EFFECT OF PRUNING CANE TWISTING AND SOME CHEMICALS ON PRODUCTIVITY OF GRAPE (*Vitis vinifera* L.) CV. THOMPSON SEEDLESS

By

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Thesis submitted to the CCS Haryana Agricultural University, Hisar, in partial fulfilment of the requirements for the degree of :

MASTER OF SCIENCE

IN

HORTICULTURE

COLLEGE OF AGRICULTURE
CCS HARYANA AGRICULTURAL UNIVERSITY
HISAR

1992

DEDICATED

TO MY

BELOVED PARENTS

CERTIFICATE I

This is to certify that this thesis entitled, "Effect of pruning, cane twisting and some chemicals on productivity of grape (Vitis vinifera L.) cv. Thompson Seedless", submitted for the degree of M.Sc. in the subject of Horticulture of the CCS Haryana Agricultural University, Hisar, is a bonafide research work carried out by Shri Shiv Kumar Singh, under my supervision and that no part of this thesis has been submitted for any other degree.

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

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CERTIFICATE II

This is to certify that this thesis entitled, "Effect of pruning severity, cane twisting and some chemicals on productivity of grape cv. Thompson Seedless (*Vitis vinifera* L.)", submitted by Shri Shiv Kumar Singh to the CCS Haryana Agricultural University, Hisar, in partial fulfilment of the requirements for the degree of Master of Science in the subject of Horticulture has been approved by the Student's Advisory Committee after an oral examination on the same, in collaboration with an External Examiner.

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DEAN, POST-GRADUATE STUDIES

ACKNOWLEDGEMENT

I abide this pleasant opportunity of expressing my deep sense of gratitude and sincere thanks to Dr. Suneel Sharma, Asstt. Horticulturist, Department of Horticulture for his luminous guidance, thoughtful suggestions, unceasing help, close supervision and constant encouragement during the entire course of these investigations.

I am also indebted to Dr. B.S. Daulta, Professor and Head, Department of Horticulture, for his kind co-operation during the investigations.

My sincere thanks are due to Dr. O.P. Gupta, Professor of Horticulture, Dr. M.S. Chaudhary, Director, Project-cum-Plan Formulation, Dr. C.L. Goswami, Associate Professor of Plant Physiology, members of my Advisory Committee, for the[illegible] valuable suggestions offered during the course of investigations.

I express my feelings of indebtedness to Dr. K.S. Chauhan, Professor of Horticulture, Dr. Kartar Singh, Professor of Horticulture, Dr. Ran Singh, Professor of Horticulture, Dr. B.M. Chauhan, Professor, Deptt. of Foods and Nutrition, Dr. Anoop Singh, Professor of Soils, Dr. M.P. Singh, Assoc. Professor of Deptt. of L.P.M., for their sincere wishes, kind co-operation and inspiration led me to complete this work successfully.

I extend my sincere thanks to my friends, Arjun Singh, Jai Singh, Raj Kumar, Som Pal, Bunti, Anil Chauhan, Rajender, Mukesh, Lekh Raj, Sanjay and Pardeep for their timely suggestions and sweet association.

I am grateful to my brother Shiv Charan Singh and Ravinder Singh for their inspirations to dedicate this work and also to Bhabhi Ji for her timely encouragement and affection.

No words of mine can express my thanks to my beloved parents without whose fillial love, affection and obstinate sacrifices, I would not have achieved my aim.

The affection of my nephew and nice, Mitender and Vanita inspired me to dedicate this work.

(SHIV KUMAR SINGH)

HISAR

October 3, 1992

CONTENTS

LIST OF ABBREVIATION

CD	Critical Difference
$CD_{0.05}$	Critical difference at 5 per cent level
cm	Centimeter
cv.	Cultivar
et al.	*et alii* (and others)
etc.	*et cetera* (and others)
e.g.	(exampli gratia) for example
Feb.	February
g	Gram
ha	Hectare
H_2CN_2	Hydrogen cyanamide
i.e.	*id est* (that is)
kg	Killogram
KNO_3	Pottasium nitrate
Mg	Milligram
no.	Number
NS	Non-significant
PB	Paclobutrazol
RBD	Randomized Block Design
Viz.	Namely
w.r.t.	With respect to
0.1N	0.1 Normal
%	Percent

1. INTRODUCTION

Grape (Vitis vinifera L.) is believed to be originated from a region lying between the Black and Caspian Sea and is now grown almost all over the world in the agroecological regions raning from temperate to tropical climate. Several cultivars are being grown for different purposes so as to form an industry of importance. India ranks first in world with regard to average yield (21.5 t ha^{-1}) of grapes (Pandey and Pandey, 1988). The grape growing industry is firmly established in South India, whereas its cultivation is continuously increasing in parts of U.P., Haryana, Punjab, Rajasthan and other regions of country. In Haryana, grapes cover a considerable area of 5000-6000 acres with a production of 50-60 thousand tonnes (Dhawan and Gupta, 1990).

Thompson Seedless cultivar of grapes is well known for its excellent fruit quality and it fetches good price in the market. However, this cultivar could not be grown commercially in Haryana owing to its Shy bearing habit and also due to its mid late ripening characteristic. The decline in yield starts after few years of cropping in this cultivar. This could be due to many factors responsible for unfruitfulness as faulty pruning, imbalance in nutrition and apical dominance, etc. Another reason of poor productivity of Thompson Seedless grapes is poor bud-break in the middle and the basal part of the cane, which may be due to dormancy or may be due to apical dominance.

Bakshi *et al.* (1970) reported maximum fruitfulness in Thompson Seedless at second and third bud position from the base of the cane when the vines were pruned at 6 bud, whereas Singhrot *et al.* (1977) found that in Thompson Seedless grapes, the yield was highest in 8-buds/cane pruning level. Bhujbal (1972) recorded maximum fruitfulness of bud in 4-bud treatment closely followed by 6-bud and 8-bud treatments in Thompson Seedless. Tomar and Brar (1986) found that varying intensities of pruning should have no effect on bunch weight, bunch size, berry weight, berry size and TSS, whereas, more number of bunches with maximum acid content in the berries were found with 9-bud cane pruning.

The chemicals such as potassium nitrate (KNO_3) (Erez *et al.*, 1971), dormex (Pandey, 1989) and ethephon (Bautistia *et al.*, 1989) have been found to influence bud break in grape. Ahmedullah *et al.* (1986) found that Paclobutrazol delayed bud-break by 3-5 days in treated vines compared to control. There was no effect of treatments on pruning weight and fruit quality. Khanduja (1984) reported that Thiourea and KNO_3 combination was less effective than Thiourea alone in enhancing the bud-burst. Shikhamany *et al.* (1987) found that cane twisting alone was found to increase the bud-break, whereas, application of pactobutrazol 1500 ppm was found to hasten the bud-break, while ethrel 3000 ppm delayed it. Dormex (1.5%) hastened bud-burst and also gave additional yield of 567.5 kg per acre. Dormex increased berry weight, TSS content significantly over control (Pandey, 1989).

Above research findings differ from each other and vary from region to region. It has been observed that the cv. Thompson Seedless has been flowering and fruiting even on 4th bud under local conditions of Haryana which provided clue to the different bearing behaviour even under local conditions due to varying weather conditions. To observe its growth and fruiting behaviour due to the intensity of pruning level as well as to observe the effect of cane twisting and various chemicals, the present investigation will be carried out with the objectives mentioned below :

1. To study the pruning level on growth and productivity of Thompson Seedless grapes.

2. To study the effect of cane twisting, growth regulators and chemical treatments on the productivity of Thompson Seedless grapes.

2. REVIEW OF LITERATURE

The pruning, cane twisting and various chemicals affect the various growth and flowering characters in vitis. A lot of literature is available on different aspects of this crop. A comprehensive review of work done in India and abroad has been given under the following heads :

2.1 Growth Characters

2.1.1 Bud break

2.1.1.1 Effect of severity of pruning : The importance of judicious pruning for productiveness has been recognized since the grape cultivation came into practice. Pruning helps to produce normal vigour and shoot growth to favour fruitfulness. But excessively increased vigour will also diminish the fruitfulness of the buds (Winkler, 1965). The effect of severity of pruning varies from variety to variety in grapes. Working with Sultana and Perlette varieties, Antcliff *et al.* (1955) and Chadha and Mand ~~et al.~~ (1969) respectively reported that the bud-burst was not affected for any length of cane. However, Antcliff et al. (1956) contradicted their own earlier observations and reported that with increase in number of canes per vine, the percentage of bud-burst showed a linear decrease, while percentage of fruitful shoot was not affected in Sultana variety. Pastena (1959) reported that greater the length of shoots, higher was the percentage in the reduction of basal bud-burst.

Daniel and Winkler (1965) reported that bud burst in short pruned canes occurred earlier than long pruned canes. Daulta and Bakshi (1970) observed that in grapes, sprouting of buds at the base of the canes get suppressed, if the length of the cane is increased. Similar results have been reported in grape cultivars Perlette and Beauty Seedless (Godara et al., 1972) and Pusa Seedless (Mukherji et al., 1970).

Pruning severities have variable effect on the days taken for bud sprouting. Terminal buds are more fruitful as compared to other buds (Banard, 1932 and Antcliff and Webster, 1956). In a study on Thompson Seedless cultivar with the cane number varying from 3 to 12 and with 14 buds per cane, Antcliff and Webster (1956) noted that the percentage of bud-burst and percentage of those that were fruitful appeared to be affected directly by the pruning levels. ~~In Bhokri variety, Kurtkoti (1966) observed that the percentage of bud sprouting was more in all canes near the cut end of the spur.~~ Singh and Singh (1968) also reported that all the buds were sprouted on one and two bud spur pruning, whereas, the bud burst was decreased with the decrease in severity of pruning of Bhokri and Gulabi varieties.

In a study with Malaga variety, Harris and Coombe (1957) reported that lateral bud on 2-bud spurs is adopted to remain dormant, while the apical bud develops into excessively vigorous canes, but this problem is removed when pruned to 6-bud cane.

A considerable reduction in basal bud-burst was also recorded with an increased bud load by Bessis (1964) in Carrignan; Todorov (1964) in Muscat Rouge; Rangelov (1964) in Pinot Noir; Spirou (1964) in Chasselas Dore; Antcliff (1965) in Sultana; Kamel et al. (1965) in Muscat of Italy; Rougni Red and Thompson Seedless; Martin and Taloi (1967) in Pearl of Csaba and Muscat of Hamburg; and Schoffling (1965) in Riesling clones Daniel (1965) concluded that in Anab-e-Shahi variety fruit bud initiation was influenced by the degree of pruning severity. Bud-burst was higher in 4 nodes spur than those of 1, 3, 5 or 7 nodes, the time of bud burst was delayed in long canes by three to four days. Contrary to these Jauhari and Nand (1970) have reported negative correlation between different severities of pruning and time taken for bud burst. The number of days taken to sprouting from the date of pruning were not affected by pruning severities in cultivars Perlette (Chadha and Kumar, 1970 and Sharma et al., 1977) and in Beauty Seedless (Sharma et al., 1978).

