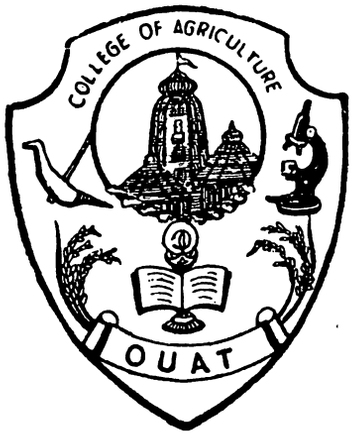
STUDIES ON TWO CLONAL POPULATIONS OF SPINE GOURD (*Momordica dioica*, Roxb.) WITH SEX LINKED CHARACTERS OF LEAF TYPES AND BREAKING DORMANCY IN THEIR ROOT TUBERS

A THESIS SUBMITTED TO
THE ORISSA UNIVERSITY OF AGRICULTURE AND TECHNOLOGY, BHUBANESWAR
IN PARTIAL FULFILMENT OF THE REQUIREMENTS
FOR THE DEGREE OF

MASTER OF SCIENCE IN AGRICULTURE
(HORTICULTURE)

By
Urmila Mohapatra



Department of Horticulture
COLLEGE OF AGRICULTURE
Orissa University of Agriculture and Technology
BHUBANESWAR
1992

THESIS ADVISOR : G. C. DAS

Dedicated to
my
Beloved Parents

Prof. G.C.Das, M.Sc.(Ag.)(Calcutta)
M.S.(Missouri)
Ex-Professor, Department of Horticulture
Orissa University of Agriculture & Technology
Bhubaneswar

Bhubaneswar
Dated, the 22nd June, 1993

CERTIFICATE-I

Certified that the thesis entitled **"Studies on two clonal populations of Spine gourd (Momordica dioica, Roxb.) with sex linked characters of leaf types and breaking dormancy in their root tubers"** submitted in partial fulfilment of the requirement for the award of the degree of **MASTER OF SCIENCE IN AGRICULTURE (HORTICULTURE)** of Orissa University of Agriculture and Technology, Bhubaneswar, is a faithful record of bona fide research work carried out by **Urmila Mohapatra** under my guidance and supervision. No part of the thesis has been submitted for any other degree or diploma or published in any other form.

The assistance and help received during the course of investigation have been duly acknowledged.

(G. C. DAS)

CERTIFICATE-II

This is to certify that this thesis entitled **"Studies on two clonal populations of Spine gourd (Momordica dioica, Roxb.) with sex linked characters of leaf types and breaking dormancy in their root tubers"** submitted by **Urmila Mohapatra** to the Orissa University of Agriculture and Technology, Bhubaneswar in partial fulfilment of the requirement for the award of the Degree of **MASTER OF SCIENCE (HORTICULTURE)** in the subject of Horticulture has been approved by the Students' advisory committee after an oral examination on the same in collaboration with an External Examiner.

Advisory Committee

CHAIRMAN

Ex- **Prof. G.C.Das**
Department of Horticulture

MEMBERS

1. **Mr. T.Maharana**
Head, Department of Horticulture

2. **Dr. B.N.Samolo** 21/7/93
Head, Dept. of Plant Breeding & Genetics

EXTERNAL EXAMINER 21/7/93

ACKNOWLEDGEMENT

I deem it a unique opportunity and proud privelege to express my profound sense of gratitude and indebtedness to Ex-Prof. Gopal Chandra Das, M.Sc.(Ag.) (calcutta), M.S. (Missouri), Department of Horticulture, College of Agriculture, O.U.A.T., Bhubaneswar for suggesting the problem, scholastic guidance, constant supervision, sustained interest, constructive criticism and ceaseless encouragement throughout the period of my investigation and preparation of this manuscript.

I express my deep sense of indebtedness to Sri T.Maharana, head, Department of Horticulture for his timely suggestion and the facilities provided during the period of my experiment.

My sincere gratification to Dr.B.N.Samolo, Prof. and Head, Department of Plant Breeding and Genetics for suggestions and encouragement, as member of my Advisory Committee.

I express my heartful gratitude to Dr. R.S.Mishra, Dr. J.M.Panda, Sri B.Nayak and Dr. C.R.Mohanty from whom I received ever willing help. I am highly indebted to Dr. D.K.Dora, Dr. B.K.Das, Dr. J.N.Das, Dr. S.Rath, Sri P.C.Lenka, Sri P.Mohapatra and Sri P.K.Acharyya.

It is my privilege to express my geatfulness to Dr. P.Sahoo, Department of Seed Technology, Dr. B.K.Ghosh, Department of Plant Physiology, Dr. N.K.Dhal, Department of Plant Pathology for rendering the help as and when required.

I can not forget the help and encouragement of Sashi Appa, Mira Appa and Jagdev Bhai during my research work. I am thankful to the staff members of our Department for their timely help and co-operation during my investigations.

I am greatly indebted to my friends Pradyumna, Tusar, Dillip, Balaji, Pun, Sudhir, Biswajit, Jayan for their encouragement and criticism. It has a great worth to express my gratitude to Basu Babu, Bhaskar Babu, Ghosal Babu, Swain Babu, Babaji Babu, Dharani Babu and Bana Babu for their cordial support, co-operation and help during my post-graduate studies.

Words run short to express my profound feeling and love to my room mates Mamata and Mriduladidi for their moral support, in exhaustable help during my post graduate studies and preparation of this volume.

I feel it pleasure to extend my sincere thanks to all my friends Linu, Babita, Kabita, Smita, Rabeya, Kakali, Alaka, Sudhadi, Pramila, Indira. My heartythanks to my juniors Padmaja, Pravati, Sunita, Durga, Preeti, Smita, Suchana, Saira, Saswati, Annapurna, Srita, Bhanu and Jolly.

I am thankful to Miss Sabita Jena for taking special interest and care for typing this dissertation.

I have indeed no word to express my heartfelt love and affection to the youngesters Rabi, Sarat, Dillip, Babi, Suka, Bhanu, Renu, Abira, Muna, Tuna, raja, Mena, Sona, Tulasi, Geeta, Bharat, Popu, Lucy, Meena and Annu.

I feel dearth of words to express my heartfelt gratitude to my parents for their eternal love, blessing, supreme sacrifice for the successful completion of this endeavour. I am specially grateful to my Teacher (Mr. Pitambar Mohanty) for his affection, inspiration and moral support during entire period of my study.

Lastly but not least with heartful devotion, I bow down my head before the **"Lord Jagannatha"** whose blessing contributed solely to reach this point. I still pray **His** blessing to proceed on the way of life.

Urmila Mohapatra.
(**Urmila Mohapatra**)

Bhubaneswar,
Dated the 22nd June, 1993

STUDIES ON TWO CLONAL POLULATIONS OF SPINE GOURD (Momordica dioica, Roxb.) WITH SEX LINKED CHARACTERS OF LEAF TYPES AND BREAKING DORMANCY IN THEIR ROOT TUBERS

ABSTRACT

Student - Urmila Mohapatra **Chairman** - Professor G.C.Das

The present investigation entitled as "Studies on two clonal populations of Spine gourd (Momordica dioica, Roxb.) with sex linked characters of leaf types and breaking dormancy in their root tubers" reveals that the character of lobed and non-lobed leaf as criteria for sex identification has been quite effective and the selected male and the female plant no the basis of non-lobed and lobed leaf character respectively have proven to produce clonal populations rapidly and in large number to take up plantation even as early as 1st July. The plant so derived are quite uniform, produced a good vegetative growth and abundant flowering and fruiting, the later planting on 16th July though not as productive as the 1st July yet the fruiting season in this case continue beyond November whereas with 1st July planting the fruiting was over by 15th November. The selected male as a pollenizer was quite compatible with female so that the females were highly fruitful besides the male did not impart any bad taste of bitterness in fruits as metaxenia effect which usually happens in cucurbits due to a bad pollen source. Well developed root tubers was also produced in the same season of planting raised from cuttings. To achieve early planting in the season from the stem cuttings obtained from the root tubers, it is essential to break the dormancy early in the root tubers for which chemicals like gibberellic acid, Kinetin, Thiourea, Potassium nitrate were tried in different concentrations. It was found that thiourea in the concentration of 1.0, 0.5 and 1.5 per cent proved the best effect in breaking the dormancy and the next best treatment was GA (50 ppm) and potassium nitrate (0.5%) concentration. Use of the characters of the shape of root tubers and presence of ring in their surface as sex linked character as reported by earlier workers could not be confirmed. The nature of twining of tendrils is a sex linked character also could not be established.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PHOTOGRAPHES

CHAPTER-I

INTRODUCTION

INTRODUCTION

The fruits of spine gourd (*Momordica dioica,* Roxb.) is a delicious vegetable, very much liked by the people of eastern India, especially Orissa, for which it commands a high price in the market. Though earlier it was not cultivated and usually gathered from forest, growing wild,but in recent years it is getting domesticated since there is a large scale denudation of forests, the population of spine gourd growing in wild habitat is declining very fast. So cultivation of spine gourd is bound to grow steadfastly by the farmers as the demand for the vegetable is very high and it fetches a lucrative price.

The difficulties in domestication of this vegetable are primarily due to (i) its dioecious nature needing a pollinizer for fruit set in female plants, (ii) requirements of maintaining proper ratio of male to female plants in the plantation for high productivity and (iii) synchronization of flowering and fruiting in the male and the female plants respectively for prolongation of fruiting season.

The crop is usually propagated through root tubers. The aerial part of the plant come to an end of their life

cycle with the onset of winter and by then the underground root tubers formed remain in rest till the next summer when they sprout after receiving the premonsoon showers. There is a inherent difficulty to identify either these root tubers or the young sprouted plants as to their sex, so that in the new plantations a proper ratio of male and female populations could be maintained as to their requirements to ensure high productivity in the plantations. Thus identification of sex-linked characters to ascertain male and female plants either at the tuber stage or at the sprouting stage of the tuber is very much essential for the profitable cultivation of this crop.

So far very little work has been done to identify sex at the preplanting stage of root tubers. Study of sex linked characters to differentiate between male and female plant is, therefore, highly essential as such work in this direction is very much a pressing need of the hour. The identification of sex from the characteristics of root tubers has been attempted earlier by Maharana and Maharana (1983) of this Department and they had found that male and female tubers vary in their shape and in the presence and absence of circular rings on the surface of tubers. Since their findings are not conclusive, root characters for identification of sex may not be a full proof one, thus relying on that basis of information plantations can not be raised. On the other hand the variation in leaf characters observed in wild populations of spine gourd have revealed quite interesting features of contrasting leaf shapes occuring in nature in the male and the female plants, irrespective

of their sex. As per leaf shape characters, there are 3 types of leaves usually appear in the population (i) leaf without lobes, (ii) leaf having 3 lobes and (iii) leaf having 5 lobes.

In the department one female plant selected earlier and it is being maintained which has 5 lobed leaves. In the present experiment a male plant has been identified which has all its leaves as entire without any lobing. So plants with two distinct leaf characters has been identified, one with lobed leaf to serve as female plant and the other with entire leaf to serve as the male plant. The cuttings taken from these two plants will provide experimental materials to study their performance as regards to growth flowering compatibility, fruiting and productivity when they are grown together.

Besides the sex problem, there is also another disadvantage of this crop is that for its propagation, root tubers utilized only, so availability of such root tubers now a day for large scale planting is becoming difficult owing to their depletion on account of the rapid denudation of forests. Further it has been reported by Das (1969) that usually males come to flower earlier and the duration of flowering period is also shorter then the females when they are propagated through root tubers, thus limiting their fruiting season because of non-synchronization of the flowering period of males with females.

To circumvent the above circumstances an alternative and quick method of regeneration of plants through cuttings have been developed by Tripathy and Maharana (1990) the department to substitute root tubers by cuttings as planting materials for large scale plantings. Although for generation of cuttings the vegetative growth from root tubers are to be used as the primary sources since one to two node cuttings are sufficient to root. So quite a large number of cuttings can be had from the vegetative growth of a root tuber in the season of planting. It is also evident that the population derived by cutting are uniform in growth and besides being earlier in flowering and fruiting compared to root tuber plants. However, the cutting population since to be raised from the vegetative growth of the root tubers, therefore, they are supposed to be planted late in the season as compared to the mother plant. So whether they can be even comparable as regards to their yield and production with that of the root tubers is the moot question for which this experiment has become necessary. Besides, another important aspect for which information required is that to know if there is any difference between the batches of cutting taken at interval as regards to their performance in growth, flowering, fruiting and the duration of the fruiting season.

Again it is a matter of common observation that the root tubers remain dormant till the onset of monsoon rain when they sprout. If the dormancy period could be shortened

then the root tubers might sprout earlier and yield the crop early. So if such early sprouted tubers are used for taking cuttings, these cuttings in turn, would become ready for planting in the field earlier affording a better scope for early flowering, fruiting and prolonged fruiting period resulting in higher productivity. It was thus realised to study if early breaking of dormancy in root tubers by application of growth regulators may become possible as it has happened in the case of breaking dormancy in potato tubers.

With the above objectives in vew the present investigation entitled as "Studies on two clonal populations of spine gourd *Momordica dioica*, Roxb. with sex linked characters of leaf types and breaking dormancy in their root tubers" is initiated to find out -

(1) the constancy in characters, uniformity in growth, flowering and fruiting in the clonal populations of cuttings derived from plants differing in sex linked characters of leaf types,

(2) synchronization of flowering time and duration and prolongation of the flowering and fruiting season,

(3) compatibility of male as a pollenizer, pollen production, visibility of pollens, ability to set fruits for higher productivity and lack of bitterness in fruits of females from the pollination factor of the pollenizer male,

(4) the performance of clonal population generated at different dates with regard to the effect on flowering, period of fruiting and yield, and

(5) the effect of some growth regulators on early breaking of dormancy in root tubers.

CHAPTER-II

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Spine gourd (*Momordica dioica*, Roxb.) though used as a vegetable for centuries yet it has not attained the status of a regular crop since so far the fruits for vegetable are used to be gathered from the scrubby jungles where the plants are found growing wild and yielding abundant fruits in the rainy season due to the availability of a very favourable environment of high humidity and high rainfall along with warm growing conditions prevailing during the period. Besides, the humus rich soils of forests and supporting scrubs for unlimited trailing of the vines provide the right niche for luxuriant vegetative growth and fruit-fulness of the plant and also for prolific tuberization of its roots to tide over the unfavourable low temperature winter and moistureless dry conditions of summer when the tubers alone without the aerial parts thrive for the next season in dormant condition to perpetuate the species (Das, 1969). Though as a vegetable it is very popular among the people yet the plant remained wild for long and now only with the depletion of forests and dwindling of its population and for rising demand of this vegetable in the markets a considerable interest has been

shown to domesticate this plant. Thus in recent years research work on the cultural needs, propagation techniques and provision of pollenizers for fruitset etc. are being carried out, also attempts have been made to standardize the cultivation aspects of this plant to bring it to a crop status.

Therefore as expected there is very little research work done in this plant earlier except other than its botany of taxonomy and systematic description gives by the earlier Botanists in describing this wild plant in the flora of different countries, regions and states where is occured.

In the Botany of Bihar and Orissa H.H. Haines (1961) has observed that the species is widely distributed in the state and placed it under the tribe cucurmerineae of the family cucurbitaceae for its ovule being horizontal, leaves not compound and female flowers usually solitary. In describing the species he has mentioned that the plant as slender, nearly glabrous climber with foetid smell, angular stem, deeply cordate simple or 3 lobed often sinuately denticulate, ovate leaves 2-4.5" and solitary axillary yellow dioecious flowers with petals 0.7 - 1" long.

Staminate : on slender peduncles 2-6" easily recognised by the persistent spathaceous deeply concave orbicular bracts wrapping around the buds and enclosing the flowers.

Pistillate : Peduncles usually somewhat shorter or as long as male with a small bract some where near the middle ovary

densely hirsute-fimbriate, the fimbriate in fruit bearing soft fleshy spines which are lanceolate or ovate when dried.

Habitat: Common in hedges throughout the province and apparently wild. Flowers: August-September. Fruits: September-October, 1-3" ellipsoid acute or ovoid. Seeds: 0.4-0.45" more or less compressed, ellipsoid, darkgrey, nearly smooth or corrugate margins.

Several other authors have also included this species in their description and Taxonomic positions in Momordica. Duthie (1960) classified all species under Momordica & described the species *Momordica dicica* systematically. Systematic description of the species have also been recorded by Hooker (1979) in the "Flora of British India" and Chakravarty (1959) in recent Botanical Survey of India.

In addition the plant having medicinal uses has been described systematically by Kirtikar and Basu (1918) in their book of "Indian Medicinal plants" and they mentioned that the plant is widely distributed in India, Cylone, Burma, Malayeisia. For its economic use and importance the species has been described in the wealth of India under Raw Materials (1962) in which it has been mentioned that the species has wide occurrence throughout India and Cylone upto an elevation of 1500 meters above the mean sea level. The text of that description is mainly includes nutritive value of its fruits and the medicinal properties of the plant and its parts.

2.1 PROPAGATION

Oridinarily the spine gourd is propagated through root tubers. The tuberous roots become dormant by the time the aerial parts of the plant die with the onset of winter in Orissa and in that condition it continues to stay till April-May when receiving the premonsoon rain it sprouts and start the vegetaive growth. Das (1969) studied its growth & tuberigation and Sahoo & Maharana (1984) studied the dormancy in the species of Momordica including dioica and in dioica the dormancy of the tuber was found to remain as such for 74 days.

