Polarity is the reverse of that of the true tuber. Examples are sweet potato and dahlia. Tuberous stems are produced by the enlargment of the hypocotyl section of the seedling plant, but may include the first nodes of the epicotyl. Tuberous begonia is an example.

The usual method for propagating tuberous roots is by dividing the crown so that each section bears a shoot bud.

Dahlia, and tuberous begonia are propagated oftenly by stem leaf, or leaf-bud cuttings. The cuttings develp tuberous roots at their base. (Hartmenn, and Kester 1983).

All Rights Reserved - Library of University of Jordan - Center of Thesis Deposit

Rhizomes:

A rhizome is a specialized stem structure in which the main axis of the plant grows horizontally at or just bellow the ground surface. The stem consists of nodes and internodes and a leaf-like sheath is attached at each node.

Propagation is carried out by cutting the rhizome into sections with each piece there should be at least one lateral bud. Bananas are propagated in this way . (Hartmann, and Kester 1983).

True bulbs :

The true bulb is a bud sheathed in layers of food-storing fleshy white leaves called scales attached to a tough basal plate. Meristems develop in the axil of the scales to produce bulblets which are miniature bulbs. Bulbs may have an outer bulb scale that is dry and memberanous which provides protection from injury and drying. These are called tunicate bulbs, and are represented by the onion, hyacinth and daffodil.

Nontunicate bulbs do not contain the covering. The scales are separate not in continuous concentric layers like the previous type. Lily is an example of the later type.

True bulbs are mainly propagated by vegetative means. Sexual propagation is too slow and is used only in specific cases of breeding and improvement purposes.

All Rights Reserved - Library of University of Jordan - Center of Thesis Deposit

Offsets :

offsets are fully grown bulblets which form the meristems in the axils of the scales. If undisturbed, the offsets may remain attached to the mother bulb for several years. They can be removed at the time the bulbs are dug and replanted to grow into flowering sized bulbs. This may require several growing seasons. This method is sufficiently rapid for the production of tulip and daffodil, but too slow for the hyacinth and lily. (Hartmann and kester, 1983).

Bulblet formation on stems:

a) Underground stem bulblets:

These bulblets form on the stem part below soil surface and not directly from the mother bulb . Bulblets form and increase in size from spring throughout summer. Between mid-August and mid-September the stems are pulled from the bulbs and stacked upright in the field. About mid October the bulblets are planted in the field. This is used in propagation of Easter lily.

b) Aerial stem bulblets:

These form in the axils of the leaves of some species of lilium. Bulbils (aerial bulblets) develop early in the season and fall to the ground several weeks after the plant flowers. They are harvested shortly before they fall naturally. (Hartmann, and Kester 1983).

All Rights Reserved - Library of University of Jordan - Center of Thesis Deposit

Stem cuttings:

The cuttings are made shortly after flowering. Bulblets form at the axils of the leaves and then produce roots and small shoots while still on the cutting. Lilies may be propagated by stem cuttings.

Leaf-bud cuttings:

The cutting is made with a single leaf and a small piece of the old stem. This may be used to propagate a number of lily species.

Leaf cuttings:

Leaves are taken at a time when they are well developed and green. An entire leaf is cut from the top of the bulb and may in turn be cut nto two or three pieces. Each section is placed in a rooting medium with the basal end several inches below the surface. Within two to four weeks small bulblets form on the base of the leaf and roots develop. (Hartmann and Kester, 1983). This method is successful for hyacinth, blood lily and others.

In propagation of hyacinth by leaf cutting the number of bulbils produced depends not only on the growing conditions, but also on cultivar. The succession of root and bulbil emergence at the base of leaves is different in many cultivars (Krause , J. 1980).

All Rights Reserved - Library of University of Jordan - Center of Thesis Deposit

Bulblet formation on scales:

In scaling, individual bulb scales are separated from the mother bulb and placed in growing conditions so that bulblets form at the base of each scale. Three or five bulblets will develop from each scale (Hartmann and Kester, 1983). Griffiths, (1930), reported that in lilium an avarage of one and one-half bulblets to the scale can be expected.

Bulb cuttings : Mature bulbs are cut into eight to ten vertical sections, each containing a part of the basal plate. These sections are further divided by sliding a knife down between each third or fourth pair of concentric scale rings and cutting through the basal plate. New bulblets develop from the basal plate between the bulb scales within a few weeks along with new roots. Plants which respond to this method are many, narcissus is one of them .

Twin scaling:

It involves dividing bulbs into portions, each containing a pair of bulb scales and a piece of basal plate.

Hanks and Rees (1978), reported that in narcissus bulblets grew satisfactorily only if twin-scaling was carried out between June and September. Large twins initiated more bulblets, but smaller twins were also effective propagules. Twin-

All Rights Reserved - Library of University of Jordan - Center of Thesis Deposit

scales cut from the intermediate scales produced most and heaviest bulblets after 1 year. Partial loss of the basal plate had no effect on bulbil initiation. Optimum bulblet initiation, emergence and first year recovery rates occurred following incubation at 15 or 20°C. Similar results have been obtained by the same reserchers in 1980. (Rees and Hanks 1980).

The practice of twin scaling of narcissus coupled with the use of growth regulators has been studied by the same researchers and the following was reported: Gibberellic acid (1-100 ppm) reduced the numbe: and weight of bulblets produced. Abscisic acid (1-100 ppm), 3-indoleacetic acid (1-100 ppm)and kinetin (1-100 ppm) increased the weight of bulblets produced (Hanks and Rees 1977).

Micropropagation by tissue culture:

Many bulb speices are highly adapted to micropropagation techniques, utilizing enhanced axillary shoot formation, adventitious shoot formation, bulblet induction on scales or flower scapes. (Hartmann and Kester,1983).

Hyacinth (Hyacinthus orientalis) propagation

A) The vegetative methods for hyacinth propagation are similar to those employed in the propagation of other bulbs, but some details of the application are unique.

392997

All Rights Reserved - Library of University of Jordan - Center of Thesis Deposit

Scooping:

It is a form of basal cuttage. Here, the entire basal plate of the mature bulb is scooped out with a special curve-bladed scalpal, a round-bowled spoon, or a small bladed knife. The scoop is made deep enough to destroy the growing point, if the scoop is not deep enough, the flower stalk should be removed before it flowers in spring. Bulblets develop from the base of the exposed bulb scales. Scooping may result in production of fifty bulblets which are quite symmetrical and uniform in size. (Griffiths. 1930) (Fig. 1).

Scoring: Here, three straight knife cuts are made across the base of the bulb, each deep enough to go through the basal plate and the growing point.

Growing points in the axils of the bulb scales grow into bulblets. An average of 30 bulblets is produced. These bulblets unlike the progeny of the scooped bulb, vary in shape the first season but become round and symmetrical at maturity.

When bulbs are scored and immediatly planted in the field with no incubation, they result in much less bulblets, not more then ten. (Griffiths. 1930) (Fig. 2).

