(I) EFFECT OF GROWTH SUBSTANCES ON VEGETATIVE GROWTH AND SEED YIELD, (II) EFFECT OF YEAR OF SEED PRODUCTION ON GERMINATION AND SEEDLING VIGOUR PARAMETERS IN LUCERNE (*Medicago sativa* L.)

By

Arvind Laxmanrao Sonone

A Thesis submitted to the

MAHATMA PHULE AGRICULTURAL UNIVERSITY
RAHURI, DIST:-AHMEDNAGAR
Maharashtra State, (India)

in partial fulfilment of the requirements for the degree of

Master of Science (Agriculture)

in

Seed Technology

DEPARTMENT OF BOTANY
POST GRADUATE INSTITUTE
MAHATMA PHULE AGRICULTURAL UNIVERSITY
RAHURI - 413 722

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Approved :

Dr. F. B. Patil
Research Guide

Dr. D. R. Bapat
Committee Member

S. V. Mahajan
Committee Member

Prof. B. P. Deore
Committee Member

MAHATMA PHULE AGRICULTURAL UNIVERSITY
POST GRADUATE INSTITUTE
RAHURI 413 722
1987

CANDIDATE'S DECLARATION

I hereby declare that this thesis or part thereof has not been submitted by me or any other person to any other University or Institute for Degree or Diploma.

RAHURI

A. L. SONONE

DATED : 6/11/87

Dr. F.B.Patil

Research Officer,
I/C Grass Breeding Scheme,
Mahatma Phule Agricultural University,
Rahuri, 413 722, Dist. Ahmednagar
Maharashtra State, India.

CERTIFICATE

This is to certify that the dissertation entitled (I)"Effect of growth substances on vegetative growth and seed yield, (II) Effect of year of seed production on germination and seedling vigour parameters in Lucerne (*Medicago sativa* L.)", submitted to the faculty of Agriculture, Mahatma Phule Agricultural University, Rahuri, Dist. Ahmednagar, Maharashtra state, India, in fulfilment of the requirements for the degree of MASTER OF SCIENCE (AGRICULTURE) in SEED TECHNOLOGY, embodies the results of a piece of *bona fide* research work carried out by Shri Sonone, A.L., under my guidance and supervision and that no part of the dissertation has been submitted for any other degree or diploma.

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

Rahuri.

Dated : 6-11-1987

Dr. F.B.Patil
Research Guide

Dr. D.S. Ajri

Associate Dean,
Post Graduate Institute,
Mahatma Phule Agricultural University,
Rahuri, 413 722, Dist. Ahmednagar,
Maharashtra State, India.

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Rahuri.

Dated : 7-11-1987

Dr. D. S. Ajri

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Sonone, A.L.

TABLE OF CONTENTS

Table of contents...(Contd...)

Table of contents...(Contd...)

LIST OF TABLES

ABBREVATIONS USED

cc	:	Cubic centimeter
C.D.	:	Critical difference
cm	:	Centimeter
g	:	Gram
ha	:	Hectare
NAA	:	Planofix (Naphthaleneacetic acid)
N.S.	:	Non-significant
q	:	Quintal
S.E.	:	Standard error
TIBA	:	2,3,5-Triiodobenzoic acid
%	:	Per cent

ABSTRACT

(I)"EFFECT OF GROWTH SUBSTANCES ON VEGETATIVE GROWTH AND SEED YIELD,(II) EFFECT OF YEAR OF SEED PRODUCTION ON GERMINATION AND SEEDLING VIGOUR PARAMETERS IN LUCERNE (*Medicago sativa* L.)

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Arvind L. Sonone

A Candidate for M.Sc.(Agri) degree
Mahatma Phule Agricultural University,
Rahuri

1987

Research Guide	:	Dr. F.B.Patil
Department	:	Agricultural Botany
Major discipline	:	Seed Technology

The present investigations were under taken with a view to (i) study the effect of different growth substances (Planofix and TIBA) on vegetative growth and seed yield of lucerne (*Medicago sativa* L.)(ii) maximise the seed yield using TIBA and Planofix at proper stage of growth. The second experiment with first year, second year and third year crop seed was conducted to decide the period (i.e. year) for lucerne seed production.

In the first experiment, two chemicals *viz.*, Planofix and TIBA with three concentrations (50 ppm, 100 ppm and 150 ppm) were sprayed before flowering (S_1) and during flowering (S_2).

The observations on seven different plant characters and six seed characters were recorded. The studies revealed that the means for different treatment combinations including absolute control, differed significantly for all the characters except plant height, weight of husk, seed density, seed volume and seed moisture. The highest seed yield per hectare was recorded with 50 ppm of TIBA sprayed at flowering (S_2) which was followed by the its spray before flowering (S_1) recording 62.80 and 55.68 per cent increase in seed yield respectively over the control.

Abstract....(Contd..)

In the case of Planofix, the concentration of 150 ppm was found better. Number of tillers per m^2 with the sprays of growth substances used were statisticaly more than the control. Germination percentage was improved with the sprays of Planofix and TIBA. The harvest and vigour indices were also improved significantly. Thousand seed weight was maximum with Planofix sprayed at flowering.

In case of laboratory experiment conducted with first year, second year and third year crop seed, the germination was recorded three times at an interval of a month. It was higher and significantly more in the case of seed produced from third year crop and gradually reduced as the period after harvest was enhanced.

Thousand seed weight from third year crop was also higher as compared to the same from first and second year crop. The differences in seed density, seed volume and seed moisture due to different year crop seed, were not significant. In the case of vigour index, same trend was noted as observed in respect of germination percentage.

Third year seed with better germination and vigour index, higher 1000 seed weight and seed volume and low seed moisture and density thus, proved its superiority in respect of seed parameters.

Pages : 1 to 77

Introduction

1. INTRODUCTION

It is believed that alfalfa (*Medicago sativa* L.) was grown in Persia as early as 700 B.C. The history of lucerne until about 1900 A.D. has not been well known and it was treated just like introduction, but now it is slowly distributed all over area. The popularity of this crop however, increased particularly during past decades. Test at Bordon, Manitoda (Canada), over a period of years, have proved alfalfa as the queen of forage crops. It is superior in yield in terms of dry matter, protein and net energy. It is better accepted by live stock and pays a good return on the money invested.

Lucerne as a forage crop was introduced in India around 1900 A.D. In early days, lucerne cultivation was restricted to military farms mainly where it was used exclusively for feeding to military horses. Thereafter, the cultivation of this crop spread around cities and towns, to feed the drought horses. It was grown as a fodder crop in Punjab on about 1600 hectares until, 1947.

In Maharashtra as early as 1906-07, four Turkistan drought resistant strains of lucerne were tried at Dhule. Since then it has spread all over western Maharashtra, Aurangabad district of Marathwada and parts of Vidharbha. The cultivation of this fodder as a cash crop is a prosperious business around Aurangabad, Nasik and Pune district of Maharashtra state.

As pointed out by Ellison (1958) Lucerne is of general merit in agriculture in building and restoring soil fertility and also high quality of forage. One of the main problems its growers facing is the continuous supply of sufficient, high quality seed for sowing. Seed production of this crop has always been thought of as relatively low and varing from place to place and season to season. A lack of sufficient information about crop management could be another limiting factor governing the success of lucerne seed production. Initial research on the approaches for increasing the seed yield started as early as 1935 (Jonson, 1974) however, there is a great need for more detailed studies since seed yield per unit area is a function of seed yield per plant and its components.

Yadava and Patil (1984) observed that the spread of improved varieties of forage depends upon the continuous availability of seed or planting material which is true to type, free from weeds and reliably establishes good pasture when planted.

The final seed yield obtained from this crop is the product of following parameters.

a) The number of shoots which appear on unit area of land.

b) The percentage of these shoots which survive to following time.

c) The percentage of surviving shoots which are fertile.

d) The number of pods formed on the individual inflorescence.

e) The number of seed formed per pod.

f) The weight of the individual seeds.

g) The percentage of seed actually harvested.

h) The percentage of harvested seeds which are viabl(

According to Patil (1985) cultivation of forage crops as a part of normal crop rotation is assuming importance with development of dairy industry in this state. The area under grassland and cultivated crops in the state is approximately 1.57 million hectares and is showing increasing trends. The cattle population is about 2.96 crores but the level of production from it is deplorably low. Among other things, it is due to inadequate and unbalanced feeding of the live stock. For improving the live stock in the state, proper forage and fodder production is therefore, of immense importance. The reports on spray of chemical growth regulators on lucerne have showed good promise in increasing the seed yield potential of this crop. Yadava and Verma (1984) observed increase in seed yield due to sprays of Planofix, ranging from 8.33 to 36.66 per cent over control. Like wise Hale (1971) reported increase in seed yield by 60 per cent over control.

This shows that in the case of crop like lucerne which is shy seed producer and seed is a costly input, the sprays of effective growth regulators at proper stage of the crop may prove most useful to boost the seed production.More over, supply of required quantity of seed is the most important component of forage production.

The another problem in the case of lucerne is year of seed production. The farmers always raise a question; which year i.e. first, second or third year lucerne crop seed is to be used for sowing?. It is therefore, necessary to study the germinability and vigour parameters of lucerne seed produced from different year crop.

Taking in to consideration the above facts, present study entitled "Effect of growth Substances (TIBA and Planofix) on vegetative growth and seed production and effect of first, second or third year crop seed, on germination and seedling vigour parameters of lucerne" was planned with the following objectives.

1. To study the effect of different growth substances (Planofix and TIBA) on vegetative growth and seed yield of lucerne at different growth stages.

2. To maximise the seed yield by using TIBA and Planofix and decide the stage for their sprays.

3. To study the effect of sprays of growth substances on germination and vigour parameters.

4. To study the germination and vigour index of first year, second year and third year crop seed of lucerne.

5. To decide the period (1st year/2nd year/3rd year) for seed production in lucerne.

Review of Literature

2. REVIEW OF LITERATURE

Plant growth substances are usually defined as average compounds, other than nutrients, which in small concentrations, affect the physiological processes of plants.

They are also defined as either natural or synthetic compounds that are applied to a plant so as to enhance yield, improve the quality or to facilitate the harvesting. The response of a plant or plant part to a growth substance may vary with the variety of the crop plants. Even a single variety may respond differentaly, depending on its age; environmental conditions and physiological stage of development.

Reports regarding the effects of growth substances on growth characters and yield attributes of lucerne are meagre. The available liturature in respect of lucerne and other forage crops was reviewed and is presented below.