The species dwindling very fast as the forest getting denuded and with that the availability of root tubers is declining. So alternative method of propagation by stem cutting from the vegetative growth of selected root tubers has been attempted by Das, Lenka and Mohapatra (1979) and they found 98 per cent success when tried during rainy season. Sahoo and Maharana (1984) observed 23, 50 and 73.5 per cent of rooting in stem cuttings of *Momodica charantia* *M. dioica* and *M. cochinchinensis* respectively and they have also observed that the percentage of rootings is highest in terminal cuttings. Tripathy and Maharana (1990) have revealed that percentage of rooting is higher in terminal cuttings (90.85%) than the basal cuttings 82.29%. As explained by theory the factors that contribute better rooting in terminal cutting are

(i) avilability of more root promoting substances in terminal leaves, buds etc. and (ii) terminal tissues are less differentiated, so more cells are available for becoming meristematic for root initiation. They also reported that IBA 100 per cent treated cuttings have higher rootings (90.78%) compared to control (81.14%). Ali et al. (1991) also successfully propagated the vine cuttings of spine gourd with and without application of rooting hormones.

2.2 FLORAL BIOLOGY

Pattanaik and Pattanaik (1976) have reported that flowering status in *Momordica dioica*, Roxb. developed from root tubers at node 9-28 on primary stem, node 1-13 on secondary branches and node one onwards on tertiary branches. The last week of August and first week of September are the peak flowering period of male and female plants respectively. The period from planting to flowering is 39 days for female and 43 days for male plants and period of bud initiation to flowering being 13 days in pistillate flowers. The duration of bud break to full opening is 36 minutes. Anthesis occured between 6.30 pm. and 8-9 pm. Sahoo and Maharana (1984) also working with plants developed from stem cuttings have reported that the male flowers appeared in a range of 42-70 cm height where as female flowers produced at a height of 45-90 cm in *Momordica dioica*. Development of male flowers has taken 17-21 days where as in female flowers, it has been 14-18

days. They also have reported the time taken for full opening of the flower, 18-20 minutes in male and 7-10 minutes in the female.

2.3 POLLEN GERMINATION AND STORAGE

Sahoo and Maharana (1984) have studied that the pollen grains remain viable for a period of 6 hours after anthesis after which the viability is gradually lost and finally become totally non-viable after 24 hours of storage in *M. dioica* under room temperature. Dubey and Gaur (1989) have also studied the pollen germination and storage in *M. dioica*. Separate solutions of sucrose and glucose each at a concertration of 0,15,20,25,30,35,40 and 45 per cent have been employed. Boric acid solutions in distilled water 0,1,2,3,4,5,6 and 7 ppm have also been used separately as germination media. With sucrose and glucose solutions a concentration of 15 per cent has produced heighest germination levels of 38.2 and 33.3 per cent respectively and longest pollen tube lengths 85.7 and 53.4 µm respectively. A 3 ppm boric acid solution produced the highest germination percentage of 33.1 and the longest pollen tube length 58.5 µm. Pollen storage at 0% relative lumidity resulted in a loss of viability after 84 hours at room temperature (31° C) but viability has been maintained upto 45 days at 3° C.

2.4 SEX AND SEX LINKED CHARACTER

Spine gourd being a dioecious plant, male and female plants occur in nature and male plants provide necessary

pollens as pollenisers to set the fruits in female.

(a) Root characters: Since the planting material is the root tuber, to indentify sex at the time of planting to maintain the proper sex ratio in the plantation, efforts has been made to utilise the morphological characters of root tubers, if any, linked with sex to identify and distinguish the male from the female. Maharana and Maharana (1983) have studied the root characters of male and female tubers and have considered tuber shape and presence of circular rings on the surface of tubers as identifying characters for distinguishing male from the female. According to them the tubers of female plants are mostly round or globular in shape with few small rudimentary side tubers and these tubers bear circular rings around thier surface. In contrast in the male plant tuber no such circular ring is generally found and tubers are mostly elongated in shape without the develipment of the side tubers.

(b) Leaf character: Das (1969) while surveying the wild populations of spine gourd around Bhubaneswar have come across with plants having different types of leaves irrespective of their sex. The leaf type may be broadly divided into two categories such as (i) leaf broadly ovate without lobes, and (ii) leaf palmately lobed with 3-5 lobes. Such lobing and non lobing character of leaves may be useful in distinguishing the male from the female. So by selecting the male with nonlobing character of leaf & the female with palmetely lobed

leaf or vice-versa, the population raised from such selection may not have any difficulty for identifying their sex in future plantations by maintaining these two lines.

2.5 SEX RATIO

Ordinarily the seed population of *Momordica dioica* has the distribution of male and female in a ratio of 1:1 occuring in nature. In plantations of *Momordica cochinchinensis*, 5 to 10 per cent of males has been recommended for adequate pollination by Sadhu & Chakrabarty (1980). But in cultivators field where root tubers were planted so far no work has been done to establish what should be the proper ratio between the male and the female so that there is no difficulty in obtaining satisfactory fruit set in the plantation.

2.6 FRUIT AND SEED CHARACTERS

Maharana and Maharana (1983) have reported that the averagenumber of seeds per fruit in *Momordica dioica* varies from 10.3 to 40.4. Sahoo and Maharana (1984) have also observed that the average number of seeds per fruit, vitamin C content (in mg per 100 gm of edible part) and dry matter content (in %) of fruits to be 18.5, 112.6 and 14.8 respectively. They have also indicated that individual seed weight (g), seed coat and cotyledron weight (%) are found to be 0.104, 45.2 and 58.4 respectively. They have also found that the seed to fruit ratio is 1:2.8.

2.7 DORMANCY AND BREAKING DORMANCY IN ROOT TUBERS

Generally root tubers go to dormancy by the time the rainy season comes to a close and winter sets in when the aerial parts of the plant die because of low temperature the tubers remain dormant underground till April to May when they break after receiving the premonsoon showers. Sahoo and Maharana (1984) have studied the dormancy in root tubers and have found that the tubers of the spine gourd remain dormant for a period of 71 to 75 days before breaking their dormancy however, as per Ali et al. (1991) they have not found any dormancy in this species under their conditions. The work of Das (1969) however, indicates that there is a possibility of avoiding dormancy in the root tubers if before the onset of winter when the aerial parts of plant are still alive, the mainstem is cut above the ground level keeping 3 to 5 nodes for producing new growth from the axils of their nodes so that the vegetative phase continues again afresh during winter.

Breaking dormancy in the root tubers of spine gourd earlier in the season is highly desirable so that the vegetative growth may start by April or even earlier so that the first fruits might be harvested before the end of May. The work of breaking dormancy in spine gourd has not been reported from anywhere but all the same there are a lot of work for breaking dormancy in other tuber bearing crops since long

as specially so in potato. In potato first work has been reported by Denny (1926) who has been able to break dormancy for the first time in potato by using several chemicals in his laboratory. He could found that the dormant potato tubers sprout freely, when exposed to ethylene chlorohydrin vapour and to the treatment of chemicals like sodium and Potassium thocyanate, thiourea, dichloroethylene, carbon disulphide xylol ethyl bromide and a number of inorganic compounds like potassium permanganet and potassium nitrate which have also been found effective. Vapours of ethylene-chloro-hydrin so hastened the growth of sprouts of 1 cm in diameter grew from the treated tubers of Irish Cobbler variety of potato, before the sprouts of the untreated tubers appeared above the surface of the ground. Solutions of sodium and potassium thiocyanate have also given almost equal striking results. Thiourea solutions has differed somewhat from the other compounds used in that, they have been found to overcome the inhibiting effect of the terminal bud upon the growth of lateral buds and used to cause the development of several shoots from each eye on the tuber. Denny (1945) also observed that combinations of two or three chemicals instead of one could produce the effect on breaking the dormancy of potato tuber many fold better than any single treatment. Such synergistic effects has been noticed when ethylene chlorohydrin, ethylene and carbon tetrachloride which have been found to be more effective than the solutions of each compounds used separately.

2.7 GIBBERELLINS

A special case can be made for gibberellins acting as a breaker of bud dormancy. In contrast to ethylene chlorohydrin and thiourea it is a natural compound and may be involved as a controlling factor in the overall process of bud dormancy. Much work has been done on the effect of gibberellins on potato for breaking bud dormancy. Rappaport et al. (1957) demonstrated with excellent success in breaking dormancy of potato tubers. Gibberellin can induce sprouting of potato tubers still on the plant as has been observed by Lippert et al. (1958) & Rappaport et al. (1985). They having used gibberellins at a concentration of 10,50,100 and 500 mg/litre prior to 1,2 and 4 weeks before harvest respectively by spraying the plant in the field could achieve sprouting in the freshly harvested tubers to the extent of 1.5 to 85.6% depending on the increase strength of the chemical and the difference in duration of the date of spraying to the date of harvest.

2.7.2 Thiourea

Azariah and Rai (1960) while trying to break dormancy of seed potatoes in Nilagiri have employed 1% aquous solution of thiourea for 1 hr by soaking the cut seed pieces and achieved a better result compared to the conventional treatment of fumigation with carbondisulphide. The thiourea treatment is prefered as it entails less delay in planting an autumn crop, allows the use of large seed piece and the simple and

comparatively harmless is the treatment to carry out. Kato and Ito (1961) studying the effect of soaking potato tubers Iris cobbler variety in gibberellin solutions at 50 ppm for 30 minutes and ethylene chlorohydrin 0.5% for 2 hours have obtained sprouted tubers by a month time to the extent of 90% with gibberellin and 20% with that of ethylene chlorohydrin. It was concluded that gibberellins did not actually break dormancy of potato tubers but eventually promoted the growth of sprouted buds, once released from growth inhibition due to native GA effect first. Slomnicki and Rylski (1964) have used cut seed tubers 2 weeks before planting by dipping the sets in one ppm GA, and have been able to break dormancy suitably better than the whole tubers but when the later is dipped in 5 ppm GA after piercing the tubers the success has been as good as the former but the higher concentration GA has no better effect rather gave rise to growth abnormalities. Duda et al. (1971) in a trial with freshly harvested tubers of potato cultivar pridneprovskii with (a) 2% thiourea solutions have induced 36-70% dormancy breaking effect, (b) GA 1-20 mg/lt has given 6-25% effect and (c) combined application of (a) + (b) however, gave 24-70% effect. The treatment (c) that is combination of thiourea and GA have given the highest tuber yield of 20.7 tons/ha compared with 12.4 tons and 13.2 tons respectively for the treatments of thiourea and GA. Lee (1976) by using gibberellic acid of 25 ppm concentration for 30 minutes to seed tubers of potato cultivar . Rosset Burbank when planted the tubers invermiculite after drying

the tuber. GA has found the greatest effect in dormancy breaking compared to other treatments such as 4000 ppm SADH and 1000 ppm chloromequat, SADH treatment has reduced shoot length and chloromequat had very little effect. In Java, Sahai et al. (1978) have used freshly harvested potato tubers or held for a month in storage then treated with 1, 5 or 9 ppm GA_3 or 20, 50, 80 ml CS_2/m^3 or 10, 20, 30 g $CaCl_2$/kg to break the dormancy of these tubers. The tubers have been planted immediately in field or stored for 5 months, tuber dormancy period has been reduced by 1 to 2.5 months by 5 or 9 ppm GA_3 and tuber yields increased by 20 to 21.6% over the control.

2.7.3 **Potassium Nitrate**

Effect of potassium nitrate in sprouting of potato tubers had been reported earlier from the work of Denny (1926) who used several other chemicals besides potassium nitrate for breaking dormancy. Potassium nitrate has been used to break dormancy in other crops such as corms of gladiolus cv. psittacinus by soaking them in solution of thiourea, GA_3, ethrel and kinetin of various concentration for 6 hours after which corms have been dried in shade for 5 days and planted. Besides potassium nitrate, ethrel and thiourea also found to promote sprouting the corms but the effect of kinetin and GA_3 was not evident in this experiment (Roy Choudhury et al., 1986).

2.7.4 **Kinetin**

Kinetin as a chemical to break dormancy either in potato or in other dormant buds, corms and rhizomes etc. in different crops has not found any success whereas its use to break dormancy in seeds has been reported to succeed quite effectively. Randhawa and Pal (1968) have reported that the kinetin has a profound effect for enhancing seed germination of grapes. Abohassan (1979) has reported that soaking of lime seeds for 24 hours in 1000 ppm GA or 5 ppm kinetin hasten the germination and increase the seedling growth. He also reported that scarified apricot stones treated with kinetin at 5-10 ppm or GA at 500 ppm produced early germination.

CHAPTER-III

MATERIALS AND METHODS

MATERIALS AND METHODS

The present investigation entitled "Studies on two clonal populations of spine gourd (*Momordica dioica*, Roxb.) with sex linked characters of leaf types and breaking dormancy in their root tubers", is carried out under Department of Horticulture of College of Agriculture, Bhubaneswar, during year 1992-93 in the agroclimatic conditions of Bhubaneswar, Meteorological data for the period presented in Table-1. The experiment has 3 aspects of study namely -

(i) The vegetative growth, flowering and fruiting of the selected male and female population and fruitset and fruiting period in the female plant,

(ii) Comparative performance of the two sets of clonal populations derived by stem cutting with two different dates as regards to their vegetative growth flowering, fruiting and yield,

(iii) Study on breaking dormancy in root tubers with chemicals.

3.1 EXPERIMENTAL SITE

The site of the experiment is the campus of College of Agriculture which is situated at 20° 15' N latitude and 85° 52' E longitude at an elevation of 25.9 m above mean

Table 1. **Monthly meteorological data from May, 1992 to April, 1993**

Months	Temperature °C			Relative humidity %			Rainfall (mm)	Number of rainy days	Sunshine hours per day
	Max^{m}	Min^{m}	Mean	Morning	Afternoon	Mean			
1992									
May	36.3	25.5	31.0	87	60	74	251.4	9	7.6
June	35.4	26.4	30.9	89	64	76	138.2	13	5.7
July	32.4	25.2	28.8	90	79	85	354.0	19	3.0
August	32.1	24.7	28.4	91	78	84	356.3	21	4.2
September	32.9	24.5	28.7	92	74	83	225.9	13	4.9
October	32.7	22.5	27.6	90	64	77	163.9	8	7.1
November	30.9	19.7	25.3	83	53	63	1.3	3	6.6
December	29.2	13.6	21.4	92	37	64	-	-	8.5
1993									
January	30.5	15.6	23.0	89	39	63	-	-	8.5
February	32.6	17.8	25.2	89	37	63	-	-	8.7
March	36.1	21.6	28.4	87	43	64	9.7	5	8.7
April	36.9	24.4	30.7	84	48	66	9.6	5	8.7

COURTESY OF METEOROLOGICAL OBSERVATORY, UNIVERSITY RESEARCH STATION, BHUBANESWAR

sea level. It is about 64 km away towards the west from the Bay of Bengal.

3.2 CLIMATIC CONDITION

The place being located not far away from the seashore, it has a salubrious climate of mild winter and a moderately hot summer. The mateorological data of this place with regards to temperature,rainfall and humidity etc. is given at Table-1. The place receive a substantial rainfall out of which about 70% of it is received mostly during the monsoon months of June to September, however, some amount of rain is also received during November to December from the retreating monsoon and some spring and summer showers in February to March. The maximum and minimum temperature of the place varies between 29.2-36.9° C and 13.6-25.5° C.

3.3 SOIL AND COMPOSITION

Soil of the site where the experimental planting is done is a sandy loam in character with average pH of 6.6. Mechanical and chemical analysis have been done and shown in Table 2(a) and 2(b) respectively.

Table 2(a). **Mechanical analysis of the soil**

Particulars	Percentage of composition	Method followed
1. Coarse sand	44.82	Bouyoucos
2. Fine sand	27.32	Hydrometer
3. Silt	12.19	Method
4. Clay	15.67	Piper 1950
5. Textural class; sandy loam		

Table 2(b). **Chemical analysis of soil**

Particulars	Percentage of composition	Standard method used in determination
1. Total N_2	0.057	Modified Kjeldahl's method (Jackson 1973)
2. Available P	0.00172	Bray's method (Jackson 1973)
3. Available K	0.01431	Ammonium acetate extraction method (Jackson 1973)
4. Organic carbon	0.5876	Walkley and Black rapid titration method (Jackson 1973)
5. C/N ratio	10.3:1	-
6. pH	6.8	Beckman's pH meter

3.4 SOURCES OF PLANTING MATERIAL

A pistillate plant has already been selected by Maharana and Maharana (1983) from their earlier investigation basing on its economic characters of high and prolonged fruiting behaviour and the plant is maintained for years by its tuberous roots. The plant has a distinct leaf character having 5 lobed leaves and palmately lobed.

From the nearby jungle of Chandaka area a staminate plant has been identified and selected which possesses non-lobing characters of leaf with broadly ovate and entire leaf. The root tuber of the plant is selected to serve as the male plant as a pollenizer for the pistillate type which is being maintained in the department as described above. If the plant is found

to be synchromious with the female in respect of its flowering time and season and besides become compatible with it so that the femaleplants have a high set of fruits, fruiting and yield than thus may be used as a male partner for the female and from its non-lobing character it would be easily disursible from the female especially when they are at the root tuber stage producing sprouts and leaves so that the sex is determined before setting them in the field. This would help a great deal in solving the problem of providing required number of males to females in the plantation for maximization of yield due to a balanced sex ratio of male and female.

