

Effect of NAA treated seed on growth and yield of different varieties of cabbage (*Brassica oleracea* Capitata)

THESIS



Submitted to the

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In partial fulfilment of the requirements for
the Degree of

**MASTER OF SCIENCE
IN
AGRICULTURE
(HORTICULTURE)**

By

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REWA (M.P.)**

2008

CERTIFICATE-I

This is to certify that the thesis entitled, "**Effect of NAA treated seed on growth and yield of different varieties of cabbage (*Brassica oleracea Capitata*)**" submitted in partial fulfillment of the requirement for the degree of **MASTER OF SCIENCE in AGRICULTURE** of Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur is a record of the bonafide research work carried out by **Sonam Singh** under my guidance and supervision. The subject of the thesis has been approved by the Student's Advisory Committee and the Director of Instructions.

No part of the thesis has been submitted for any other degree or diploma (Certificate awarded etc.) or has been published/published part has been fully acknowledged. All the assistance and help received during the course of the investigation has been duly acknowledged by him.

Place: Rewa

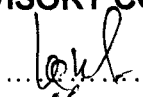
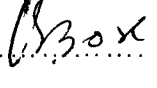
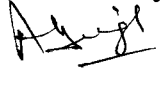
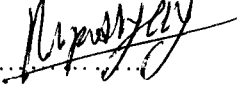
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CERTIFICATE-II

This is to certify that the thesis entitled "**Effect of NAA treated seed on growth and yield of different varieties of cabbage (*Brassica oleracea Capitata*)**" submitted by **Sonam Singh** to Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE in AGRICULTURE** in the **Department of Horticulture**, College of Agriculture, Rewa (M.P.) has after evaluation been approved by the Student's Advisory Committee after an oral examination of the same.

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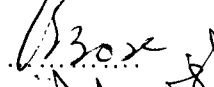
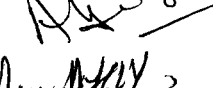
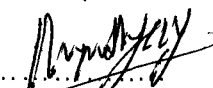
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College of Agriculture, Rewa (M.P.)


(Sonam Singh)

Date 13/02/09

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LIST OF ABBREVIATIONS

Words	Abbreviations
Centimeter	cm
Co-workers	<i>et al.</i>
Critical difference	C.D.
Cultivar	cv.
Degree of centigrade	°C
Degree of Freedom	d.f.
Days after sowing	DAS
Figure	Fig.
Farm yard manure	FYM
Fisher's value	"F" value
Gram(s)	g
Hectare	ha
Kilogram(s)	kg
Maximum	Max.
Mean sum of square	M.S.S.
Metre	m
Minimum	Min.
Muriate of Potash	K ₂ O
Nitrogen	N
Non-significant	N.S.
Number	No.
Per	/
Per cent	%
Phosphorus	P ₂ O ₅
Potential of hydrogen ions	pH
Quintal	q
Rupees	Rs
Serial No.	S.No.
Significant at 5% level	*
Significant at 1% level	**
Single Super phosphate	SSP
Source of variation	S.V.
Sum of square	S.S.
Square	sq.
Standard error of means	S.Em _±
Standard error of difference	S.Ed
Temperature	Temp.

INTRODUCTION

CHAPTER-I

INTRODUCTION

Cabbage (*Brassica oleraceae* var. *Capitata*) is an important vegetable crop of India. It covers about 3.84% of the total area under vegetables. India is the second largest producer of vegetables next to China covering about 233.8 thousand hectares area with the production of 5392.0 thousand tonnes (Anonymous, 2005).

Cabbage is one of the important vegetable crop which is cultivated throughout India. Cabbage (*Brassica oleraceae* var. *Capitata* Linn.), a botanically modified leaves, is grown during winter season in truck gardens, market gardens and kitchen gardens also. It covers about 4% of the total area under vegetables. Cabbage is a popular vegetable in temperate, subtropical and tropical regions and is grown almost throughout the year. In India, Orissa, West Bengal, Karnataka, Maharashtra, Gujarat and Punjab are the major cabbage growing states. The total area under vegetables in India worked out hardly two per cent (2%) of the total cropped area, which is very low in view of national requirements. At present annual requirement of vegetables is 52 million tonnes, which is not possible but due to low acreage and production.