All Rights Reserved - Library of University of Jordan - Center of Thesis Deposit

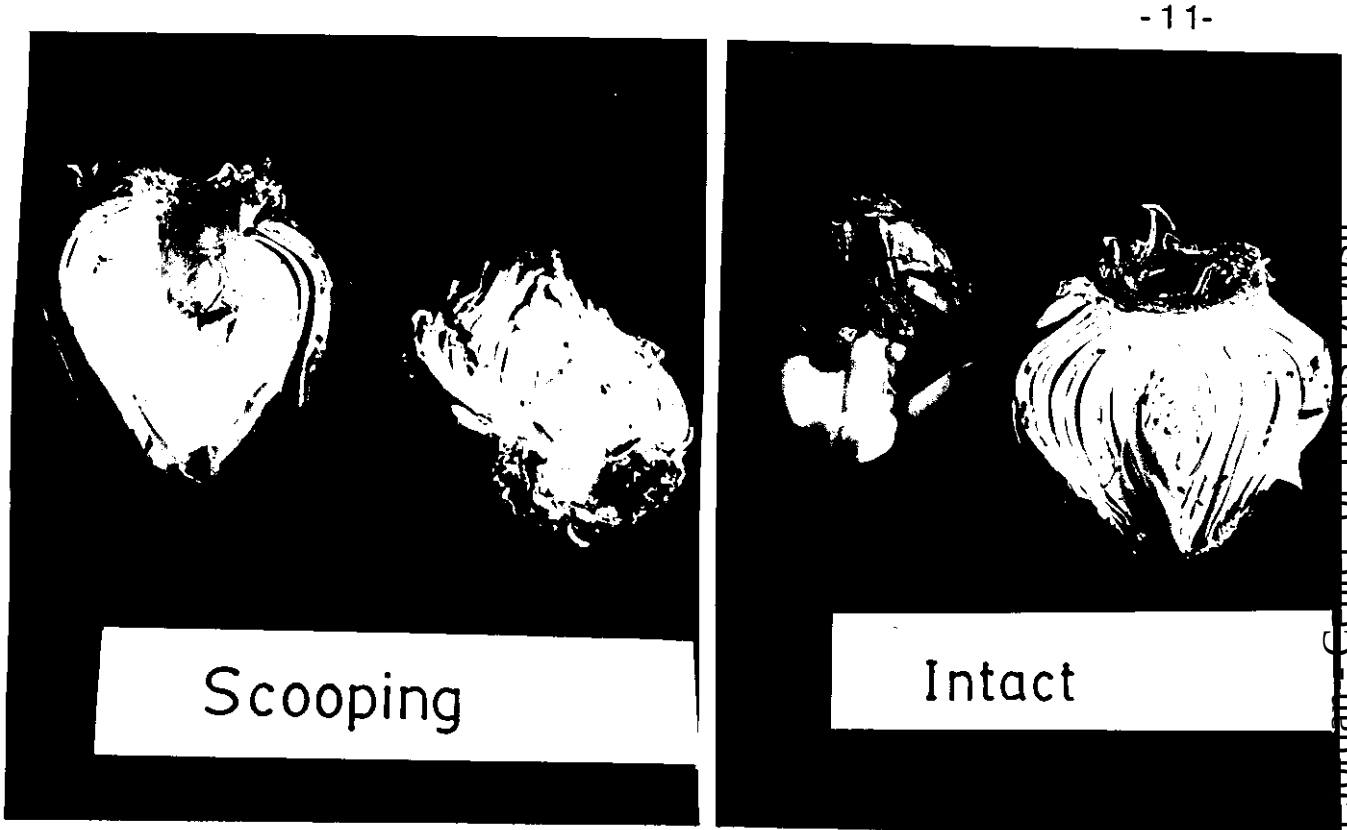


Fig (1) : A longitudinal section of a scooped hyacinth bulb and an intact hyacinth bulb.

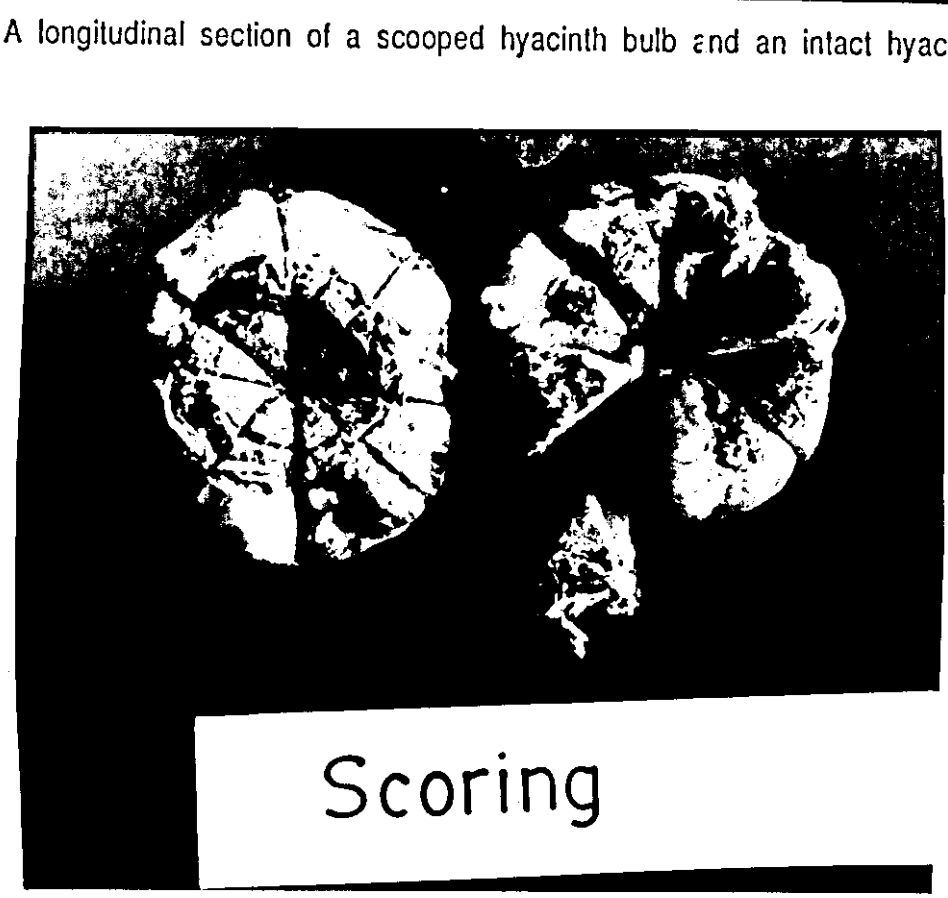


Fig. (2): A scored hyacinth bulb.

All Rights Reserved - Library of University of Jordan - Center of Thesis Deposit

Coring: This method is analogous to scoring. It consists in the entire removal of the growing point with a minimum of mutilation of the basal plate. Such a distruction of the growing point forcess the development of adventitious buds between the bulb scales as in the scoring method (Griffiths 1930).

B) Hot water treatment:

This treatment was principaly used to control Xanthomonas hyacinthi. It proved to induce bulblet formation and could substitute for basal cuttage. (Hartmann and Kester 1983).

Amano and Tsutsui, 1980, reported that treatment of bulbs at temperatures of 40°C for 7 days was less effective than treatment with 43°C for four days. The largest number of divided bulblets could be obtained when treatments were started in mid to late August, and the thickening of bulblets decreased with delayed treatment.