3.5 PROPAGATION OF THE SELECTED PISTILLATE AND STAMINATE PLANT BY STEM CUTTING

Stem cuttings are taken both from the selected male and the female at two different dates at fortnight interval to have two sets of population with a view to ascertaining the performance of the population at two planting dates of these cuttings planting dates of these cuttings, as they influence fruiting, fruit set, fruiting period etc. and the fruit yield of the female and the compatibility of the male to serve as pollenizer for the two different dates of planting.

Stem cutting of two nodes each from the male and female plant are taken on 1st July and 2nd, on 16th July at an interval of fifteen days. These are allowed to root in a sand medium. After the stem cuttings have produced sufficient

roots for good establishment, these are removed from the sand bed and the cuttings washed to free the roots from sand and planted in the experimental field.

3.6 EXPERIMENTAL PLANTINGS

The rooted stem cuttings of both the pistillate and staminate plants are set in the experimental field as per paired plot technique after Le-clerg et al. (1939) as described in their statistics text of Field-Plot-Technique. The rooted staminate cuttings are interplanted with the pistillate ones at the ratio of 1:5 maintaining a sex ratio of 20 per cent with the hope that the ratio may prove optimal for effective fruit setting and yield.

Preparation of experimental field and planting : The plot for the experiment has been lying fellow for some years which is dug with the summer showers in May and then levelled. Pits are made of 20 cm cube at 1 meter apart both way so as to give the spacing to vines one meter distance between rows and within rows. The pit is filled up with equal quantities of FYM and soil and about 1 kg of FYM is used per pit. Six gram of nitrogen and 6 g phosphorus are given to each pit. Since the soil is rich in potash due to the presence of burnt briquette ash heaped in the site earlier so potassic fertilizer is not applied. Nitrogen in the form of urea and phosphorus in the form of single super phosphate are applied. P_2O_5 is applied at the time of planting, N is given in 2

split, 1st split at the time of planting and 2nd split after one month of planting. A single stake of 4 feet height is provided to each bush to allow the vines to grow properly. Plant protection measures are taken to keep the plant free from insect pests especially epilachna beetle. Intercultural operations like hoeing, weeding and irrigation were given timely as required for the crop.

3.7 BREAKING DORMANCY IN TUBER

After the end of fruiting season the tubers have been harvested and stored in December. Breaking of dormancy in tubers early in the spring is a most important factor for planting next year crop before the onset of monsoon. The best would be if there is no dormancy at all. So to break dormancy of tubers an experiment has been designed using 4 chemicals and each chemical were tried in 3 concentrations. There are total 13 treatments including the control. The experiment is a complete randomised block design with 2 replications. The treatments are as follows, gibberellic acid 10, 25 and 50 ppm; Kinetin 10, 25 and 50 ppm. Thiourea 0,5%, 1.0% and 1.5%; Potassium nitrate 0.5, 1.0 and 1.5% respectively and one control. Tubers were soaked in respective chemical solutions for 12 hours and control with water, then they are dried under shade and kept under sand bed for sprouting.

3.8 OBSERVATION TECHNIQUES

(A) Vegetative growth

Shoot growth : To record the rate of shoot growth in male and the female plant at two months of growth, three terminal branches of the observed plant is tagged at the point of 3rd node below tip. Then the rate of growth at 2 days interval is measured upto 15 days and the rate of growth per day is calculated and expressed in centimeters.

Internode growth : The growth rate of internode of the tagged male and female plant at 2 days interval is also measured till the length of the internode become constant without growing any longer. The growth per day was calculated and expressed in centimeters.

Leaf growth : To record the increase in dimension of the leaves in male and female plant from initiation of leaf upto full development, measurement are done at 2 days interval and the rate of increase per day is calculated.

Internode length : The length of the fully developed internode of male and female plants are measured and average is calculated and expressed in centimeter.

Leaf length, width and leaf area : At two months of growth, of the male and the female plant, the average length and width of fully developed leaves are measured in centimeters. The length is measured from the tip to base of leaf and

width is taken at 3 points, one at centre and other two points are one above and the other below and the average is found out. These leaves are taken and their area is calculated by taking their alinement on a graph paper. Leaf area is calculated on the basis of individual leaf and the average is found out and expressed in centimeter.

Dry matter content of leaf : The weight of three fully developed leaves from the individual plant of male and female are recorded accurately in a chemical balance and kept in the oven till a constant weight is obtained. Then the dry matter content of leaves is assessed and expressed in percentage.

Petiole length : The petiole length of fully developed leaves are measured and the average is expressed in centimeters.

Tendril length : The tendrils in the fully developed nodes of 3 branches are measured and average is expressed in centimeters.

Twining direction of tendrils : The twining of tendrils in the observed plants are ascertained as to their mode of direction of twining either clockwise or anticlockwise.

Leaf shape group : The shape of the leaf was expressed as palmately lobed or incised and broadly ovate and nonlobed or entire or denticulated leaf by visual observations.

(B) **Flowering and fruiting phase**

Flowering height and node and days taken to first flowering: The height and node number at which the first flower is observed in the male and female are recorded. Also days taken to appear first developed flower is observed and recorded.

Time taken for development of flower : The time taken between flower bud initiation (observed under magnifying glass) to the opening of flower is recorded in days for the male and female flower separately.

Time of anthesis : Anthesis time is studied by observing the earliest time of opening of male and female flowers and the time when the last flower opened on that day.

Time taken for opening of flower : The period between starting of a small rupture at the tip of the petal is taken as the beginning of anthesis and the time taken to complete opening of flower is observed in male and female flowers, the range is found out and expressed in minutes.

Withering of petals : The withering time of petals for both male and female flowers are observed and data are recorded.

Floral characters : The floral characters like length, width in different parts of the flower like bracts, calyx and corolla are observed from male and female flowers. The

average data are computed out and expressed in centimeters.

Monthly flower production : Flower production per day per plant is observed in each for the male and female and average is worked out separately.

Pollenological study : Pollens collected from male flowers just after the time of anthesis are observed under microscope for colour and shape. But for viability of pollens study they are observed after staining in acetocarmine stain. Average pollen size is expressed in microns.

Pollen germination : Freshly collected pollens are dusted over cavity slide containing 3% sucrose solution. The germination of pollen tube is observed microscopically. The percentage of viable pollens are average time taken for pollen germination are calculated.

Stigmatic receptivity : The female flowers to open on next day are bagged before opening with butter paper bags to prevent outside contamination of pollens or visit of insects. The male flowers are collected just before opening in the same day evening and preserved in moist petridish chamber. Ten flowers are pollinated each time at six hours intervals for 24 hours and fruit set is recorded by observing the ovary swelling and the receptivity expressed in hours.

Days taken to fruit development and rate of fruit growth: The period between pollination and fruit set to complete

maturity of fruit is observed and the days required for fruit development is recorded. Increase in circumference of fruit from pollination to complete maturity of fruit is measured at two days interval and increase in circumference per day is calculated.

Flowering duration : The date on which first flower appear on both male and female plants recorded and also at the end of the season, the date on which last flower appeared has been recorded. Flowering duration is calculated from 1st date and the last date of flowering.

Number of flowers per plant : The number of flowers opened per day is recorded. At the end of the season, number of flowers opened daily is added up to get the total number of flowers per plant.

Number of fruits and yield per plant : At the end of the season number of fruits per picking per plant during the fruiting period as observed is added up to get total number of fruits per plant. The fresh weight of fruits harvested at intervals are added up to get the yield per plant and it is expresed In grans

Weight of individual fruits : Five fruits are randomly selected after harvest from each plant and weight of each fruit is calculated separately average and expressed found out in grams.

Length, circumference and rind thickness of fruits : Fruits collected for measurement of weight also measured for their length, circumference, rind thickness. The average length, circumference and rind thickness as found out are averaged out and expressed in centimeters.

Dry matter content of fruits : The individual fresh weight of 5 fruits were collected from each plant and recorded accurately by weighing in a chemical balance and the fruits are cut into small pieces, dried in an oven till a constant weight is obtained. Then the dry matter content is assessed and expressed as percentage.

Number of seeds per fruit : Number of seeds of 5 fruits are counted separately and averaged out to obtain number of seeds per fruit.

Fruit to seed ratio : Five well matured fruits collected and weight of these fruits recorded. The weight of seed extracted from those fruits are also recorded separately and expressed in grams. Then fruit to seed ratio thus is found out.

Seed characters : Ten seeds collected, dried uniformly. The seed weight is taken and after then the cotyledon and seed coat weight is taken and expressed in gram and cotyledon and seed coat weight is expressed as percentage seed.

(C) **Character of root tuber**

Tuber shape : The shape of the tuber is expressed as elongated, globular or roundish by visual observation.

Tuber weight : The weight of tubers produced by the individual plant is recorded. The average tuber weight is found out and expressed in grams.

Tuber length : Length of tubers recorded separately and average length is expressed in centimeters.

Tuber circumference : The tubers taken for analysis of length were also observed for calculation of average circumference and expressed in centimeters.

3.9 STATISTICAL ANALYSIS OF DATA

Paired 't' test was employed for two sets of population planted in first July and 16th July as per Le-clerg et al. (1939) as described in the book "Field Plot Technique". For the experiment of breaking dormancy in root tubers, a complete Randomise Block design is employed. Mean, standard error, analysis of variance and critical difference are calculated. The percentage values as do not adhere to the normal distribution, therefore, they are transformed to their angular values. Significant tests for 't' value are found out from 't' table and 'F' value from 'F' table.

Formula for 't' test -

$$t = \frac{\bar{d}}{\sqrt{S^2/n}}$$

$\bar{d}$ = Mean of the difference between two population

S = Standard deviation

n = Number of observation

The formula for standard error mean (SEM) and critical difference (C.D.) is given below :

$$S.E.(m) = \sqrt{\frac{EMS}{r}}$$

EMS = Error mean square

r = replication

C.D. = S.E.(m) x $\sqrt{2}$ x t (0.05) at error d.f.

CHAPTER-IV

RESULTS

RESULTS

The results of the present investigation entitled as "studies on two clonal populations of spine gourd (Momordica dioica, Roxb.) with sex linked characters of leaf types and breaking dormancy in their root tubers" are presented in this chapter with regards to growth characters such as vegetative growth like shoot, internode, leaf and root characters and reproductive growth like days to first flowering, duration of flowering, total flower production, anthesis, pollination and fruiting behaviours like growth of fruits, duration of fruiting, fruit per plant, yield per plant and fruit to seed ratio etc. Further the results of the experiment on breaking dormancy of tubers by application of dormancy breaking chemicals are also presented. The experimental findings has been presented as follows.

4.1 GROWTH CHARACTERS

A. Vegetative growth characters

Shoot growth: (Table 3(a) and Fig.1) : The increase in length of shoot per day in male ranges from 3.57 to 3.69 cm. and 3.34-3.50 cm. with an average of 3.63 and 3.42 cm. for the 1st and 16th July planting respectively. The increase in length per day in female ranges from 2.57 to 3.19 cm.

and 2.44 to 3.0 cm. with an average of 2.88 and 2.72 cm. for the 1st and the 16th July planting respectively. As it appears from the result that the shoot growth is comparatively higher in the male than the female. Besides the shoot growth of 1st July planting is higher than that of the 16th July planting.

Internode growth: (Table 3(b) and Fig.2) : As regards to internode, the increase in length per day in male ranges from 0.80 to 1.06 and 0.75 to 1.01 cm. with an average of 0.93 and 0.88 cm. for 1st and 16th July planting respectively. Similarly in female it ranges from 0.71 to 0.97 and 0.66 to 0.92 with an average of 0.84 and 0.79 cm. for 1st and 16th July planting respectively. Both male and female internode have required 7-8 days for complete development. The rate of internode growth is higher in male as compared with female and as regards to date of planting 1st July planting is higher than 16th July planting.

Leaf growth : (Table 3(c), Fig. 3(a) and 3(b)): As regards to increase in dimension of leaf the increase in length of leaf for male ranges from 0.27 to 0.31 and 0.24 to 0.30 cm with an average of 0.29 and 0.27 cm and width ranges from 0.18 to 0.22 cm and 0.17 to 0.21 cm with an average 0.20 and 0.19 cm for 1st July and 16th July planting respectively. Similar trends also observed for females. The increase in length ranges from 0.28 to 0.32 cm (mean 0.30 cm) and 0.27

Table 3.(a) **Shoot growth (cm)**

Planting date	Increase in shoot length								Total, length in 15 days	Increase in length per day
	1st day	3rd day	5th day	7th day	9th day	11th day	13th day	15th day		
Male										
1st July	2.5	7.0	13.5	20.0	27.3	37.3	47.1	57.0	54.5	3.63
16th July	2.0	6.3	11.4	13.1	25.6	33.2	43.5	53.3	51.3	3.42
Female										
1st July	1.8	5.1	9.6	15.2	21.8	28.0	35.8	45.0	43.2	2.88
16th July	1.6	4.8	8.5	14.0	20.5	26.1	32.5	42.4	40.8	2.72

Table 3. (b) **Internode growth (cm)**

Planting date	Increase in internode length								Increase in length per day
	1st day	2nd day	3rd day	4th day	5th day	6th day	7th day	8th day	
Male									
1st July	0.1	0.4	1.3	3.0	5.1	6.3	7.2	7.4	0.93
16th July	0.1	0.3	1.1	2.8	4.8	6.0	6.8	7.0	0.88
Female									
1st July	0.1	0.3	0.9	2.5	4.3	5.8	6.5	6.7	0.84
16th July	0.1	0.2	0.8	2.3	4.0	5.6	6.2	6.3	0.79

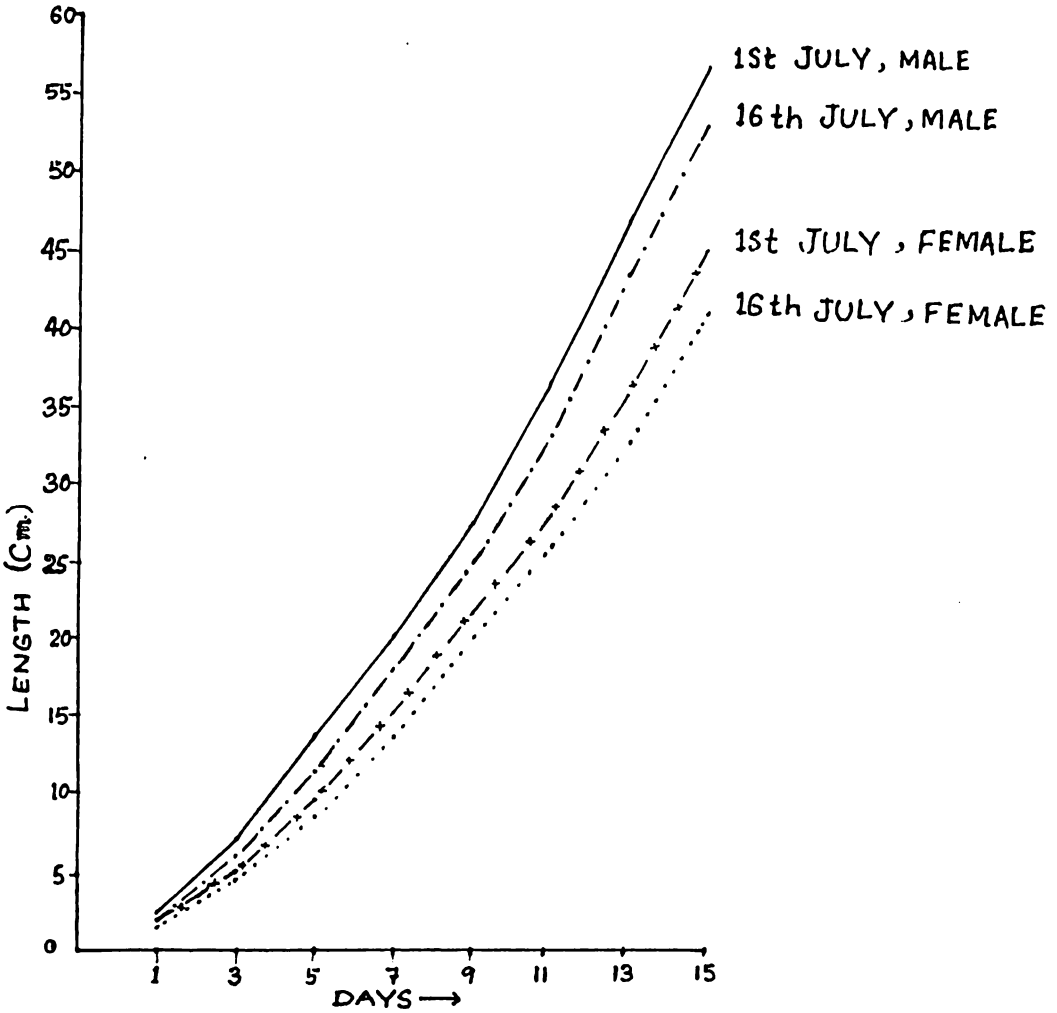


Fig. 1. Shoot growth of male and the female plant on two different dates of planting

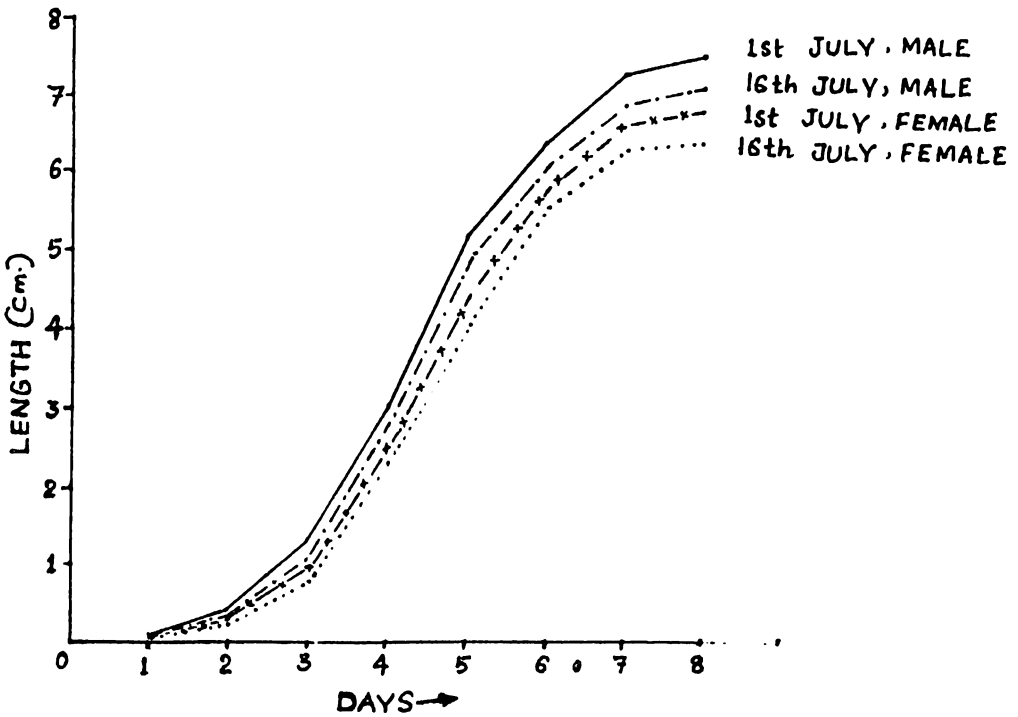


Fig. 2. Internode growth of male and the female plant on two different dates of planting.