Singhrot et al. (1977) observed that pruning at 10-buds per cane increased the bud-burst and reduced the percentage of fruit buds. Kumar and Chohan (1984) concluded that for Thompson Seedless grapes, 7 or 8-bud per cane pruning with 24 canes per vine seems to be optimum for better fruiting under arid-irrigated regions of Punjab.

2.1.1.2 Effect of chemicals and growth regulators : Effect of cyanamide, ethephon and endothal on bud break was studied by Bracho et al. (1980) and observed that the H_2CN_2 treatment after 10, 13 and 17 days resulted in 0, 50 and 74% bud break, respectively. Endothal treated buds began to open 15 days after treatment, but 90 days later only 10% of the buds had opened. The first untreated bud opened 92 days after treatment. Lin et al. (1985) reported that cyanamide solution (2.45% H_2CN_2) application during late August induced defoliation of Golden Muscat grapes within six days, followed by bud opening. This cyanamide application immediately after the normal harvest season induced the second flush of shoot growth, making the harvesting of two crops possible per year. The most significant effects of cyanamide application were to increase fruit yield and early harvest of the second crop.

Lin and Wang (1985) observed that cyanamide (H_2CN_2) application was effective in inducing bud sprouting of vegetative Kyoho grape vine in single bud cuttings. During November 1983, bud-burst was found to start 10 days after cyanamide (1%) application. The percentage of buds that broke in two independent experiments with cuttings of different ages were 58% and 27%, respectively, whereas, in the control cuttings, the percentage of bud opening were 3.3% and 0%, respectively. Erez (1987) observed that potassium nitrate, in addition to supplying two macroelements, also acts as a rest-breaking chemical. This salt, having a mild effect by itself, may enhance the action of oil + DNOC, when applied prior to it. Concentration as high as 15% were tried on apple with no damage, but concentrations of 5% to 7% were effective. The specific effect of KNO_3 is to improve flower bud-break, hence, whenever flower bud-break is a problem, the addition of this chemical to oil + DNOC may improve yield. Also, in cases where flowers are abnormal, and hence fruit develop unevenly as in peach cultivars, if KNO_3 is applied early enough it may improve yield by inducing bud break prior to events that lead to abnormal bud development. KNO_3 was found to have strong effect in enhancing sprouting of dormant buds at initial stages of rest in a rest avoiding treatment. Combination of KNO_3 with oil + DNOC improved sprouting in combination to oil + DNOC alone. Williams (1987) reported that cyanamide (H_2CN_2) was applied to dormant canes on Thompson Seedless grape vines. A 2.5% (v/v) solution of cyanamide was sprayed on vines just subsequent to pruning in a 2 year study. Vines pruned and treated with cyanamide on January 17 had bud break 3 and 7 days earlier than the pruned controls in 1984 and 1985, respectively. The same treatment imposed on March 1 delayed bud break when compared with the controlled vines.

Zelleke and Kliewer (1989) observed that Hydrogen cyanamide at either 1% or 2% significantly increased the percentage bud-burst on the basal two-third portion of canes of all varieties and age groups. Pandey (1989) reported that dormex hastened bud-burst by six days in the previous year and 26 days in the latter year and ripening by 16 days when applied on 4th January.

2.2 Floral Characters

2.2.1 Panicle emergence

2.2.1.1 Effect of severity of pruning : Panicle emergence was delayed in cultivars Perlette and Beauty Seedless (Godara *et al.*, 1972) with an increase in bud load per spur. The severity of pruning has little or negligible effect on the panicle emergence in cultivars Anab-e-Shahi (Chadha and Mand, 1969), Perlette (Chadha ~~et al.~~ and Mand, 1969; Chadha and Kumar, 1970 and Jauhari and

Nand, 1970) and Gulabi (Moti, 1971). The number of canes per vine (18 to 36) did not affect the number of days taken for panicle emergence in cultivars Perlette and Beauty Seedless as reported by Sharma et al. (1977) and (1978) respectively. As reported by Amarjeet (1987), pruning treatments significantly vary the number of days taken for panicle emergence. Severe the pruning earlier is the panicle emergence.

2.2.2 Berry set

2.2.2.1 Effect of severity of pruning : Kimball and Shaulis (1958) reported that severe pruning in contrast to light pruning in Concord grapes resulted in decreased bud number, but increased the number of berries per bunch. Daniel (1965) found that pruning to 7 and 5 buds per cane resulted in higher fruit set than severe pruning in Anab-e-Shahi vines. Similar results have also been reported by Tomar and Brar (1982) in Thompson Seedless cultivar of grapes. Singh and Kumar (1980) found that 5 bud with 24 canes pruning gave maximum fruit set which was significantly higher than 4 or 6 buds with 40, 30 or 20 canes, respectively, in Anab-e-Shahi cultivar of grapes.

2.2.2.2 Effect of chemicals and growth regulators : Growth retardant application bear tremendous effect on fruit set and the response varies with the cultivar, time of application and concentration. Application of cycocel to inflorescence before anthesis greatly increased fruitset in different cultivars of grapes but in no case set increased significantly after anthesis (Coombe, 1965). B-Nine was also equally effective in increasing berry set. Tukey et al. (1967) reported that when B-Nine was applied as foliar spray at concentration varying from 500 to 2250 ppm, in general, lower concentration were most effective in increasing berry set. Chundawat et al. (1971) also reported that application of B-Nine at 0.5 per cent concentration at pre-anthesis stage increased berry set. Contrary to it, Barritt (1970) reported that pre-bloom Alar spray at most concentrations from 250 to 2000 ppm failed to improve berry set significantly. Naito et al. (1983) dipped the developing florets of Kyoho cultivar in 2500 ppm of B-Nine. The treatment increased the number of seeded berries. Ahlawat and Daulta (1981) obtained best fruit set at 500 ppm as compared to 1000 ppm CCC in cultivar Kishmish Charni.

2.2.3 Maturity

2.2.3.1 Effect of severity of pruning : Pruning severity enhances the maturity. Shaulis and Robinson (1953) have reported that the maturity was delayed by increasing the bud load from 30 to 50 per vine in Concord and Fredonia grape varieties. Earliest ripening was obtained in Motrasa vines by pruning to 12-buds per cane (Radaev, 1967). Kimball and Shaulis (1958) found delayed maturity in Concord with vigorous growth due to inadequate exposure of the large leaf surface. Chadha ~~et al.~~ and Mand (1969) have reported that both the length and number of canes had no effect on time of maturity in Perlette grapes.

Chadha et al. (1969) and (1974) reported that pruning severity did not affect the time of ripening in cultivar Perlette and Kandhari, respectively. Lider et al. (1973) reported that with decreasing severity of pruning there was a significant delay in fruit maturity of vine cultivars. Further Lider et al. (1975) stated that pruning severity affect crop maturity in Thompson Seedless grape.

2.2.3.2 Effect of chemicals and growth regulators

George et al. (1988) reported that hydrogen cyanamide hastened bud-burst at all times of applications. When cyanamide was applied 8-10 weeks before natural bud-burst, fruit maturity was advanced by 14-18 days. However, application with 4-6 weeks of natural bud-burst had little or no effect on time of fruit maturity. Low temperature during flowering can adversely affect pollination, seed development and hence yield, may limit the use of early pruning and cyanamide application, particularly under coder subtropical conditions. Under warm subtropical conditions, cyanamide application at 4-6 weeks before natural bud-burst gave significant yield increase by increasing the number of bunches produced per spur.

McColl (1986) observed that fruit ripening in Sultana H4 was advanced by 4, 3 and 2 weeks by cyanamide applications on 30 May, 27 June and 25 July, respectively. Ripening on cardinal was advanced by 3.5 and 2.5 weeks by cyanamide applications on 27 June and 25 July, respectively. Reddy and Prakash (1989) reported that the effects of girdling, the vine trunk in combination with 250 ppm ethrel at various stages of cluster development on the ripening and quality of Gulabi grapes were studied. A positive interaction of double girdling + 250 ppm ethrel improved the quality of berries and also hastened maturity of bunches by about 10 days.

2.3 Physical Characters

2.3.1 Berry size

2.3.1.1 Effect of severity of pruning : In Anab-e-Shahi cultivar, Daniel

(1965) observed significantly higher berry size in the one node pruning than in all other pruning treatments. Whereas, Van Haarlam and Lipshall (1938) also recorded larger berries by over pruning and small berries due to under pruning in Concord grapes.

Chadha et al. (1974) reported that length and breadth of berry was found maximum by 60 buds as compared with 40, 80, 100 and 120 buds pruning but the differences were negligible. Sharma et al. (1978) also reported the largest berry size at 4-buds pruning treatment as compared to 3 or 5 buds but the differences were non-significant.

2.3.1.2 Effect of chemicals and growth regulators : While experimenting on the effect of cycocel, phosphon-D, Alar and CO-11 on grapes, Coombe (1967) reported that cycocel decreased berry size by about 10 per cent. However, Alar and CO-11 were without any effect. El-Hamady et al. (1979) reported that application of cycocel to Roumi Red grape resulted in reduction of berry size. Coppola and Forlani (1980) observed that effect of cycocel at 250, 500 or 1000 ppm sprayed on IM6.0.13 grape vines, 12 days before flowering, the 500 ppm treatment gave best yield with reduced berry size. Effect of paclobutrazol on fruit size is available in other fruits. Proebsting and Mills (1985) reported that application of paclobutrazol on peach, cherry and apricot resulted in larger fruits in contrast to controls at early harvest dates. Spray of 1000-2000 mg/litre applied at full bloom thinned flowers increased fruit size of plum (Webster and Andrews, 1985). Spray of 125-1000 mg/litre in late May thinned small fruit but had little effect on fruit size.

2.3.2 Berry weight

2.3.2.1 Effect of severity of pruning : Berry weight increased with pruning severity. Daniel (1965) reported in cultivar Anab-e-Shahi significantly higher berry weight in one node pruning than in all other pruning treatments. Bessis (1964) observed that the berry weight was lower with long (40-buds) pruning than short (12 buds) pruning in Casignon vines. However, pruning severity had no significant effect on berry weight in cultivar Perlette (Sarowa and Bakhshi, 1972; Kumar and Bajwa, 1973) in Kandhari (Chadha et al., 1974), in Concord (Cawthon and Morris, 1977) and in Anab-e-Shahi (Singh and Kumar, 1980).