Propagation requirments

1) Media

Various materials and mixtures of materials are used for propagation.

a) Soil : it is composed of materials in the solid, liquid, and gaseous states. For satisfactory plant growth these materials must exist in the proper proportions.

b) Sand : Sand consists of small rock grain. Its mineral compositon depends upon

All Rights Reserved - Library of University of Jordan - Center of Thesis Deposit

the type of rock. Quartz sand, consisting chiefly of a silica complex, is generally used for propagation purposes. Sand is the heaviest of all rooting media used . It should be fumigated or heat treated before use. Sand contains no mineral nutrients.

c) Peat: Peat consists of the remains of aquatic, marsh or swamp vegetation, which has been preserved under water in a partially decomposed state. Moss peat is the least decomposed of the peat types and is derived from sphagnum, hypnum or other mosses. It has a high moisture holding capacity, has a high acidity (pH of 3.2-4.5), and contains a small amount of nitrogen but little or no phosphorus or potassium.

d) Perlite :

It is a gray-white silicaceous material, is of volcanic origin, mined from lava flows. The crude ore is crushed and screened, then heated in furnaces to about 760°C, at which temperature the small amount of moisture in the particles changes to steam, expanding the particles to small, sponge-like kernels. Perlite holds three to four times its weight of water.

It is essentially neutral with pH of 6.0 to 8.0.It is most useful in increasing aeration in a mixture. Perlite, in combination with peat mass, is a very popular rooting medium for cuttings .

All Rights Reserved - Library of University of Jordan - Center of Thesis Deposit

e) Vermiculit: Is a micaceous mineral that expands markedly when heated. When expanded, vermiculite is very light in weight , neutral in reaction and insoluble in water. It contains enough magnesium and potassium to supply most plants. (Hartmann and Kester 1983).

The hyacintyh requires an abundance of moisture and perfect drainage. It is recomended therfore, to culture hyacinth plants in a friable loam which is constantly moist, never soggy, and well aerated during the growing season. The soil should remain friable and loose during the crop period; otherwise the bulbs can not develop properly. (Griffiths 1930).

2) Temperature and photoperiod:

A wide range of temperatures is permissible in the propagation of hyacinth bulbs. The optimum of 21-32°C should not be deviated from . The callusing may be done at a lower temperature, but with lower temperatures the process of development of bulblets will be retarded. (Griffiths 1930).

Many plants respond photoperiodically to day light plus twilight.

Potato plants form tubers more readily under short photoperiods than long (Werner 1935). In Begonia, aerial tuber formation many likewise be strictly controlled by short photoperiods. (Esashi 1960) .

All Rights Reserved - Library of University of Jordan - Center of Thesis Deposit

Onion and garlic bulb formation is controlled by long photoperiods, some onion varieties form bulbs under day lengths as short as 12hrs and others only at longer minimum day lengths. (Magruder and Allard 1937).

The hyacinth bulb formation is unaffected by photoperiod.

3) Plant growth regulators:

Plant-growth regulators have widely overlapping functions. While each is distinctive, both in chemical characteristics and in being able to bring about characteristic growth responses, each of the five types of regulators is capable of altering most aspects of growth, including cell division, cell enlargement, differentiation, and differential growth phenomena. (Leopold et al., 1975).

The five plant growth regulators are :

a) Auxins :

They are substances which generally resemble indoleacetic acid and have the ability to stimulate elongation of coleoptiles. Auxins have the ability to inhibit the enlargement of the lateral bud in apical dominance.

b) Gibberellins : These are diterpenoids, which have the ability to stimulate the elongation of the stems of green seedlings.

c) Cytokinins : They are usually substituted adenines which resembel zeatin. They regulate cell division activities. Adenine was shown to be active in the

All Rights Reserved - Library of University of Jordan - Center of Thesis Deposit

stimulation of bud differentiation in tissue culture (Skoog and Tsui, 1948).

d) Ethylene : is a gaseous regulator which stimulates isodiametric growth in the apices of dicot seedlings.

e) Inhibitors : These are regulators of growth which ordinarily depress cell enlargement activities. (Leopold et al., 1975).

Regulators have been used to induce or enhance bulbing and tuberization including cytokinins (Asahira and Nitsch 1968), ethylene, abscisic acid (El-Antably et al., 1967), and growth retardants (Nagao and Okagami, 1966; Moser and Hess, 1968). Tawagen and Ali 1983, reported that hyacinth plants treated with cycocel at 500-1000 ppm produced significantly greater numbers of large and small bulblets, when compared to the use of indoleacetic acid or indolebutyric acid at the concentration of 100-200 ppm. They also reported that hyacinth plants treated with ethrel, produced long fibrous roots and few bulbs.

All Rights Reserved - Library of University of Jordan - Center of Thesis Deposit

MATERIALS AND METHODS

The study includes five experiments set to study the effect of different vegetative propagation methods and the effect of some growth regulators on Hyacinthus orientalis bulb production (number of bulblets produced per bulb and their weight).

Grade A prepared bulbs of the cultivar Amethyst were imported from Holland. All bulbs used had a circumference of 12 cm or more. .

The bulbs were then further divided into groups according to the treatments each group was to receive .

The vegetative bulb treatments :

a) Scooping :

Scooping was done by a small bladed knife, the entire basal plate was removed and the growing point was also scooped out.

b) Scoring:

Three straight cuts were made through the basal plate up to the growing point.

c) Divisions:

Each bulb was divided into eight equal parts, each containing a part of the basal plate and leaf scales.

All Rights Reserved - Library of University of Jordan - Center of Thesis Deposit

When scooping, scoring or divisions were made, the knife was disinfected by alchohol after each cut.

d) Hot water treatment:

The bulbs were placed in jars filled with water and placed in an incubator at 42°C for four days.

e) Twin scales:

Bulbs were divided into four parts each, then the mid-scales from each quarter were separated from the rest. Two or three scales were left attached by the basal plate. The twins were then divided into three groups and placed in plastic bags filled with peat mass. One group was placed in the green house where temperatures ranged between 20-25°C, another was placed in an incubator with temperatures ranging from 10-15°C, while the third was placed in a refrigirator with temperatures ranging for 0-5°C. The bags were pierced for air exchange, and watering was performed when needed.

Chemical bulb treatments:

a) Promaline treatments:

The concentrations were prepared by disolving 11.11 ml of promaline in two liters of water for the 100 ppm concentration, 5.55 ml in two liters of water for the

All Rights Reserved - Library of University of Jordan - Center of Thesis Deposit

50 ppm and 2.77 ml promaline in two liters of water for the 25 ppm concentration. The active ingrediant of promaline was 18%. Bulbs were placed in jars according to the concentrations and were allowed to soak for 24 hrs.

b) Daminozide treatments:

Assigned daminozide concentrations were prepared by disolving 1.176 gm of daminozide in two liters of water for the 500 ppm concentration, 0.588 gm in two liters for the 250 ppm and 0.235 gm in two liters for the 100 ppm concentration. The active ingrediant of daminozide was 85%.

c) Hot promaline treatment:

A 50 ppm promaline solution was prepared in jars of water. The bulbs were palced in the jars and the jars were divided into two groups, one was placed in an incubater at 42°C for 24 hrs, the other group was kept n the laboratory at the ambiant temperature of 20°C.

Four other groups of bulbs were separated. One was placed in jars of water at 42°C for 24 hrs, another in jars of water at 20°C, the third was kept dry at 42°C for 24 hrs and the fourth was also kept dry but at 20°C for 24 hrs.

All bulbs after being treated by any of the previous treatments were placed on trays and left to dry for a period of 48 hrs.

All Rights Reserved - Library of University of Jordan - Center of Thesis Deposit

Soil preparation:

The alocated area in the plastic house, was weeded, cleaned from stones, plant residues and leveled. Rows were prepared for planting with a distance of 30 cm between the rows.

In the green house, a high bench was filled with a mixture of garden soil, peat mass and perlite at a ratio of 2:1:1 by volume.