Table 3 (c). **Leaf growth (cm)**

Planting date	Increase in dimension														Average per day	
	0th day		4th day		8th day		12th day		16th day		20th day		24th day		length	width
	Length	width	length	width	length	width	length	width	length	width	length	width	length	width		
Male																
1st July	0	0	1.2	0.9	2.5	1.9	4.4	3.5	6.0	4.2	6.6	4.7	6.9	4.9	0.29	0.20
16th July	0	0	1.1	0.7	2.3	1.7	4.2	3.1	5.7	3.9	6.4	4.3	6.6	4.5	0.27	0.19
Female																
1st July	0	0	1.3	0.9	2.8	2.2	4.8	4.0	6.5	4.7	7.1	5.2	7.2	5.3	0.30	0.22
16th July	0	0	1.2	0.8	2.6	2.0	4.6	3.7	6.3	4.4	6.9	4.8	7.0	5.0	0.29	0.21

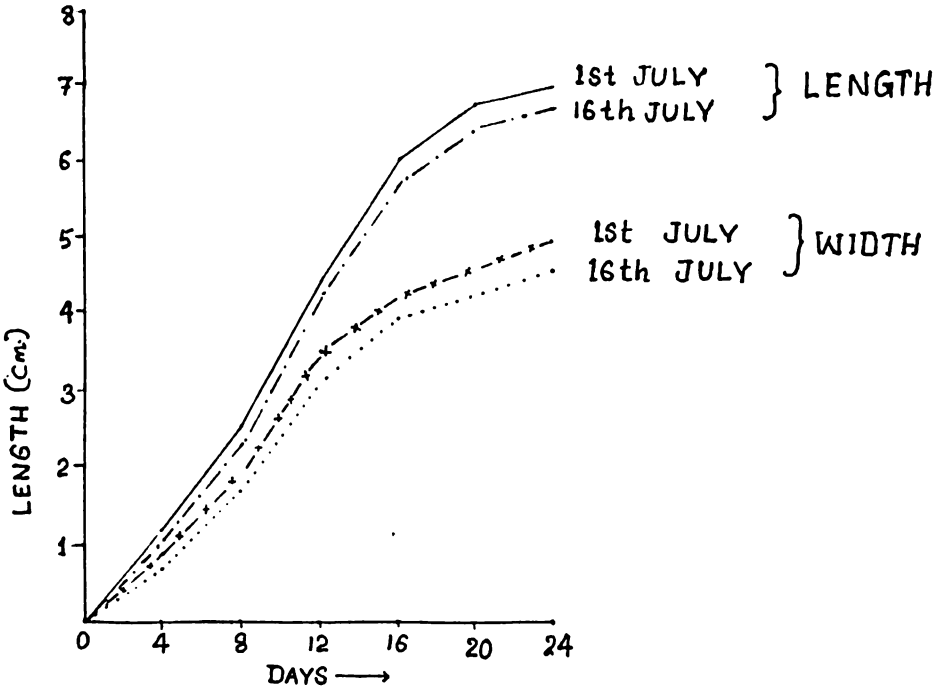


Fig.3(a). Leaf growth of the male plant on two different dates of planting

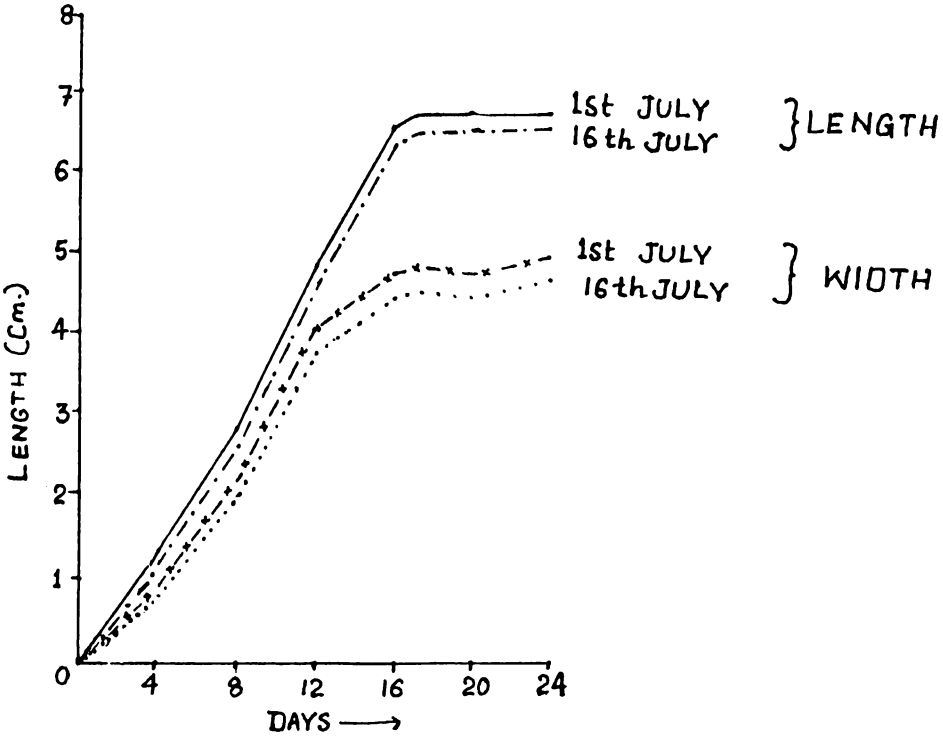


Fig.3(b). Leaf growth of the female plant on two different dates of planting.

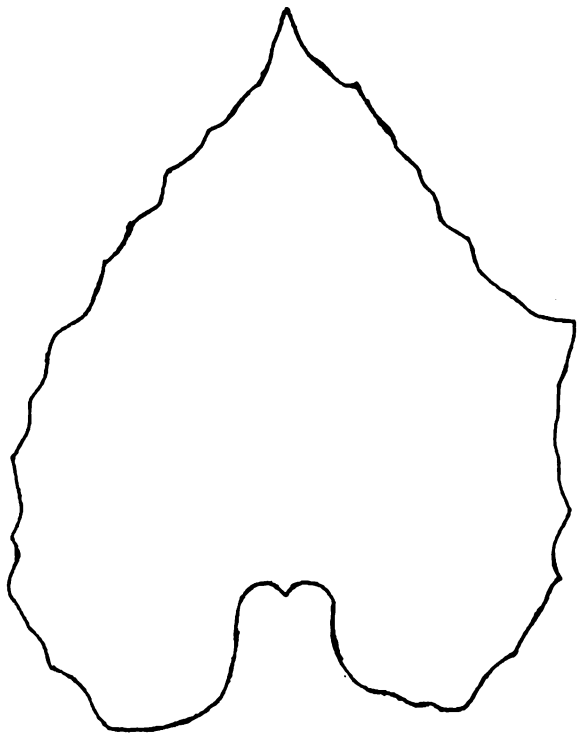
to 0.31 cm (Mean 0.29 cm) and width 0.21-0.23 cm (Mean 0.22 cm) and 0.20 to 0.22 cm (Mean 0.21 cm) from 1st July and 16th July planting respectively. Both male and female leaf have required 22-24 for complete expansion and development. The rate of increase in dimension is higher in female as compared to male, also 1st July planting than 16th July planting.

Leaf characters (Table 4): In male length of leaf varies from 6.4 to 7.4 cm and 6.1 to 7.1 cm with an average 6.9 cm and 6.6 cm for 1st and 16th July planting respectively. Similarly width of leaf varies from 4.5 to 5.3 cm and 4.0 to 5.0 cm with an average of 4.9 and 4.5 cm for 1st and 16th July planting respectively. As regards to female, length varies from 6.8 to 7.6 cm and 6.5 to 7.5 cm with an average of 7.2 and 7.0 cm and width varies from 5.0 to 5.6 and 4.8 to 5.2 cm. with an average 2.3 and 5.0 cm for 1st and 16th July planting respectively. Similarly actual leaf area studied from graph paper and revealed that males have more leaf area than the female. Average leaf area at a male was 29.6 and 27.8 cm^2 and for female was 24.1 and 22.3 cm^2 for 1st and 16th July planting respectively. Length of petiole tendril and internode in male varies from 2.5 to 3.5, 19.8 to 22.4 and 6.4 to 8.4 cm with an average 3.0, 21.1 and 7.4 cm for 1st July planting and 2.2 to 3.4, 17.2 to 19.0 and 6.0 to 8.0 cm with an average 2.8, 18.1 and 7.0 cm for 16th July planting respectively. Similarly in female

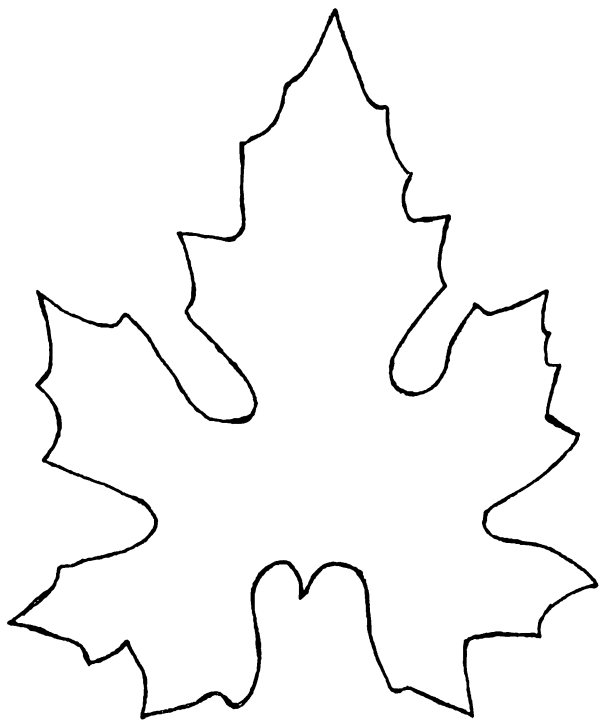
length of petiole, tendril and internode varies from 2.1 to 3.3, 14.0 to 18.2 and 5.6 to 7.8 with an average 2.7, 16.1 and 6.7 cm for 1st July planting and 1.8 to 3.0, 12.5 to 15.5 and 5.3 to 7.3 with an average 2.4, 14.0 and 6.3 cm for 16th July planting respectively. The dry matter content of male leaf ranges from 22.1 to 22.7 and 21.0 to 20.0 per cent with an average 22.4 and 21.5 per cent for 1st and 16th July planting. Similarly dry matter content of male leaf varies from 20.1 to 21.5 and 18.1 to 18.7 per cent with an average of 20.8 and 18.4 per cent in 1st and 16th July planting respectively.

Twining direction of tendril : Twining direction of tendrils are studied in both male and the female plant on both dates of planting. There is no difference in twining direction of tendril with respect to sex. In both the sex, tendrils twined in clockwise and also in anticlockwise direction.

Leaf shape (Fig.4 plate 1) : The male and female plant from which the cuttings are taken and grown in different dates of planting indicates that all through the growth period, there is no difference among the leaves of male at different stages and dates of growth till the end that is there is no lobing of leaf from the beginning of growth to the end of growth cycle in all the plants under observation and all the leaves are broadly ovate and uniform in size and shape.



MALE



FEMALE

Fig.4 LEAF SHAPE OF

Momordica dioica

Table 4. **Leaf characters showing leaf length, width (in cm), area (in cm^2) length of petiole, tendril, internode (in cm) and dry matter content of leaves (in %) in two different dates of planting, i.e. 1st and 16th July**

Date of planting	L E A F			Length of petiole(cm)	length of tendril(cm)	Length of internode (cm)	Dry matter content (%)
	Length (cm)	width (cm)	Area (cm^2)				
Male							
1st July							
Range	6.4-7.4	4.5-5.3	26.4-32.8	2.5-3.5	19.8-22.4	6.4-8.4	22.1-22.7
Average	6.9	4.9	29.6	2.0	21.1	7.4	22.4
16th July							
Range	6.1-7.1	4.0-5.0	24.7-30.9	2.2-3.4	17.2-19.0	6.0-8.0	21.0-20.0
Average	6.6	4.5	27.8	2.8	18.1	7.0	21.5
Female							
1st July							
Range	6.8-7.6	5.0-5.6	21.4-26.8	2.1-3.3	14.0-18.2	5.6-7.8	20.1-21.5
Average	7.2	5.3	24.1	2.7	16.1	6.7	20.8
16th July							
Range	6.5-7.5	4.8-5.2	19.2-25.4	1.3-3.0	12.5-15.5	5.3-7.3	18.1-18.7
Average	7.0	5.0	22.3	2.4	14.0	6.3	18.4

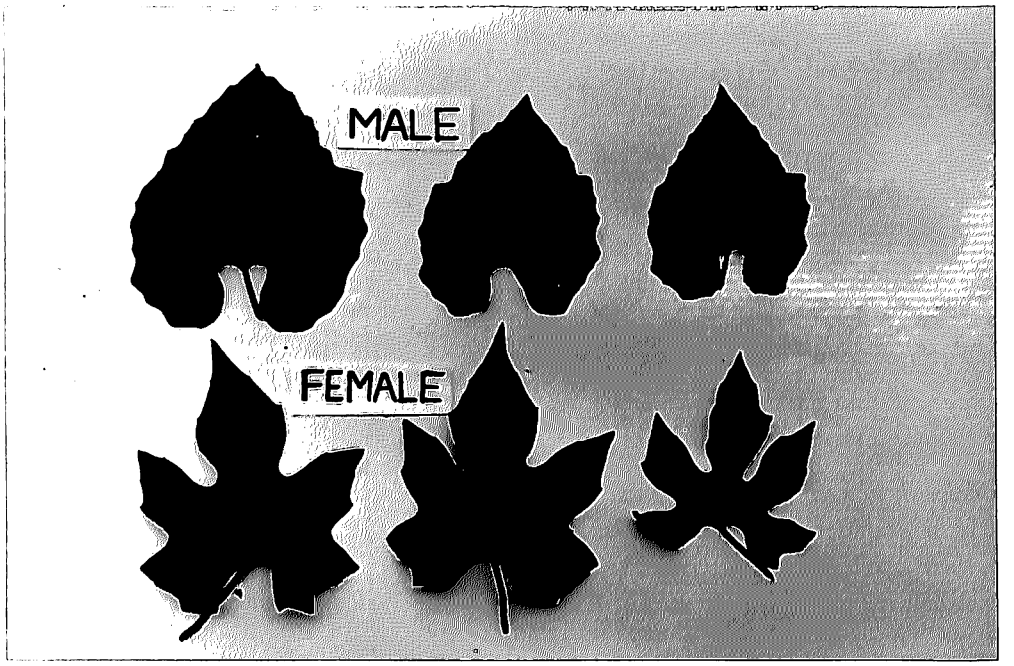


Plate 1. Leaf shape of *Momordica dioica*

Plate 2. Female plant of *Momordica dioica*

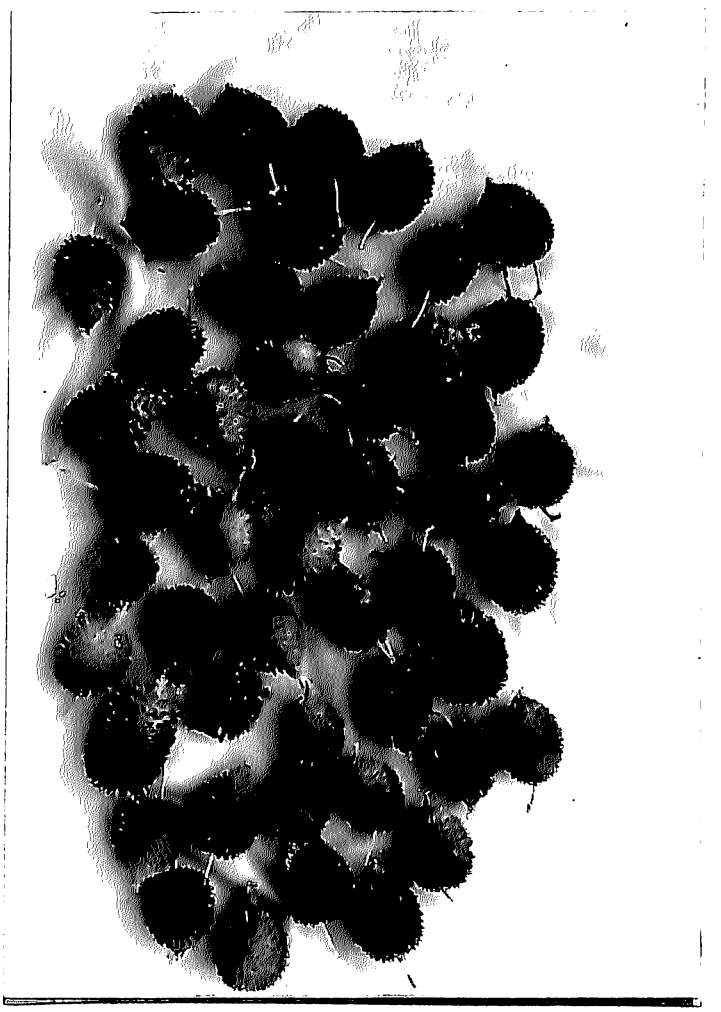


Plate 3. Well develop fruits *of Momordica dioica*

Similarly, the cuttings taken from the selected female and grown under two different dates of planting do not show any variation in leaf shape throughout their life cycle of vegetative and reproductive growth. All the leaves of the female were found to be palmately 5 lobed as it was in the female plant from where cuttings were obtained.