Similarly, varying number of buds and canes did not influence berry weight significantly in cultivar Perlette (Kumar and Bajwa, 1973, and Sharma et al., 1977) and in cv. Beauty Seedless (Sharma et al., 1978). Lane (1977) reported non-significant results in berry weight between spur and cane pruning in Muscadines grape. Increasing number of buds and canes decreased berry weight in cultivar Perlette (Godara et al., 1972). Sarowa and Bakhshi (1972) obtained maximum berry weight with 4-buds pruning as compared to 2 and 5 buds pruning in same cultivar. Sharma et al. (1977) found in Perlette cultivar that the berry weight was highest by 2-buds with 36 canes as compared to 3 or 4 buds with 24 or 18 canes, respectively. Okamoto et al. (1985) reported that berry weight increased berry weight (Amarjeet, 1987). Increased severity of pruning resulted in significant increase in berry weight (Sharma, 1987).

2.3.2.2 Effect of chemicals and growth regulators : Reduction in individual berry weight by cycocel treatments was reported by Claus (1969); Barritt (1970); Beetz (1970): Brain (1970); Peterson (1970); Naito et al. (1983) and Simirnov et al. (1984). Most of the above stated workers had observed that early application of CCC was more effective than after fruit set. Tukey et al. (1967) reported that when B-Nine was applied as foliar spray at concentration varying from 500 to 2000 ppm, in general, lower concentrations were uneffective on average berry weight. But the higher concentration reduced the average berry weight. Similarly, pre-bloom and full-bloom application of B-Nine at 1000, 2000 or 3000 ppm reduced average weight of the berry and the later application did not have any effect (Morris et al., 1975). Baritt (1970) reported that pre-bloom Alar spray at most concentration from 250 to 2000 ppm showed a tendency to reduce the average berry weight. El-Hamady et al. (1979) reported that with application of 100, 300 or 1000 ppm CCC to Roumi Red grape vine, 2 weeks before flowering the berry weight was reduced. CCC at 500 or 1000 ppm applied one week before bloom decreased fruit pedicel length and fruit weight (Hifny et al., 1980). Grape vines were sprayed at early bunch development with CCC at 1.6 or 3.2 gm a.i./vine. It reduced the berry weight (Forment and Spinola, 1982). George and Nissen (1987) obtained no significant difference in average fruit weight of Fla 6-3 with foliar applications of paclobutrazol at low concentration (250 ppm) given 42, 54, 69 and/or 80 days after full bloom.

Shikhamany and Reddy (1989) found that mean weight of berries as judged by the 50 berry weight was not influenced significantly by any of the growth retardant treatments. This implies that the variation in the mean bunch weight could be due to increased number of berries/cluster than the mean weight of berries.

2.3.3 Bunch size

2.3.3.1 Effect of severity of pruning : Effect of pruning on bunch size varies from cultivar to cultivar. Shaulis (1948) reported that the cluster size increased by longer pruning in Fredonia grapes. Singh and Singh (1968) found that size of clusters increased with increase in number of bud per spur in Bhokri and Gulabi cultivar. Contrary to these results Van Haarlam and Upshall (1938) obtained large size of bunch by severe pruning as compared with lighter pruning in Concord cultivar. Similar were the findings of Godara et al. (1972a) in Perlette cultivar. Chadha and Mand, ~~et al.~~ (1969) reported that bunch length and breadth were significantly affected by varying level of bud and cane respectively. They also reported that varying number of buds with varying number of canes had significant effect on bunch breadth. Bunch breadth was greater in 3-bud pruning with 100 canes as compared with same or more number of buds with 100 and 140 canes. However, the bunch length was not affected in their studies. Chadha and Kumar (1970) obtained highest bunch size (length and breadth) by 4-bud pruning with 150 canes as compared with 3-bud with 200-canes and 6-bud with 100 canes in Perlette cultivar. Sarowa and Bakhshi (1972a) found greatest bunch size (length and breadth) with 4-bud pruning as compared to 5, 3 and 2-bud pruning with constant number of cane in same cultivar trained on Kniffin system. Nauriyal et al. (1973) obtained highest bunch size (length and breadth) by 3-bud pruning with 140 canes in same cultivar Perlette trained on Bower system. Varying level of bud and cane did not affect the bunch size in cultivar Perlette (Kumar and Bajwa, 1973 and Sharma et al., 1977), Kandhari (Chadha et al., 1974) and Beauty Seedless (Sharma et al., 1978).

2.3.3.2 Effect of chemicals and growth regulators : Effect of ethephon on bunch size varies with variety and stage of application. Costacurta and

Catalano (1988) reported an increase in bunch size in grape hybrid. Whereas, Dhaliwal and Sidhu (1984) reported that bunch size (length and breadth) was not affected significantly with ethephon (100 to 500 ppm) applied at veraison stage in cultivar Perlette. Similarly, Tanwar (1986) has also reported that ethephon 500 ppm applied at verasion did not significantly affect bunch size.

2.3.4 Bunch weight

2.3.4.1 **Effect of severity of pruning** : The severity of pruning has variable effects on bunch weight. Lesser the number of bunds more would be the bunch weight (Godara et al., 1972a and Bhujbal, 1972). Sarowa and Bakshi (1972) also reported that the bunch weight increased progressively from the 2-bud to 4-bud pruning and thereafter, a slight but insignificant decline was observed with 5-bud pruning. Sharma et al. (1977) and (1978) reported that the bunch weight was higher in 2-bud pruning with 36 canes as compared with 4-bud pruning with 15 canes but the effect was not significant. Contrary to these findings Antcliff et al. (1956) and Daniel (1965) reported an increase in bunch weight with increased bud load in Sultana and Anab-e-Shahi cultivar respectively. Chadha and Kumar (1970) noted that 4-bud pruning with 150 canes gave heavier bunch weight than 3-bud with 200 canes or 6-bud with 100 canes in Perlette cultivar trained on Bower system. Similarly, 4-bud pruning with 24 canes in same cultivar trained on Kniffin system (Sarowa and Bakshi, 1972b). Kumar and Bajwa (1973) obtained heavier bunch weight by 4-bud pruning with 15 canes as compared with 2-bud with 30 canes or 3-bud with 20 canes or 5-bud with 12-canes in Perlette cultivar but the effects were not significant. On the other hand, bunch weight was not affected by the pruning severity in cultivar Merlot (Licuni and Calo, 1966), Kandhari

(Chadha et al., 1974) and Himrod (Kumar and Tomar, 1978).

2.3.4.2 Effect of chemicals and growth regulators : Bunch weight could not be increased significantly by ethephon treatments at veraison. Ethephon (400 to 1400 ppm) applied to the berries when they were 5 mm in diameter in cultivar Cabernet sauvignon failed to increase the bunch weight significantly (Martinez-Heredia et al., 1975). El-Banna and Weaver (1978) reported that vines treated with any level of ethephon at veraison stage has no significant effect on cluster weight in Thompson Seedless. However, ethephon (500 ppm) when applied in combination with girdling had a significant increase in bunch weight in cultivar Perlette (Dhaliwal and Sidhu, 1984).

2.3.5 Number of bunches per vine

2.3.5.1 Effect of severity of pruning : It has been reported by various workers that pruning severity affects the number of bunches. Colpy and Tucker (1933) observed a reduction in number of inflorescences consequent to the severity of pruning in Concord. Singh and Singh (1968) obtained increased number of clusters per spur with decreased in pruning severity in Bhokri and Gulabi varieties. Contrary to above, Tomkins and Shaulis (1955) and Schoffling (1965) reported that increase in severity of pruning was associated with an increase in number of cluster per bud in Catawba and Riesling varieties respectively. There was an increase in the number of bunches per vine due to increased bud load and number of canes in Walthan cross (Malan, 1960), Aligote (Martin et al., 1960), Anab-e-Shahi (Daniel, 1965), Sultana (Antcliff et al., 1956).

Upper buds produced more bunches when pruned to 4-buds per vine as compared to 12-buds per vine in Carrignane variety (Bessis, 1964). Deidda (1968) found that the number of bunches per bud was greater on 10 bud pruned canes than on spurs pruned to 4-bud in Malvasia and Tokay varieties but not in Carignane and Vermentino varieties. More number of bunches were obtained when the canes were pruned 10-12 buds in Rkaciteli grapes (Kulinic, 1969).

Pruned vines bear lesser number of bunches as compared to unpruned ones (Singh and Singh, 1968 and Moti, 1971). The number of bunches per vine were increased with increased bud load and number of canes in Anab-e-Shahi (Daniel, 1965), Perlette (Godara et al., 1972 and Kumar and Bajwa, 1973) and Thompson Seedless (Singhrot et al., 1977) varieties. Contrary to above, Tomkins and Shaulis (1955) and Schoffling (1965) reported that increase in severity of pruning was associated with an increase in number of bunches per vine in Catawba and Riesling varieties, respectively.

Kumar and Tomer (1978) observed that 5-bud with 10 canes pruning gave maximum number of bunches than 6-bud with 10-canes or 3-buds with 20 canes in Himrod grapes. Similarly, Sarowa and Bakshi (1972) observed that 4-bud pruning gave higher number of bunches than 5-bud pruning in Perlette grape. Similar results have also been reported by Al-rawi and Al-doori (1977) in Desalanis grape. Pruning severities did not influence the number of bunches per vine in cultivar Perlette (Chadha and Kumar, 1970; Kumar and Bajwa, 1973 and Sharma et al., 1977) and Beauty Seedless (Sharma et al., 1978).

Singh and Kumar (1980) observed that 3-bud with 40-canes pruning level produced the maximum number of bunches per vine which was significantly higher than those observed under 4-bud with 30-canes, 5-bud with 24-canes and 6-bud with 2-canes pruning. Tomar and Brar (1986) reported that number of bunches/vine were decreased with increasing number of bud/ cane. Sharma (1987) reported that increase in number of canes per vine increased the number of bunches.

2.3.5.2 Effect of chemicals and growth regulators : Sedletakii et al. (1980) reported that CCC when applied at the rate of 0.10% just before flowering increased the number of bunches/vine. Similar observations were made by Forlani and Coppola (1980). Bindra et al. (1980) reported that CCC when applied at 4, 8 and 12 per cent to buds of grape vine cultivar Anab-e-Shahi after pruning in January, significantly reduced the loss of floral primordia by conversion them to tendrils, resuslting in more bunches/vine than untreated control. Myrianthousis (1984) observed that spray application of CCC on vines increased number of bunches per vine over control, but to a lesser extent. George and Nissen (1987) reported that both soil and foliar treatments of paclobutrazol increased floral bud differentiation which should a trend towards higher number of bunches per vine.

Shikhamany and Reddy (1989) reported that there was no significant influence of the growth retardent treatments on the number of clusters per vine, though Bajwa (1979) reported increased number of bunches per vine in Thompson Seedless when CCC was sprayed at 1000 ppm and 2000 ppm. Non-significant influence of CCC on the cluster number per vine indicated that the concentrations used in the present investigations are inadequate to exert the desirable influence under the conditions of experimentation.