Cabbage is used as vegetable in curries, salad and pickling. It is used alone or mixed with potatoes for vegetable purpose. The tender leader leaves are primarily used as cooked vegetables, more in raw than in processed form. It is a rich source of vitamin A, B, C, and also contains minerals. It may be used for feeding stock and chicken. 100gm of cabbage contains –Water- 92.1g. protein- 1.4g Fat-0.2g Carbohydrate- 5.7g Fiber- 1.5g. Vitamin 'A'-70 I.U. Vitamin B1-0.05mg, Vitamin B2-0.5mg Vitamin B6-0.11mg Vitamin 'C' 46mg, Vitamin 'E'-0.7mg, Fe -0.08mg, Na-13mg, K-227mg, Ca- 40. From the above data, it is evident that cabbage is a good source of calcium, potassium and vitamin 'A'.

The use of plant growth substances has brought about a sort of revolution in growing of horticultural crops. The plant growth substances can be used either as seed dressing, seed soaking, root treatment or foliage treatment. The seed treatment by aqueous solution or in powder form has given better response in most of the research work done in India and abroad in vegetable crops. The two vital components for better production i.e. improved variety and plant growth substances are of more attraction in modern age of scientific agriculture. Plant growth substances are the chemicals other than nutrients, which increase, decrease or modify the utilization of organic and inorganic materials for the balanced development of the plants.

There are specific cultivars for different seasons of year but no particular cultivars of a group is suitable for growing successfully throughout the year. Therefore, selection of suitable cultivar for growing in a particular season with the use of plant growth substances has paramount importance. Keeping these points in view, the present experiment entitled **"Effect of NAA treated seed on growth and yield of different varieties of cabbage (*Brassica oleracea Capitata*)"** was conducted at the Horticulture Department of College of Agriculture, Rewa (M.P.) with the following objectives:

1. To identify the suitable variety of cabbage for the agro-climatic conditions of Vindhya region.
2. To determine the influence of different concentrations of NAA on the growth, yield and yield attributes of cabbage.
3. To evaluate the suitable combination of variety and concentration of NAA for better growth, yield and yield attributes of cabbage.
4. To estimate the economics of different treatments.

REVIEW OF LITERATURE

CHAPTER-II

REVIEW OF LITERATURE

In this chapter, an attempt has been made to review the research work done so far in India and abroad by different workers on the usefulness of growth substances. The use of plant growth substances enhanced the germination, growth and development, quality and yield of vegetable crops to a greater extent. The response of cabbage and other allied crops to different plant growth, plant growth substances and their concentrations have been found encouraging. The important results obtained by different research workers are reviewed as under:

Singh and Saimphi (1968) studied the effect of three concentrations (0, 50 and 100 ppm) of each of the three plant growth regulators (GA, IBA and NAA) sprayed two and four weeks after transplanting of Chinese cabbage. All the plant growth regulators were found effective to increase the number and size of leaves, fresh and dry weight and protein content of Chinese cabbage leaves as compared with unsprayed plants.

Chouhan and Singh (1970) reported that all the treatments with GA and urea induced early head formation in cabbage. GA at 15 ppm sprayed twice gave the maximum number of leaves and maximum yield and compactness of head. Urea also produced better result than control, but inferior to GA.

Mohanty and Nema (1970) reported that on cabbage, starter solution and growth regulator treatments were found to be more effective than control in respect of height of plant, leaf area, number of roots and percentage of head formation. Head formation with starter I and 1 ppm NAA treatment was earlier than control. Starter and its combination with growth regulator treatments were also effective in increasing the yield of head and outer leaves over control. The maximum yield of head (420.33 q/ha) and outer leaves (319.43 q/ha) was recorded with starter-I and 0.1 ppm NAA treatment.

Chauhan and Bordia (1971) while working on pre-sowing treatment in cabbage with GA, NAA and 2-4-B reported that none of three treatments affected

the height of the plant and the time taken for head formation. They have further reported that the weight of head was maximum at 50 ppm GA (1.43 kg) followed by Betanaphthoxy acetic acid at 0.5 ppm (1.42 kg) and at 2.5 ppm (1.40 kg) as against 0.81 kg only under control.

Das and Pattnaik (1971) observed that seed treatment with certain growth regulators on vegetable crops like brinjal, tomato, onion, bhindi and cabbage have increased germination, growth and yield of the crops.

Patel and Patel (1983) concluded that IBA 5 ppm, NAA 10 ppm and GA 10 ppm in the form of foliar spray gave the beneficial effect on the growth, yield and quality of knol-knol.