2.1 Effect of growth substances on vegetative growth :

Massengale and Medler (1958) observed that spraying with different growth regulators, altered the height of plant, length of internodes and flowering responses of alfalfa crop. Stoddart (1961) reported shorter stems more branching and a higher percentage of head emerging with the sprays of growth regulators in the first ten days of flowering. The time of commencement of flowering was not affected. Edey and Byth (1970) reported that application of TIBA also increased tillering of established lucerne plants. Hale (1971) reported that in the case of alfalfa, TIBA stimulated an increase in number of stems per plant and the greater number of stems probably accounted for the increased seed weight. TIBA retarded vegetative growth.

Yadava and Verma (1979) studied the seed germination of different Medicago species following various chemical and physical treatments. Sulphuric acid (10 min.), Thiourea (100 ppm), Gibberllic acid (100 ppm) and aternating temperature (24 hr. cold/15 min. hot) treatments increased germination percentage than the same in case of control in all the species tested. Other treatments were species-specific. There were also differences in the response of the species to the treatments in relation to shoot and root length of germinating seedling. Galston (1947) revealed TIBA not possessing floregenic properties. Morphological responses of vegetative soyabean plant to TIBA suggested that TIBA caused auxin aberrations with the plants.

Greer and Anderson (1965) revealed that 2,3, 5-T sprayed at beginning of flowering in soyabean caused the plants to change from vegetative to reproductive development more rapidally than normal. The anti-auxin chemical also caused morphological changes in leaf size and in canopy shape of row, which logically allowed the plants to utilize sunlight more effectively. These two type of effects of the chemical caused an increase in seed yield.

Yadava and Patil (1976) reviewed the literature on growth regulators in forage crops and observed that their application especially increased germination, vegetative growth, seed yield and were useful for breaking dormancy. Rigger and Eggers (1974) observed that when, TIBA was sprayed on blue grass plant between 5 and 8 week after sowing with highest concentration (100 and 1000 ppm) produced significantly more tillers, Seed head formation however, was decreased particularly when the plants were sprayed at later stage tested.

2.2 Effect of growth substances on seed yield :

Feltner and Sackett (1964) revealed that when low rates of 2,4, 5-T were applied to alfalfa plant, at early flowering stage, produced on an average 19 per cent more seed yield than control plants. Volume, sugar concentration and ratio of sugar components (sucrose, fructose and Glucose) of nectar from flower of 2,4,5-T treated and untreated alfalfa plants were studied in green house and laboratory. The sugar components in nectar from treated plants were nearly in 1:1:1 ratio than its untreated plants. All these factors may influence bee visits to the crop. Phillips (1975) observed that seed yield of alfalfa was not increased due to increased number of seeds per pod & number of podsper raceme with application of TIBA.

Yadava and Verma (1984) pointed out that lucerne seed yield was increased by lower dose of Planofix to the extent of 8.33 to 36.66 over control. However, 50 ppm of Planofix was found to be the best concentration for lucerne seed production. Pandey (1975) observed differential requirement of harmones, maximum production of biomass and grain yield with application of Planofix. Low concentrations were found effective in two phases of growth in both the legumes tried. On the other hand, high concentrations were effective at (flower abscission) first phase of growth.

Kapoor (1976) studied the effects of foliar application of Planofix at the flower initiation stage and 15 days latter on seed yield of sudan grass. The yields were higher at 20 ppm Planofix. But the differences were not significant in yield from the ratoon crop.

Yadava and Verma (1980) revealed that growth regulators have varied effects on growth and development of cowpea plant. Planofix caused several physiological effects in growth and development of plants. However, the increased grain yield caused by growth substances was directly associated with the enhancement in the number of grains per pod, length of pods and 1000 grain weight. 100 ppm Ethrel and 10 ppm Planofix gave significantly more seed yield over control. Increase in seed yield over control was to the tune of 9.77 to 44.67 per cent.

2.3 Effect of growth substances on other crops :

Shahidullah and Hossain (1974) reported that NAA at 10 ppm applied to pine apple plants induced 90 per cent of the plants to flower, compared with 53 per cent in untreated plants Mote et al. (1975) observed that Planofix sprayed on chillies with 10, 25 or 50 ppm at full bloom and 20 days later, effectively controlled flower drop and yield were increased up to 41 per cent. The optimum concentration appeared to be 50 ppm.

Warade and Singh (1977) applied Planofix to chillies at 0, 100, 200 and 300 ppm concentrations as a seed treatment and as foliar sprays at 4-6 leaf stage, first bud stage and bloom stage and observed early flowering, increased fruit set, fruit size and yield per plant. Planofix at 200 ppm applied at bloom stage had given maximum fruit set percentage (70.5), volume of fruit (11.866) and yield per plant (0.741 kg) against 52.16, 6.26 (cc), and 0.541 kg respectively in the case of control. Misra et al. (1979) studied preharvest drop in apple and responsed that the Planofix applied 20 days before harvest, reduced the fruit drop. The respective fruit drops in control trees were 20 to 25 per cent. A fortnight delay in picking showed heavy drop of fruits in control trees, but Planofix (10 ppm) checked this drop significantly. The fruit weight and quality was unaffected by these treatments.

Bal et al. (1984) with the studies on ber trees reported that NAA and 2,4,5-T each at 10 to 50 ppm just after fruit set (13, Oct.) and again at one month after first spray (13,Nov.) reduced the fruit drop most effectively by 2,4,5-T at 25 ppm, which also resulted in heaviest fruits. Stone weight was decreased most by NAA at 25 ppm.

Bhattacharya and Rao (1984) reported that the application of TIBA at 50-200 ppm to papaya at the brown stigma stage and twice more at 15 days intervals, reduced the mean number and weight of seeds/fruit and mean germination percentage at the highest dose of TIBA.

Subbian and Chamy (1984) found that two foliar applications of 20 and 40 ppm NAA to green gram, increased number of flowers and pods per plant and also increased percentage of pod set and seed yield.

Chua and Talib (1985) found that shoot development in *Piper nigrum* was significantly enhanced in *vitro* by adding NAA on Murashige and Skoog medium with NAA at 0.1 ppm. Root weight per plant increased by 82 per cent compared with medium with NAA added.

Sarkar et al. (1985) studied the effect of NAA on litchi trees with 10 to 60 ppm concentrations applied during panicle emergance and again at completion of fruit set. The highest fruit set of 37.3 per cent, lower fruit drop (54.5 per cent), good fruit size and best quality were obtained with NAA at 40 ppm.

Singh et al. (1985) showed that Planofix at 100 ppm and 150 ppm applied 14 days before harvest gave the greatest reduction in berry drop in Himred grapes.

Goubran and Elzeftawi (1986) revealed that NAA at 20 ppm applied during full bloom produced seedless fruit in loquate Low concentration reduced the number of seed by half. Seedless fruits were smaller, elongated and matured 4-5 weeks earliar than seeded fruits.

Vegera (1986) found that NAA (0.01%) applied 10 days after flowering increased yield and improved fruit quality of apple. Zarasingh and Dhillon (1986) pointed out that the incidence of floral malformation in mango was reduced by spraying with NAA at 200 ppm prior to flower bud differentiation. NAA (200 ppm) followed by deblossoming resulted in highest percentage of flowers in malformed panicles.

Hradilik and Kalorik (1986) studied the effects of growth regulators applied immediately after flowering on flax cultivars which were susceptible to spontaneious dehiscence when grown under warm, dry condition. Application of 100 mg TIBA/Liter induced branching in all the cultivars as well as increased flower bud formation and prolonged growing season.

Zayed (1986) revealed that TIBA significantly decreased the length of the main stem of cucumber. At the lower rate, the compounds increased dry weight of plant and also increased leaf chlorophyll content, TIBA at 100 mg/Lit. produced the highest yield.

2.4 Effect of other factors on seed production :

Hason (1961) determined the pollen viability of alfalfa by applying an undetermined number of pollen grains to the stigma of male sterile blossoms and obtaining the percentage of blossoms setting pods and the number of seeds in each pod. The longevity of pollen left in the blossom was about equal to the life of the untripped blossom which ranged from about 8 to 15 days. The overies were apparentaly fully functional for about a week.

Rychtarik (1970) observed the highest average seed yield of red clover (171.1 kg/ha) by cutting at bud stage. Cutting 6 days before or after budding decreased yield by 20.6 and 20.5 per cent. Further, delay in cutting decreased yield.

Rai and Joshi (1977) conducted the field experiment to study the effect of sowing dates and seed rate on seed yield and germination ability of berseem which revealed that seed rates did not affect the seed yield. Among the sowing dates, crop sown on Oct., 11 gave 86.6, 100 and 41.05 per cent higher yield in first, second and third year respectively, when compared with the crop sown on Nov., 10. Storage of seed up to September, increased germination percentage by 26-30 per cent over fresh harvested seed. Sharma and Sharma (1978) found that when lentil seed from the store house of eight different localities were tested for seed moisture percentage and seed germination percentage, a direct correlation was obtained between seed moisture and seed germination. High moisture content of seed showed low percentage of germination. The study clearly indicated that high moisture content results in reducing germination percentage.

Wurr and Fellows (1985) observed significant differences between the seed vigour of lettuce seed stocks. Vigour was not correlated with mean seed weight. However, heavier plant with longer cotyledons at transplanting and heavier heads at maturity were significantly correlated with seed vigour. The head weight at maturity was not correlated with root length. The root length measured in the plant was significantly correlated with seed weight.

Zubal (1986) investigated the influence of cross pollination on seed yields of *Medicago sativa* and observed in the field trials using larger exclusion cage, the seed yields of 44.8 kg/ha with self pollination and 629.33 kg/ha from cross pollination. Seed yields were significantly increased by 18.31 kg/ha by foliar application of Mo and B at bud formation stage. Nutritional status with respect to B and Mo did not influence the number of visits to the stands by honey bees. Seed yield was affected by climate rather than number of bees.

There are almost no reports available on the effect of first year, second year and third year lucerne crop seed, on germination, vigour and yield.

Chapter Opener Page

Material and Methods

3. MATERIALS AND METHODS

A field experiment with a view to study the effect of growth substances on vegetative growth and seed production of lucerne (Medicago sativa L.), was conducted during summer, 1986, at Grass Breeding Scheme, Department of Botany, Mahatma Phule Agricultural University, Rahuri, Maharashtra state. A laboratory experiment was also initiated, to study the effect of first year, second year and third year lucerne crop seed, on the germination and vigour parameters, at the Seed testing laboratory, of this Department.

The details of material and methods used are presented in this chapter.

3.1 Preparation of land :

The field experiment was conducted on the third year crop, established by Grass Breeding Scheme, Rahuri, on medium black, well drained soil. The soil before establishing the crop in first year, was brought to fine tilth by giving heavy ploughing followed by harrowing.