2.4 Chemical Characters

2.4.1 TSS

2.4.1.1 Effect of severity of pruning : Increase in severity of pruning, increased total soluble solids of grape juice in cultivars Perlette (Chadha and Mand ~~et al.~~, 1969; Chadha and Kumar, 1970 and Sharma et al., 1977). Italian Riesling (Balkrishana and Rao, 1963), Rashmeu (Al-rawi and Al-doori, 1977), Thompson Seedless (Singhrot et al., 1977) and Beauty Seedless (Sharma et al., 1977). Chadha and Mand ~~et al.~~ (1969) also reported that the percentage of TSS was significantly higher with 100 canes as compared with 120 and 140 canes per vine in cultivar Perlette. They also stated that 3 bud pruning with 140 canes gave higher total soluble solids than 3 bud pruning with 120 canes and 6 bud pruning with 100, 120 and 140 canes per vine. Godara et al. (1972) obtained higher TSS with decreased number of buds and canes in same cultivar. Sarowa and Bakshi (1972) obtained higher total soluble solids by 4 bud pruning with 24 canes as compared with 2 and 5 bud pruning with the same number of canes in Perlette cultivar. Similarly, Kumar and Bajwa (1973) obtained higher percentage of TSS by 4 bud pruning with 15 canes than the 2 bud with 30 canes and 5 bud with 12 canes in same cultivar. Cawthon and Morris (1977) reported that increasing bud load per vine decreased total soluble solids in Concord grapes. Sharma et al. (1978) obtained highest TSS at 2 bud with 36 canes than 3 or 4 bud with 24 or 28 canes, respectively, in Beauty Seedless grapes. Similarly, Singh and Kumar (1980) also observed significantly higher TSS at 4 bud with 30 canes as compared to 3, 5 or 6 bud with 40, 24 or 20 canes, respectively, in cultivar Anab-e-Shahi. Shikhamany and Reddy (1989) found that quality of berries as judged by TSS and titrable acids contents was not influenced significantly by the retardant treatments.

2.4.1.2 Effect of chemicals and growth regulators : Quality of grapes in terms of TSS is reported to remain unaffected with cycocel treatments (Tukey and Fleming, 1967; Chundawat et al., 1971 and Weaver, 1981). There are, however, a few contradictory reports which show an increase in TSS in grapes by cycocel treatments (Ahlawat and Daulta, 1981, Forlani et al., 1983). B-Nine at 500 to 1500 ppm sprayed at pre-bloom did not significantly affect the fruit quality in terms of TSS in Kyoho grapes (Tukey and Fleming, 1967, Chundawat et al., 1971). Weaver (1981) reported that chloromequat applied just before flowering to Cabernet Savrignon, Pinot Noir and Chardonnay Vines at 600, 300 and 1000 ppm, respectively, did not affect soluble solids content in cultivars Sauvignon and Chardonnay. El-Hamady et al. (1979) observed that cycocel treatments at various concentrations did not alter the TSS content of the juice. Similar results were obtained by Mohammed et al. (1987) on Roumi Red grapes and Panwar (1985) on Kishmish Charni. Ahlawat and Daulta (1981) obtained an increase in TSS content of juice from 17.2% to 17.3-18.6% with application of CCC at 500 or 1000 ppm. B-Nine at 1000 or 1500 ppm did not alter the TSS. Chloromequat applied to Greco Bianco grapes at 250, 500 and 1000 ppm 15 days before full bloom lowered sugar content of berries, slightly but not significantly (Forlani et al., 1983).

2.4.2 Acidity

2.4.2.1 Effect of severity of pruning : The percentage of acidity decreased with increased severity of pruning in grape cultivars Perlette (Chadha ~~et al.~~ and Maud, 1969 and Sharma et al., 1977). Contrary to the reports, the percentage of acidity increased with increased severity of pruning in cultivar Perlette (Chadha and Kumar, 1970 and Sarowa and Bakshi, 1972). On the other hand, pruning severity did not affect the percentage of total acidity in cultivars (Nauriyal et al., 1973), Kishmish Charni (Sharma et al., 1977), Concord (Cowthon and Morris, 1977), Beauty Seedless (Sharma et al., 1978) and Anab-e-Shahi (Singh and Kumar, 1980).

2.4.2.2 Effect of chemicals and growth regulators : B-Nine spray did not alter the acidity significantly (Tukey and Fleming, 1967). El-Hamady et al. (1979) observed the effect of various concentrations of cycocel on Roumi Red grape vines, applied two weeks before flowering. The cycocel application did not alter the acidity of the juice. The acidity decreased by 0.2-1.3%, when cycocel was applied just before flowering to grape vines trained on a stem, and again at the beginning of grape growth (Sedlotskii et al., 1980). Ahlawat and Daulta (1981) obtained a lowered grape acidity from 0.84% to 0.67-0.69% with application of CCC at 500 or 1000 ppm concentration to Kishmish Charni grape vine. B-Nine at 1000 or 1500 ppm did not significantly alter the acidity. Pera et al. (1983) applied CCC at 250-500 and 1000 ppm, 15 days before full bloom and found that all treatments increased the total acidity. Application of paclobutrazol at 5000-20,000 ppm, trunk applied at 3 stages of growth had no effect on fruit quality (Ahmedullah et al., 1986). Similar results were obtained by Mohammad et al. (1987) with application of CCC at 500, 100 or 1500 ppm on Roumi Red grape.

3. MATERIALS AND METHODS

The present study entitled, "Effect of pruning, cane twisting and some chemicals on productivity of grape (Vitis vinifera L.) cv. Thompson Seedless", was carried out in the experimental vineyard of Department of Horticulture, CCS Haryana Agricultural University, Hisar, during the year 1990.

3.1 Plant Material

Six year old vines of uniform vigour spaced at 3 x 3 meter apart and trained on Bower system were selected for experimental purposes and were given uniform cultural practices.

3.2 Layout of the Experiments

Two separate sets of experiments were laid out to study the effect of various chemicals and pruning on growth and productivity of Thompson Seedless grapes. The first experiment consisted of four pruning treatments, whereas, in second experiment cane twisting and four different chemicals were applied each at single concentration just after pruning. The details of experiments are given below :

3.2.1 Experiment No. 1

Pruning studies on Thompson Seedless cultivar of grape trained on Bower system

S.No.	Number of fruiting canes/vines	No. of buds/cane
1.	16	4
2.	16	6
3.	16	8
4.	16	10

Plant Unit : 1

Replication : 4

Design : Randomized Block Design

Sixteen vines were pruned at required number of buds/cane level on 18th ~~February,~~ January 1990.

3.2.2 Experiment No. 2

Cane twisting and chemical studies on Thompson Seedless cultivar of grape trained on Bower system

S.No.	Chemicals	Concentration applied
1.	KNO_3	6%
2.	Ethrel	2000 ppm
3.	Paclobutrazol	1500 ppm
4.	Dormex	2%

5.	Cane twisting	Twisting and water spray
6.	Non-twisted control	Water spray

Plant unit : 2

Replication : 4

Design : Randomized Block Design

Forty-eight vines were pruned at 7 bud level per cane by keeping 16 canes per vine on 18th ~~February~~ January, 1990. Various chemicals were sprayed immediately after pruning.

To observe the cane twisting effect, the individual canes of pruned vines were twisted by hand to rupture the cambium in between the nodes.

3.2.2.1 Method of preparing and using solutions

Weighed required quantity o. KNO_3, ethrel, paclobutrazol, dormex and water dissolved in small quantity of distilled water and required concentration solutions were prepared separately for each chemical using distilled water. Tween-20 @ of one tea-spoonful per litre was used as sticker for effective spraying. Distilled water added with Tween-20 was used as control.

3.3 Observations

The observations were divided into four broad categories recorded in both the experiments :

1. Growth characters
2. Floral characters

3. Physical characters
4. Chemical characters

The details how the observations were recorded are given below :

3.3.1 Growth characters

For recording various growth characters four canes on each vine were tagged for recording data on bud-break, panicle-emergence and berry set etc.

3.3.1.1 Time of bud-break

The first appearance of rudimentary leaves from swollen bud was used as criteria for bud-break. The bud-break was noted on the cane by putting that data against the position of the node from which bud sprouted. The number of days required for bud-break were calculated from the date of pruning.

3.3.2 Floral characters

3.3.2.1 Time of panicle emergence

The fresh growth from various buds on the marked canes on each treatment was constantly kept under observation after the sprouting to see the panicle emergence. The appearance of panicle was noted on the freshly growing shoot by putting that date against the position of bud from which panicle emerged. The number of days taken for panicle emergence were calculated from the date of pruning.

3.3.2.2 Time of berry set

The date of berry set was recorded when the berries were of pinhead size and clearly visible to the naked eye. Number of days taken to berry set was calculated from the date of pruning.

3.3.2.3 Date of harvest

The bunch was considered mature when it attained a minimum of 20.24 per cent total soluble solids, T.S.S./acid ratio of 26.28 and acidity less than 0.77.

3.3.3 Physical characters

Four bunches per vine were tagged from the already tagged canes for recording various observations of physico-chemical characteristics of fruits.

3.3.3.1 Average berry size (length and breadth)

The length and breadth of fifty berries were measured with the help of meter scale and average berry length and breadth has been expressed in cm.

3.3.3.2 Average berry weight

The average berry weight was recorded on the basis of 50 normal berries randomly taken from four selected bunches on the triple beam balance and has been expressed in gram.

3.3.3.3 Average bunch weight

The weight of four representative bunches randomly selected was recorded in gram and average weight was calculated.

3.3.3.4 Bunch size (length and breadth)

After recording the bunch weight, the length and breadth of four bunches were measured with the help of a meter scale and average length and breadth was worked out and expressed in cm.

3.3.3.5 Number of bunches per vine

When berries attained pea size, the total number of bunches per vine under each treatment were counted.

3.3.4 Chemical characters

3.3.4.1 Total soluble solids (T.S.S.)

The extracted juice was immediately analysed for total soluble solids (T.S.S.). The TSS was determined by using Erma Hand Refractometer of 0-32 per cent range at 20°C. Mean value was expressed as per cent total soluble solids in juice.

3.3.4.2 Acidity

Five ml of freshly extracted juice was diluted to 20 ml with distilled water and titrated against N/10 NaOH using phenolphthalein as an indicator. The acidity was expressed as gram of tartaric acid per hundred ml of juice.