The same mixture was used to fill some boxes assigned for planting.

Irrigation and fertilization:

All planted bulbs were irrigated twice a week and more often as temperatures grew higher. They were fertilized twice a week by Crystalfert* at the rate of 300 ppm.

---

*Crystalfert is a fertilizer most recommended for drip irrigation systems.

It is composed of 20% total nitrogen.

20% phosphoric acid (p_2O_5).

20% potassium oxide (k_2O)

and 1.33 Zn + 0.17 T.E

It is chloride free.

All Rights Reserved - Library of University of Jordan - Center of Thesis Deposit

EXPERIMENT (1):

The objective of this experiment was to compare different vegetative propagation methods , for bulblet formation under plastic house conditions.

A randomized complete block design was used, with five treatments namely; control, scooping, scoring, divisions and the hot water treatment. Each treatment received five bulbs and was replicated four times.

All bulbs were planted on the 2nd of November 1989. The depth of planting was eight cm, and bulbs were placed fifteen cm apart within the row.

Bulblets were dug-out at the begining of June1990, when all the vegetative parts of the bulb and flower had completely dried.

Bulblets were then counted and weighed.

EXPERIMENT (2) :

The above experiment was replicated in the grean house. Each treatment received four bulbs and was replicated three times.

The bulbs were planted on the 15th of November 1989.

Bulblets were dug out at the end of June 1990 after the vegetative parts had dried completely. Bulblets were then counted and weighed.

All Rights Reserved - Library of University of Jordan - Center of Thesis Deposit

EXPERIMENT (3) :

The objective of this experiment was to compare some methods of vegetative propagation, combined with the use of growth regulators.

A three times seven factorial combination was arranged in a split design. The main plot was arranged in a randomized complete block design, with the main treatments of intact, scooping and scoring, and with sub treatments of control, daminozide 100, daminozide 250 ppm, daminozide 500 ppm, promaline 25 ppm, promaline 50 ppm, and promaline 100 ppm.

Bulbs were planted on the 13th of November 1989 at a depth of 8 cm and 15 cm between bulbs in a row and a distance of 30 cm between rows.

Bulbs and bulblets were dug out in June 1990 after all the vegetative parts had dried. Bulblets were then counted and weighed.

EXPERIMENT (4) :

In this experiment, the effect of promaline soaking at two temperatures (20°C and 42°C) on the number of bulblets formed and their weight was evaluated under plastic house conditions.

Six combination treatments were tested in this experiment which was arranged according to the RCBD as follows:

1) Dry ambient (20°C).

All Rights Reserved - Library of University of Jordan - Center of Thesis Deposit

2) Dry hot (42°C).

3) Water (O ppm promaline) ambient (20°C).

4) Water (O ppm promaline) hot (42°C).

5) Promaline (50 ppm) ambient (20°C).

6) Promaline (50 ppm) hot (42°C).

Each treatment received five bulbs and was replicated four times.

All bulbs were palnted on the 5th of November 1989 with an eight cm depth and fifteen cm space between bulbs in the row. Irrigation and fertilization were as in experiment (1).

After the green parts and flowers had dried out in June, the bulbs and bulblets were dug out, bulblets were then counted and weighed.

Due to lack of planting area in the plastic house, the some experiment was repeated with bulbs planted in boxes filled with a mixture of garden soil and peatmoss. Each box had two treatments planted in it, one at each side. Each treatment received four bulbs and was replicated four times. .

Bulbs were planted on the 22nd of November 1989. After the vegetative parts dried, the bulbs were dug-out and bulblets were counted and weighed.

All Rights Reserved - Library of University of Jordan - Center of Thesis Deposit

EXPERIMENT (5):

In this experiment the effect of twin scaling on bulblet formation was studied.

The experiment started on November 24th 1989. On the 12th of February 1990, the scales were removed from the bags, and bulblets were counted then replanted in boxes filled with peat moss and placed in the plastic house, where they received irrigation and fertilization.

Each box contained two treatments one on each side and were distributed so that there were three replicates for each treatment.

When the vegetative parts of the sprouted scales died in June, the scales were removed, placed in paper bags and the bulblets were counted and weighed.

All experiments were analyzed using the statistical analysis system (SAS) program. The analysis of variance was followed by mean separation procedure.

All Rights Reserved - Library of University of Jordan - Center of Thesis Deposit

RESULTS

Experiment (1)

Effect of some vegetative means of propagation and water treatment on the number and weight of hyacinth bulblets formed under plastic house conditions

Scooping hyacinth bulbs resulted in significantly the highest numbers of bulblets per bulb (18.0). Hot water treatment ranked second to scooping and produced (11.5) bulblets but was not significantly different from the control or scoring. The lowest number of bulblets was obtained from divisions (3.00) (Table 1), but was not significantly lower than the control or scoring.

All treatments resulted in significantly different weights of bulblets, and ranked in the following order starting with the heaviest: hot water treatment, scooping, scoring, control and divisions. (Table 1) and (Fig. 3,4)

With regard to the average size of bulblets formed, it was noted that hot water treatment resulted in the largest bulbs followed by scooping and scoring. Dividing the mother bulb into eight parts resulted in very small bulblets. (Table 1)

All Rights Reserved - Library of University of Jordan - Center of Thesis Deposit

Experiment (2)

Effect of some vegetative means of propagation and hot water treatment on the number and weight of hyacinth bulblets in the green house

Scooping hyacinth bulbs resulted in significantly the highest number of bulblets produced (10.7) compared to the control, but not significantly higher from the other treatments (Table 2). Even though the control treatment gave the least number of bulblets (5.2), it was not significantly lower than scoring divisions, or the hot water treatment .

Scooping again resulted in significantly the heaviest total weight of bulblets per blub (25.0 gm), but was not significantly larger than scoring. Divisions was significantly lower than scooping and scoring (3.4 gm) but not significantly lower than the control or the hot water treatment. (Table 2)

With regard to the average weight of bulblets formed, scooping and scoring gave the largest bulblets, where as divisions gave very small bulblets. (Table 2)

All Rights Reserved - Library of University of Jordan - Center of Thesis Deposit

Table (1) : Effect of some vegetative means of propagation and hot water treatment on the number and weight of hyacinth bulblets formed under plastic house conditions.

Treatment	Average number of bulblets/bulb	Average total wt. of bulblets/bulb (g)	Average wt. of bulblets (g)
Control	7.2 bc	9.5 d	1.3
Scooping	18.0 a	30.5 b	1.7
Scoring	7.6 bc	12.1 c	1.6
Divisions	3.0 c	0.9 e	0.3
Hot water treatment.	11.5 b	31.7 a	2.8