3.2 Fertilizer application :

FYM @ 20 t was mixed in the soil and a basal dose of 15 kg N and 160 kg P_2O_5 per hectare, was applied before sowing. In subsequent years, a dose of 80 kg P_2O_5/ha was given, as lucerne crop gives good response to phosphatic fertilizers.

3.3 Experimental layout :

The experiment was laid out in a factorial randomised block design with thirteen treatments replicated four times. The gross plot size was 2.40 x 3.60 m^2 and the net plot size was 1.5 x 3.0 m^2. The experiment under laboratory conditions was conducted in a completly randomised block design with six treatments replicated four times.

3.4 Seeds :

The field experiment involved the adapted variety, Sirsa-9 while, for the laboratory experiment, the seeds of two varieties of lucerne viz., Sirsa-9 and Poona-1-B were obtained from Grass Breeding Scheme, Mahatma Phule Agricultural University, Rahuri.

3.5 Inter culturing and after care :

Weedings were given as and when required to keep the crop free from weeds and in a healthy condition and the care was taken to irrigate the crop from time to time.

3.6 Treatments :

Two growth substances viz., Planofix and TIBA were used in the fieldexperiment. The details of concentrations, stages of the crop at which sprays were given are described below.

3.6.1 Stages : 2

A) S_1 - Spray before flowering

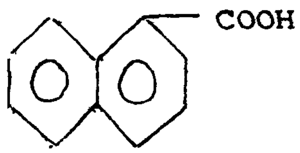
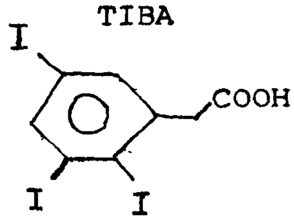
B) S_2 - Spray at flowering i.e. 15 days after first spray.

3.6.2 Chemicals : 2

A) C_1 - Planofix (NAA)

B) C_2 - 2,3,5-T = Triiodobenzoic acid (TIBA)

The details of the chemicals used are as below (Nickell, 1982).

Growth regulator :	Planofix :	TIBA
Chemical name	Naphthaleneacetic acid	2,3,5-Triiodobenzoic acid
Common name	NAA	TIBA
Structure		
Trade name(s)	Tree-Holds, Phymone, Rootone, fruitone-N, Transplantone, Niagara silk	Regim-8
Oral LD 50, Mg/kg[a]	1,000-5,900	813
Use(s)	Fruit thinner, flowering agent, tree fruit thinner, preventer of preharvest fruit drop, root inducer	Growth retardent, increaser of pod

3.6.3 Level of concentrations (sub-sub treatments) :

A) L_1 - 50 ppm

B) L_2 - 100 ppm

C) L_3 - 150 ppm

Thus total treatment combinationswere -

T_1 = 50 ppm Planofix at stage one ($S_1C_1L_1$)

T_2 = 100 ppm Planofix at stage one ($S_1C_1L_2$)

T_3 = 150 ppm Planofix at stage one ($S_1C_1L_3$)

T_4 = 50 ppm TIBA at stage one ($S_1C_2L_1$)

T_5 = 100 ppm TIBA at stage one ($S_1C_2L_2$)

T_6 = 150 ppm TIBA at stage one ($S_1C_2L_3$)

T_7 = 50 ppm Planofix at stage two ($S_2C_1L_1$)

T_8 = 100 ppm Planofix at stage two ($S_2C_1L_2$)

T_9 = 150 ppm Planofix at stage two ($S_2C_1L_3$)

T_{10} = 50 ppm TIBA at stage two ($S_2C_2L_1$)

T_{11} = 100 ppm TIBA at stage two ($S_2C_2L_2$)

T_{12} = 150 ppm TIBA at stage two ($S_2C_2L_3$)

T_{13} = Absolute control (A.C.)

3.7 Preparation and application of solutions :

The stock solutions of Planofix and TIBA were prepared in laboratory after taking in to consideration their active ingredients. Thus one m.l. active ingredient of Planofix was dissolved in one litre of distilled water so as to get

1000 ppm stock solution. Similarly one gram of TIBA was dissolved in one litre of distilled water so as to get 1000 ppm stock solution. The required concentrations were made by diluting the stock solutions at the time of application. The sprays were done as per stages selected for the study.

3.8 Growth characters :

Growth observations were recorded on 10 tillers selected randomely from each net plot. These ten tillers were marked by tagging white lables to each selected plant.

Following growth observations were recorded.

3.8.1 Height of the crop :

The height of 10 tillers (cm) was measured from ground level to the base of fully emerged top leaf and the average was worked out which represented the height of the crop.

3.8.2 Number of tillers in 1 x 1 m^2 plot :

The number of tillers per square meter of land were counted in each replication and averaged over replications.

3.9 Yield components :

The observational tillers were harvested separately from each treatment in each replication. Following post harvest observations were recorded.

1. Seed weight per 10 tillers (g)
2. Husk weight (g)
3. Thousand seed weight (g)

Seed yield per net plot was also recorded.

3.10 Harvest index :

Harvest index was calculated using following equation :

$$H.I. = \frac{\text{Dry grain weight}}{\text{Total dry weight of the plant}} \times 100$$

3.11 Laboratory studies :

Following vigour parameters and seed characters were recorded in laboratory.

3.11.1 Seed germination :

Seed germination was determined using four replications each of 100 seeds at 20°c by between paper (BP) method in paper towel. The final count was recorded after 10 days (Anonymous, 1976). The germination percentage was determined on the basis of normal seedlings only.

3.11.2 Vigour index :

Ten normal seedlings from each replication of germination test, were selected randomly and root and shoot length of each seedling was measured in cm. On the basis of average root and shoot length, the vigour index was calculated using formula given by Abdul-Baki et al. (1973).

Vigour Index = (Root length + shoot length) x Germination %

3.11.3 Seed moisture :

The seed moisture content was determined by using drying temperature of 130-133°c for one hour (Anonymous, 1976). The moisture content as a percentage by weight was calculated by means of following formula :

$$M_2 - M_3 \times \frac{100}{M_2 - M_1}$$

Where,

M_1 = Weight in grams of the container and its cover.

M_2 = Weight in grams of the container, its cover and its contents before drying and

M_3 = Weight in grams of the container, cover and contents after drying.

3.11.4 Seed volume and seed density :

The seed volume was calculated by displacement of water method on weight basis and from the seed volume, seed density was calculated by the following formula.

$$\text{Seed density (g/CC)} = \frac{\text{Seed weight (g)}}{\text{Seed volume (CC)}}$$

3.12 Statistical analysis :

The data was analysed statistically for analysis of variance as per Chochran and Cox (1957). The means were calculated and presented with appropriate standard errors and critical differences at 5 per cent level of significance.

Results

4. EXPERIMENTAL RESULTS

The field experiment, to study the effects of growth substances on vegetative growth and seed production of lucerne (Medicago sativa) was conducted during summer, 1986 and the results obtained are presented in this chapter.

4.1 Mean performance and analysis of variance :

The means for different treatment$ combinations (Table 1) including absolute control, differed significantly for all the characters except plant height, weight of husk, seed density, seed volume and seed moisture. The plant height was maximum with the treatment combination, $S_1 C_1 L_2$ (94.45 cm) while, absolute control had the crop with minimum height (82.50 cm). Weight of husk per 10 tillers was the highest(5.33 g) with the treatment of TIBA (100 ppm) sprayed at preflowering ($S_1C_2L_2$), however, the seed weight from 10 tillers was maximum with Planofix (150 ppm) sprayed at both the stages i.e. pre and at flowering. The obsolute control had the lowest estimates for both the traits.

The highest seed yield per hectare (186.159 kg) was recorded with the treatment of TIBA with 50 ppm sprayed at flowering ($S_2C_2L_1$) which was followed (178.248) by the same growth regulator with the same concentration, but sprayed at preflowering stage. All the treatments except the higher concentrations of TIBA (150 ppm) sprayed at both the growth

Table 1. Mean performance for different treatment combinations.

Treatment	Plant height (cm)	Weight of husk (10 tillers) (g)	Weight of seeds (10 tillers) (g)	No. of tillers in 1 x 1 m^2	Seed yield (kg/ha)	Harvest index	1000 seed weight (g)	Seed germination (%)	Seed volume (cc)	Seed density (g/cc)	Seed moisture (%)	Vigour index
$S_1C_1L_1$	84.08	3.40	3.18	358.00	159.006	0.19	2.72	89.00	2.35	0.84	11.67	1557.10
$S_1C_1L_2$	94.45	3.23	2.70	322.50	149.829	0.20	2.71	86.00	2.25	0.89	13.32	1194.25
$S_1C_1L_3$	89.96	5.32	3.78	359.50	169.605	0.20	2.75	91.00	2.25	0.80	12.49	1172.83
$S_1C_2L_1$	84.05	3.70	3.08	329.50	178.248	0.21	2.67	81.00	2.28	0.93	12.48	1071.93
$S_1C_2L_2$	83.28	5.33	3.55	374.50	158.495	0.26	2.71	91.50	2.10	0.98	12.49	1197.73
$S_1C_2L_3$	89.90	3.53	2.85	310.00	131.831	0.21	2.69	86.00	2.13	0.94	11.65	1225.95
$S_2C_1L_1$	86.90	2.50	3.23	375.00	159.495	0.20	2.79	89.50	2.18	0.92	12.69	1193.83
$S_2C_1L_2$	89.75	2.75	2.93	363.50	151.873	0.19	2.72	88.50	2.10	0.95	13.13	1127.35
$S_2C_1L_3$	86.42	4.73	3.80	304.50	166.650	0.22	2.70	91.50	2.15	0.93	11.65	1248.05
$S_2C_2L_1$	85.93	4.18	3.70	383.75	186.159	0.21	2.75	87.50	2.30	0.87	13.33	1117.65
$S_2C_2L_2$	88.78	3.83	3.30	361.75	168.938	0.20	2.68	83.50	2.15	0.94	12.49	1176.53
$S_2C_2L_3$	84.13	4.78	2.73	339.50	140.319	0.19	2.69	84.60	2.18	0.91	12.49	1084.83
A.C.	82.50	2.48	2.53	301.00	114.490	0.17	2.62	79.99	2.18	0.88	11.65	970.85
S.E.	3.43	0.72	0.27	28.01	11.44	0.02	0.024	2.04	0.077	0.03	1.40	38.49
C.D.	N.S.	N.S.	0.76	77.65	32.84	0.05	0.066	5.67	N.S.	N.S.	N.S.	106.69

stages recorded significantly higher seed yield than the absolute control (114.49 kg/ha). The treatment differences were also significant and the percentage increase in seed yield by the former ($S_2C_2L_1$) and latter treatments($S_1C_2L_1$) over control was 62.60 per cent and 55.68 per cent respectively. It was interesting to note that all the treatment combinations recorded increased seed yield as compared to absolute control.