4. EXPERIMENTAL RESULTS

The present investigation on the "Effect of pruning cane twisting and some chemicals on productivity of grapes cv. Thompson Seedless" was carried out in the Department of Horticulture, CCS Haryana Agricultural University, Hisar, during the year 1990. In order to achieve the objectives of the study, two separate experiments were conducted. The results of present investigations are presented under different sub-heads as follows :

EXPERIMENT NO. 1

Studies on pruning severity on growth and productivity of Thompson Seedless grapes

The vines were pruned to various levels of buds per cane. The cane number per vine was kept constant (16 canes per vine). The effect of pruning levels on various characters viz., growth, floral, physical and chemical, has been studied and presented under different sub-heads.

4.1 Growth Characters

4.1.1 Number of days taken for bud-break

The data presented in Table 4.1 showed that the pruning at 4-bud significantly reduce the number of days (50.25) taken for bud-break in comparison to 8 and 10 bud levels. The pruning at 10-bud level took maximum number of days (55.75). There were non-significant differences between number of days taken for 6, 8 and 10-bud pruning levels. However, a trend for earlier sprouting was noticed with increased severity of pruning.

4.2 Floral Characters

4.2.1 Number of days taken for panicle emergence

The perusal of data in Table 4.1 show as that the number of days taken for panicle emergence were significantly lower in 4-bud pruning (62.00 days) as compared to other pruning levels. The 4-bud and 6-bud pruning indicated significant reduction in number of days taken for panicle emergence to that of 10-bud pruning (67.75 days). But there were non-significant differences between 8-bud and 10-bud prunings. It was noticed that with increased pruning intensity the number of days required for panicle emergence were also increased.

4.2.2 Number of days taken for berry set

The effect of pruning levels on number of days taken for berry set was significant with 4-bud pruning (Table 4.1). However, significant reduction in number of days taken for berry set with 4-bud (92.00 days) and 6-bud

Table 4.1. Effect of severity of pruning on number of days taken for bud break, panicle emergence, berry-set and harvest in *Thompson Seedless grapes*

Treatment	Bud-break	Panicle-emergence	Berry-set	Harvest
4-bud	50.25	62.00	92.00	141.75
6-bud	53.75	65.25	95.75	145.75
8-bud	54.75	66.50	96.50	146.00
10-bud	55.75	67.75	97.75	149.50
$CD_{0.05}$	3.64	1.71	1.69	2.53

(95.75 days) pruning level was observed. The difference between 8- and 10-bud treatments could not attain the level of significance. However, maximum number of days (97.75) were taken with 10-bud pruning treatment which were significantly higher than the number of days taken with 4-bud treatment.

4.2.3 Number of days taken for harvest

The pruning effect on number of days taken for harvest was pronounced as evidenced from Table 4.1. At each level of pruning treatment there was significant difference in number of days taken for harvesting the crop. However, 4-bud pruning significantly reduced the number of days required for harvest (141.75 days) in comparison to 6, 8 and 10-bud pruning treatment. It was noticed that maturity was advanced with increased severity of pruning.

4.3 Physical characters

4.3.1 Berry size (length and breadth)

The effect of pruning levels on physical characters of berries were recorded and the results obtained are presented in Table 4.2. Pruning with 8-bud level showed that maximum average berry length (1.49 cm) whereas minimum average berry breadth (1.14 cm) were recorded with 8-bud pruning, which differed significantly with other levels of pruning. There were non-significant differences between 4- and 6-bud pruning treatments, however, with respect to average berry length and breadth maximum average increase (1.22 cm) in berry breadth was recorded with 10-bud pruning.

4.3.2 Berry weight

Average berry weight increased favourably with all levels of pruning

Table 4.2. Effect of severity of pruning on berry- length, berry breadth and berry-weight in Thompson Seedless grapes

Treatment	Average berry-length (cm)	Average berry-breadth (cm)	Average berry-weight (g)
4-bud	1.41	1.18	1.36
6-bud	1.38	1.20	1.34
8-bud	1.49	1.14	1.38
10-bud	1.31	1.22	1.31
$CD_{0.05}$	0.04	0.03	N.S.

(Table 4.2). However, pruning at 8-bud showed a maximum average increase (1.38 g) in berry weight, but this increase was non-significant in comparison to 4- and 6-bud levels of pruning. Pruning with 10-bud had lower average berry weight (1.31 g) than other levels of pruning.

4.3.3 Bunch size (length and breadth)

It was noticed from the Table 4.3 that average length and breadth were significantly affected by pruning level. Maximum average bunch length (20.23 cm) and breadth (10.43 cm) were recorded with 8-bud pruning level, which were significantly higher than 4- and 8-bud prunings. At 4-bud pruning treatment the minimum average increase in bunch length (16.26 cm) and breadth (9.08 cm) was recorded. A significant difference was observed in bunch breadth with 6 and 8 bud pruning, however, a non-significant difference was observed between 4 and 6 bud; 8 and 10 bud pruning with regard to average bunch breadth.

4.3.4 Bunch weight

Average bunch weight was significantly increased with 6- and 8-bud pruning treatments in comparison to 10 and 4-bud level (Table 4.3). The maximum average weight (415.44 g) observed with 8-bud level of pruning. There was non-significant difference between 6 and 8 bud pruning level.

4.3.5 Number of bunches/vine

Average number of bunches per vine were significantly affected by the pruning severity except pruning at 6-bud level (Table 4.3). Average number of bunches decreased with increased in pruning severity. Maximum

Table 4.3. Effect of severity of pruning on bunch-length, bunch breadth, bunch-weight and number of bunches per vine in Thompson Seedless grapes

Treatment	Average bunch-length (cm)	Average bunch-breadth (cm)	Average bunch-weight (g)	Average number of bunches/vine	Average yield/vine (kg)
4-bud	16.26	9.08	395.12	15.25	6.03
6-bud	17.18	9.11	411.44	16.75	6.90
8-bud	20.23	10.43	415.44	24.00	9.97
10-bud	19.30	9.23	375.84	25.75	9.68
$CD_{0.05}$	1.89	1.25	14.87	2.87	-

Table 4.4. Effect of severity of pruning on TSS and acidity in Thompson Seedless grapes

Treatment	TSS (%)	Acidity (%)
4-bud	22.67	0.71
6-bud	23.49	0.72
8-bud	22.42	0.74
10-bud	20.52	0.75
$CD_{0.05}$	2.03	N.S.

average increase (25.75) was noticed in 10-bud pruning, which was significantly higher when comparing with 4-bud pruning (15.25). However, there was non-significant differences between 4- and 6-bud, and in between 8- and 10-bud pruning levels.

4.4 Chemical Characters

4.4.1 T.S.S.

From Table 4.4, it was observed that the maximum total soluble solids (23.49%) was observed in 6-bud and followed by 4-bud (22.67%), 8-bud (22.42%) and 10-bud (20.52%) treatments. The T.S.S. content of berry decreased with increased bud load per cane. The T.S.S. in 4-bud and 6-bud treatments were significantly higher over 10-bud treatment. However, 8-bud pruning could not attain the level of significance.

4.4.2 Acidity

The maximum per cent acidity (0.75%) was recorded with 10-bud pruning, whereas, the lowest (0.71%) was recorded with 4-bud pruning (Table 4.4). The treatment differences failed to show any significance, however, the percent acidity decreased with increased intensity of pruning.

4.5 Growth Characters

4.5.1 Effect of severity of pruning on bud-break w.r.t. position of node

The data relating to number of days taken for bud break at different nodal position were recorded and presented in Table 4.5.

Table 4.5. Effect of severity of pruning on number of days taken for bud-break w.r.t. position of nodes in Thompson Seedless grapes

Treatment	Nodal position										$CD_{0.05}$
	1	2	3	4	5	6	7	8	9	10	
4-bud	55.25	53.00	51.75	49.00							2.20
6-bud	57.50	55.25	59.00	57.25	53.00	51.50					2.10
8-bud	57.25	56.00	52.75	55.00	53.75	52.75	51.50	50.50			2.69
10-bud	58.50	58.50	56.25	57.50	56.50	54.25	54.00	53.25	51.75	53.00	3.44

Days required for bud-break with different pruning levels varied significantly in respect of all the nodal positions. At all pruning levels the terminal nodes required less number of days for bud-break, which were significantly higher as compared to number of days required at lower nodal positions. Similarly, the mean number of days required for break of buds at 4-bud pruning were lower than other pruning treatments. However, there were non-significant difference between 6-bud and 10-bud prunings on the number of days taken for bud-break. In general, the number of days required for bud-break decreased significantly from basal to terminal nodal positions.

4.6 Floral Characters

4.6.1 Effect of severity of pruning on panicle emergence w.r.t to position of node

The data for number of days taken for panicle emergence w.r.t. different nodal positions were recorded and presented in Table 4.6.

The perusal of data in Table 4.6 show that at different nodal positions the number of days required for panicle emergence differed significantly. Panicle emergence at basal buds of canes took more days (66.00, 67.50, 68.25 and 69.50 days in 4, 6, 8 and 10-bud prunings, respectively) as compared to terminal one's (60.50, 63.75, 62.25 and 62.75 days, respectively for 4, 6, 8 and 10-bud prunings), which differed significantly. Similarly, mean number of days required for panicle emergence were lower at 4-bud pruning treatment than other pruning treatments. However, there seemed to be non-significant difference between first four buds in 6-bud pruning and between first five buds in 10-bud pruning. In general the number of days required for panicle emergence decreased with nodal positions from basal to terminal one's.

Table 4.6. Effect of severity of pruning on number of days taken for panicle emergence w.r.t. position of node in Thompson Seedless grapes

Treatment	Nodal position										$CD_{0.05}$
	1	2	3	4	5	6	7	8	9	10	
4-bud	66.00	64.50	62.25	60.50							2.52
6-bud	67.50	66.00	69.50	68.00	64.50	63.75					3.4[illegible]
8-bud	68.25	67.00	65.50	64.25	64.50	63.75	63.25	62.25			2.10
10-bud	69.50	69.50	67.25	68.50	67.50	65.25	65.00	64.25	62.75	64.00	3.85

EXPERIMENT-2

Studies on some chemicals and cane twisting on growth and productivity in Thompson Seedless cv. of grape

The vines were pruned at 7-bud and the number of canes per vine were kept constant (16 canes per vine) for observing the effect of cane twisting and chemicals on growth and productivity of Thompson Seedless grapes. The chemicals sprayed were different growth regulators viz. ethrel, paclobutrazol, dormex and one chemical KNO_3 and compared with twisted and non-twisted control- for various characters under different sub-heads :

4.7 Growth Characters

4.7.1 Number of days taken for bud-break

The data relted to different chemicals' and twisting effect are presented in Table 4.7. It is clear from the Table 4.7 that dormex significantly reduced the number of days (50.25) required for bud-break as compared to control (59.85 days). There were non-significant differences in number of days taken for bud-break between KNO_3, Ethrel, PB and twisting, however, these treatments significantly reduced the number of days required for bud-break when compared with non-twisted control (59.85 days).