Singh *et al.* (1983) treated the roots of 5 weeks old onion seedling for 24 hour before transplanting in solutions of IAA, NAA or GA each at 20, 30, 40, ppm. The treatment with GA at 40 ppm, gave the best plant growth, highest yields (249.8q/ha) and bulb quality. The control yield was 140 q/ha.

Omran *et al.* (1984) sprayed the plants of the onion cv. Behairy with IAA at 0-300 ppm and ZnSO_4 or MnSO_4 each at 0-0.15% in different combination. The sprays were applied 3 times at 15 days intervals starting 40 days after transplanting. Data were tabulated on leaf fresh weight and dry weight, neck diameter and leaf number, bulb length and diameter and bulb fresh weight and dry weight. Bulb fresh weight rose with increasing IAA concentration where as dry weight rose with IAA up to 200 ppm. ZnSO_4 up to 0.05% or MnSO_4 up to 0.1% increased bulb weight whereas higher rates decreased it. The best combination with regard to bulb weight was IAA at 200 ppm + ZnSO_4 at 0.05%

Parihar and Singh (1984) noted that NAA 30 ppm sprayed on onion plants had significantly increased height of plant, number of leaves and root diameter of bulbs, weight of bulb and yield of onion than IAA ppm, IBA 30 ppm and GA 30 ppm.

Abd-El-Gavad *et al.* (1986) conducted the trails with the cv. Behairy, where IAA at 0.50 ppm or GA_3 at 0-200 ppm, were applied once at 120 days or twice at 120 and again at 135 days after transplanting. Only GA_3

at 100 ppm, applied once or twice increased the yield slightly in relation to the control whereas all other treatments decreased it slightly, especially GA₃ at 200 ppm, applied once. The treatments did not generally have a beneficial effect on quality but pungency was slightly increased.

Midan *et al.* (1986) reported from a trial that mother plant sprayed with IAA ZnSO₄ or MnSO₄ or with IAA plus either ZnSO₄ or MnSO₄ at various concentrations, the number of flower head per plant and the total seed yield increased with IAA concentration (100-300ppm.) The number of flower heads was also increased following spraying with 0.05%, ZnSO₄ or 1.15 % MnSO₄. The interaction between numbers of application; IAA and either ZnSO₄ or MnSO₄ did not significantly affect the number of flower heads and the weight of 1000 seeds. IAA sprays did not significantly affect the % germination of harvested seeds, whereas micro nutrient sprays increased it.

Kaur *et al.* (1987) found that in cv. Punjab selection, storage losses due to *Alter naira pore* were reduced up to maximum and seed yield was increased up to highest by spraying MH at 2000 mg/ liter.

Muthoo *et al.* (1987) observed that foliar application of GA₃ at 100 ppm. NAA at 120 ppm and 0.2% molybdenum increased the average fresh and dry weight of leaves, curd and yield of cauliflower.

Singh and Yadav . (1987) reported that NAA application at 30 ppm and early January transplanting was more effective in increasing the growth and yield of onion as against February transplanting.

Patil and Patil (1987) conducted a field trial with the cultivars "Pride of India", GA or NAA each at 25, 50, 75 or 100 ppm was applied one month after transplanting. Plant growth and yield were highest (23.83 t/ha) with GA 50 ppm. The yield from untreated (control) was only 16.81 t/ha.

Maurya and Lal (1987) treated the roots of 6 week old seedlings of cv. Pusa Red onion and 7 weeks old seedlings of cv. Bullnose *Capsecum* for 24 hour in aqueous solutions containing one of three growth regulators. The onion seedling were transplanted on 5th January and the Capsicum seedlings on 10th April. Growth and yield data were tabulated. The highest

onion yield was up to 256 q/ha. 82 q/ha was obtained with GA at 60 ppm and 183 q/ha in the control. GA at 150 ppm gave the highest Capsicum yield of 280.66 q/ha (199.2 q/ha) in the control.

Bhadoria (1988) reported that NAA 30 ppm when applied in combination with NPK 40:40:40 as a seed treatment has significantly stimulated the growth characters and increased the yield characters of knol-khol under the agro-climatic conditions of Rewa region.

Hore *et al.* (1988) applied nineteen different seed treatments. All the treatments gave good results with regard to germination and yield. Thiourea at 100 ppm, $\text{NaH}_2\text{PO}_4 \cdot 2\text{H}_2\text{O}$ at 200 ppm, thiourea at 50 ppm and KH_2PO_4 at 100 ppm gave 93.00, 92.25, 91.00 and 90.25% germination, respectively compared with 56.75% in the untreated control. Thiourea at 200 ppm gave maximum plant height and fresh weight of leaves and roots. GA at 100 ppm significantly increased both fresh weight and dry weight of bulbs, and leaf dry weight and the percentage of dry matter bulb yield was also highest with this treatment.