Number of tillers per m^2 were significantly more than the control in the case of same treatment combination ($S_2C_2L_1$)which recorded the highest seed yield. However, 1000 seed weight was maximum (2.79 g) and statistically more than control with the treatment of Planofix (50 ppm) sprayed at second stage ($S_2C_1L_1$)which was followed by $S_1C_1L_3$(2.75g).

Germination percentage was observed to be improved with sprays of Planofix and TIBA with all the concentrations and at both stages. The increase was the highest and statistically more in the case of treatments <u>viz</u>., $S_1C_2L_2$ and $S_2C_1L_3$(91.5 % each) than that from control (79.99%).

In the case of seed volume, seed density and seed moisture, the highest estimate recording combinations were $S_1C_1L_1$,$S_1C_2L_2$ and $S_2C_2L_1$ respectively. The absolute control had the lowest estimates for all the three characters.

Vigour index was also significantly improved in the case of all the treatments with Planofix and TIBA as compared to the same from control. Increased harvest index was also observed for all the treatment combinations. The highest estimate recording combinations were $S_1C_1L_1$ for the former and $S_1C_2L_2$ for the latter character.

4.2 Interaction effects :

4.2.1 Vegetative growth and yield characters :

4.2.1.1 Height :

The interaction effects in respect of plant height are presented in Table 2, which revealed that the plant height with the treatments of Planofix and TIBA was at par. It is interesting to note that Planofix and TIBA irrespective of concentrations and method of application could not increase the plant height significantly over control.

The effects of chemicals were also statistically non-significant. Among the chemicals tried, the crop treated with Planofix had numerically more plant height (88.59 cm) than the TIBA (86.05 cm).

The concentrations used also could not affect the plant height significantly. However, the plants sprayed with 100 ppm concentration had more height as compared to other concentrations.

Table 2. Interaction effects for plant height (cm)

Stages x chemicals

Chemicals : Stages	Planofix	TIBA	Mean
S_1	89.5	85.74	87.62
S_2	87.69	86.27	86.98
Mean	88.59	86.05	-

	S.E. ±	C.D. at 5%
Stage	2.43	N.S.
Chemicals	2.43	N.S.
Chemicals x stage	1.98	N.S.

Chemicals x Levels

Levels : Chemicals	50 ppm	100 ppm	150 ppm	Mean
Planofix	85.48	91.1	88.2	88.59
TIBA	84.98	86.02	87.01	86.00
Mean	85.23	89.06	87.70	-

	S.E. ±	C.D. at 5%
Chemicals	1.98	N.S.
Levels	2.43	N.S.
Chemicals x Levels	1.40	N.S.

Stages x Levels

Levels : Stages	50 ppm	100 ppm	150 ppm	Mean
S_1	84.06	88.86	89.93	87.62
S_2	86.41	89.26	85.27	86.98
Mean	85.23	89.06	87.70	-

	S.E. ±	C.D. at 5%
Stages	1.98	N.S.
Levels	2.43	N.S.
Stages x levels	1.40	N.S.

The differences due to spraying the solutions at different stages and the interactions between stages x chemicals, chemicals x levels and stages x levels were also non-significant.

4.2.1.2 Weight of husk (10 tillers) :

The differences in weight of husk of 10 tillers due to chemicals were statistically non-significant (Table 3) at all the stages of crop. Among the chemicals tried, TIBA had higher weight of husk (3.88 g). The interaction, stages x chemicals was also non-significant. The differences due to levels of concentrations were also non-significant while, the interaction, chemicals x levels was significant. The highest weight of husk from 10 tillers was recorded with 150 ppm in the case of both the individual chemicals i.e. Planofix and TIBA (5.02 and 4.15 g respectively) and also over the chemicals (4.58 g).

The interaction stages x levels of concentrations was significant. The weight of husk was significantly more with the concentration of 150 ppm at both the stages, than rest of the concentrations.

4.2.1.3 Weight of seeds from 10 tillers :

The data on weight of seeds from ten tillers presented in Table 4 revealed non significant differences due to stages, chemicals and levels of chemicals tried. Similarly all the interactions effects observed were also non-significant.

Table 3. Interaction effects for weight of husk/ 10 tillers from (g)

Stages x chemicals

	Planofix	TIBA	Mean
S_1	3.98	3.51	3.74
S_2	3.32	4.25	3.78
Mean	3.65	3.88	-

	S.E. ±	C.D. at 5%
Stages	0.51	N.S.
Chemicals	0.51	N.S.
Stages x chemicals	0.41	N.S.

Chemicals x Levels

	50 ppm	100 ppm	150 ppm	Mean
Planofix	2.95	2.98	5.02	3.65
TIBA	3.93	3.57	4.15	3.88
Mean	3.44	3.27	4.58	-

	S.E. ±	C.D. at 5%
Chemicals	0.41	N.S.
Levels	0.51	N.S.
Chemicals x levels	0.29	0.84*

Stages x Levels

	50 ppm	100 ppm	150 ppm	Mean
S_1	3.55	3.27	4.42	3.74
S_2	3.33	3.28	4.75	3.78
Mean	3.44	3.27	4.58	-

	S.E. ±	C.D. at 5%
Stages	0.41	N.S.
Levels	0.51	N.S.
Stages x levels	0.29	0.84*

Table 4. Interaction effects for seed weightfrom 10 tillers (g)

Stages x chemicals

	Planofix	TIBA	Mean
S_1	3.21	3.15	3.18
S_2	3.30	3.25	3.28
Mean	3.26	3.20	-

	S.E. ±	C.D. at 5%
Stages	0.18	N.S.
Chemicals	0.18	N.S.
Stages x chemicals	0.15	N.S.

Chemicals x levels

	50 ppm	100 ppm	150 ppm	Mean
Planofix	3.20	2.81	3.78	3.26
TIBA	3.38	3.43	2.78	3.20
Mean	3.29	3.12	3.28	

	S.E. ±	C.D. at 5%
Chemicals	0.15	N.S.
Levels	0.18	N.S.
Chemicals x levels	0.10	N.S.

Stages x Levels

	50 OOm	100 ppm	150 ppm	Mean
S_1	3.12	3.12	3.31	3.18
S_2	3.46	3.12	3.26	3.28
Mean	3.29	3.12	3.28	-

	S.E. ±	C.D. at 5%
Stages	0.15	N.S.
Levels	0.18	N.S.
Stages x levels	0.10	N.S.

Planofix among the chemicals, 50 ppm among the concentrations and the sprays at flowering (S_2), among the stages recorded the highest seed weight.

Though the individual factors had non significant differences for their effects, five treatment combinations <u>viz.</u>, $S_1C_1L_3$, $S_1C_2L_2$, $S_2C_1L_3$, $S_2C_2L_1$ and $S_2C_2L_2$ recorded significantly more seed weight as compared to absolute control (Table 1).

4.2.1.4 Number of stems in 1 x 1 m^2 :

It is observed that the differences in number of stems per m^2 plot due to chemicals, stages, levels of chemicals and their interactions were non significant (Table 5). However, the different treatment combinations exhibited significant differences for this trait when compared with absolute control (Table 1). TIBA among the chemicals (349.23), 100 pmm among the concentrations (355.56) and stage second among the stages (354.66) recorded the highest number of stems per m^2. Though all the treatment combinations recorded higher number of stems as compared to the same from absolute control, the only one treatment i.e. $S_2C_2L_1$ recorded significantly more stems per m^2 than control (Table 1).

4.2.1.5 Harvest index :

The interaction effects (Table 6) revealed significant differences in the harvest indices due to chemicals,

Table 5. Interaction effects for number of stems in 1 x 1 m^2 plot.

Stages x chemicals

	Planofix	TIBA	Mean
S_1	346.66	338.00	342.33
S_2	347.66	361.66	354.66
Mean	347.16	349.23	-

	S.E. ±	C.D. at 5%
Stages	19.81	N.S.
Chemicals	19.81	N.S.
Stages x chemicals	16.19	N.S.

Chemicals x Levels

	50 ppm	100 ppm	150 ppm	Mean
Planofix	366.50	343.00	332.00	347.16
TIBA	356.60	368.12	324.75	349.81
Mean	346.55	355.56	328.37	-

	S.E. ±	C.D. at 5%
Chemicals	16.19	N.S.
Levels	19.81	N.S.
Chemicals x levels	11.43	N.S.

Stages x Levels

	50 ppm	100 ppm	150 ppm	Mean
S_1	343.75	348.50	334.75	342.33
S_2	379.37	362.62	322.00	354.66
Mean	346.55	355.56	328.37	-

	S.E. ±	C.D. at 5%
Stages	16.19	N.S.
Levels	19.81	N.S.
Stages x levels	11.43	N.S.

Table 6. Interaction effects for harvest index.

Stages x chemicals

	Planofix	TIBA	Mean
S_1	0.193	0.225	0.209
S_2	0.201	0.199	0.200
Mean	0.197	0.212	-

	S.E. ±	C.D. at 5%
Stages	0.01	0.286
Chemicals	0.01	0.286
Stages x chemicals	0.01	0.286

Chemicals x Levels

	50 ppm	100 ppm	150 ppm	Mean
Planofix	0.193	0.190	0.208	0.197
TIBA	0.207	0.230	0.199	0.202
Mean	0.200	0.210	0.203	-

	S.E. ±	C.D. at 5%
Chemicals	0.01	0.286
Levels	0.01	0.286
Chemicals x levels	0.01	0.286

Stages x Levels

	50 ppm	100 ppm	150 ppm	Mean
S_1	0.197	0.227	0.203	0.209
S_2	0.203	0.193	0.204	0.200
Mean	0.200	0.210	0.104	-

	S.E. ±	C.D. at 5%
Stages	0.01	0.286
Levels	0.01	0.286
Stages x levels	0.01	0.286

stages, levels of chemicals and all their interactions like stages x chemicals, levels x chemicals and stages x levels. TIBA among the chemicals (0.212), spraying at pre flowering (0.209) and 100 ppm (0.210) among concentrations recorded the highest harvest indices.

TIBA sprayed at S_1 (Table 6) had the highest estimate of harvest index (0.225), which was followed by the same with the spraying of Planofix at flowering (0.201).

The data presented in Table 1 indicated that the mean harvest index was higher under treatment $S_1C_2L_1$ which was significantly more than the control. All other treatments also recorded significantly more harvest index than the absolute control.