B. Flowering and fruiting stage

Flowering height and node and days taken to first flowering(Table 5) : In 1st July planting flowering occures at a higher height and node as compared to 16th July planting, also days taken for appearance of first flower in 1st July is longer than the 16th July in both male and the female plants. The first flowering in male shows that the height ranges from 52-78 cm and 37-55 cm with an average of 65 and 46 cm and flowering node at 12-14 and 7-11 with an average of 13 and 9 in 1st and 16th Julyplanting respectively. Similarly in female, the flowering height ranges from 68 to 90 cm and 40 to 80 cm with an average of 79 and 63 cm and first flowering node ranges from 14 to 18 and 10 to 12 with an average 16 and 11 for the 1st and the 16th July planting respectively. The days taken for appearance of first flower in male varies from 24 to 30 days and 20 to 24 days with an average of 27 and 22 days for 1st and 16th July planting respectively. In female the days taken for appearance of first flower ranges from 31 to 35 days and 25 to 29 days with an average

of 33 and 27 days respectively for 1st and 16th July planting respectively.

Table 5. **Flowering height and node and days taken to first flowering**

	Flowering height (cm)		Flowering node		Days taken to 1st flowering (days)	
	Male	Female	Male	Female	Male	Female
1st July planting	52-78 65	68-90 74	12-14 13	14-18 16	24-30 27	31-35 33
16th July planting	37-55 40	41-85 63	7-11 9	10-12 11	20-24 22	25-29 27

Flower development (Table 6): Days required for flower bud development, time taken for full blooming of a flower, time of anthesis, withering time of petals remain the same for the two dates of planting. Male flowers take 18 to 22 days from bud initiation to full development of flowers and female flowers take 14 to 17 days. In general lesser number of days were taken for bud development in female compared to male flowers. Time taken for complete blooming of developed flower bud i.e. from initiation of small rupture at the tip of the petal to complete opening of flower i.e. anthesis time as recorded shows that the female flowers takes less time than the male. Male flowers take 18.22 minutes whereas female flowers take 9 to 12 minutes. The time for anthesis has been recorded for both male and female flowers which shows that the anthesis time of male flowers are observed

to be starting within 4.15 p.m. to 6.00 p.m. whereas in the female it is between 4.45 to 6.30 p.m. In both male and the female petals withered within a few hours of pollination. Withering of petal is noticed within 6.30 to 7.30 a.m. in male and 7.00 to 7.30 a.m. in the female.

Table 6. **Days taken for flower development, time taken for full opening of petals, time of anthesis and withering of petals**

	Days required for flower bud development	Time taken for full opening of flower	Time of anthesis	Withering time of petals
Male	18-22 days	18-22 minutes	4.15-6.00 PM	6.30-7.30 PM
Female	14-17 days	9-12 minutes	4.45-6.30 PM	7.00-7.30 PM

Floral characters (Table 7) : Bract is more conspicuous in the male flowers than the female which appears like a hood. Bract length in male varies from 1.4-1.8 and 1.2-1.8 cm with an average of 1.6 and 1.5 cm and width varies from 1.5 to 2.1 and 1.4 to 2.0 cm with an average 1.8 and 1.7 cm for 1st July and 16th July planting respectively. Similarly the length of calyx varies from 1.6 to 2.8 and 1.5 to 2.7 with an average of 1.7 and 1.6 cm, and width varies from 0.6 to 0.8 and 0.6 to 0.7 cm with an average of 0.7 and 0.65 cm for 1st and 16th July planting respectively. Length of corolia varies from 2.0 to 2.6 cm and 1.8 to 2.6 cm with an average of 2.3 and 2.2 cm and width of corolia varies from 1.2 to 1.6 cm and 1.0 to 1.4 cm with an average of

1.4 and 1.2 cm for 1st and the 16th July planting respectively. The flower length varies from 3.1 to 3.5 cm and 2.9 to 3.5 cm with an average of 3.3 and 3.2 cm and opening diameter of flower varies from 3.2 to 3.8 cm and 3.0 to 3.6 cm with an average of 3.5 and 3.3 cm for 1st July and 16th July planting respectively. Similar trends also observed for female flowers, except that the length of the penduncle is shorter and possesses a foliaceous bract in the middle of the penduncle. Bract length and width is more or less the same. Length of bract varies from 0.6 to 1.0 cm and 0.5 to 0.9 cm with an average of 0.8 and 0.7 cm and width of bract varies from 0.6 to 0.8 cm and 0.5 to 0.8 cm with an average of 0.7 and 0.65 cm for 1st July and 16th July planting respectively. Calyx length varies from 0.7 to 0.9 cm and 0.7 to 0.8 cm with an average of 0.8 and 0.75 cm for 1st and 16th July planting respectively. The width of calyx remain the same i.e. 0.1 cm for both the planting dates. Length of corolla varies from 1.6 to 2.0 cm and 1.4 to 2.0 cm with an average of 1.8 and 1.7 cm and width of corolla varies from 1.2 to 1.4 cm and 1.0 to 1.4 cm with an average of 1.3 and 1.2 cm for 1st and 16th July planting respectively. Flower length varies from 2.5 to 3.5 and 2.2 to 3.4 cm with an average of 3.0 and 2.8 cm and diameter of the flower when it is fully opened varies from 3.0 to 3.4 cm and 2.8 to 3.4 cm with an average of 3.2 and 3.1 cm for 1st and 16th July planting respectively.

Table 7. **Floral characters showing bract length and width calyx length & width corolla length and with, flower length and opening diameter of flower in centimeter in two different dates of planting i.e. 1st and 16th July**

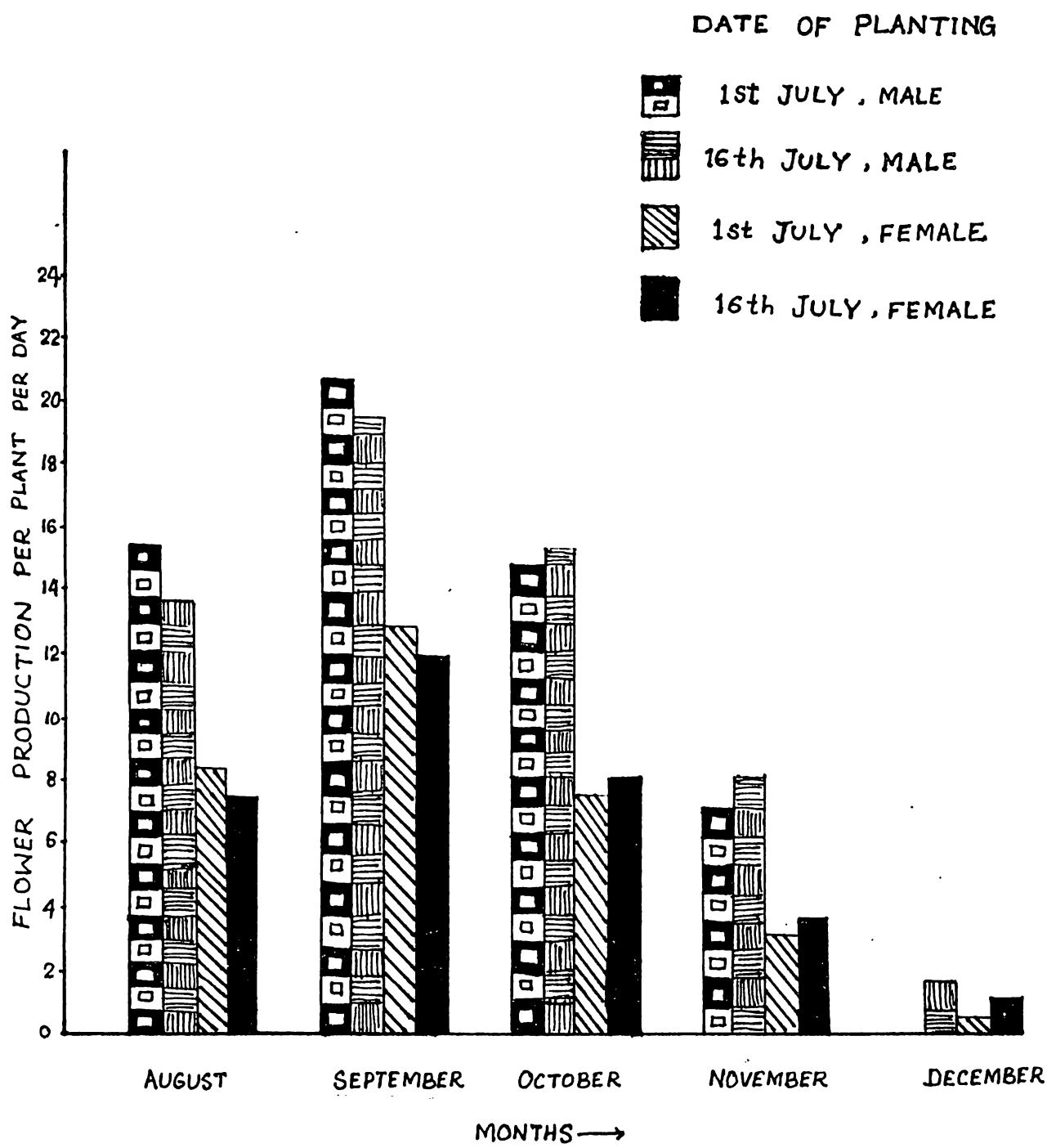
Date of Planting	Bract		Calyx		Corolla		Flower length (cm)	Opening diameter (cm)
	Length (cm)	Width (cm)	Length (cm)	width (cm)	Length (cm)	width (cm)		
Male								
1st July								
Range	1.4-1.8	1.5-2.1	1.6-2.8	0.6-0.8	2.0-2.6	1.2-1.6	3.1-3.5	3.2-3.8
Average	1.6	1.8	1.7	0.7	2.5	1.4	3.3	3.5
16th July								
Range	1.2-1.8	1.4-2.0	1.5-2.7	0.6-0.7	1.8-2.6	1.0-1.4	2.9-3.5	3.0-3.6
Average	1.5	1.7	1.6	0.65	2.2	1.2	3.2	3.3
Female								
1st July								
Range	0.6-1.0	0.6-0.8	0.7-0.9		1.6-2.0	1.2-1.4	2.5-3.5	3.0-3.4
Average	0.8	0.7	0.8	0.1	1.8	1.3	3.0	3.2
16th July								
Range	0.5-0.9	0.5-0.8	0.7-0.8	0.1	1.4-2.0	1.0-1.4	2.2-3.4	2.8-3.4
Average	0.7	0.65	0.75		1.7	1.2	2.8	3.1

Flower production per plant per day to different months (Table 8) ; The flower production per plant per day are observed from August to December. In the 1st July planting male plant produces 15.4 number of flowers open per day in August and then it increases to 20.7 (peak period) in September and then it decreases thereafter and only 7.2 numbers of flowers open per day in November. Similarly for 16th July planting 13.8 number of flowers open per day that increases to 19.5 number per day and thereafter it is decreases only to 1.5 number of flower per day in December. In case of female, female phase started with 8.4 number of flowers with 1st July planting and 7.5 number flowers in 16th only

Table 8. **Flower production per plant per day in different months**

	August	September	October	November	December
Male					
1st July planting	15.4	20.7	14.8	7.2	-
16th July planting	13.8	19.5	15.3	8.3	1.5
Female					
1st July planting	8.4	12.8	7.6	3.2	0.5
16th July planting	7.5	12.0	8.2	3.7	1.2

planting. The peak period of flowering is noticed in September which are 12.8 and 12.0 respectively for 1st and 16th July planting. Thereafter the number is decreased only to 0.5 and 1.2 number of flowers per day in December for 1st July



Fig·5 FLOWER PRODUCTION PER PLANT PER DAY IN DIFFERENT MONTHS

and 16th July planting respectively. In both male and the female irrespective of planting date peak period of flowering is September.

Pollenological study (Table 9) : Pollenological study has been carried out for both the planting dates and it is found that there is no difference in pollen characters. It is observed that almost all the pollens in spine gourd are fertile. By acetocarmine staining pollen takes uniform staining and pollens are also perfect round in shape and they confirmed 100% viability. Pollen grain size is 52.28 µ on average. The pollen viability tested on the basis of germinability in 3% sucrose solution revealed that the pollen viability is upto 24 hours after anthesis and has taken 1.30-2.30 hours (Mean 2.0 hrs) for germination. The pollen viability studied through tube germination suggested that freshly collected pollen show 100% viability but afterwards they are observed at 6 hourly intervals, the pollen germination decreases and it is only 10% by the time it has been kept in storage for 24 hours.

Table 9. **Shape, size of pollen, viability and time taken for pollen germination**

Pollen shape	Pollen size µ	Period of pollen viability	Time taken for pollen germination
Round	52,28 µ (micron)	24 hours	1.30-2.30 hr mean 2.0 hr

Stigmatic receptivity (Table 10) : The flowers are pollinated at 6 hours interval for 24 hours with properly stored pollens.

The receptivity is studied in terms of fruitset and ovary swelling after 5 days of pollination. The data reveales that the stigmatic receptivity is 100% upto 12 hours after anthesis and after that it decreases to 50% at 18 hr after anthesis. Thereafter it declines and stigmatic receptivity is completely lost 24 hours after anthesis. The maximum hours for stigmatic receptivity is observed upto 12 hours of anthesis.

Table 10. **stigmatic receptivity**

Number of flowers pollinated	Time of pollination	Total number of fruit set	Percentage of fruit set (%)
10	6 p.m.	10	100
10	12 p.m.	10	100
10	6 a.m.	5	50
10	12 a.m.	0	0

Days taken to fruit development and rate of fruit growth (Table 11) : Fruit requires 26 to 32 days to mature but the edible maturity stage is attained within 16-20 days irrespective of date of planting. Fruit circumference increases slowly at initial stage i.e. upto 4 to 6 days after pollination, then increases rapidly upto 14 days then there is a gradual decline. After 20th day no further increase in circumference is noticed.