4.8 Floral Characters

4.8.1 Number of days taken for panicle emergence

It is observed from the Table 4.7 that the chemical, various growth regulators and cane twisting, significantly reduced the number of days taken

Table 4.7. Effect of chemical, growth regulators and cane twisting on bud-break, panicle-emergence, berry-set and harvest in Thampson Seedless grapes

Treatment	Bud-Break	Panicle-emergence	Berry-set	Harvest
Control	59.85	72.17	102.67	151.44
KNO_3 6%	56.85	66.50	96.75	145.65
Ethrel 2000 ppm	56.50	67.25	98.19	147.20
Dormex 2%	50.25	62.75	91.47	140.71
PB 1500 ppm	56.60	67.63	97.88	147.45
Cane twisting	57.05	68.36	98.79	148.15
$CD_{0.05}$	2.73	2.36	2.09	1.88

for panicle emergence. Dormex seemed to be the most effective in hastening panicle-emergence by about ten days (from 72.17 days in control to 62.75 days when treated with Dormex). KNO_3, Ethrel, PB and cane twisting also reduced the number of days required for panicle emergence. However, there were non-significant differences between different treatments. Dormex treated canes reached the level of significance as compared to other chemical-treatments.

4.8.2 Number of days taken for berry set

The chemicals, growth regulators and cane twisting had a favourable effect on the number of days required for berry set (Table 4.7). The effect of Ethrel, PB and twisting had a similar effect, whereas, KNO_3 significantly reduced (96.75 days) the number of days required for berry set. Dormex treated canes caused the flowers to set too early by about 10-11 days (91.47 days as compared to control 102.67 days).

4.8.3 Number of days taken for harvest

The perusal of data from Table 4.7 show that harvesting time greatly enhanced by about ten to eleven days (151.44 days in control to 140.71 days by Dormex) when treated with Dormex. Although other treatments also significantly reduced the number of days required for harvest, but there were non significant differences between the harvesting time in Ethrel, PB and cane twisting.

4.9 Physical Characters

4.9.1 Berry size (length and breadth)

The effect of chemicals, growth regulators and cane twisting on

Table 4.8. Effect of chemical, growth regulators and cane twisting on berry-length, berry breadth and berry-weight in Thompson Seedless grapes

Treatment	Average berry-length (cm)	Average berry-breadth (cm)	Average berry-weight (g)
Control	1.21	1.33	1.31
KNO_3 6%	1.40	1.19	1.35
Ethrel 2000 ppm	1.29	1.25	1.35
Dormex 2%	1.23	1.33	1.33
PB 1500 ppm	1.24	1.32	1.33
Twisting	1.27	1.31	1.35
$CD_{0.05}$	0.09	0.05	N.S.

physical characters of berries were presented in Table 4.8.

Maximum average berry length (1.40 cm) and berry breadth (1.19 cm) were observed when treated with KNO_3 which were significantly differed with other treatments. All other treatments had non-significant effect when compared with control w.r.t. average berry length and breadth.

4.9.2 Berry weight

Average berry weight was not affected significantly with cane twisting or other chemicals under study (Table 4.8). However, maximum average berry weight was observed with KNO_3, Ethrel and twisting (1.35 g in each case) as compared to minimum average berry weight (1.31 g) in control.

4.9.3 Bunch size

The data related to bunch characters is presented in Table 4.9. Average length and breadth were significantly affected by growth regulators and chemicals. Twisting increased the average bunch length (14.86 cm) non-significantly when compared with control (14.75 cm). Maximum average bunch length (17.61 cm) was achieved with KNO_3 treatment followed by PB (16.28 cm) and Ethrel (16.23 cm) in comparison to control. Minimum average bunch breadth (9.39 cm) was recorded by twisting method followed by PB (9.28 cm).

4.9.4 Bunch weight

Maximum average bunch weight (494.64 g) was observed with PB, followed by Dormex (481.75 g). However, treatments differed non-significantly

Table 4.9. Effect of chemical, growth regulators and cane twisting on bunch-length, bunch breadth, bunch weight and number of bunches/vine in Thompson Seedless grapes

Treatment	Average Bunch-length (cm)	Average Bunch-breadh (cm)	Average Bunch-weight (g)	Average Number of bunches/vines	Average Yield/vine (Kg)
Control	14.75	9.34	448.50	18.25	8.19
KNO_3	17.61	9.07	410.25	24.13	9.90
Ethrel 2000 ppm	16.23	9.25	417.92	22.13	9.25
Dormex 2%	15.85	9.26	481.75	27.88	13.43
PB 1500 ppm	16.28	9.28	494.64	19.63	9.75
Twisting	14.86	9.39	455.05	19.88	9.05
$CD_{0.05}$	0.37	0.10	16.13	2.33	-

with each other. Ethrel and KNO_3 treatments significantly reduced the average bunch weight (417.92 g and 410.25 g, respectively) over the control.

4.9.5 Number of bunches/vine

The vines treated with dormex significantly increased the average number of bunches per vine (27.88) as compared to control (16.25), followed by KNO_3 (24.13) and ethrel (22.13) treated vines. PB and cane twisting treatments could not attain the level of significance.

4.10 Chemical Characters

4.10.1 T.S.S.

The data related to T.S.S. is presented in Table 4.10 indicated that maximum total soluble solids (23.5%) was recorded in ethrel treatment followed by KNO_3 treated vines (22.58%), which were significantly higher over control (20.24%). There were non-significant differences within dormex, PB and twisting treatments.

4.10.2 Acidity

From the Table 4.10 it was inferred that reduction in acidity was observed with ethrel and cane twisting. There were non-significant differences within KNO_3, dormex, PB and twisting treatments, however, maximum acidity was in the berries when the vines were treated with KNO_3 followed by PB treatment.

Table 4.10. Effect of chemical, growth regulators and cane twisting on T.S.S. and acidity in Thompson Seedless grapes

Treatment	T.S.S. (%)	Acidity (%)
Control	20.24	0.77
KNO_3 6%	22.58	0.89
Ethrel 2000 ppm	23.51	0.82
Dormex 2%	21.60	0.83
PB 1500 ppm	21.21	0.86
Twisting	21.69	0.80
$CD_{0.05}$	0.86	N.S.

Table 4.11. Effect of chemical, growth regulators and cane twisting on number of days taken for bud-break w.r.t. position of node in Thompson Seedless grapes

Treatment	Nodal position							Mean
	1	2	3	4	5	6	7	
Control	58.25	57.50	63.25	60.25	61.25	60.00	59.25	59.96
KNO_3 6%	58.25	57.00	56.50	56.00	58.75	58.00	57.50	57.43
Ethrel 2000 ppm	58.50	57.00	57.75	56.50	59.25	58.25	57.75	56.43
Dormex 2%	55.75	54.25	54.25	51.00	51.50	52.25	52.00	53.00
PB 1500 ppm	57.25	58.25	58.75	54.75	55.25	56.00	56.25	56.64
Twisting	58.25	56.75	56.25	57.75	58.00	58.00	57.50	57.50
Mean	57.71	56.79	57.79	56.04	57.33	57.08	56.71	
$CD_{0.05}$	2.80	2.93	3.57	3.64	4.65	3.53	2.78	

Node : 3.75
Interaction : 10.65

4.11 Growth Characters

4.11.1 Effect of chemicals and cane twisting on bud-break w.r.t position of node

The number of days required for bud-break as affected by growth regulators, chemicals and cane twisting were observed on different nodal positions (Table 4.11).

The days required for bud-break with different chemicals, growth regulators and cane twisting treatment varied significantly in respect of all nodal positions. Dormex caused the buds to induce early at all the nodes when compared to twisted or non-twisted control. Duration of bud-break was narrowed by all treatments including cane twisting. Among various chemicals except dormex, PB was significantly superior to twisted control at 4th, 5th, 6th and 7th nodal positions, while to non-twisted control at 3rd, 4th, 5th 6th and 7th nodal positions, in reducing the number of days required for bud-break. However, there was non-significant difference in between KNO_3 and ethrel treatments. Similarly, mean number of days required for break of buds with various chemicals treatments reduced significantly as compared to non-twisted control. In general, the number of days required for bud-break were lower in terminal nodal positions as compared to lower nodal positions.

4.12 Floral Characters

4.12.1 Effect of chemicals and cane twisting on panicle emergence w.r.t position of node

The number of days required for panicle emergence at different nodal positions were presented in Table 4.12.

Table 4.12. Effect of chemical, growth-regulators and cane twisting on number of days taken for panicle emergence w.r.t. position of node in Thompson Seedless grapes

Treatment	Nodal position							Mean
	1	2	3	4	5	6	7	
Control	69.25	68.75	73.25	71.00	72.00	71.25	70.00	70.78
KNO_3 6%	69.50	68.25	67.75	66.75	69.75	69.25	68.75	68.57
Ethrel 2000 ppm	69.75	68.00	68.50	67.25	70.25	69.25	68.75	68.82
Dormex 2%	67.50	67.00	66.25	64.50	65.50	65.00	65.75	65.93
PB 1500 ppm	68.50	69.25	69.50	65.50	66.25	67.00	67.25	67.61
Twisting	69.50	67.50	67.25	68.50	68.75	69.00	68.75	68.47
Mean	69.00	68.13	68.75	67.25	68.75	68.46	68.25	
$CD_{0.05}$	1.17	1.39	3.05	3.92	3.98	4.10	2.33	

Node : 3.95
Interaction : 8.79

From the data, it was concluded that emergence of panicle hastened significantly when treated with chemicals and growth regulators. Dormex observed to be most effective in respect to that it induced too early emergence of panicles. However, there seemed to be non-significant differences in hastening the number of days required for panicle emergence with various chemicals except with dormex treatment. In general, the number of days required for panicle emergence were lower in terminal nodal positions in comparison to lower nodal positions. Similarly, the mean number of days required for emergence of panicles hastened with chemical treatments over that of non-twisted control.

5. DISCUSSION

The present investigation on the "Effect of pruning, cane twisting and some chemicals on productivity of grape (*Vitis vinifera* L.) cv. Thompson Seedless", yielded some useful and interesting observations.

Effect of pruning severity

The results obtained by various levels of pruning are discussed below :

Growth characters

Bud break : The present studies indicated that with increased severity of pruning the number of days taken for bud-break reduced significantly. Pruning at 4-bud had a pronounced effect on time taken for bud-burst. This could be due to the better distribution of food reserves, which caused earlier sprouting than in vines with higher bud load caused by longer canes. The findings of Madhava Rao (1968), Winkler (1970), Bhujbal (1972) Rao and Mukherjee (1972), Singhrot *et al.* (1977), Wang (1985), Jensen and Bettiga (1985) in various cv. of grape also support the contension.