TIBA with 100 ppm (0.230) and the spray of 100 ppm at S_1 (0.227) also exhibited the highest harvest indices among the respective interaction effects which were statistically significant over rest of the interaction effects.

4.2.1.6 Seed yield (kg/ha) :

Though the differences due to various treatments of growth regulators as compared to control were significant, (Table 1), the data presented in Table 7 revealed non-significant differences in seed yield among the chemicals, concentrations and stages of sprays. The interactions, stages x chemicals,

Table 7. Interaction effects for seed yield (kg/ha).

Stages x chemicals

	Planofix	TIBA	Mean
S_1	159.472	156.228	157.850
S_2	161.561	165.139	163.350
Mean	160.516	160.683	-

	S.E. ±	C.D. at 5%
Stages	8.088	N.S.
Chemicals	8.088	N.S.
Stages x Chemicals	5.710	N.S.

Chemicals x Levels

	50 ppm	100 ppm	150 ppm	Mean
Planofix	162.583	150.851	168.138	160.516
TIBA	182.204	163.716	136.141	160.683
Mean	172.393	157.283	152.139	-

	S.E. ±	C.D. at 5%
Chemicals	6.590	N.S.
Levels	8.088	N.S.
Chemicals x levels	4.666	N.S.

Stages x Levels

	50 ppm	100 ppm	150 ppm	Mean
S_1	168.627	154.162	150.784	157.850
S_2	176.160	160.406	153.495	163.350
Mean	172.393	157.253	152.139	-

	S.E. ±	C.D. at 5%
Stages	6.590	N.S.
Levels	8.088	N.S.
Stages x levels	4.666	13.391

chemicals x levels were also non-significant. However, the interaction, stages x levels was significant.

The differences in mean seed yield due to Planofix and TIBA were very marginal (160.516 and 160.683 kg/ha respectively). The concentration of 50 ppm (172.393 kg/ha) and sprays at flowering (163.350 kg/ha) stage (S_2) recorded numerically the highest mean seed yield. The interaction $S_2 L_1$ i.e. spray of 50 ppm at S_2 (176.160 kg/ha) yielded the highest which was significantly more than the rest of interaction effects of this type. It was followed by the spray of the 50 ppm at pre flowering (168.627 kg/ha).

All the treatments of the chemicals recorded higher seed yield as compared to control. However, sprays of TIBA with 50 ppm at both the stages of growth (S_1 and S_2) with increase in seed yield of 55.68 per cent and 62.80 per cent respectively were found most beneficial. It was interesting to note that the sprays of the same chemical (TIBA) with higher concentrations (150 ppm) at both the stages were not as high yielding as the sprays with lower concentrations.

4.2.2 Seed characters :

4.2.2.1 1000 seeds weight :

It can be seen from the data presented in Table 1 that seed weight was affected by foliar sprays of the chemicals significantly as compared to the control. All the treatment combinations except the treatments, $S_1C_2L_2$, $S_1C_1L_3$, $S_2C_1L_1$ and $S_2C_2L_1$, showed higher thousand seed weight.

The data for interactions (Table 8) revealed significant differences in 1000 seed weight, due to stages of sprays, chemicals, levels of concentration of the chemicals and their interactions.

Seed weight with the sprays of TIBA was significantly more (2.69 g) than that from the crop sprayed with Planofix (2.50 g). However, among the stages, the sprays at second stage (2.71 g) recorded significantly more 1000 seed weight than the sprays at S_1 (2.48 g). Planofix with 50 ppm sprayed at S_2 ($S_2C_1L_1$) exhibited the highest seed weight (2.79 g). Among the concentrations, the highest mean 1000 seed weight was obtained with the sprays of 50 ppm (2.73 g) which was on par with the same of 100 ppm and significantly more than the seed weight obtained with 150 ppm. Planofix with 50 ppm among the chemicals x levels interaction, recorded the highest seed weight, (2.75 g) which was significantly more than rest of the interactions.

Among the interactions, stages x levels, sprays with 50 ppm at S_2 (2.77 g), recorded the highest seed weight which was significantly higher than rest of the interaction effects of this type.

Table 8. Interaction effects for 1000 grain seed weight(g).

Stages x chemicals

	Planofix	TIBA	Mean
S_1	2.57	2.69	2.48
S_2	2.73	2.69	2.71
Mean	2.50	2.69	-

	S.E. ±	C.D. at 5%
Stages	0.015	0.04
Chemicals	0.015	0.04
Stages x chemicals	0.012	0.03

Chemicals x Levels

	50 ppm	100 ppm	150 ppm	Mean
Planofix	2.75	2.71	2.72	2.50
TIBA	2.71	2.69	2.66	2.69
Mean	2.73	2.70	2.69	-

	S.E. ±	C.D. at 5%
Chemicals	0.012	0.03
Levels	0.015	0.04
Chemicals x levels	0.009	0.025

Stages x Levels

	50 ppm	100 ppm	150 ppm	Mean
S_1	2.69	2.70	2.72	2.48
S_2	2.77	2.70	2.67	2.71
Mean	2.73	2.70	2.69	-

	S.E. ±	C.D. at 5%
Stages	0.012	0.03
Levels	0.015	0.04
Stages x levels	0.009	0.025

4.2.2.2 Seed germination percentage :

The data summarised in Table 1 revealed significant differences due to treatments. The combinations $S_1C_2L_2$, $S_2C_1L_3$ (91.5% each) gave the highest germination percentage. Seed germination was increased with the sprays of both the chemicals. The increase in germination percentage with all the treatments except three viz., $S_1C_2L_1$, $S_2C_2L_2$ and $S_2C_2L_3$, was significantly more than the control.

The effects of chemicals, stages of sprays, and level of concentrations of the chemicals, when tested among themselves, were however, observed to be non-significant. The germination was more with Planofix (89.03%). The differences in mean germination percentages due to different levels of concentrations and stages of sprays, were very marginal. The interaction , chemicals x levels was also non significant. Planofix with 150 ppm (90.75%) followed by Planofix with 50 ppm (89.37%) recorded the highest germination percentages which were significantly more with two concentrations of TIBA (50 ppm and 150 ppm) and on par with the rest.

4.2.2.3 Seed volume :

The differences in seed volume due to different treatments including the control, due to chemicals, concentrations and stages of sprays were non-significant. The interactions effects viz., chemicals x levels and stages x levels however,

Table 9. Interaction effects for seed germination percentage.

Stages x chemicals

	Planofix	TIBA	Mean
S_1	88.66	86.16	87.41
S_2	89.41	85.50	87.45
Mean	89.03	85.83	-

	S.E. ±	C.D. at 5%
Stages	1.44	N.S.
Chemicals	1.44	N.S.
Stages x chemicals	1.18	N.S.

Chemicals x Levels

	50 ppm	100 ppm	150 ppm	Mean
Planofix	89.37	87.00	90.75	89.07
TIBA	84.00	89.00	84.50	85.83
Mean	86.68	88.00	87.62	-

	S.E. ±	C.D. at 5%
Chemicals	1.18	N.S.
Levels	1.44	N.S.
Chemicals x levels	0.83	N.S.

Stages x Levels

	50 ppm	100 ppm	150 ppm	Mean
S_1	85.00	88.75	88.50	87.41
S_2	88.37	87.35	86.75	87.45
Mean	86.68	88.00	87.62	-

	S.E. ±	C.D. at 5%
Stages	1.18	N.S.
Levels	1.44	N.S.
Stages x levels	0.83	N.S.

differed significantly. TIBA with 50 ppm had the highest estimate of seed volume (2.28 cc) which was on par with the same of Planofix with 50 ppm and 150 ppm and significantly more than rest of the combinations (Table 10). Similarly the sprayings of the chemicals with 50 ppm at S_1 had the highest estimate of seed volume (3.31 cc) which was significantly more than remaining interaction effects of this type.

4.2.2.4 Seed density :

It can be seen from the data presented in Table 1 that seed density was not affected significantly by the treatments of growth regulators. However, in general the seed density was observed to be higher with the sprays of TIBA.

The chemicals did not affect the seed density significantly at any level of concentrations (Table 11). The interaction effects between stages x chemicals were non-significant whereas, due to chemicals x levels of concentrations were significant. Mean seed density was the highest with 100 ppm (0.93 g/cc). TIBA with 100 ppm recorded the highest seed density (0.95 g/cc) which was significantly more than Planofix with 50 ppm and 150 ppm and TIBA with 50 ppm. Similarly the interaction, stages x levels of concentrations, were also statistically significant. The sprays of 100 ppm at S_2 recorded the highest density (0.94 g/cc) which was followed by the sprays of the same concentration at S_1 (0.93 g/cc).

Table 10. Interaction effects for seed volume (cc).

Stages x Chemicals

	Planofix	TIBA	Mean
S_1	2.28	2.16	2.22
S_2	2.14	2.20	2.17
Mean	2.21	2.18	-

	S.E. ±	C.D. at 5%
Stages	0.05	N.S.
Chemicals	0.05	N.S.
Stages x chemicals	0.04	N.S.

Chemicals x Levels

	50 ppm	100 ppm	150 ppm	Mean
Planofix	2.26	2.17	2.20	2.21
TIBA	2.28	2.12	2.15	2.18
Mean	2.27	2.14	2.09	-

	S.E. ±	C.D. at 5%
Chemicals	0.04	N.S.
Levels	0.05	N.S.
Chemicals x levels	0.03	0.088

Stages x Levels

	50 ppm	100 ppm	150 ppm	Mean
S_1	2.31	2.17	2.18	2.22
S_2	2.23	2.12	2.16	2.17
Mean	2.27	2.14	2.09	-

	S.E. ±	C.D. at 5%
Stages	0.04	N.S.
Levels	0.05	N.S.
Stages x levels	0.03	0.088

Table 11. Interaction effects for seed density (g/cc).

Stages x Chemicals

	Planofix	TIBA	Mean
S_1	0.87	0.94	0.90
S_2	0.98	0.90	0.94
Mean	0.92	0.92	-

	S.E. ±	C.D. at 5%
Stages	0.02	N.S.
Chemicals	0.02	N.S.
Stages x chemicals	0.01	N.S.