Flowering duration, number of flowers per plant, number of fruits and yield per plant (Table 12) : Significant difference

Table 11. **Fruit growth**

Date of Planting	Average increase in circumference days after pollination											22nd-23th day
	0th day	2nd day	4th day	6th day	8th day	10th day	12th day	14th day	16th day	18th day	20th day	
1st July	0.9	1.2	1.5	2.0	2.9	4.3	6.4	7.9	8.9	9.3	9.5	9.6
16th July	0.8	1.0	1.3	1.7	2.5	3.7	5.7	7.3	8.3	8.8	9.1	9.2

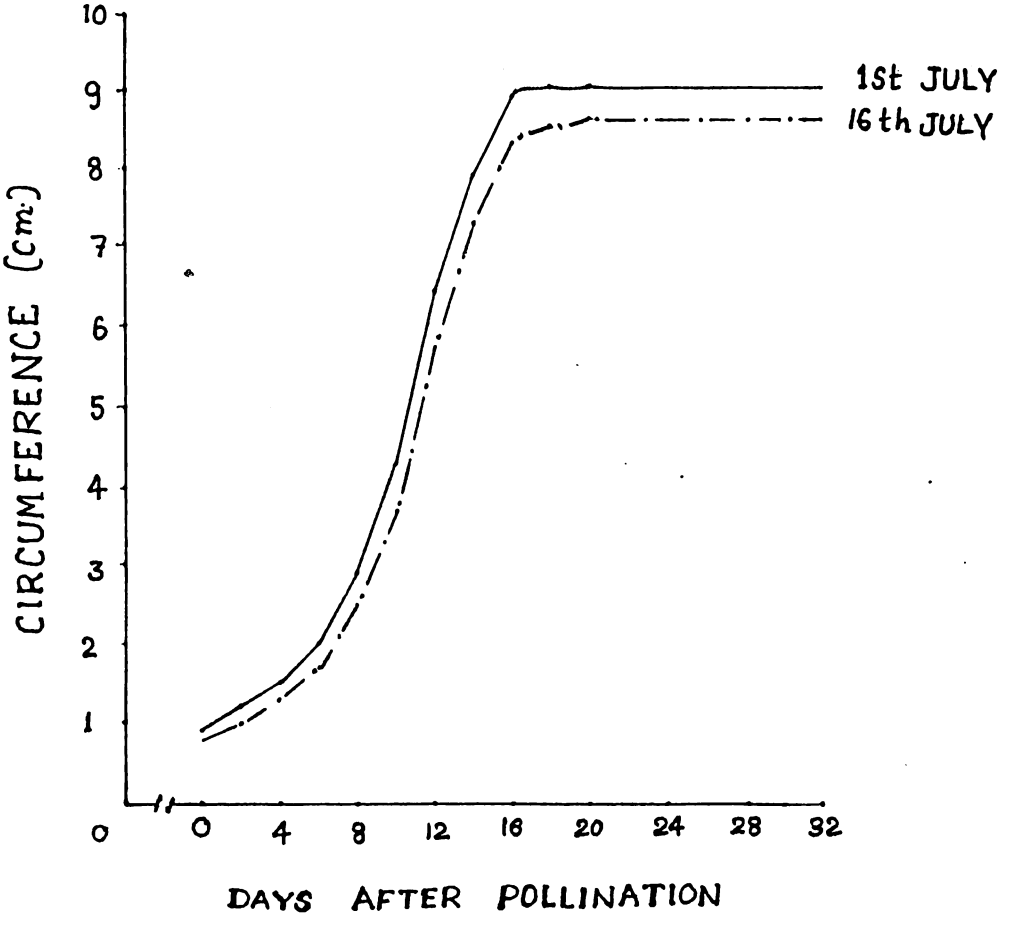


Fig. 6 FRUIT GROWTH ON TWO DIFFERENT DATES OF PLANTING.

in flowering duration, number of flowers per plant, number of fruits and yield per plant are observed in plants planted at two different dates. The flowering duration is 123 days in 1st July planting, as compared to 127 days in 16th July planting, that indicates that the duration of flowering is more in 16th July planting. But the number of flowers per plant is higher in 1st July planting than 16th July planting, number of flowers per plant is 864 in 1st July planting as compared to 823 in 16th July planting. Average number of fruits are 135.5 in 1st July planting as compared to 111.5 in 16th July planting. Similarly the yield per plant is 1382.5 g in 1st July planting as compared to 1151.5 g in 16th July planting.

Table 12. **Flowering duration, number of flowers per plant, number of fruits and yield per plant**

Planting date	Flowering duration	Number of flowers per plant	Number of fruit per plant	Yield per plant(g)
1st July planting	121-125 123	850-878 864	129-142 135.5	1295-1470 1382.5
16th July planting	126-128 127	808-838 823	106-117 111.5	1110-1193 1151.5
't' test	Sig**	Sig**	Sig**	Sig**

Fruit characters (Table 13) : The length of pedicel has been observed to be within a range of 3.4-4.0 cm and 3.2-4.0 cm with an average of 3.7 and 3.6 cm, length of fruit varies

Table 13. **Fruit characters showing length of pedicel and fruit, circumference of fruit, Rind thickness (in cm.), individual fruit weight (in g), dry matter content of fruit (in %) and days required for edible maturity and ripening**

Date of Planting	Length of pedicel (cm)	Length of fuirt (cm)	Circumference of fruit (cm)	Rind thickness (cm)	Individual fruit weight (g)	Dry matter contment (%)	Days require for edible maturity	Days require for ripening
1st July								
Range	3.4-4.0	4.6-6.2	8.4-10.6	0.4-0.6	9.8-14.6	16.0-17.8	1.6-2.0	2.6-3.2
Average	3.7	5.4	9.5	0.5	12.2	16.9	1.8	2.9
16th July								
Range	3.2-4.0	4.4-6.0	8.0-10.2	0.4-0.5	9.2-14.4	16.0-172	1.6-2.0	2.6-3.2
Average	3.6	5.2	9.1	0.45	11.8	16.6	1.8	2.9

from 4.6 to 6.2 cm and 4.4 to 6.0 cm with an average of 5.4 and 5.2 cm and circumference of fruit varies from 8.4 to 10.6 cm and 8.0 to 10.2 cm with an average of 9.5 and 9.1 cm for 1st and 16th July planting respectively. Rind thickness varies from 0.4 to 0.6 and 0.4 to 0.5 cm with an average of 0.5 and 0.45 cm for 1st July and 16th July planting respectively. Individual fruit weight varies from 9.8 to 14.6 g & 9.2 to 14.4 g with an average of 12.2 and 11.8 g for 1st and 16th July planting respectively. Dry matter content of fruit varies from 16.0 to 17.8% and 16.0 to 17.2% with an average of 16.9 and 16.6% for 1st and 16th July planting respectively. days required for edible maturity and ripening remain same for both dates of planting which ranges from 16-20 days and 26-32 days with an average of 18 and 29 days respectively.

Taste of fruits : Organoleptic teste is undertaken for the cooked fruits as vegetable to indicate if the fruits taste bitter.

But samples of fruits at due maturity stage has been tasted as for its bitterness and it is observed that non of them are found to be bitter.

Seed characters (Table 14 a. & 14 b.)

(a) Number of seeds per fruit and fruit to seed ratio : The range of number of total seeds per fruit is 23 to 31 and 22-30 with an average of 27 and 26, the number of perfect seeds ranges from 20-23 (Mean 24) and 18-26 (Mean 22) and

rudimentary seeds 2 to 3 to (Mean 2.5) and 3 to 4 to (Mean 4) for 1st and 16th July planting respectively. Fruit to seeds ratio in an average 3.1 and 2.98; 1 for 1st and 16th July planting respectively.

(b) One hundred seeds cotyledon and seed coat weight : One hundred weight, cotyledon weight and seed coat weight remain same for both dates of planting 100 seed weight varies from 5.80 to 6.35g with an average of 6.08 g, cotyledon and seed coat weight varies from 51.24 to 56.16 and 46.30 per cent respectively.

Table 14 a. **Number of seeds per fruit and fruit to seed ratio**

	Number of seeds per fruit			Fruit:seed
	Perfect seed	Rudimentary seed	Total seed	
1st July	20-28	2-3	23-31	(2.94-3.06)
Planting Average	24	2.5	27	1.3:1
16th July	18-26	3-5	22-30	(2.92-3.04):1
Average	22	4.0	26	2.98:1

Table 14 b. **One hundred seed, cotyledon and seed coat weight**

	100 seed weight g	Cotyledon weight %	Seed coat weight %
Range	5.80-6.35	51.24-56.16	48.76-43.84
Average	6.08	53.70	46.30

C. Character of root tubers (Table 15 Fig.6 and Plate 4)

The tuber character remains the same for two dates of planting. Length of tubers in male ranges from 6.4 to 45.8 cm. with an average of 26.1 cm. where as in female

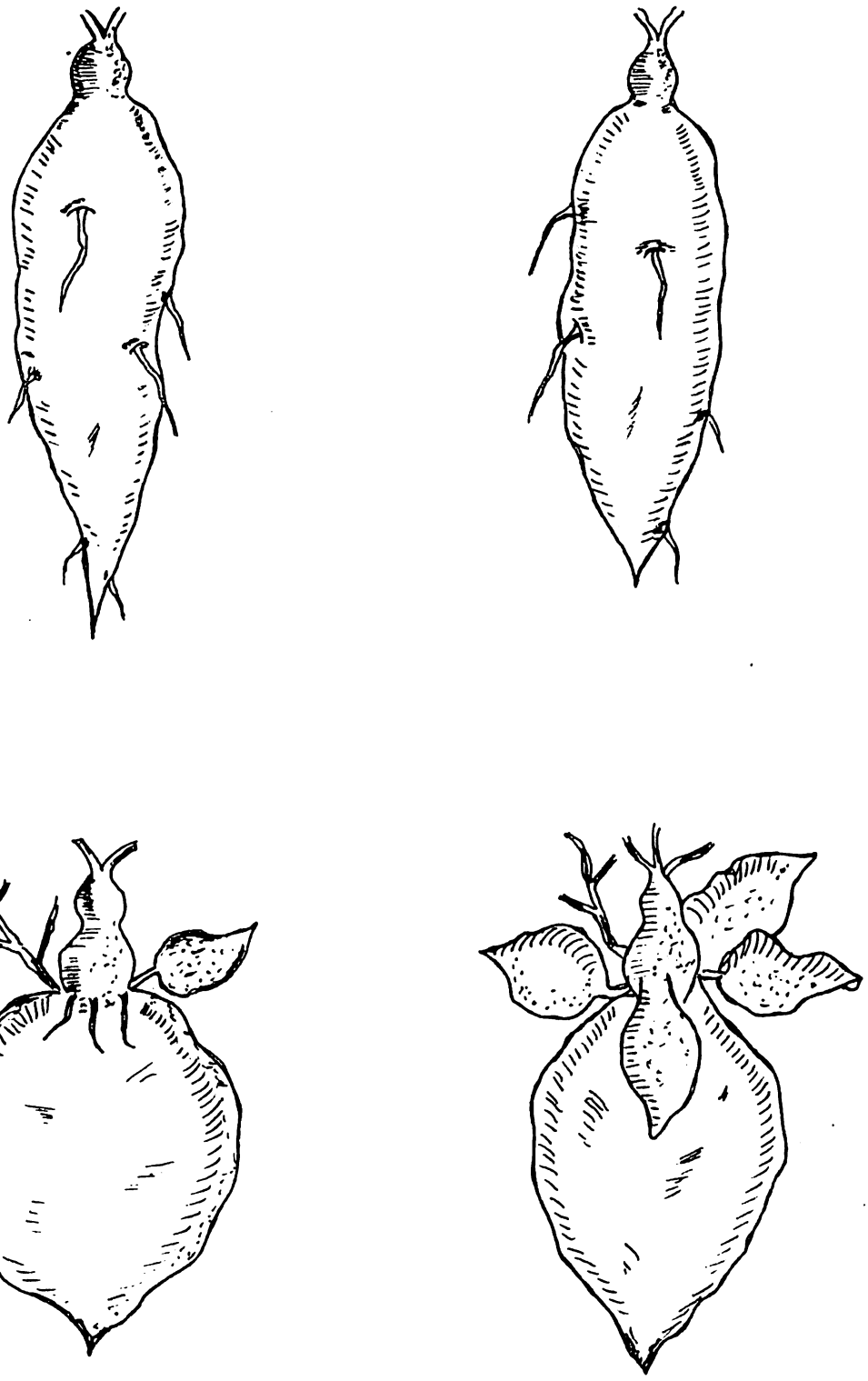


Fig.7 DIFFERENT SHAPE OF TUBERS IN *Momordica dioica*

it ranges from 3.2 to 27.2 cm with an average of 15.2 cms. The circumference of male and female tuber ranges from 4.3 to 12.7 cm (Mean 8.5 cm) and 5.3 to 12.5 cm. (Mean 8.9cm) respectively. Weight of male and female tuber ranges from 11-270.4 g (Mean 140.7g) and 12.2 to 130.2 g (Mean 71.2 g) Respectivley.

The tubers in spine gourd are classified into 3 groups such as, globular, elongated or roundish. The number of tuber varies from 1 to 4. In most cases only one or two tubers per plant but in rare cases 3 or 4 tubers per plant are observed. There is no difference in shape of tubers among male and female but usually the male tubers are larger and heavier than female tubers.

Table 15. **Length, circumference and weight of tubers**

Tubers sex	Length cm	Circumperence cm	Weight cm
Male			
Range	6.4-45.8	4.3-12.7	11-270.4
Average	26.1	8.5	140.7
Female			
Range	3.2-27.2	5.3-12.5	12.2-130.2
Average	15.2	8.9	71.2

4.2 BREAKING DORMANCY IN TUBERS (Table 16)

In the dormancy breaking experiment it was observed that with the 10,25, and 50 ppm GA there are 31.1, 43.7 and 56.3 per cent sprouting respectivley. The difference

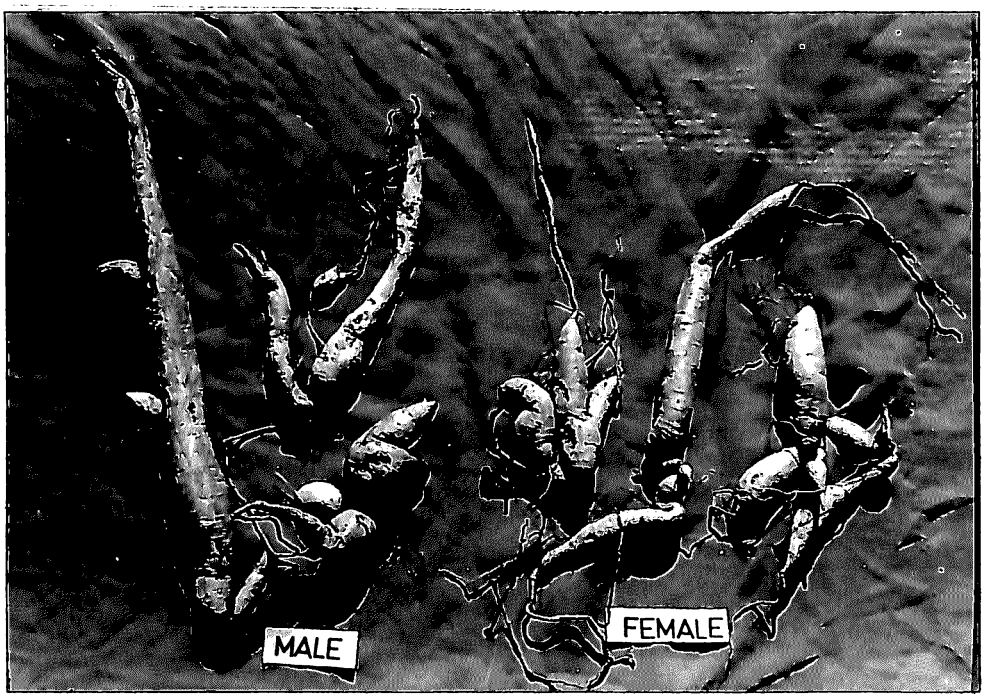


Plate 4. Different shapes of tubers in Momordica dioica

Plate 5. Sprouted tubers of Momordica dioica

Table 16 . **Breaking dormancy in root tubers**

Sl. No.	Treatments Chemicals	Concentration	Percentage of dormancy breaking (%)
1.	GIBBERE	(PPM)	
	LLIC ACID	10	33.88 (31.1)
		25	41.38 (43.7)
		50	48.62 (56.3)
2.	KINETIN	10	25.35 (18.3)
		20	33.88 (31.3)
		50	30.00 (25.00)
3.	THIOUREA	PERCENT(%)	
		0.5	56.12 (68.9)
		1.0	69.30 (87.5)
		1.5	52.24 (62.5)
4.	POTASSIUM NITRATE	0.5	48.62 (56.3)
		1.0	45.0 (50.0)
		1.5	33.38 (31.1)
5.	CONTROL	DISTILLED WATER (100%)	25.35 (18.3)

S.E.(m) for treatment = ± 3.29 C.D.(5%) 10.14

FIGURES IN PARENTHESIS INDICATE THE PER CENT VALUE

is significant between 10 ppm and 50 ppm GA, but not in between 10 and 25 ppm, 25 and 50 ppm GA. Among the 3 concentrations of GA 50 ppm is better. In kinetin 18.3, 31.1 and 25.0 per cent sprounting observed in 10, 25 and 50 ppm concentration respectivley. Differencis significant between 10 and 50 ppm but not in 10 and 25, and 25 and 50 ppm concentrations. Kinetin 25 ppm gives better result as compared to 10 and 50 ppm. There are 68.9, 87.5 and 62.5 per cent sprouting in 0.5, 1.0 and 1.5 per cent concentration ofthiourea respectivley. The difference is significant among 1.0 and 0.5, and 1.0 and 1.5% but not between 0.5 and 1.5 per cent. Thiourea 1.0% gives best result then the other two other concentrations. In potassium nitrate (KNO_3) 65.3, 50.0 and 31.1% per cent sprouting was observed in 0.5, 1.0 and 1.5 per cennt concentrations respectively. There is significant difference between 0.5 and 1.0 and 1.5 per cent but not in between 0.5 and 1.0 per cent. KNO_3 0.5% gives better result followed by 1.0 and 1.5%. In control there is only 18.3% sprouting. There is significant difference among all the treatments except kinetin 10 ppm and 50 ppm. Thiourea 1.0% is the bests followed by Thiourea 0.5% and 1.5% in the breaking of dormancy effect compared to other treatments.

temperature for their optimum growth. So either 1st or 16th July planting coinciding with the high rainfall months of the year acompanied by high temperature, therefore, growth rate of shoots showing a uniform and high value is quite plausible and natural. The observation being taken during grand period of growth thus high rate of growth is all the same positively established. But the late plantings on the 16th July has comparatively lesser rate of growth, though not significant, may be attributed to the fact the later planting might have been subjected to the same favourable environment as the plantings of the 1st July.