Pruning with 4-bud/cane significantly enhanced the number of days required for bud-break at each nodal position in comparison to other pruning treatments. Similarly, the terminal nodal positions on the canes, the bud-break was early as compared to lower buds. According to accepted principles of pruning, the buds next to cut sprouts first (Winkler, 1970). The inhibitory effect of bud, next to pruning cut, on lower buds with long pruned cane may be either through auxin inhibition or depletion of food material caused by the vigorous growth of the buds next to pruning cut (Antcliff et al., 1955). These results are in confirmity with the findings of Pastena (1959), Daniel (1965), Khajuria et al. (1970), Daulta and Bakshi (1970), Singhrot et al. (1977), Lagier (1987), Kumar and Chohan (1989).

Floral characters

Panicle emergence

The number of days taken for panicle emergence were lower in 4-bud pruning as compared to other pruning levels, indicating that with increased intensity of pruning the number of day required for panicle emergence were decreased linearly. This reduction was significant at each nodal position in 4-bud pruning as compared to other levels of pruning. Terminal buds seemed to be more responsive to pruning treatments than basal buds. This may be due to the delay in sprouting of lower buds at increased bud levels. Further, with the increase in the number of sprouts per vine, the amount of nutrients and metabolites available will naturally fall short than that in the severe prunings with lesser number of sprouts per vine and hence the delay in panicle emergence and decreased vigour. Contrary results have been observed observed by Sehrawat (1988), that pruning severity comprising different cane and bud levels have not affected the days taken for growth and panicle emergence calculated from date of pruning. The present findings were also supported by Daniel (1965), Chadha ~~et al.~~ and Mand (1969), Winkler (1970), Godara et al. (1972), whereas, results of Chadha and Mand (1969), Jauhari and Nand (1970), and Sharma et al. (1977) and (1978) are also in agreement with the obtained results.

Berry set

The effect of pruning levels on number of days taken for berry set was significant with 4-bud treatment, while other pruning treatment could not enhance the days significantly, required for berry set. The reason for early berry set in severity pruned vines can be explained by early appearance of full bloom stage owing to greater availability of nutrients and metabolites per sprout.

Maturity

Similarly like flowering, the ripening was also enhanced with increased severity of pruning and decreased level of spur. Early flowering and berry development due to better nutrition and distribution of food materials in these treatments are the factors responsible for enhanced ripening. The findings of Kimball and Shaulis (1958), Lider (1973) in Concord and wine cultivars respectively also supported the idea that increased severity of pruning enhanced fruit maturity.

Physical characters

Berry characters

Berry weight, length and breadth were highest in 8-bud treatment followed by 6- and 10-bud pruning treatments. The reason for less berry length and weight under present study can be explained on the basis of poor distribution of metabolites owing to higher bud load per cane.

Contrary to it, increased berry size and weight with increased severity of pruning has been noted in cvs. Perlette (Sarowa and Bakshi, 1972) and Godara et al. (1972), Kandhari (Chadha et al., 1974), Kishmish Charni (Sharma et al., 1977), Concord (Cauhan and Morris, 1977), Muscadine (Lane, 1977), Rashmi (Al-rawi and Al-doori, 1977) and Perlette (Sharma, 1987). Contrary to these reports Kumar and Bajwa (1973), Sharma et al. (1977) and (1978) and Tomar and Brar (1986) found no effect of pruning intensity on berry weight.

Bunch characters

It was observed that increased in length, breadth and weight of bunch and total number of bunches/vine were achieved in 8-bud pruning treatment. And with increased severity of pruning the length, breadth, weight and number of bunches/vine were reduced. However, lower weight of bunches was also recorded in 10-bud pruning, but with more number of bunches per vine in comparison with other pruning treatments. The increase in bunch length and breadth may be due to increase in bunch weight, berry weight and berry size thus making the bunch less compact. Amarjeet (1987) has reported improved bunch compactness with pruning treatments. The results are in agreement with those of Singhrot et al. (1977), Kumar and Tomar (1978), Isodia (1986), Sehrawat (1988). Contrary to it, Chadha and Kumar (1970), Sarowa and Bakshi (1972) and Amarjeet (1987) observed increase in bunch size with increase in severity of pruning.

There was clear cut improvement in the bunch weight with decreased in severity of pruning. Possibly, lower weight in 4-bud pruning may be due to lesser development of the basal buds while in 10-bud pruned vines may be due to the competition among the larger number of bunches developing per vine. The difference in weight from various groups of buds was probably due to difference in vegetative vigour of the shoots thus vigour depended on their position on the cane rather than inherent factors in the buds. It is also possible that the buds which was at basal positions and close to the parent vine may loose a major part of the organic substances, that they received by basipetal movement from the leaves above, to the parent vine which acts as strong sink and as such their development may be hindered. The bunds at slightly higher positions which are somewhat away from this influence of the parent vine may have better chances for development. Another reason could be that buds in the basal positions may not receive sufficient light, due to congestion as the buds in higher positions may get.

These results are in agreement with findings of Bhujbal and Phadnis (1971), Bhujbal (1972), Chitkara et al. (1972), Singhrot et al. (1977) and Sehrawat (1988). Contrary findings were also reported by Van-Haarlem and Upshall (1938), Castro and Guerrero (1964), Daniel (1965), Bakshi et al. (1970), Godara et al. (1972), Sharma et al. (1978), who recorded large sized bunches by over pruning and observed small bunches by light pruning.

The data reveal that the severity of pruning has influenced the number of bunches per vine appreciably. The number of bunches increased with increased number of buds per cane. The increase in cane level may also be having a desirable effect on number of bunches/vine. This is obviously due to greater bearing area provided by more number of buds and canes. The results are in agreement with those of Singh and Singh (1968), Daniel (1965), Chadha and Nand (1969), Mukherjee et al. (1970), Moti (1971), Bhujbal and Phadnis (1971), Godara et al. (1972), Kumar and Bajwa (1973), Singhrot et al. (1977). Contrary to above results, Tomkins and Shaulis (1955), Schoffling (1965) and Tomar and Brar (1986) reported that number of bunches per vine decreased with increasing number of buds per cane.

The bunches on more severely pruned canes should have been bigger in size and heavier in weight, because such canes bore lesser number of bunches, but this tendency was reversed presumably. The genetic constitution of this particular cv. Thompson Seedless has got some specific requirement to be met with, the one of the important ones could be that it has got a tendency of bearing on long canes for optimum yield and quality and the more severe pruning might have resulted adversely w.r.t. above characters, as such treatments were not falling within the optimum range of the genetic behaviour of the variety.

Chemical characters

Total soluble solids (T.S.S.)

With increase in severity of pruning the percentage of total soluble solids increased significantly. The possible reason for such increase in T.S.S. may be due to the increased availability of metabolites with lesser number of bunches on severely pruned vines. Similar findings were reported by Balkrishanan and Rao (1963), Chadha and Nand ~~et al.~~ (1969), Draganov and Spirov

(1969), Shrivastav et al. (1970), Bhujbal (1972), Balasubrahmanyam et al. (1973), Cawthon and Morris (1977). Al-rawi and Al-doori (1977), Singhrot et al. (1977), Sharma et al. (1988) and (1978), Singh and Kumar (1980), Joon (1988) and Sehrawat (1988) in different cvs. However, findings of Chadha et al. (1974), Lavee (1977), Kumar and Tomar (1978) and Tomar and Brar (1986) donot lend support to this contention and they obtained no effect of pruning intensity on T.S.S. Increased T.S.S. and lower acidity as a result of severe pruning has also been reported by Taha (1958) and Rangelov (1964).

Acidity

The percent acidity decreased with increased severity of pruning, but the differences were not significant. The possible explanation of the above trend could be the same as mentioned earlier for T.S.S. The findings are in confirmity with Chadha ~~et al.~~ and Mand, (1969), Sharma et al. (1977), Al-rawi and Al-doori (1977), Singhrot et al. (1977) and Sehrawat (1988). But the findings of Chadha and Kumar (1979), Sarowa and Bakshi (1972) could not confirmed with our results. Contrary to it Nauriyal et al. (1973), Sharma et al. (1976), Cawthon and Morris (1979), Kumar and Tomar (1978), Sharma et al. (1978), Singh and Kumar (1980), Tomar and Brar (1986) and Amarjeet (1987), reported no effect of pruning intensity on total acidity.

Effects of chemicals and cane twisting

The salient features of the results obtained as a result of various chemicals and twisting treatments are disucssed below.

Growth characters

Bud break

The present investigations have brought out that growth regulators and chemical significantly reduced the number of days required for bud break. However, out of various growth regulators, dormax was most effective in enhancing the number of days required for bud break by about nine to ten days. These results are in confirmity with Iwasake and Weaver (1981), Lin et al. (1983a and 1983b), Shulman et al. (1983, 1985 and 1986), Smit (1985), Lin and Wang (1985), Pandey and Pandey (1988a), Pandey (1989) and Zelleke and Kliewer (1989), who have reported that H_2CN_2, generally led to earlier release of buds from dormancy, as well as a greater percentage of total buds that burst. Treatments that cause increase in bud-burst have generally been associated with increase in bud respiration. Shulman et al. (1983) have shown that H_2CN_2 increase respiration of grape buds.

Potassium nitrate is also an effective chemical, it in addition to supplying two macro-elements, also acts as a rest-breaking chemical. The specific effect of KNO_3 is to improve flower bud break (Kuroi et al., 1963; Erez, 1987). Hence, whenever flower bud break is a problem the addition of this chemical to oil + DNOC may improve yield (Erez et al., 1971. Shulman et al. (1983) reported that the use of acid cyanamide as a spray was found to be especially valuable for grape vine. Proper timing could enhance bud-break and earlier fruit ripening and compensate for lack of chilling. This treatment was especially valuable for cane-pruned cvs., such as 'Thompson Seedless'. For grapes, cyanamide were superior to all other rest breaking chemicals.

Cane twisting also has prnounced effect in reducing the number of days required for bud break, panicle emergence, berry set and ultimately the harvesting period. These results are in agreement with Chittiraichelvan et al. (1984) and Shikhamany (1988), they observed highly significant difference in the number of bud burst and panicle emergence between a twisted and non-twisted cane.

It is clear from the data that terminal nodes break the bud earlier than basal or lower nodes. As apical dominance is closely co-related with bud rest completion. The apical bud has a much shallower rest than the lateral ones, hence the retardants break the rest earlier and cause the apical bud to sprout (Erez and Lavee, 1974; Smit and Burnett, 1986), therefore, conditions that lead to poor bud break will result in increased apical dominance. Further more, early leafing out of the terminals suppresses further lateral bud-break. By use oı rest breaking treatment close to terminal bud-break strong apical dominance may be prevented. Favourable effect of PB was also studied by Wample et al. (1984) and Intrieri et al. (1986) in various cvs. of grape.