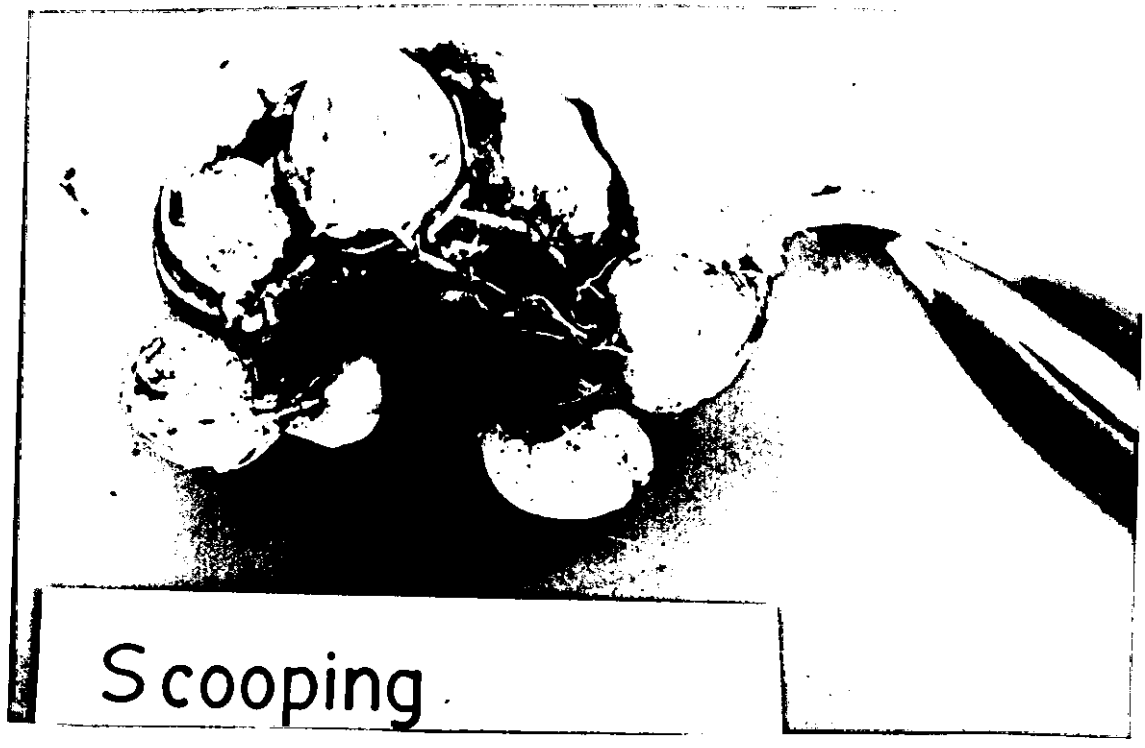
Means followed by different letters are significantly different at the 0.05 level.

Table (2) : Effect of some vegetative means of propagation and hot water treatment on the number and weight of hyacinth bulblets in the green house.

Treatment	Average number of bulblets/bulb	Average total wt. of bulblets/bulb (g)	Average wt. of bulblets (g)
Control	5.2 b	8.9 bc	1.8
Scooping	10.7 a	25.0 a	2.3
Scoring	7.8 ab	16.5 ab	2.1
Divisions	8.0 ab	3.4 c	0.4
Hot water treatment.	6.3 ab	7.6 bc	1.2

Means followed by different letters are significantly different at the 0.05 level.

All Rights Reserved - Library of University of Jordan - Center of Thesis Deposit



(3) : A scooped hyacinth bulb with several bulblets.

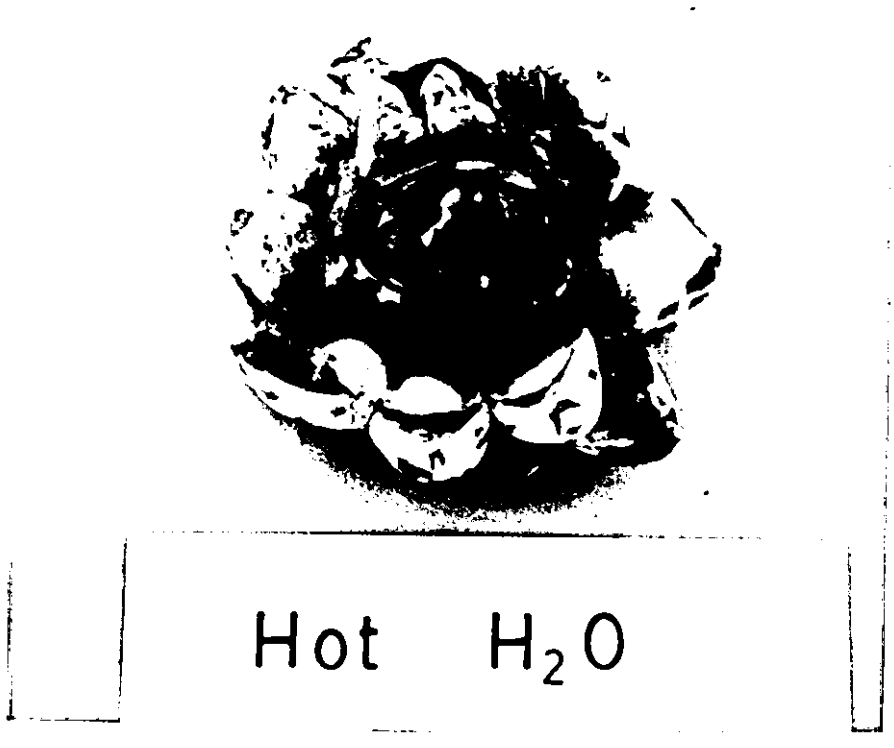


Fig. (4) A hyacinth bulb propagated by hot water treatment

All Rights Reserved - Library of University of Jordan - Center of Thesis Deposit

Experiment (3)

The effect of some vegetative means of propagation combined with the use of growth regulators on the number and weight of hyacinth bulblets

Effect of vegetative treatments : Scooping and scoring gave the highest number of bulblets per bulb (9.7) and (8.2). Intact bulbs gave significantly the lowest number of bulblets per bulb (4.9). (Table 3)

Scooping again gave the heaviest weight of bulblets (20.5 g) which was significantly larger than scoring and intact bulbs. (Table 4).

Effect of the growth regulators:

Treatment with daminozide at concentration of 100 ppm gave significantly the highest number of bulblets per bulb (9.0) when compared with promaline 50 ppm, which gave (6.1) bulblets/bulb (Table 3). Daminozide 100 ppm gave the heaviest total weight of bulblets per bulb (21.1g) Compared with all promaline treatments , but was not significantly heavier than daminozide 250 ppm, daminozide 500 ppm or the control (Table 4).

Promaline 100 ppm gave the lowest total weight of bulblets per bulb (11.0 g) but was not significantly lower than promaline 50 ppm, promaline 25 ppm or the control (Table 4).

All Rights Reserved - Library of University of Jordan - Center of Thesis Deposit

Results of the interaction :

The treatments of scooping plus dominozide 250 ppm and scoring plus promaline 25 ppm gave the highest number of bulblets/bulb (14.5) but were not significantly different from treatments of intact plus D 100, scooping plus control, scooping plus D 100, scooping plus D 500 and scoring plus P 50 ppm. (Table 3)

Intact bulbs treated with D 250 ppm gave the lowest number of bulblets/bulb (2.1), but was not significntly different from intact plus control, intact plus D 500, P 25, scooping plus P 50, intact plus P 100, scooping plus P 25, scooping plus P 50, scoring plus control, scoring plus D 100 and scoring plus P 100. (Table 3)

Scooping plus daminozide 250 ppm gave the heaviest total weight of bulblets/bulb (33.89) but was not significntly different from treatments of intact plus D 100, scooping plus control, scooping plus D 100, scooping plus D 500, scoring plus control, scoring plus D 500 and scoring plus P 50 ppm The lowest total weight of bulblets/bulb resulted from the treatment of intact bulb plus P 50 ppm (2.5g), which was not significantly lower than the treatments of intact plus control, intact plus D250, intact plus D 500, intact plus P 25, intact plus P 100, scooping plus P 25 scooping plus P 50, scooping plus P 100, scoring plus D 100, scoring plus D 250 and scoring plus P 100 ppm. (Table 4).