Although very few works have been done in spine gourd with respect to their rate of growth, yet the earlier work done in this department by Maharana and Maharana (1983), Sahoo and Maharana (1984) indicate in general the vigorous nature of growth of the vine of spine gourd during the monsoon months which is in accordance with our findings.

Comparing the rate of shoot growth in male vis-a-vis with female population, it is observed that growth in male was slightly superior than that of the female. The male selected for this purpose is having a non-lobed character and a broadly ovate shaped leaf with a higher leaf area where as the female plant having a palmately five lobed leaf character, as such that the leaf area of the male is higher than the females. As leaf area index is a true reflection

of its photosynthetic potential, so that, the necessary growth factors like shoot growth per day concurrent to higher leaf area in the male may be in accordance to its higher photosynthesis level.

Internode length (Table 3b, Fig. 2) : Likewise the results obtained with shoot growth the internode length also varies showing higher rate of growth in the 1st July planting than the 16th July planting, besides, the growth of the male as compared to female plant.

As already discussed before that the growth period of the cucurbit has coincided with the mid monsoon months when temperature and rainfall are quite favourable so that luxuriant growth is expected and that is what observed in this experiment. As shoot length is a reflection of the internode growth therefore, the high rate of growth of internode in general is expected. According to the rate of growth of internode observed in this experiment irrespective of the date of planting and the sex are natural outcome. It is worth citing the compilation of Whitaker and Davis (1962) in this regard from their book of 'Cucurbits' where they had illustrated the various cucurbits have a growing season requirement of high temperature and high humidity and prolonged summer season for their successful cropping, of course they have not mentioned spine gourd in their report.

CHAPTER-V

DISCUSSION

DISCUSSION

The salient findings of the present investigation are discussued as follows.

5.1 GROWTH CHARACTERS

A. Vegetative growth

Shoot length (Table 3(a) Fig. 1) : Shoot length under two different dates of planting i.e. 1st and 16th July are found to be different from each other irrespective of sex since both the populations were derived from cuttings taken from the same mother plant there, as anticipated that the shoot growth per day within one population whether be the 1st or 16th July planting are almost same and equal. So the statistical analysis has not shown to have any significant difference among them.

However, from the mean data it is noticed that the mean length of shoot per day is lower in 16th July planting as compared to first July planting. As the crop is cucurbitaceous one, the climatic requirement as per the classification furnished by Thompson and Kelly (1957) and MacGillivray (1953) that all of them need high summer

as of the shoot length, the length of internode is slightly higher in the male and 1st July planting than the female and 16th July planting, it is expected accordingly since the population on the later date of planting is subjected in their growth phase to autumn temperature in September and October therefore, this might have decilarated the rate of growth. Because then, though, the day temperature is quite high yet the night temperature start falling which might have influenced the growth rate of the internode length. The male population being more vigorous the rate of increase in internode length is the concurrent effect of the leaf area increase which has been evident in the finding.

Leaf character (Table 3c and 4, Fig. 3a & b) : The findings of the dimension of leaves had shown that the length and width of leaves of female are slightly higher than male and so also the 1st July planting to that of 16th July planting.

But the leaf area is higher in the male than the female irrespective of the date of planting. The anomaly as observed to the dimension to area between the male and the female plants are due primarily to the lobing characters of female leaves as compared to non-lobing character of male leaves though the dimension of female leaves are slightly higher than the male, yet the area is in the female less than the male because the lobing character found in the female leaves is the cause for the net area loss because its deep notches

in their leaves is the reason for the shrinkage in area.

The lobing and nonlobing characters distinguishing the female from the male are utilised in this experiment to establish the male and the female lines for future plantation on the basis of their leaf characters of lobing and on-lobing as sex linked character for sex identification at the time of setting a new plantation. Haines (1961) has observed earlier as described in the "Flora of Bihar and Orissa" the variation in the leaf shape and incision in the wild population of spine gourd occuring throughout the state of Orissa during his survey in the early part of the century. According to him the leaves may or may not have lobes and the lobes vary from 3 to 5 in number. In the present investigation the 5 lobed leaves as female and non-lobed leaves as male has been selected and cuttings have been taken from this selected mother plants for the present investigation.

The interesting points observed in the experimental planting are that irrespective of the date of planting of the cuttings obtained from the selected male and the female plants, the vegetative growth and their rate of growth of all the plants are identical and uniform. Further the leaves produced in the entire population of female or male are quite similar in shape with regard to lobing and non-lobing of leaves as the case may be, thereby indicating that this character of leaf is quite fixed and constant and it does

not vary in the population as such these two characters may be availed to identify the male from the female as sex linked characters for sex identification in the early stage of planting when there is no other ways to identify the plant. When the root tubers are just producing the first few leaves in the beginning of the season of planting and there is no way to ascertain the sex of individual tuber at that stage so only the first few leaves as may appear in the root tubers would indicate immediately its sex thus helping the grower to be sure of the sex he is planting and would maintain the number of female and male as per requirement so that a proper balance between the male and the female and proper ratio in the plantation is established for maximisation of production because of better fruit set and fruit yield.

It is also further observed that the leaves produced both by the female and the male has their natural shape of lobing or non-lobing without any variation. In cucurbits there are examples where the diversified forms of leaves occur in the same plant as during the growth period as observed in Melothrea and the snake gourd especially when they are multiplied by seed. This heteromorphic forms of leaves however, is totally absent in the plant population of spine gourd in our experimental planting. Had it been generated from seeds than there might have been some variation noticed in their leaf shape or form within the plant population. But as they are vegetatively propagated from stem cuttings

therefore, this anomaly has not occurred at all in this experiment. Therefore, the leaf characters if multiplied through vegetative propagation would maintain the constancy in leaf character to be used as sex-linked characters.

However, as it appears from the data that the male plants produced better vegetative growth and higher number of flowering than the female plant irrespective of their dates of planting it is evident that the male clone selected in this experiment is somewhat vigorous than the female one. Since the yield of fruits, fruiting time and duration it is dependent mainly on the performance of the female plant it is therefore, desirable now to have a more vigorous female than the male for higher productivity. So future investigation may be directed to select a vigorous female basing on their broad leaf and non-lobing character of leaves than the palmately 5 lobed leaves and in that place a male with that character of lobed leaves may be tried to overcome this difficulty.

Nature of twining of tendrils : Tendrils are produced in each node of the vine opposite to a leaf and the twining nature of such tendrils may be useful criteria to distinguish the male from the female, if there would have been any difference in them on the basis of their sex. In the present study the nature of the tendrils in the male and the female plant were studied and no definite clone could be obtained to utilise their character to identify the sex.

B. Flowering and fruiting phase

Flowering height and node and days taken to first flowering (table 5) : It may be seen from the table that first flowering is noticed in the 1st July planting in the vine of female plants at higher level and at higher node than the flowers occuring in 16th July planting. The same was the observation with respect to staminate ones. Cucurbits ordinarily when grown from seed and planted with the premonsoon showers produce a profuse vegetative growth before the onset of flowering in them by virtue of favourable climate of high temperature, high rainfall and high humidity as discussed earlier. But as the planting date is delayed, then there is a correspondingly less of vegetative growth and flowering occur earlier in the lower nodes and lesser height. Under the same analogy the observation made here of later appearance of flowering at higher node of the plant in the 1st July planting as compared to the 16th July planting is therefore, quite obvious. The pistillate plants ordinarily prolong their vegetative growth before the first flower appear in them whereas in the staminate once flowering appear earlier in the lower node since the pistillate one are to bear a substantial fruit load, there is, therefore, a necessity to have correspondingly a large frame of vegetative growth in the female before flowering to sustain the high production in the field whereas such a necessity is not there for the staminate ones. So the findings in the present investigation that pistillate ones come late

to flowering is well expected. In between the two dates of planting the later planting of 16th July produce the first flower in their plants in a shorter length of time from the date of planting taking only an average 27 days whereas with 1st July planting the days required was 33 days. However, the first flowering observed in the 1st July planting was ahead of 9 days. From this finding it is evident that the later planting are tending to come to reproductive stage earlier, within less number of days than the earlier planting where they take more number of days for coming to maiden flowering. As cucurbits are warm season crop later planting is bound to restrict their vegetative growth and flowering phase may set in earlier due to the prevalence of autumn conditions of lower night temperature which might be retarding the vegetative phase and induce reproductive phase. Such observations have already been recorded by earlier workers, Maharana and Maharana (1983), Sahoo and Maharana (1984).

Flower development, floral characters and anthesis (Table 6 & 7): A thorough study is made on the different characters of flower and its development leading to anthesis. The characters such as bract, calyx, corolla, flower length and flower diameter at full opening etc. have been recorded both for male and the females under two dates of planting. It is seen that ordinarily male plants took 18-22 days for full development of flower from date of their initiation whereas females took a lesser time 14-17 days. Earlier other workers, of this

department such as Maharana and Maharana (1983), Sahoo and Maharana (1984) have reported like-wise and our findings quite agree with theirs. Another report from Gujurat by Shikhalia and Sachan (1993) also revealed that the female and male buds open by 9 and 11 days respectively from bud stage. Since our observations relate to the stage of initiation to full bloom of the flower, so number of days reported here are bound to be more.

The flower bud which has been fully developed and expected to bloom in the same evening is tagged to observe the time of breaking of the bud and the opening of the corolla. the time when a suture is observed in the bud was noted and also when all the petals become fully opened. The time taken between the two stages are recorded. It appears that male flowers took 18-22 minutes and female flowers 9-12 minutes, on average, to attain full blooming stage. The time of anthesis also has been noted which starts at 4.15 p.m. and continue upto 6 p.m. in case of male and 4.45 p.m. in case of the female. The findings here is in full agreement with the works of earlier investigators of this department.

Since the observation on anthesis is taken in the month of August and early part of September the anthesis time noted appears to be earlier as compared to the anthesis of flowers towards the last leg of flowering season in October, November where the earlier report says anthesis might be

as late as 7.30 p.m. So it appears that climatic factor plays a vital role in deciding the time of anthesis and time taken from bud break stage to full bloom (Das, 1969).

Flower production/plant/day in different months (Table 8): The study of data on flower production per plant per day in different months starting from August and ending with December reveals that the number of male flowers produced per plant per day is higher as compared to females, that is what observed by Whitaker and Davis (1962) in other cucurbits. In between the female it is observed that first July planting has more number of flowers per day than the 16th July planting. Among the 5 months maximum flower production is observed during the months of September irrespective of date of planting and the sex, thereafter there is gradual declining in flower production, but in October and November figures are quite low even in some cases less than 50% is observed in November as compared to October. In December there is a drastic reduction in production of female flowers and there are no male flowers observed from the first July planting. Female flower production has been found to be lower in months of November and December in the 1st July planting as compared to 16th July planting. Thus earlier planting in July has lesser chance of fruiting towards the later period of November and December whereas later planting of 16th July for its vigourousness continue to produce more flowers in months of November and December and also some male flowers for

effective fertilisation. There has been reports (Das, 1969) that in Orissa ordinarily the staminate plants are first to sprout with the onset of monsoon and they complete their life cycle by mid monsoon period mainly by October on the contrary the pistillate plants sprout later than the male in the season say in July and continue to produce flowers even upto mid December. But since the male phase is over by mid October or early November, so all the female flowers produced beyond this date go to begging the pollination as a result, no fruit-set occurs during the period inspite of the fact that there are enough of female flowers produced during the period. Such nonsynchronisation of male phase with female is a genuine handicap for extending the availability of fruits beyond October. However, in the present investigation as the plant populations raised from cuttings and such cuttings were planted late in 1st and mid July, the flowering phase as specially the male ones prolonged their flowering beyond November thus prolonging the fruiting season, so it is advantageous now to go for large scale clonal propagation for building planting materials through cuttings, then the usual method of propagation through root tubers collected from the jungles.

Pollenological study and stigmatic receptivity (Table 9 and 10) : It appears that the anthesis of the flower and the brusting of the pollen sac are concurrently observed. Pollen production is quite abundant throughout the flowering season irrespective

of the plants of 1st and 16th July planting. By acetocarmine test it is found that the pollen are 100% viable and pollen germination is also normal as observed by allowing them to germinate in the cavity slide. The viability of pollen is maintained for 24 hours. The shape of pollen grain is round and average size is 52.28 μ.

The stigma is found to be receptive when the flowers began to open indicating the species to be slightly a protogynous one. The stigma remain receptive for 24 hours in the beginning of the season and 48 hours towards the last phase of flowering in November and December. But by then since there are no male flowers such ovaries go unpollinated thus there is no fruit set. As it appears that there is no restriction or incompatibility problem between the male and the female, so, observation of fruits occuring in every node of pistillate plant laden with heavy load of fruits is a common sight. Since the staminate plant selected in the present investigation has been found to be fully compatible with the pistillate one and there is a prolonged phase of synchronization in flowering in both the male and the female resulting in extended and prolonged fruiting season, so the purpose of finding a suitable male with nonlobed character of leaves to match with the selected female having lobed leaves has been very successful.

Flowering duration number of flowers per plant number of fruits and yield per plant (Table 12) : It may be seen from the table that the period of flowering varies from 123 to 127 days, the former being observed with the 1st July planting and the later was with 16th July planting. Number of flowers produced per plant also varies from 864 in the former and 823 in the later case. Average number of fruits per plant has been 135.5 and 115.5 respectively for the two dates of planting and finally the yield varies from 1382.5 g to 1151.5 g. From the above it is evident that the fruiting season lasts for about three months, with the second date of planting it extended for 15 days more because of its late planting compared to the first. Because the two dates of planting higher yield is obtained with the 1st date of planting which is significantly higher than the second date of planting. From this it may be inferred that the 1st planting having got the favourable condition of environment of rainfall, humidity and temperature the fruiting has been more compared to the second date of planting where through the fruitting period extended beyond the November compared to the first, yet its yield could not out bit the first because, towards the close of the season both male and female flower production is drastically reduced and there is also less of pollination activity to ensure higher fruit set druing the dry months of November and December. So from this it is clear that

early planting should be advocated not only to get higher fruit yield but also an earlier and a prolonged season of fruiting, besides, earlier fruiting is quite profitable to the grower since early arrival of fruits to the market fetches a premium price thus giving the grower a higher returns.

Rate of fruit growth and fruit character (Table 13) : Since the experimental plants are all derived through cuttings from one and the same pistillate plant, therefore the fruits formed in different parts of the plants are quite similar to one another and the rate of fruit growth is also all alike. The fruits come to edible maturity stage within 16-20 days irrespective of the date of planting. Initially for the period of 4-6 days the rate of growth of the fertilized ovary grew at a lesser pace but there-after during the next 10-14 days the growth is rapid and substantial. The growth curve of fruit is a single sigmord curve. Similar growth curve also reported by Tazuke and Sakiyama (1984) on cucumber fruits on vine using fruit shape dimensions. The fruits ordinarily attained an average length of 5.4 and 5.2 cm. longitudinally and 4.7 and 4.5 cm. transversely and rindthickness 0.5 and 0.45 cm. in 1st and 16th July planting respectivley.

Seed characters (Table 14 (a) and 14 (b)) : The fruit is quite seedy and number of seeds per fruit varies from 23-31 with a mean value 27. Certain seeds are well developed

as compared to some others which are quite rudimentary. Fruit to seed ratio varies from 3:1 to 2.9:1, one hundred seed weight varies from 6.35 to 5.80 and cotyledon and seed coat weight in an average 53.70 and 46.30 per cent, respectively. All the findings corroborate well with the findings of the earlier workers like Maharana and Maharana (1983), and Sahoo and Maharana (1984).

Fruit quality : Ordinarily fruits available in the market in some instances on cooking a bitter taste is produced which might have been due to certain fruits in the lot have a bitter principle in them which impacts the bitter taste to the preparation.

The transfer of bitter principle to fruits in cucurbitaceous crops has been said to be due to the pollen source which carries the bitter principle and that it remits to the ovary and the developed fruit being pollinated from such source, tastes bitter. This sort of metaxenia effect has been reported by Seshadri (1985). But under the present investigation such bitter taste in fruits has not at all been noticed, thereby the male plant selected for the present investigation here does not have in its genome this bitter principle factor, thus, the male used in the present study in besides being compatible also not imparting a tiller taste which is very desirable.

C. Character of root tubers (Table 15)

In the present study it is observed that the plants derived from the cuttings could produce well developed root tubers along with its vegetative growth & by November-December when the aerial growth is already over by then the root tubers undergo dormancy. It is observed that the mean length, circumstances and weight of female tubers are 15.2 and 8.9 cm and 71.1 g respectively and the corresponding figures for the male tuber are 26.1 and 8.5 cm and 140.7 g. respectively. The average figure of length and circumference between the male and the female are show not quite that different but with respect to weight the male tubers are heavier in weight also they are large in size.