Chemicals x Levels

	50 ppm	100 ppm	150 ppm	Mean
Planofix	0.88	0.92	0.90	0.92
TIBA	0.89	0.95	0.92	0.92
Mean	0.88	0.93	0.91	-

	S.E. ±	C.D. at 5%
Chemicals	0.01	N.S.
Levels	0.02	N.S.
Chemicals x levels	0.01	0.03

Stages x Levels

	50 ppm	100 ppm	150 ppm	Mean
S_1	0.88	0.93	0.91	0.90
S_2	0.89	0.94	0.91	0.94
Mean	0.88	0.93	0.91	-

	S.E. ±	C.D. at 5%
Stages	0.01	N.S.
Levels	0.02	N.S.
Stages x levels	0.01	0.03

4.2.2.5 Seed moisture :

The data from Table 1 indicated non-significant differences in seed moisture due to different treatments including control. However, the seed moisture was lower (11.65% at 150 ppm of both the chemicals but sprayed at different stages. The spliting of interaction effect, (Table 12) showed that the differences in seed moisture due to chemicals, stages, levels of concentrations and the interactions of these factors were non-significant.

4.2.2.6 Vigour index :

The data presented in Table 1 indicated significantly higher vigour index with all the treatment combinations as compared to control. The treatment $S_1C_1L_1$ recorded the highest vigour index (1557.1) which was followed by treatments, $S_2C_1L_3$ (1248.15) and $S_1C_2L_3$(1225.95).

The interaction effects, stages x chemicals, and stages x levels, were statistically non-significant. (Table 13). Similarly the vigour indices due to stages, chemicals, and levels separately were also non-significant. The only interaction, chemicals x levels was significant. Planofix with 150 ppm had the highest vigour index (1210.44) while, the lowest index was observed with the spray of TIBA with 50 ppm (1094.79).

Planofix amongst the chemicals (1182.25), 150 ppm among the concentrations (1182.91) and sprays at S_1 (1169.96) had the highest mean vigour indices.

Table 12. Interaction effects for seed moisture (%).

Stages x Chemicals

	Planofix	TIBA	Mean
S_1	12.49	12.20	12.34
S_2	12.48	12.76	12.61
Mean	12.48	12.48	-

	S.E. ±	C.D. at 5%
Stages	0.99	N.S.
Chemicals	0.99	N.S.
Stages x chemicals	0.80	N.S.

Chemicals x Levels

	50 ppm	100 ppm	150 ppm	Mean
Planofix	12.07	13.31	12.07	12.48
TIBA	12.89	12.49	12.07	12.48
Mean	12.48	12.09	12.07	-

	S.E. ±	C.D. at 5%
Chemicals	0.80	N.S.
Levels	0.99	N.S.
Chemicals x levels	0.57	N.S.

Stages x Levels

	50 ppm	100 ppm	150 ppm	Mean
S_1	12.07	12.90	12.07	12.34
S_2	12.90	12.90	12.07	12.61
Mean	12.48	12.90	12.07	-

	S.E. ±	C.D. at 5%
Stages	0.80	N.S.
Levels	0.99	N.S.
Stages x levels	0.57	N.S.

Table 13. Interaction effects for vigour index.

Stages x Chemical

	Planofix	TIBA	Mean
S_1	1174.73	1165.20	1169.96
S_2	1189.74	1126.33	1158.03
Mean	1182.23	1145.76	-

	S.E. ±	C.D. at 5%
Stages	27.21	N.S.
Chemicals	27.21	N.S.
Stages x chemicals	22.22	N.S.

Chemicals x Levels

	50 ppm	100 ppm	150 ppm	Mean
Planofix	1175.46	1160.80	1210.44	1182.23
TIBA	1094.79	1187.13	1155.39	1145.76
Mean	1135.72	1173.96	1182.91	-

	S.E. ±	C.D. at 5%
Chemicals	22.22	N.S.
Levels	27.21	N.S.
Chemicals x levels	15.71	45.09

Stages x Levels

	50 ppm	100 ppm	150 ppm	Mean
S_1	1114.51	1195.99	1199.39	1169.96
S_2	1155.74	1151.94	1166.44	1158.03
Mean	1135.72	1173.96	1182.91	-

	S.E. ±	C.D. at 5%
Stages	22.22	N.S.
Levels	27.21	N.S.
Stages x levels	15.21	N.S.

4.3 Effects of first year, second year and third year crop seed :

A laboratory experiment to study the germination and seedling vigour parameters of first year, second year and third year crop seed of lucerne (Madicago sativa) was also conducted. The results of this study, are presented in Table 14 to 16.

4.3.1 Germination percentage :

The differences in germination percentage exhibited by different year crop seeds of two varieties and recorded at three stages i.e. one, two and three months after harvest, were significant (Table 14 and 15). The germination recorded one month after harvest was higher and it was gradually reduced as the period after harvest was enhanced. The germination of seed produced from third year crop was better (91.63%, 84.5% and 82.5% at respective stages) which were significantly more than those of seed produced from first and second year crop of lucerne.

The varietal differences and V x Y interaction effects were non-significant at all the three stages (Table 16-i) However, Sirsa-9 exhibited higher germination percentage as compared to Poona-1-B at first and third stage of observation.

4.3.2 1000 seed weight (g) :

Differences in 1000 seed weight due to different treatment combinations, were significant. Seed produced from

Table 14. ANOVA : M.S.S. due to various sources of variation.

Source of variation	D.F.	Germination per cent: S_1	Germination per cent: S_2	Germination per cent: S_3	1000 seed weight (g)	Seed moisture (%)	Seed volume (c.c.)	Seed density (g/cc)	Vigour index: S_1	Vigour index: S_2	Vigour index: S_3
Treatment	5	25.640	67.37*	43.865*	0.00205	1.814	0.0114	0.0013	45971.20	19400.564*	24843.47*
Varieties (v)	1	1.043	0.035	2.663	0.0020	0.00	0.020	0.0020	798.00	117.52	2.30
Years (y)	2	60.29	167.38*	106.16*	0.0040*	3.176	0.013	0.0005	36294.1*	47704.4*	62058.71*
V x Y	2	3.289	0.87	2.003	0.00025	1.358	0.0055	0.0050	481.24	738.23	48.835
Error (C.R.D.)	18	11.764	10.431	9.555	0.0008	2.72	0.0079	0.0007	8639.295	5499.35	6206.095

Table 15. Mean performance of seed characters in respect of first year, second year and third year crop seeds of two varieties.

	Germination per cent			1000 seed wt. (g)	Seed moisture (%)	Seed volume (cc)	Seed density (g/cc)	Vigour index		
	S_1	S_2	S_3					S_1	S_2	S_3
V_1Y_1	87.50	76.50	73.50	2.77	11.65	2.40	0.83	1145.77	1000.40	960.77
V_1Y_2	86.50	80.50	78.50	2.80	10.82	2.35	0.84	1157.75	1075.75	1049.23
V_1Y_3	92.00	84.00	82.00	2.81	10.82	2.47	0.80	1277.58	1166.11	1138.76
V_2Y_1	86.00	78.00	73.25	2.75	11.65	2.32	0.85	1131.92	1025.90	964.73
V_2Y_2	87.50	80.00	78.50	2.78	11.65	2.35	0.84	1162.65	1063.80	1043.37
V_2Y_3	91.25	85.00	83.00	2.80	10.00	2.37	0.85	1251.65	1165.75	1138.87
S.E.	1.71	1.54	1.61	0.014	0.824	0.044	0.013	46.47	37.07	39.38
C.D.	5.09	4.59	4.79	0.042	N.S.	N.S.	N.S.	137.55	109.72	116.59

Table 16. Interaction effects in respect of seed vigour parameters.

(i) Germination per cent

	S_1			Mean
	Y_1	Y_2	Y_3	
V_1	87.50	86.50	92.00	88.66
V_2	86.00	87.50	91.25	88.28
Mean	86.75	87.00	91.63	
	Variety	Year	Variety x Year	
S.E. ±	0.990	1.212	1.714	
C.D. at 5%	N.S.	3.589	N.S.	

	S_2			Mean
	Y_1	Y_2	Y_3	
V_1	76.50	80.50	84.00	80.33
V_2	78.00	80.00	85.00	81.33
Mean	77.25	60.25	84.50	
	Variety	Year	Variety x Year	
S.E. ±	0.892	1.194	1.545	
C.D. at 5%	N.S.	3.53	N.S.	

	S_3			Mean
	Y_1	Y_2	Y_3	
V_1	73.50	78.50	82.00	78.00
V_2	73.25	73.50	83.00	76.58
Mean	73.37	76.00	82.50	
	Variety	Year	Variety x Year	
S.E. ±	0.931	1.141	1.614	
C.D. at 5%	N.S.	3.379	N.S.	

Continued.....

third year crop in the case of both the varieties viz., Sirsa-9 and Poona-1-B (2.81 and 2.80 g respectively) had the highest 1000 seed weight as compared to other treatments. On an avarage over varieties also (Table 16-ii)the third year crop seed had the highest 1000 seed weight (2.81 g) which was significantly more than that from first year crop (2.76 g) and on par with the same of second year crop (2.79 g). Differences in seed weight due to varieties and varieties x year interactions were non significant.

4.3.3 Seed moisture :

The differences in seed moisture from different treatments (Table 14 and 15) and also due to varieties and the V x Y interaction (Table 16-ii) were non-significant. However, it was interesting to note that seed moisture from third year crop seed which exhibited the highest germination and 1000 seed weight, was numerically less (10.41%) as compared to other treatments (11.65 and 11.24 from first and second year crop seed respectively).

4.3.4 Seed volume (c.c.) and seed density (g/cc) :

The seed volume and seed density due to different treatments were found to be non-significant (Table 14 and 16-ii). The differences in these parameters due to varieties and also due to year of seed production and the interactions of these factors were also non-significant. Sirsa-9 had numerically high seed volume (2.40 cc) while seed density was more in the case of Poona-1-B (0.85 g/cc). The third year seeds had high seed volume (2.42 cc) and low seed density (0.83 g/cc).

Table 16 (ii) 1000 seed weight (g), Seed moisture (%), Seed volume(cc) seed density g/cc.

	1000 seed weight (g)			Mean
	Y_1	Y_2	Y_3	
V_1	2.27	2.80	2.81	2.79
V_2	2.75	2.78	2.80	2.27
Mean	2.76	2.79	2.81	
	Variety	Year	Variety x Year	
S.E. ±	0.00816	0.011	0.0014	
C.D. at 5%	N.S.	0.0296	N.S.	
	Seed moisture (%)			
V_1	11.65	10.82	10.82	11.10
V_2	11.65	11.65	10.00	11.10
Mean	11.65	11.24	10.41	
	Variety	Year	Variety x Year	
S.E. ±	0.476	0.583	0.82	
C.D. at 5%	N.S.	N.S.	N.S.	
	Seed volume (c.c.)			
V_1	2.40	2.35	2.47	2.40
V_2	2.32	2.35	2.37	2.34
Mean	2.36	2.35	2.42	
	Variety	Year	Variety x Year	
S.E. ±	0.025	0.031	0.044	
C.D. at 5%	N.S.	N.S.	N.S.	
	Seed density (g/cc)			
V_1	0.83	0.86	0.81	0.83
V_2	0.85	0.84	0.85	0.85
Mean	0.84	0.85	0.83	
	Variety	Year	Variety x Year	
S.E. ±	0.007	0.009	0.013	
C.D. at 5%	N.S.	N.S.	N.S.	