Floral characters

Panicle emergence

From the observations recorded it can be revealed that application of different chemicals and cane twisting significantly reduced the number of days required for panicle emergence were lower in terminal nodal positions in comparison to lower nodal positions. Dormex observed to be most effective for significant reduction in the mean number of days and also the number of days required for panicle emergence at each nodal positions. The possible explanation of the above trend could be same as mentioned for hastening the number of days required for bud break, as early release of buds from dormancy by dormex (hydrogen cyanamide), cause early breaking of bud that led to early panicle emergence. As dormex is most effective in reducing the number of days for bud burst (Shulman et al., 1983) by increasing the respiration of grape buds, thus equally effective in early emergence of panicles. And terminal nodes burst earlier, hence panicles emerged from these buds in advance than those of basal buds (Erez and Lavee, 1974). These results are in conformity with Coombe (1967), Erez et al. (1971), Balasubrahmanyam et al. (1975), Bajwa (1979), Sodagar and Chauhan (1984), Ahmedullah et al. (1986), Shikhamany (1988), Shikhmany and Reddy (1989).

Cane twisting also has pronounced effect in reducing the number of days required for bud break, panicle emergence, berry set and ultimately the harvesting period. These results are in agreement with Chittiraichelvan et al. (1984) and Shikhamany (1988), they observed highly significant difference in the number of bud burst and panicle emergence between a twisted and non twisted canes. The ratio of the length of ultimate shoot to the penultimate was significantly less in twisted canes as compared to non-twisted indicating the reduction in the degree of apical dominance by the treatment. Total shoot length was also significantly high in the twisted canes. This may be due to the increased number of buds sprouted. Thus it is seen that the apical dominance could be overcome by twisting the canes. Twisting possibly reduces the apical dominance by temporary suspension of the downward translocation of auxins due to breakage of phloem tissues, second reason is the production of ethylene, which is called wound hormone, on account of mild injury to the cambium. According to the theory of co-relation inhibition, auxins move basipetally from the apical buds into lower buds and inhibit their outgrowth and elongation. Hormonal directed transport (HDT) theory indicate that higher concentrations of auxins in the apical meristems to grow fasten than the apical laterals or auxillary meristems resulting in apical dominance.

Ethylene, which can also inhibit auxin transport has been found to counteract apical dominance. Continuous exposure of intact plants to ethylene inhibited the growth of the main apex, but did not bring about out growth of lateral buds. Phillips (1975) opined that this might have resulted from inhibitory effect of ethylene on either basipetal auxin transport of auxin bio-synthesis or on both.

In grape, ethrel application was found to overcome apical dominance (Shivashankara et al., 1970; Bautista et al., 1987), thus controlling the bud burst and panicle emergence.

Berry set

It was observed from the data that application of difference chemicals and cane twisting have a favourable effect in reducing the number of days for berry set. KNO_3, however, they also significantly reduced the number of days to set the berry. A pronounced effect was observed in dormex treated vines. Earlier berry set by dormex, ethrel and cane twisting can be explained by early bud break and blooming followed by early berry set.

Harvesting time

Harvesting time is also enhanced when treated with growth chemicals. Dormex reduced it by ten to eleven days, whereas, other grwoth retardant like PB also reduced the time significantly. Dormex helps to break dormancy of bud and thus causing early release of bud which ultimately lead to enhancement of harvesting time appreciably. Similar results have also been reported by Pandey et al. (1980), Lin et al. (1983), Shulman et al. (1983), McColl (1986), Lin (1987), Pandey (1989), Rajkumar (1990). Paclobubazol, KNO_3 and ethrel are also helpful in breaking dormancy, thus enhancing maturity time.

Physical characters

Berry characters

Growth chemicals controlled the berry characters by increasing the berry length, breadth and weight. These results are in confirmity with Singhrot et al. (1977), Ahmedulla et al. (1986), George and Nissen (1987). George et al. (1988) reported that there were significant changes in berry weight, when the vines are treated with dormex. The yield response was mainly due to an increase in bunch number with cyanamide application. Lavee (1986) also reported that the similar results using growth regulators like dormex. However, Pandey (1989) reported that berry weight increased significantly with dormex applied at an early date over control. The number of berries, on the other hand decreased significantly in treated bunches over control, but there was no significant reduction in the weight of treated bunch due to lighter weights.

Bunch characters

It is clear from the data that growth chemicals significantly increased the length of bunches, whereas, bunches breadth was reduced conversely. The possible reason for increase in weight of bunch could be that the formation of berries act as major sink and growth retardant the PB also checked the excessive vegetative growth, thus, diverting all the metabolites to the berries. This can lead to increase in bunch weight, which increased significantly with the application of growth chemicals viz. dormex, PB and with cane twisting method. These results are in agreement with the findings of El-Hamady et al. (1979), Coppla and Forlani (1980), Kucher and Sherer (1983), El-Wahab et al. (1985) and Mohammad et al. (1987). With the application of ethrel there was no increase in bunch weight and breadth.

The number of bunches per vine were affected significantly by the application of growth chemicals over control. KNO_3, ethrel and dormex were found to be most effective in increasing the bunch number. The possible reason for increase in number of bunches may be due to the fact that the growth chemicals reduced the loss of floral primordia by converting them into tendrils (Bindra et al., 1980). This may also be due to greater shoot fertility (Kucher and Sherer, 1985). There was also a possibility that the growth retardants like PB resulted in more storage of food material due to retardation of excessive vegetative growth which indirectly helped in more floral bud differentiation and increased shoot fertility. The results are in agreement with those of Sedlotskii et al. (1980), Forlani and Coppola (1980), Bindra et al. (1980), Myrianthousis (1984) and George and Nissen (1987), Pandey (1989). George et al. (1988) studied the effect of hydrogen cyanamide on table grapes and found that the number of bunches produced per spur were significantly increased by increasing the node numbers per spur. The increased number of bunches produced on longer spurs was due to more shoots per spur rather than to more bunches per shoot. Twisting of canes at time of dormancy significantly increased number of bunches/vine. Similar results were also reported by Chittiraichelvan et al. (1984) that the number of panicles borne on shoots arising from twisting canes was 24 per cent more as compared to non-twisted canes. The differences, however, were non-significant. This may be due to the non-productivity of the buds below the fruitful zone.

Chemical characters

Total Soluble Solids (T.S.S.)

From the observations recorded it can be revealed that ethrel and KNO_3 significantly increased total soluble solids in the grape cv. The possible reason for such an increase may due to the increased availability of metabolites due to reduction in excessive vegetative growth. These findings are in confirmation with those of Armugam (1970), Ahlawat and Daulta (1981). Ethrel significantly increased the T.S.S. Ribereau Gayon (1968) suggested that transformation of organic acids to sugars is one of the reason for decrease in acids during ripening. Therefore, possibility seems that ethephon might have enhanced the conversion of organic acids and increased the percentage of total soluble solids in the juice. Chauhan et al. (1981) also observed a significant increase in T.S.S. in Red-Prince and Seedless grapes when ethephon was applied at the beginning of color development.

Acidity

The acidity of grape berries was not influenced by growth regulators, chemicals and cane twisting. These results are in supoort of the observations made by Tukey and Fleming (1967), Forlani and Coppola (1978), El-Hamady et al. (1979), Ahmedullah et al. (1986) and Mohammad et al. (1987) who reported that acidity remained unaffected with growth retardant treatments. The acidity per cent in juice was decreased non-significantly by the use of ethrel.

6. SUMMARY

The present investigation on the effect of pruning, cane twisting and some chemicals on productivity of grapes cv. Thompson Seedless was conducted in Department of Horticulture, CCS Haryana Agricultural University, Hisar, during the year 1990. The effect was studied on various characters viz. growth, floral, physical and chemical characters. The salient features of the results are summarised and concluded as under :

1. Pruning at 4-bud level was most effective in reducing the number of days taken for bud-break, panicle emergence, berry set and harvest.

2. The bud-break was earlier in the terminal nodes as compared to basal nodes in pruning experiment.

3. Significant enhancement of bud-break was observed at all nodal positions with 4-bud pruning; at 2nd, 5th and 6th nodal position with 6-bud pruning; at 3rd, 5th, 6th, 7th and 8th nodal positions with 8-bud pruning and at 6th to 10th nodal positions with 10-bud pruning treatments.

4. Prunings significantly enhanced the number of days required for panicle emergence at terminal buds as compare to lower buds.

5. Significant reduction of number of days required for panicle emergence was observed with 4-bud pruning at all nodal positions; 6-bud at 2nd, 5th and 6th, 8-bud at 10-bud at 6th, 7th, 8th, 9th and 10th nodal positions, respectively.

6. Berry length and berry weight was improved markedly with 8-bud pruning, whereas, 10-bud pruning was effective in increasing the berry breadth.

7. Pruning with 8-bud treatment was most effective increasing the bunch length, breadth, weight and also the number of bunches per vine, however, maximum number of bunches/vine were recorded with 10-bud pruning.

8. Total soluble solids content was increased significantly with 6-bud pruning followed by 4-bud pruning.

9. The lowest acidity was obtained when vines were pruned at 4-bud level, followed by 6-bud level.

10. Dormex, a growth retardant, was most effective in reducing the number of days required for bud-break, panicle emergence, berry set and harvest.

11. Terminal nodal positions sprouted earlier when treated with growth retardants like PB as compared to lower nodal positions.

12. Dormex at all nodal positions; KNO_3 at 3rd, 5th and 6th nodal positions, ethrel at 3rd and 4th nodal positions, were significantly superior to non-twisted control.

13. Cane twisting was also effective in enhancing the bud-break at 3rd, 4th, 5th, 6th and 7th nodal positions.

14. Upper sprouted buds emerged earlier in PB treated vines as compared to lower sprouted buds.

15. Among the various growth retardants used, significant hastening in panicle emergence was observed with dormex at all nodal positions, KNO_3 and ethrel at 3rd and 4th nodes and PB at 3rd, 4th, 5th, 6th and 7th nodal positions when comparing with non-twisted control.

16. Cane twisting also hastened the panicle emergence at all nodes but significantly reduction was observed at 3rd, 4th and 5th nodal positions.

17. Cane twisting was most effective in increasing the berry breadth and weight followed by dormex. Whereas berry length was most pronouncedly increased with KNO_3 treatments.

18. Bunch length was increased effectively by KNO_3 bunch breadth by twisting treatment and bunch weight by PB followed by dormex.

19. Maximum increase in bunch number was noticed with dormex treatment followed by KNO_3 and ethrel.

20. Ethrel significantly increased the total soluble solids, followed by KNO_3 as compared to other treatments.

21. A non-significant change in acidity was observed in chemical and twisted treated vines.

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✡ please see ✡1, 2, 3

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