The data obtained in the previous years by Maharana and Maharana (1983) that the shape of tubers in male & female on different is not discernible in the present investigation The unusual large size tubers observed in certain male were due to the fact that these large sized tuber producing plants are planted in a soil where a good of qualities of burnt briquette ash from the nearby canteen has been spread as such the soil is too porous and rich in potash. Since potasic manures are highly essential for tuber formation and development (Grewal and Singh 1978) the large sized tubers obtained under such soils is quite apparent. Although there has been quite heavy and large tubers of giant size,

the presence of rings on the surface of the tubers either in the male or in the female are not discernible as it is earlier obtained by Maharana and Maharana (1983). Besides the shape of tubers globular in female and elongated in the male found by them was also not seen in the present investigation. So reliance on the root shape and presence of the ring on the surface of the root tuber as identifying traits between the male and the female as proposed by Maharana and Maharana (1983) is not confirmed in the present investigation. So characteristic shape of root and presence of ring on their surface criteria for sex linked character may not hold good.

On the other hand lobing and non-lobing character of leaf as a good criteria to distinguish the male from the female as has been established here may be utilised as sex linked character to identify the sex when the root tubers are used for planting, however the root tubers need to be sprouted first at the time of planting so that the presence of leaves in the sprouted tuber would indicate the sex depending on the characters of lobing and nonlobing of leaves. In the present study the nature of twining of tendrils such as wheather clockwise or anticlockwise was noticed in both male and the female plants but no definite clue could be obtained to utilise this character to identify the sex. As stated earlier that root character can not be taken to differentiate

the sex so also the twining mature of tendrils as observed in the present study also may not prove any use for such purpose.

So therefore, the leaf stage and lobing and non-lobing character could only be utilised as sex linked character to distinquish the male from the female.

5.2 BREAKING OF DORMANCY IN ROOT TUBERS (Table 16)

The root tubers, for breaking the dormancy were treated with chemicals like Thiourea, GA, Kinetin and Potassium nitrate in three different concentrations each. The findings reveal have that there is a significant difference among the chemicals in their efficacy in breaking the dormancy of the tubers, besides certain concentrations of some chemicals are quite efficient which is significantly superior compared to the other treatments. The treatments as per their order of efficiency are arranged in ascending order and is given here which would indicate their respective merit of each chemical and their suitable concentration over others. From this, it is evident that the best result was obtained with Thiourea 1% solution, where 87.5% of the treated tubers produced sprouts successfully, the next best treatment was also Thiourea again but it was with 0.5% concentration. The 3rd best treatment was also Thiourea under the concentration of 1.5%.

Thiourea as a dormancy breaking chemical has been well established in case of breaking dormancy in white potato (Denny, 1926, 1945). Other than Thiourea the other treatments which has been found to be significantly successful are GA 50 ppm and KNO_3 0.5%. Use of GA as dormancy breaking chemicals has been reported earlier in potato by Lippert et al. (1958)and Rappaport et al. (1957, 1958). However, for KNO_3 no earlier reports are available. However, one reference of its use as dormancy breaking chemical has been cited by Shanmugavelu (1989) in the book "Production and technology of vegetable crops". Roychoudhury et al. (1985) used KNO_3 for breaking dormancy in corms of gladiolus cv. psilltacinus hybrid.

Early dormancy breaking in spine gourd tubers has become a necessity if stress is given to raise plantation through stem cuttings of the vines for raising an early and uniform plantation . Earlier the plantation raised, greater is the scope for early fruiting and maximisation of yield as the growing season of the crop will coincide with the rainy season; when high soil moisture, high humidity and high temperature all combined together would provide a better niche for the crop to become quite productive and fruitful. Hence there is a necessity for early breaking of the dormancy in the root tuber of the crop for raising the early plantation. In the present study Thiourea as the most successful chemical

to break the dormancy in all the three concentrations tried at 0.5, 1 and 1.5% has been a good finding besides also GA the next best chemical which has also been found to be effective at 50 ppm concentration though the work is preliminary one yet it is suggestive that these chemicals might do the job well which needs repeatition for confirmation.

CHAPTER-VI

SUMMARY AND CONCLUSION

SUMMARY AND CONCLUSION

The present investigation entitled as "Studies on two clonal populations of spine gourd (*Momordica dioica*, Roxb.) with sex linked characters of leaf types and breaking dormancy in their root tubers", has been carried out in the premises of the College of Agriculture during 1992-93 with the following objectives in view and methodology employed for carrying out of the experiments.

Use of sex linked characters in spine gourd to differentiate the staminate from the pistillate plant has been attempted by using non-lobed broadly ovate leaf and palmately five lobed leaf character respectively in selecting the male and the female parent form the collections made earlier in this department.

Possibility of generating sufficient planting material through stem cuttings are attempted on two different dates of 1st and the 16th July and observation is made if there is any difference in their performance with regards to vegetative growth, flowering, fruiting, duration of fruiting, fruit yield and fruit quality. Besides, study is also made as anthesis,

pollination, fruit set compatibility of male with the female and maintenance of proper sex ratio etc. Further the root tubers and their characters are also investigated so as to break dormancy in them by treatment of chemicals like Gibberellic acid, Thiourea, Potassium nitrate and Kinetin.

The salient findings are summarised as follows :

It has been observed that the leaf characters of lobing and nonlobing in the female and male plants respectively have been uniformly observed during the entire growth and fruiting period of the plantation, thereby confirming the leaf characters so selected for sex identification is stable and not variable. Therefore, characters being sex linked in nature may be utilised for distinction of sex at the time of planting using the sprouted root tubers. This would facilitate in identifying sex at the planting time and also to maintain proper sex ratio for maximisation of yield.

The performance of staminate and pistillate plants planted in two different dates of 1st and 16th July indicate the early planting bears the 1st flower earlier so also fruited earlier whereas the 16th July planting, the first flowering and fruiting date was late by 7 days. The vegetative growth such as shoot growth, leaf production, internode length etc. are more or less same irrespective of the sex and also under two different dates of planting. However, male plant is slightly vigorous and produced flowers early corresponding

to the female plants planted on the same date of planting. This might have been due to the vigorous nature of male plant because of their broadly ovate and entire leaf having more leaf area than the corresponding female with 5 lobed leaves which might have less area. Since female is responsible for high fruitset and yield, so instead of a non-vigorous female a vigorous one may be selected with nonlobed leaf and the male with lobed leaf for higher productivity.

Though the second planting date is 15 days later yet the second planting could make up and flower earlier thus compensating to some extent the delay in planting in mid July. Duration of flowering and fruiting was more prolonged in the 1st July planting then the 16th July planting. However, the late planting continue to produce female flowers quite late in the season i.e. upto late to December but the fruit set is poor owing to early ceasation of male phase.

Study of opening of flower from bud, anthesis pollen study, pollination and fruit set etc. are carried out which indicated that the male plant is quite compatible with the female as a pollenizer plant. Besides it is also observed that the impact of pollination from the specific male has no deleterious effect on the fruit. In some instances metaxenia effect of cucurbit pollen cause bitterness of fruits due to pollen effect. Such situation has been reported in cucumber by Seshadri (1985) but in the present investigation no such bad effect of bitter taste is found in this experimental planting.

Fruit yield is higher in 1st July planting than the mid July planting because earlier in the season the climatic condition of high humidity, high moisture content in the soil and high temperature prevailing then are quite conducive for fruitfullness.

The early planting initially produced quite a good crop of fruits but towards the last leg when the winter has already set in the vegetative growth is impaired so also the production of female flowers. Lack of male phase also contributed for no fruit set in the later part of December. However, the materials of second date of planting has no so much of problem in yielding fruits at a later stage.

From this it is evident earlier the planting it is better for to have earlier fruiting and a prolonged fruiting season.

It is interesting to note that in the same season of planting of the rooted cuttings root tuber production was quite good simultaneously to vegetative growth, when in November-December the root tubers are harvested it showed a considerable growth of their tubers underground. But roots produced by the male could not be differentiated from the female either from the shape of the tuber or from the presence and absence of circular rings on their surface as indicated earlier by other workers.

Since early planting in the season is quite essential to have higher production and productivity, so to get earlier

plants for cuttings, it is necessary this root tubers break dormancy quite early in the season preferably by March and April.

In order to achieve early breaking of dormancy an experiment has been conducted using chemicals like Gibberellic acid, Kinetin, Thiourea and Potassium nitrate. The results show that all the three ancentrations of thiourea used at the rate of 0.5, 1.0 and 1.5 per cent produced quite good result in breaking dormancy in more than 60% of the dormant tubers, the highest being 87.5% with 1.0% thiourea. Effects of GA and potassium nitrate also was found to be somewhat successful than the control whereas 18.3% of the tubers have broken dormancy .

BIBLIOGRAPHY

BIBLIOGRAPHY

*Abohassan, A.A.; A.A.M. EL-Hamady and M.A. Hamouda. 1979. Effect of GA and kinetin on germination of Apricot and lime seeds and subsequent seedling growth. Proceedings of the Saudi Biological Society. **3** : 1-6.

Ali, M., H. Okubo, T. Fujii and K.Fujieda. 1991. Techniques for propagation and Breeding of Kakrol. Scientia Horticulturae. **47** : 335-343.

Azariah, M.D. and R.P.Rai. 1960. Breaking the dormancy of seed potatoes in Nilgirs. Indian Potato Journal **2** : 100-101.

Chakravarty, H.L. 1959. Monograph on Indian cucurbitaceae, Taxonomy and description. Recbot Surv India. **17**:91.

Das, G.C. 1969. Collection of different forms of Momordica dioica, Roxb. growing wild in the forest of Orissa and Study of their morphological variation and breeding behaviour. Symposium on the recent trend in vegetable breeding. Katrain, Kuluvelly pp. 34-48.

Das, P., P.C.Lenka and P.Mohapatra. 1979. Quality planting material through stem cuttings in spine gourd. OUAT Journal of Research. **IX** (182) Oct. 111-121.

*Denny, F.F. 1926. Hastening the sprouting of dormant tubers. Centre Boyee thompson inst **1**: 50-96.

*Denny, F.F. 1945. Synergestic effects of three chemicals in the treatment of dormant potato tubers to hasten germination. Centr. Boyee thompson inst **14**: 1-14.

Dubey, A.K. and G.S. Gaur, 1989. Studies on pollen germination and storage in Kakrol. Haryana Journal of Horticultural Science **18**: 119-122.

*Duda, G. Ya., J.A. Palladina, and A.S. Kanenko, 1971. On the theory and practice of breaking the dormancy of freshly harvested potato tubers for planting. Fiziologiya Rastenii **18**: 1046-1053.

Duthie, J.F. 1960. Toxonomic description of Momordica species. Flora of upper Gangetic Plains and the adjacent Siwalik and Sub Himalayan tracts. Botanical survey of India Calcutta. Vol. I. Part. I & II, PP 338-340.

*Grewal, J.S. and S.N. Singh, 1978. Correlation of soil tests with potato responses to potassium application in alluvial soils. International seminar on Approaches towards increasing the potato production in developing countries Cent. Potato Res. Inst. Simla. P. 72.

Haines, H.H. 1961. Taxonomy of Momordica dioica and classification of genus Momordica. Botany of Bihar and Orissa. Botanical Survey of India Calcutta. Vol. II. P. 402 and 411-412.

Hooker, J.D. 1879. Taxonomic description of Momordica dioica Roxb. Flora of British India L. Reeve and Co Ltd. Ashford Vent. England Vol. III. P. 616-617.

Jackson, M.L. 1973. Soil Chemical Analasis Prentice Hall Inc., Engle wood, Cliffs New Jersy, U.S.A.

Kato, T., and H. Ito. 1961. Interactions between gibberellin and dormancy of potato tubers Tohoku J. Agric Res. **12**: 1-8.

Kirtikar, K.R., and B.D. Basu. 1918. Taxonomic description and Medicinal uses of Momordica dioic Roxs. Indian Medicinal Plants Vol. II. P. 1133-1135.

Le-clerg, E.L., W.H. Leonard, and A.G. Clark. 1939. Field Plot Technique. Burgess Publishing Company. U.S.A.

*Lee, T.S.G., 1976. The effect of gibberellic acid (GA), 2 chloroethyl, trimetyl-ammonium chloride (CCC) and 2-2 dimethyl-hydrazine (SADH) on dormancy breaking of Potato tubers. Arquivov de Biologics e Technologia **19**: 3-4.

Lippert, L.F., L. Rappaport, and H. Tim. 1958. Systematic induction of sprouting in white potato by foliar application of gibberellin. Plant Physiol **33**: 132:

Mac-Gillivray, J.H. 1953. Vegetable production Blakiston. New York.

Maharana, U.K., and T. Maharana. 1983. Growth yield, propagation and Taxonomic Studies in spine gourd Types. Unpublished Research Thesis. M.Sc. (Ag.) Bhubaneswar.

Pathanaik, B.P. and K.A. Pattanaik. 1976. Studies on flowering, pollination, Pruitset, fruit development and yield in Momordica dioica, Roxb. Recent Advances in Plant Science, Session 13 Vegetable Crops P. 123.

Piper, S.C. 1950. Soil and Plant analasis. Academic Press. New York.

Randhawa, G.S., and N.C. Pal. 1968. Studies on seed germination and Subsequent seedling growth of grapes Unpublished.

Rappaport, L., L.F. Lippert., and H. Tim. 1957. Sprouting plant growth and tuber formation as affected by chemical treatment of white potato seed pieces. I. Breaking dormancy with Gibberellie acid. Amer Potato Journal **34**: 254.

*Rappaport, L., L.F. Lippert., and H. Tim. (1958) Gibberellin on white potato. Calif. Agr. **12**: 4-14.

Roychoudhury, N., J. Biswas, R.S. Dhua, and S.K. Mitra. 1958. Effect of chemicals on germination, growth and corn yield of gladioeus. Indian Agric. Journal **29**: 215-217.

Sadhu, M.K., and V. Chakravarty. (1980). Growth Kakrol for more profit. Indian Hort. **25**: 5-6.

*Sahai, S., H. Sanarjona, and A.R. Soleh. 1978. Effect of some chemical substances on the breaking dormancy and the effect of early sprouting on yield in potato CV. Rapan 106, Bulletin Penelitian Hortikultura **6**: 43-50.

Sahoo, P.C. and T. Maharana. 1984. Taxonomy Flower biology and crossability study in Momordica dioica Unpublished Research Thesis. M.S.C. (Ag.) Bhubaneswar.

Seshadri, V.S. (1985) Chapter cucurbits, Vegetable Crops in India (by Bose T.K. & Som M.G.) Nayaprakash, Calcutta P. 91-164.

Shanmugavelu K.G. 1989. Production technology of Vegetable crops. Oxford and IBH . Publishing Co. Pvt. Ltd., Delhi. P. 636-637.

*Shikhalia, V.R., and S.C.P. Sachan. 1993. Studies on floral biology, pollen physiology and Fruitset in spine gourd. Momordica dioica, Roxb. Golden Jubillee Symposium, Horticultural Society of India, Bangalore P. 398-399.

Slomicki, I., and I. Rylski, 1964. Effectof cutting and gibberellin treatment on autumn grown seed potato for spring planting. Eur. Potato J. **7**: 184-192.

*Tazuke, A., and R. Sakiyama. 1984. Growth analysis of cucumber fruits on the vine using fruit shape dimensions. Journal of Japaneese Society for Horticultural Sciences **53**: 30-37.

Thompson, H.C., and W.C. Kelly 1957. Vegetable Crops. Mc-growth Hill Publications P. 513-543.

Tripathy, P.K. and T. Maharana. 1990. Studies on production of planting material from stem cutings of spinegourd and pointed gourd. Unpublished Research Thesis M.Sc. (Ag.) Bhubaneswar.

Whitaker, T.W., and G.N. Davis. 1962. Cucurbits. World Crops Books Leonard Hill, New York.

Economic use of tubers of Momordica dioica and its distribution in India Wealth of India Rawmaterials 1962. Counsil of Scientific Research New Delhi.

---

* Original papers not seen.

APPENDIX

APPENDIX I. Paired 't' test for flowering duration, number of of flowers per plant, number of fruits per plant and yield per plant for 1st and 16th July planting

Flowering duration	Number of flowers per plant	Number of fruits per plant	Yield per plant
5.471**	8.904**	13.894**	11.07**
Table t at 5% = 2.262 and at 1% 3.250			

APPENDIX II. Paired 't' test for length of pedicel, length of fruit, circumference of fruit, Rind thickness, individual fruit weight and dry matter content of fruits for 1st and 16th July planting

Length of pedicel	Length of fruit	Circumference of fruit	Rind thickness	Individual fruit weight	Dry matter content of fruit
NS 2.01i	3.212**	5.738**	NS 1.318	15.813**	14.343**
Table 't' at 5% = 2.262 and at 1% 3.250					

APPENDIX III. Analysis of variance for breaking dormancy in tubers

Sources	d.f	S.S.	M.S.	F_{cal}	F_{tab} 5%	F_{tab} 1%
Replication	1	25.681	0.099			
Treatment	12	4084.736	340.395	15.72**	2.69	3.96
Error	12	259.87	21.656			
Total	25	4370.87				