Continued.......

4.3.5 Vigour index :

The differences in vigour indices estimated at various stages of seed germination were significant (Table 14 and 15). The vigour indices of third year crop seed in the case of both the varieties (Table 16-iii) were higher (S_1 - 1277.58 and 1251.65, S_2 - 1166.11 and 1165-75, S_3-1138.76 and 1138.87 for Sirsa-9 and Poona-1-B respectively). As observed in the case of germination percentage, there was gradual decrease with seed ageing, in respect of this trait also. On an average, over varieties also, the third year seed had the highest vigour index which was significantly more than the same from first two years at all the stages (Table 16-iii) thus, suggested the superiority of the third year crop seed as compared to the first two years. Differences among the varieties were not significant. However, Sirsa-9 had slightly better vigour index (1049.58) as compared to Poona-1-B (1048-98). The variety x year interaction was also non-significant.

The third year seed with better germination and vigour index, higher 1000 seed weight and seed volume and lower seed moisture and seed density thus, proved superior in respect of seed parameters.

Table 16. (iii) Vigour index

	S_1			Mean
	Y_1	Y_2	Y_3	
V_1	1145.47	1157.75	1277.58	1193.60
V_2	1131.92	1112.65	1251.65	1182.07
Mean	1138.70	1160.20	1246.62	
	Variety	Year	Variety x Year	
S.E. ±	26.83	32.862	46.27	
C.D. at 5%	N.S.	97.27	N.S.	

	S_2			Mean
	Y_1	Y_2	Y_3	
V_1	1000.4	1075.75	1166.11	1080.75
V_2	1025.90	1063.80	1165.75	1085.15
Mean	1013.15	1069.76	1165.93	
	Variety	Year	Variety x Year	
S.E. ±	21.40	26.21	37.07	
C.D. at 5%	N.S.	77.60	N.S.	

	S_3			Mean
	Y_1	Y_2	Y_3	
V_1	960.76	1049.23	1138.76	1049.58
V_2	964.72	1043.36	1138.88	1048.98
Mean	962.74	1046.29	1138.82	
	Variety	Year	Variety x Year	
S.E. ±	22.74	27.80	39.38	
C.D. at 5%	N.S.	82.44	N.S.	

Discussion

5. DISCUSSION

The pace of progress in agricultural production depends upon the speed with which we are able to multiply and market good quality seeds of high yielding varieties (Agrawal, 1980). Lucerne (*Medicago sativa* L.) is considered as the queen of forage crops because of its highly nutritious forage. However, the low seed yielding ability poses a problem for its rapid spread (Ellison, 1958). Use of chemical growth regulators, as in tropical pasture plants, on lucerne also has shown good promise in increasing the seed yield potential of this crop. (Yadava and Verma, 1984).

The present investigations therefore, were, undertaken to study (i) The effect of growth substances on the vegetative growth and seed yield and (ii) the effect of first year, second year and third year crop seed on seedling vigour parameters of lucerne.

The application of growth substances changes the physiology of the plants and modifies the plant growth and development (Massengale and Medler, 1958). The time and method of application also had an important significance in respect of effectiveness of growth substances. (Sircar, 1965). In the present studies, two growth substances *viz.*,Planofix and TIBA, were sprayed at two stages *viz.*, before flowering (S_1) and at the time of flowering (S_2) with three concentrations, *viz.*, 50, 100 and 150 ppm, of each chemical. The results obtained are discussed on ensuing pages.

5.1 Vegetative growth and yield characters :

The plant height was maximum with the spray of 100 ppm Planofix before flowering (94.45 cm) as compared to that of absolute control (82.50 cm). However, irrespective of concentrations and time of application, Planofix and TIBA could not increase the plant height significantly over the control. The lower concentrations accelerated plant height whereas, the higher ones retarded the growth of the plant. Similar observations were also made by Pillai and Chond-oke (1961) in sorghum with the spraying of G.A. at the seedling stage of growth. massengale and Medler (1958) also observed alterations in plant height, length of internodes in lucerne with the sprays of different growth regulators. Reduction in plant height with sprays of TIBA might be due to rapid conversion of plants from vegetative to reproductive phase as compared to control (Greer and Anderson, 1965).

The differences in weight of husk from 10 tillers due to chemicals, stages and levels of concentrations were also not significant. However, the interaction effects of chemical x level and stages x levels were significant. Among the chemicals, TIBA had higher weight of husk (3.88 g). The concentration of 150 ppm in the case of both the chemicals i.e. Planofix and TIBA, exhibited higher production of husk (5.02 and 4.15 g respectively).

Though non significant differences for the individual factors like chemicals, growth stages and levels of concentration were obtained, **five of the treatment combinations** *viz.*, two of Planofix with 150 ppm sprayed at both the stages, and three of TIBA including 100 ppm sprayed before flowering and 50 and 150 ppm sprayed at flowering recorded significantly more seed weight from ten tillers, suggesting that even lower concentrations of TIBA sprayed before flowering can change the plant from vegetative to reproductive phase. Hale (1971) reported overall increase in seed weight with application of TIBA which simultaneously, retarded the vegetative growth of plant. Similarly Greer and Anderson (1965) also reported that TIBA sprayed at the begining of flowering in soyabean increased the seed yield. It was evident that the yield per hectare and yield from 10 tillers (Table 1 and 7), with 150 ppm of Planofix sprayed at both the stages, were significantly higher (S_1-169.605kg and S_2-166.650 kg) than that of the control (114.49 kg/ha). While in the case of TIBA, the dose of 50 ppm at both stages was significantly superior (S_1-178.248 kg and S_2-186.159 kg) to control. It is interesting to note that 100 ppm Planofix sprayed at both stages gave less seed yield as compared to the other concentrations tried while, in the case of TIBA it gradually decreased from 50 ppm onwards except 150 ppm sprayed at flowering.

In the present investigation thus, 150 ppm of Planofix was the best concentration for increasing the seed yield. The results of Yadava and Varma (1984) in Lucerne were contradictory who observed increased seed yield by lower dose of Planofix and 50 ppm of Planofix as the best concentration for seed production. Kapoor (1976) studied the effects of foliar application of Planofix at flower initiation stage and observed higher yields at 20 ppm. While, in the present investigation TIBA at 50 ppm was more effective for increasing the seed yield. Similar results were recorded by Feltner and Sackett (1964) who noted that when low rates of TIBA were applied to alfalfa plants, on an average 19 per cent more seed yield was obtained compaired to control. Likewise Hale (1971) also observed increased seed weight with the application of 70 and 140 g of TIBA/ha

All the treatment combinations recorded higher number of stems per m^2 and seed yield per hectare as compared to absolute control. However, the 50 ppm TIBA spray at flowering ($S_2C_2L_1$) only exhibited significantly more stems per m^2 than the control. Highest seed yield per hectare (186.159 kg) was also recorded with the same treatment (Table 1). Number of stems/tillers thus, was observed to be the important character contributing to seed yield. Edey and Byth (1970) and Hale (1971) also observed an increase in number of stems per plant and the greater number of stems probably accounted for increased seed weight of lucerne which are in confirmity of the present investigations.

The differences in number of stems per m^2 due to chemical's, stages, levels of concentration and their all interactions except the stages x chemicals in respect of seed yield per hectare, were non-significant. However, TIBA among the chemicals, 100 ppm among the concentrations and sprays at flowering (S_2) in respect of stem number and concentration of 50 ppm sprayed at the same stage of growth (S_2) in respect of seed yield per hectare showed numerical superiority over rest of the treatments from their respective groups. Though the differences in mean seed yield due to Planofix and TIBA were very marginal, TIBA with 50 ppm sprayed at both the stages of growth (S_1 and S_2) recorded 55.68 and 62.80 per cent increased seed yield respectively over the control.

Yadava and Patil (1976) reviewed the literature on the use of growth regulators in forage crops and observed increased seed yield in number of reports with the application of the chemicals tried in the present study. Yadava and Verma (1984) also observed increased seed yield of lucerne to the extent of 8.33 to 36.66 per cent by lower doses of Planofix. In the present investigations also, the concentration of 50 ppm was observed to be better as compared to other concentrations tried. The higher concentration (150 ppm) at both the stages was not as high yielding as the sprays with lower concentrations. Yadava and Varma (1980) noted increase in seed yield of cowpea to the extent of 9.97 to 44.67 per cent with the sprays of Planofix. Number of workers in various crops (Mote et al. 1977;

Warade and Singh, 1977; Subbian and Chamy, 1984 and Zayed, 1986) have also reported increase in seed yield with the sprays of either Planofix or TIBA.

The percentage increase in seed yield due to different treatments (Table 1) ranged from 15.41 to 62.80 per cent. This increase, in addition to number of stems per m^2, can also be attributed to increased husk and seed weight. The increase in seed yield due to growth regulators like TIBA has been related to increased bee visits with the sprays of TIBA by Fellner and Sackett (1964). They studied volume, sugar concentration and ratio of sugar components (sucrose, fructose and glucose) of nectar from flowers of treated and untreated alfalfa plants and observed Chi-square goodness of fit for these components in 1:1:1 ratio in the nectar from flowers of treated plants with P= 0.80 and χ^2= 9.47 while the same from untreated plants was poor/with P= 0.10 and. χ^2= 21.05. The presence of sucrose, fructose and glucose in nectar from treated plants nearly in 1:1:1 ratio influenced the bee visits to the crop thereby resulting in increased seed yield. Pandey (1975) noted maximum production of biomass and grain yield with the application of Planofix. Low concentrations were effective in two phases(flower abscission and full bloom stage of growth)and high concentrations were effective at (flower abscission) first phase of growth.

Harvest index, which is the ultimate result of increased seed yield through its components, in the present study, differed significantly due to all the factors viz., chemicals, stages, levels of concentration and their interactions. As in the case of seed yield per hectare, harvest index was the highest with TIBA spray of 100 ppm at pre-flowering (S_1) stage. As observed by Greer and Anderson (1965), the harvest indices might have been improved due to changes in leaf size and in canopy shape of row, which might have altered the plants to utilize sunlight more effectively leading to increase in seed yield and in turn improving the harvest index.