All Rights Reserved - Library of University of Jordan - Center of Thesis Deposit

Table (3). The effect of some vegetative means of propagation combined with the use of some growth regulators on the number of (Hyacinth) bulblets.

Treatment	Control	D100	D250	D500	P25	P50	P100	Mean
Intact	4.9 def	10.2 abcd	2.1 f	3.7 def	7.4 bedef	2.8 ef	4.2 def	4.9
Scooping	8.7 abcde	12.5 ab	14.5a	11.6 abc	4.8 def	5.6 cdef	11.0 abc	9.7
Scoring	7.0 bcdef	4.2 def	8.7 abcde	9.1 abcde	14.5 a	10.0 abc	6.0 bcdef	8.2
								$LSD_{0.05}$ =2.65
Mean	6.9	9.0	8.4	8.1	8.9	6.1	7.1	$LSD_{0.05}$ =2.2

Means followed by different letters are significantly different at the 0.05 level.

All Rights Reserved - Library of University of Jordan - Center of Thesis Deposit

Table (4): The effect of some vegetative means of propagation combined with the use of some growth regulators on the total weight of (Hyacinth) bulblets.

Treatment	Control	D100	D250	D500	P25	P50	P100	Mean
Intact	10.7 defgh	28.0 abc	5.03 gh	7.4 efgh	8.6defgh	2.5h	4.3 gh	9.8
Scooping	21.7 abcde	28.8 ab	33.89 a	27.4 abc	6.9 efgh	10.2 defgh	14.5 bcdefgh	20.5
Scoring	21.1 abcdef	6.5 fgh	16.2 bcdefgh	22.4 abcd	18.6 bcdefg	23.2 abcd	13.9 cdefgh	8.2
								$LSD_{0.05} = 8.06$
Mean	17.8	21.1	19.0	19.07	11.4	12.0	11.0	$LSD_{0.05} = 6.78$

Means followed by different letters are significantly different at the 0.05 level.

All Rights Reserved - Library of University of Jordan - Center of Thesis Deposit

Experiment (4):

The effect of promaline soaking at two temperatures (20° and 42°C) on the number and weight of hyacinth bulblets.

Even though soaking bulbs in water at 20°C resulted in the highest number of bulblets/bulb and heaviest total weight of bulblets/bulb, there were no significant differences among the treatments for both number of bulblets produced and the total weight of bulblets/bulb (Table 5). With regard to the average weight of bulblets, soaking bulbs in promaline at 42°C gave the heaviest weight of bulblets (1.8 g) (Table 5).

For those bulbs planted in boxes the following results were obtained :

Soaking bulbs in promaline at 42°C gave the highest number of bulblets/bulb (5.4) but it was not significantly different from the other treatments as all showed no significant differencess between them. (Table 6)

Soaking bulbs in water at 20°C gave the heaviest total weight of bulblets (9.9 g) but was not significantly heavier than the other treatments except for dry at 42°C which was significantly lighter than the other treatments (Table 6).

Soaking bulbs in promaline at 20°C gave the average largest weight of bulblets (4.4 g). (Table 6)

All Rights Reserved - Library of University of Jordan - Center of Thesis Deposit

Table (5) : The effect of promaline soaking at two temperatures (20 and 42°C) on the number and weight of bulblets formed in hyacinth (Hyacimthus orientalis) in the plastic house.

Treatment	Average number of bulblets/bulb	Average total wt. of bulblets/bulb (g)	Average wt. of bulblets (g)
Dry 20°C	4.9 a	6.5 a	1.3
Dry 42°C	3.7 a	6.7 a	1.8
Water 20°C	7.5 a	10.8 a	1.4
Water 42°C	10.4 a	13.8 a	1.3
Promaline 20°C	5.0 a	5.9 a	1.2
Promaline 42°C	2.7 a	4.4 a	1.6

Means followed by different letters are significantly different at the 0.05 level.

Table (6) The effect of promaline soaking at two temperatures (20 and 42°C) on the number and weight of hyacinth bulblets formed in boxes.

Treatment	Average number of bulblets/bulb	Average total wt. of bulblets/bulb (g)	Average wt. of bulblets (g)
Dry 20°C	3.7 a	7.3 a	3.6
Dry 42°C	5.4 a	8.0 a	1.5
Water 20°C	5.1 a	3.5 b	0.7
Water 42°C	5.1 a	9.9 a	1.9
Promaline 20°C	3.0 a	13.3 a	4.4
Promaline 42°C	1.7 a	6.5 a	3.8

Means followed by different letters are significantly different at the 0.05 level.

All Rights Reserved - Library of University of Jordan - Center of Thesis Deposit

Experiment (5):

The effect of twin-scaling on the number and weight of hyacinth bulblets.

Incubating hyacinth twin-scales under temperatures of 10-15°C and 20-25°C, resulted in significantly the highest number of bulblets produced per 100 twins (91.0) and (93.0) (Table 7). Incubation under 0-5°C resulted in significantly the lowest number of bulblets (0.0) (Table 7).

After transplanting the following results were obtained :

Incubation under 0-5°C gave the highest number of bulblets (186.0) but was not significantly higher than treatment of 20-25°C. The lowest number of bulblets was produced after incubation under 10-15°C and was only significantly lower from the treatment of 0-5°C (Table 7).

Incubation of scales under 0-5°C resulted in significantly the heaviest weight of bulblets 99.3 g. The least weight resulted from treatment 10-15°C (8.6 g) but was not significantly less than treatment of 20-25°C (43.6 g) (Table 7).

All Rights Reserved - Library of University of Jordan - Center of Thesis Deposit

Table (7) : The effect of twin scaling on the number of hyacinth bulblets formed before transplanting and on the number and weight of bulblets formed after transplanting.

Treatment	Average Nno. of bulblets/100 twins before transplanting	Average No. of bulblets per 100 twins after transplanting	Mean No. total wt. of bulblets per 100 twins after transplanting (g)
0-5°C	0.0 b	186.0 a	99.3 a
10-15°C	91.0 a	38.0 b	8.6 b
20-25°C	93.0 a	114.3 ab	43.6 b

Means followed by different letters are significantly different at the 0.05 level.

All Rights Reserved - Library of University of Jordan - Center of Thesis Deposit

DISCUSSION

Scooping hyacinth bulbs proved to be the best method of vegetative propagation, in that it gave the highest numbers of bulblets/bulb, and in most experiments it gave the heaviest total weight of bulblets per bulb.

Scooping and scoring, assure the complete destruction of the growing point and so both eliminate apical dominance. In scooping a large part of the basal plate is scooped out, so many scale bases are exposed, which allows the growing point to grow into bulblets, where as with scoring, not so many points have the space to grow into bulblets.

Divisions under the plastic house failed to give results as would be expected. This could have been atributed to the great exposure of scales to the unsterilized soil and so was more susceptable to decay and rot. The garden soil used in the plastic house may have been unsuitable for hyacinth bulb propagation, and so caused some of the bulbs especially the divided ones to decay and rot. On the other hand , divisions planted in the green house gave quite satisfactory results due to more suitable propagation media. Hot water treatment didn't show much advantage over most treatments, but, it acts as a safeguard over Xanthomonas hyacinthi.