5.2 Seed characters :

Seed weight with the sprays of TIBA was significantly more (2.69 g) than the crop sprayed with Planofix (2.50 g). Thus, the seed weight appears to be another important component contributing to increased seed yield. The highest mean 1000 seed weight was observed with 50 ppm (2.73 g) which was on par with 100 ppm spray and was significantly more than the seed weight obtained with 150 ppm treatment. Yadava and Verma (1980) noted direct association of increased seed yield with 1000 grain weight in addition to increased length of pods and grains per pod which also confirmed the present findings.

Though the differences in seed germination when compared with control were significant, the effects of chemicals, stages of sprays and levels of concentration of the chemicals when tested among themselves, were however, observed to be non-significant. The germination, as compared to control, was significantly improved with all the treatments of growth regulators excepting with 50 ppm TIBA sprayed before flowering (S_1) and 100 and 150 ppm sprayed at flowering (S_2). Planofix with 150 ppm (90.75%) followed by Planofix with 50 ppm (89.37%) recorded the highest germination. The differences in seed moisture due to all the factors including control, however, were non-significant. The seed moisture per cent was around 12 per cent. Inspite of differences in germination, very marginal differenes in moisture content due to chemicals, stages of sprays and concentrations, were observed. Thus, no definate relationship between germination and moisture could be established. Sharma & Sharma (1978) in lentil noted direct correlation between these two traits. Yadava and Patil (1976) when reviewed the literature on growth regulators in forage crops observed increased germination which confirmed the present observations. Yadava and Verma (1984) observed 50 ppm of Planofix as the best concentration for lucerne seed production. In the present investigation also Planofix with 50 ppm and 150 ppm recorded, highest germination percentages.

Seed volume and seed density were not affected significantly by the various treatments of growth regulators. However, significant interaction effects for chemicals x levels and stages x levels were noted in the case of both the characters. TIBA with 50 ppm had the highest estimate of seed volume (2.28 cc.) However, seed density was the highest (0.95 g/cc) with 100 ppm of the same chemical and was significantly more than the Planofix with 50 and 150 ppm and TIBA with 50 ppm. Significantly higher vigour indices with all the treatments, as compared to control, were observed. Planofix with 50 ppm sprayed before flowering (S_1) recorded the highest vigour index (1557.1) which was followed by 150 ppm of Planofix and TIBA both sprayed before flowering (1248.15 and 1225.95 respectively). Zayed (1986) observed increased leaf chlorophyll content of plant with TIBA @ 100 mg/lit. Yadava and Verma (1979) observed increased shoot and root length of germinating seedlings of Medicago species. Chua & Talib (1985) found increased shoot length in Piper nigrum by adding NAA, Wurr and Fellows (1985) also observed increased root length.

Thus, the foregoing discussion has clearly revealed that there is good scope for increasing the seed production potential of forage crops like lucerne by using chemical growth regulators like TIBA and Planofix. The use of these chemicals in this crop, therefore, needs to be encouraged for making available the quality seed or planting material of improved varieties to the cultivators as pointed out by Yadava et al. (1984).

5.3 Effect of year of seed production in lucerne :

The laboratory studies conducted on the effect of first, second and third year crop seeds in lucerne indicated increased germination (91.63%) from third year seed which was significantly more than those from first and second year crop of lucerne. Sirsa-9 exhibited numerically higher germination as compared to Poona-1-B. However, variety x year interaction effects were not significant suggesting that not only the genotypic differences but the major contribution for variation in germination is due to the stage of the crop at which the seed is produced. The genetic basis for this increased germination of third year seed needs to be studied. The differences in seed moisture due to varieties and V x Y interaction, were also non-significant. However, interestingly it was observed that the seed moisture from third year crop seed which exhibited the highest germination and 1000 seed weight, was numerically less (10.41%) as compared to other treatments (11.65 and 11.24% from first and second year crop seed respectively) which confirmed the relationship of germination and moisture percentage as suggested by Sharma & Sharma (1978) in lentil. As stated earlier, 1000 seed weight from third year crop was also higher in the case of both the varieties i.e. Sirsa-9 and Poona-1-B.

The differences in seed volume and seed density due to varieties, year of seed production and their interactions, were not significant. Sirsa-9, however, had numerically high seed volume (2.40 cc) while,seed density was more in the case of Poona-1-B (0.85 g/cc). Third year seeds had high seed volume (2.42 cc) and low seed density suggesting antagonestic relationship between these two traits.

Vigour index which is the ultimate result of root length, shoot length and germination percentage as suggested by Abdul-Baki et al. (1973), differed significantly, at all the stages of observations. The third year crop seed, in the case of both the varieties, had higher vigour indices (S_1=1277.58 and 1251.65, S_2= 1166.11 and 1165.75 and S_3= 1138.76 and 1138.88 for Sirsa-9 and Poona-1-B respectively). On an average over varieties also, third year crop seed exhibited significantly higher vigour index as compared to first two years. The increased germination appears to be an important attribute contributing to high vigour Index. As observed in the case of germination, there was gradual decrease in vigour index also with seed ageing.

The present study thus, clearly revealed that the seed produced from third year crop has better seed weight, good germination percentage, low moisture and ultimately increased seedling vigour index. All these factors might be contributing to better field stand and thereby resulting in higher forage yield from the seed produced from third year crop. In addition to this, use of such seeds also assure perenial ability of the crop as the seed is produced from the crop which yields the green forage upto three years. During the process of natural selection the poor, weak and diseased seedlings might be eliminated and only the healthy and competitive plants might be remaining at third year. The seed produced from this crop, therefore, might be showing better vigour resulting in good and stable forage yield. These may be the probable reasons, why the cultivators prefer third year seed as compared to first year and or second year. Thus, the farmers' choice regarding the acceptability of the variety as suggested by Jain and Banerjee (1982) is also important. The field studies for confirmation of above observations however, need to be initiated.

Summary and Conclusions

6. SUMMARY AND CONCLUSIONS

A field experiment was conducted at Grass Breeding Scheme, Department of Botany, Mahatma Phule Agricultural University, Rahuri, during summer, 1986, to study the effect of growth substances on vegetative growth and seed production potential of lucerne (*Medicago sativa* L.) variety Sirsa-9. In this experiment, two chemicals *viz.*, Planofix and TIBA each with three concentrations, *viz.*, 50 ppm, 100 ppm, 150 ppm were tested in factorial randomised block design with four replications. A laboratory experiment on two varieties *viz.*, Sirsa-9 and Poona-1-B, in a completely randomised block design, was also undertaken to know the effect of first, second and third year crop seed, on germination and seedling vigour parameters of lucerne.

The data collected on various quantitative characters such as plant height, number of tillers per m^2, weight of husk and seed from 10 tillers, seed yield per hectare from the field experiment and on germination and seedling vigour parameters from laboratory studies were subjected to statistical analysis of respective designs. The results obtained are summarised below :

6.1 Summary :

6.1.1 Effect of growth regulators :

1. Among the chemicals tried, the highest seed yield per hectare was recorded with the spraying of 50 ppm

TIBA at flowering which recorded 62.59 per cent increased seed yield as compared to that from absolute control. The highest seed yielding combination of Planofix ($S_1C_1L_3$) however, exhibited the increase in seed yield to the tune of 48.14 per cent over the control. The interaction stages x chemicals effectively increased the seed yield.

2. Planofix and TIBA irrespective of concentrations and time of application, could not increase the plant height significantly over the control. All the interaction effects were also non-significant.

3. Weight of husk from 10 tillers due to sprays of either TIBA or Planofix could not be increased significantly. However, highest estimates for these characters were recorded by spraying TIBA with 100 ppm before flowering.

4. Number of tillers per m^2 were the highest in the case TIBA with 100 ppm sprayed at flowering, which also recorded the highest seed yield. Increased tillers, was the important factor for increasing seed yield.

5. TIBA among the chemicals, spraying at pre flowering and 100 ppm among the concentrations recorded the highest harvest indices. All the interaction effects in respect of this trait, were significant.

6. Thousand seed weight was significantly increased by foliar sprays of the chemicals. Planofix with 50 ppm sprayed at flowering showed the highest 1000 seed weight.

7. Planofix and TIBA with all the concentrations sprayed at both stages, increased the germination percentage as compared to control plot whereas, seed volume, seed density and seed moisture were not affected significantly.

8. Vigour index, as compared to control, was improved in all the treatments of growth regulators. Planofix with 150 ppm sprayed before flowering recorded the higher vigour index.

6.1.2 Effect of year of seed production :

i) Sirsa-9 exhibited higher germination percentage as compared to Poona-1-B.

ii) The germination percentage of the seed produced from third year crop was better as compared to the same from earlier two years.

iii) The seed produced from third year crop in both the varieties had the highest 1000 seed weight. It also had numerically higher estimates of seed volume and low for seed density and seed moisture. As in the case of germination percentage, higher vigour index was obtained from third year seed. Sirsa-9 had slightly better vigour index as compared to Poona-1-B.

6.2 Conclusions :

6.2.1 Effects of growth regulators :

1. Seed production potential of lucerne can be increased substantially by the sprays of growth regulators particularly more with TIBA.

2. The lower concentration of 50 ppm was observed to be optimum.

3. Though seed yield and its components like 1000 seed weight, number of tillers were enhanced with sprays of growth regulators however, the major vegetative character like plant height was not affected significantly.

4. There was parallel increase in seed yield, weight of husk, tillers per m^2, harvest index, germination and vigour index with sprays of TIBA, while, the sprays of Planofix resulted in the increase of germination,1000 seed weight and vigour index.

5. Seed characters as a whole were improved with the sprays of growth regulators tried.

6.2.2 Effect of year of seed production :

1. The seed produced from third year crop exhibited increased seed germination and better seedling vigour paramaters.

2. Use of third year crop seed is expected to give better field stand thereby increased forage yield.

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7. LITERATURE CITED

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* Originals not seen.

Vita

VITA

Arvind L. Sonone

Candidate for the
Degree of Master of Science (Agriculture)

Title of Thesis	:	(I) Effect of growth substances on vegetative growth and seed yield, (II) Effect of year of seed production on germination and seedling vigour parameters in lucerne (*Medicago sativa* L.)
Major field	:	Seed Technology
Department	:	Agricultural Botany
Biographical information		
Personal data	:	Born at Akola Dist. Akola, 3rd Nov., 1963, son of Shri L.Z.Sonone.
Education	:	Attended primary, Secondary and higher secondary school at Akola, Dist. Akola, Received the Bachelor of Science (Agriculture) degree at Punjabrao Agricultural University, Akola Dist. Akola.