Scooping combined with daminozide 250 ppm gave the highest number of

All Rights Reserved - Library of University of Jordan - Center of Thesis Deposit

bulblets/bulb and the heaviest total weight of bulblets/bulbs. The effect of daminozide comes from it being a growth inhibtor which have been reported to affect lateral bud growth through their alteration in the endogenous balance between auxins and cytokinin controling apical dominance. (Woodson and Kaiford 1986). Since the apical bud has been already removed by scooping and scoring, the growth regulator still shows to enhance bulblet formation through some mechanism other than the removal of apical dominance.

The same high number of bulblets/bulb was given by scoring combined with promaline 25 ppm.

Bud application of 6-benzylamino purine (BA) suspended in lanolin at concentrations of 1,5,25 and 50 ppm, induced shoot development in nonbranching poinsettia (Semeniuk and Greisbach 1985). Multiple spray with BA at 500-700 ppm, highly induced production of basal shoots in nonbranching dieffenbachia (Henny 1986). Application of BA+ (GA_4+GA_7) about doubled the number of lateral branching in some apple cultivars at concentrations of BA 5000 ppm+ $GA_{4,7}$ 500 ppm. (Forshey 1982).

It would be suggested to study the effect of several low promaline concentrations. Since gibberellin is a growth promoter, high concentrations of

All Rights Reserved - Library of University of Jordan - Center of Thesis Deposit

promaline may fail to induce bulbing, unless a certain high percentage of BA in the solution is provided.

Soaking bulbs in promaline at two temperatures 20°C and 42°C did not show any significant differences in number of bulblets produced or their weight when compared to the controls. The failure of promaline in exerting similar effect to those previously mentioned for similar regulators could be due to the concentration used, GA_4+GA_7 at 500 ppm was reported to be an effective concentration for branching. (Forshey, 1982). In experiment (3) intact bulbs treated with promaline at 50 ppm showed to give the lowest number of bulblets per bulb and the lowest total weight of bulblets per bulb. Another possible reason for promaline failure in exhibiting a positive effect is the method of application; bulbs were soaked in promalline for 24 hrs before planting, which may have resulted in early absorbtion and metabolism of the chemical before it started to affect the desired parts.

Wilson and Nell 1983 used BA as foliar application on welkeri dieffenbachia to induce branching, and Forshey 1982 again used foliar spraying of BA+ $GA_{4,7}$ to induce branching in apples.

Temperatures of 20-25°C are in the optimum range for bulb incubation, which was reported to be 21.1-32°C (Griffith 1930). This range was found to accelerate

All Rights Reserved - Library of University of Jordan - Center of Thesis Deposit

development of bulblets which resulted from the transfer of large amounts of substancess from the scales into the bulblets. Lower temperatures retarded the development of bulblets or at least slowed down the process. This was evident when scales were kept at temperatures lower than optimal but higher than freezing. These scales were able to produce bulblets but in significantly lower numbers and poor size, and even after transplanting the number of recovered bulblets was low.

Scales kept at very low temperatures near freezing gave no bulblets during that period, but produced the highest number of bulblets after transplanting into a suitable environment. On the other hand, those scales that didn't change their environment gave their potential of bulblet production from the start and after transplanting very little change of number occurred.

Higher number of bulblets may have been obtained for all treatments if scaling had been performed at the optimal time which was reported to be during June and September (Rees and Hanks 1980).

Twin scaling hyacinth bulbs although quite difficult to perform, because the bulb is of the tunicate type, and so scales are not easy to separate from each other, it seems to be a promising method that should be further investigated.

All Rights Reserved - Library of University of Jordan - Center of Thesis Deposit

SUMMARY AND CONCLUSION

Five experiments were conducted to evaluate some vegetative methods of Hyacinthus orientalis propagation.

Two experiments, under two locations, the plastic house and the green house, compared the treatments of control, scooping, scoring, divisions and the hot water treament.

From these, scooping gave the highest number of bulblets/bulb and under the green house conditions it gave the heaviest total weight of bulblets/bulb. Divisions in the green house gave very high numbers of bulblets but were not significantly different from those produced by scooping.

A third experiment was conducted in the plastic house, where scooped, scored and intact bulbs were treated separatly with daminozide (100, 250, 500 ppm) and promaline (25, 50, 100 ppm). Scooping combined with daminozide 250 ppm, gave the highest number of bulblets/bulb and the heaviest total weight of bulblets/bulb. Combining scoring with promaline 25 ppm gave the same amount of bulblets/bulb, but the heaviest total weight was obtained when promaline 50 ppm was used, although no significant differences occurred between the two combinations.

Soaking hyacinth bulbs in promaline 50 ppm at two temperatures of 20 and

All Rights Reserved - Library of University of Jordan - Center of Thesis Deposit

40°C didn't show any superiority over the control treatments.

Twin scaling was also performed and those scales which received incubation temperatures of 0-5°C then were transplanted into the plastic house where temperatures were around 20-25°C, gave the highest number of bulblets and significantly the heaviest total weight of bulblets.

Of the vegatative methods studied scooping prooved to be the best one. Twin scaling may be a rewaring technique, so further studies on temperatures and duration of incubation are necessary.

The growth regulators seem to have a positive role in inducing bulblet production, but should be further investigated in terms of concentration and method of application.

All Rights Reserved - Library of University of Jordan - Center of Thesis Deposit

الملخص العربي

دراسات حول انتاج ابصال الهياسنث

في هذه الدراسة تم اجراء خمس تجارب لتقييم بعض طرق الإكثار الخضرية لأبصال الهياسنث Hyacinthus Orientalis .

اجريت تجربتان في موقعين منفصلين ، البيت الزجاجي والبيت البلاستيكي لمقارنة المعاملات التالية : Scooping, Scoring ، التقسيم divisios، معاملة الماء الحار hot water treatment اضافة الى الشاهد Control .

اعطت طريقة Scooping في التجربتين اعلى انتاج بصيلات للبصلة وتحت ظروف البيت الزجاجي اعطت طريقة الإكثار بالتقسيم في البيت الزجاجي اعداداً كبيرة من البصيلات إلا انه لم تظهر فروقات معنوية بينها وبين تلك المنتجة عن طريق Scooping.

أجريت تجربة ثالثة في البيت البلاستيكي حيث عوملت ابصال صحيحة واخرى محضرة بطريقتي Scooping و Scoring بمنظما نمو كل على حدى :

أ- داميتوزايد Daminozaide بتراكيز ١٠٠ ، ٢٥٠ ، ٥٠٠ جزء في المليون .

ب- برومالين Promaline بتراكيز ٢٥ ، ٥٠ ، ١٠٠ جزء في المليون .

وقد ظهرت تأثيرات معنوية للمعاملتين الخضرية والكيميائية ، حيث اعطت الأبصال المعاملة بطريق Scooping اضافة الى معاملتها بداميتوزايد ٢٥٠ جزء في المليون أعلى انتاج من البصيلات للبصلة واكبر وزن كلي للبصيلات للبصلة الواحدة . دمج معاملة Scoring مع البرومالين ٢٥ جزء في المليون اعطى اعداداً مماثلة من البصيلات البصلة إلاّ ان أكبر وزن كلي للبصيلات للبصلة نتج عن دمج معاملة Scoring بالبرومالين ٥٠ جزء من المليون .

نقع ابصال الهياسنث في محلول البرومالين بتركيز ٥٠ جزء في المليون على درجتي حرارة ٢٠ و ٤٠ درجة مئوية لم يعطى اي تفوق على الشواهد .

في تجربة خامسة تم تقسيم الأبصال بطريقة الحراشف المزدوجة Twin Scaling وبعد

All Rights Reserved - Library of University of Jordan - Center of Thesis Deposit

فصلها في ثلاث مجموعات حضنت على حرارة صفر-٥م٢ ، ١٠-١٥م٢ و ٢٠-٢٥مْ ، ثم نقلت الى البيت البلاستيكي .

تحضين الحراشف المزدوجة على درجة حرارة صفر-٥م٢ اعطى اعلى عدد وأعلى وزن كلي معنوي للبصيلات الناتجا .

من الطرق الخضرية التي تم دراستها اظهرت طريقة Scooping تفوقاً ملحوظاً كما ان طريقة التقسيم Twin Scaling يمكن ان تكون واعدة ولكنها بحاجة الى المزيد من الدراسة خاصة حول مدة الحضانة ودرجة الحرارة المناسبة .

تبين ان لمنظمات النمو دوراً حافزاً في انتاج البصيلات يدعو لمزيد من البحث حول التراكيز المستعملة وطريقة الإضافة .

All Rights Reserved - Library of University of Jordan - Center of Thesis Deposit

REFERENCES

1- Asahira and Nitch.1968. Tuber and Bulb Formation. Cited in Leopold, A. and P. Kriedemann. Second edittion. Plant Growth and development. McGraw-Hill Book Company. 1975. p 339.

2- Amono, M. and K. Tsutsui. 1981. Bull. Tonami Hort. Branch Sta. 16:21-30.

3- El-Antably et al., 1967. Tuber and Bulb Formation. Cited in Leopold, A. and P. Kriedemann. Second edittion. Plant Growth and development. McGraw-Hill Book Company. 1975. p. 339.

4- Esashi, 1960. Tuber and Bulb Formation. Cited in Leopold, A. and P. Kriedemann. Second edittion. Plant Growth and development. McGraw-Hill Book Company. 1975. p. 341.

5- Forshey, C.G. 1982. J. Amer. Soc. Hort. Sci. 107 (4): 538-541.

6- Genders, R. 1973. Bulbs . R. Hale and company, London.

7- Griffiths, D. 1930. Circular No. 102. U.S. Department of Agriculture. Washington, D.C.

8- Hanks, G. and A. Rees. 1977. Scientia Horticulturae, 6:237-240.

9- Hanks, G. and Rees. 1978. Scientia Horticulturae, 9 : 399-411.

10- Hartmann, H. and D. Kester 1983. Fourth edittion Plant. Propagation. Prentice

All Rights Reserved - Library of University of Jordan - Center of Thesis Deposit

/Hall International, Inc.

11- Henny, R. 1985. HortScience: 20(1) :115-116.

12- Leopold, A. and P. Kriedemann. 1975. Second edition . McGraw-Hill Company. pp. 107-108. and p. 183.

13- Krause, J. 1980. Acta Horticulturae 109:271-274.

14- Magruder and Allerd 1937. Tuber and Bulb Formation. Cited in Leopold, A. and P. Kriedemann. Second edittion. Plant Growth and development. McGraw-Hill Book Company. 1975. p. 340 .

15- Moser and Hess, 1968. Tuber and Bulb Formation. Cited in Leopold, A. and P. Kriedemann. Second edittion. Plant Growth and development. McGraw-Hill Book Company. 1975. p. 339.

16- Nagao and Okagami. 1966.Tuber and Bulb Formation. Cited in Leopold, A. and P. Kriedemann. Second edittion. Plant Growth and development. McGraw-Hill Book Company. 1975. p. 339.

17- Rees, A. and R. Hanks. 1980. Acta Horticulturae 109: 211-216.

18- Semeniuk, P. and R. Griesbach. 1985. HortScience 20 (1) 120-121.

19- Skoog and Tsui. 1948. Cytokinins. Cited in Leopold, A. and P. Kriedemann. Second edittion. Plant Growth and development. McGraw-Hill Book Company. 1975. p.157

All Rights Reserved - Library of University of Jordan - Center of Thesis Deposit

20- Tawagen, A. and E. Ali, 1983. Zanco, Series. A. 8 (1) : 47-56.

21- Werner. 1935. Tuber and Bulb Formation. Cited in Leopold, A. and P. Kriedemann. Second edition. Plant Growth and development. McGraw-Hill Book Company. 1975. p. 340

22- Woodson, W. and T. Raiford, 1986. Hort Science 21 (1):71-73.

All Rights Reserved - Library of University of Jordan - Center of Thesis Deposit

APPENDIX

Table (1): Analysis of variance for the number of bulblets produced per bulb and their total weight, from vegetative means of hyacinth propagation in the plastic house.

Source of variation	DF	Mean Square: No. of bulblets/ bulb	Mean Square: Total weight of bulblets/bulb
Total	16	28.25	144.29
Treatment	4	90.97*	511.96*
Block	3	1.41	86.44*
Error	9	9.32	0.17

* Significant at 5% level .

Table (2): Analysis of variance for the number of bulblets produced per bulb and their total weight, from vegetative means of hyacinth propagation in the green house.

Source of variation	DF	Mean Square: No. of bulblets/ bulb	Mean Square: Total weight of bulblets/bulb
Total	13	12.51	75.98
Treatment	4	12.95*	196.04*
Block	2	35.19*	20.01*
Error	7	5.78	23.38

* Significant at 5% level .

All Rights Reserved - Library of University of Jordan - Center of Thesis Deposit

Table (3): Analysis of variance for the number of bulblets and their total weight, produced from hyacinth bulbs treated with vegetative means of propagation combined with growth regulators.

Source of variation	DF	Mean Square	
		No. of bulblets/ bulb	Total weight of bulblets/bulb
Total	64	24.86	145.96
block	3	34.19*	86.00
Main treatment	2	145.79*	86.70*
Error A	6	12.39	114.29
Sub treatment	6	15.83*	258.10*
Main X sub	12	39.97*	209.54*
Error B	35	15.66	74.27

* Significant at 5% level .

Table (4): Analysis of variance for the number of bulblets produced per bulb and their total weight, from soaking hyacinth bulbs in promaline at two temperatures in the plastic house.

Source of variation	DF	Mean Square	
		No. of bulblets/ bulb	Total weight of bulblets/bulb
Total	21	28.95	69.88
Treatment	5	31.56*	49.87
Block	3	12.06	27.90
Error	13	31.85	87.27

* Significant at 5% level .

392097

All Rights Reserved - Library of University of Jordan - Center of Thesis Deposit

Table (5): Analysis of variance for the number of bulblets produced per bulb and their total weight, from soaking hyacinth bulbs in promaline at two temperatures in boxes.

Source of variation	DF	Mean Square No. of bulblets/ bulb	Total weight of bulblets/bulb
Total	16	6.64	23.69
Treatment	5	5.09	26.60*
Block	3	7.53	41.85*
Error	8	7.27	15.06

* Significant at 5% level .

Table (6): Analysis of variance for the number of bulblets produced befor transplanting and their total weight, after transplanting in twin scales of hyacinth.

Source of variation	DF	Mean Square No. of bulblets/ bulb before transplanting	No. of bulblets/ bulb after transplanting	Total weight of bulblets/bulb after transplantin
Total	8	46.03	116.94	37.73
Treatment	2	164.78**	320.44*	122.48**
Block	2	78.00	78.77*	14.72
Error	4	9.27	34.28	6.85

*,** Significant at 5% level and 1% level respectively .

All Rights Reserved - Library of University of Jordan - Center of Thesis Deposit