Singh (1988) studied the role of growth regulators and concluded that growth regulators play an important role in increasing the growth and yield of cabbage. NAA (30 ppm) were identified as better growth regulators as compared to GA and IAA each at 30 ppm in the growth characters and yield of cabbage. The variety Pride of India performed better than Golden Acre in Vindhya region of M.P.

Vanangnamudi *et al.* (1988) conducted trials with the cv. Rampur Local and reported that soaking the seeds with GA at 100 ppm. for 3 hour has broken the dormancy and improved the germinability, vigour index and emergence of seedlings in the nursery. It did not influence the bulb and seed yields but significantly increased flowering percentage.

Tomar *et al.* (1988) conducted two season trials with the cultivars Pusa Red. The seeds were sown on 15 November, 15 December and 15 January and 4 different growth regulators were applied at the seedling stage or 60 or 120 days after transplanting. The highest bulb yield (449 q/ha) was obtained with the earliest sowing compared with 194 and 111

q/ha with sowing on 15 December and 15 January, respectively. In one year GA at 200 ppm and in the other year CCC (Chlormequat) at 1500 ppm gave the best results.

Salah and Abd (1989) studied on the effect of GA₃ and NAA each at 3 concentrations (50, 100 and 150 ppm) on growth, yield and quality of onion. Application of GA₃ or NAA increased the vegetative growth viz. plant, leaf length, number of leaves per plant, plant fresh weight and % dry matter as compared with control plants. Total yield, average bulb weight and total soluble solids contents were also increased. The use of either NAA or GA₃ at 150 ppm was recommended.

Singh *et al.* (1989) regulated that solution method of GA₃ and NAA with 30 ppm concentration identified the best growth regulators which have given 71.1% and 57.82% higher yield over control on radish

Singh *et al.* (1990) obtained highest growth and yield of radish over control with the application of 30 ppm of Gibberellic acid.

Deore and Bharud (1991) treated onion cv. N-2-4-1 seedling with GA (30 or 60 ppm) or NAA (10 or 20 ppm) applied as a 24 hours root dip before transplanting and as foliar spray 25 days after transplanting or a combination of root dip + spray treatments. Control plants were sprayed with water or received no treatment. GA at 60 ppm, applied either as root-dip + foliar spray resulted in greatest plant growth and yield compared with the other treatments. The highest yield was obtained with the 60 ppm GA as a root dip.

Nandeker and Sawarkar (1992) studied on the effect of dipping 6 week old onion plants in the growth regulators IAA, NAA, GA at 20, 30 and 40 ppm. for 24 hours before planting. Treatment with GA at 40 ppm was found the most effective giving significant increases in the number, length and weight of leaves, number of root, size and weight of bulbs. number of scales presents and the percentage of grade 'A' bulbs (diameter 4.5 cm)

Sundaravelu and Muthu Krishan (1993) obtained that highest growth and yield in Japanese radish over control with the application of Azospirillum spp. 75 g + GA 10 ppm.

Nirmal *et al.* (1994) reported that seedlings of onion cv. N-2-4-1 were dipped or sprayed or applied both ways with GA and NAA, before transplanting bulb yield were highest (294 q/ha) after a root-dip in 60 ppm GA whereas the yield was 250 q/ha in the control. The increased yield was attributing to increased LAI and bulb diameter.

Singh *et al.* (1995) reported that onion bulbs for production of a *kharif* seed crop were dipped in 150, 300 or 450 ppm solution of GA₃ NAA or ethephon or in water for 6 hours, direct and then planted in the field GA₃ and NAA treatment increased the plant height, number and size of leaves and number of umbels per plant at the concentration up to 300 ppm, whereas 450 ppm was found less effective. Ethephon decreased the plant height with the increasing concentrations. The highest 1000 seed weight (2.904 to 3.096) and seed yield (5.131 to 5.417) q/ha) were obtained with 300 ppm NAA.

Wage and Deore (1995) studied the influence of spray of NAA 50 or 100 ppm and GA 25 or 50 ppm on onion crop. NAA 50 ppm and GA 50 ppm gave higher seed yield and seed weight.

Rizk *et al.* (1996) reported that plants spray with 50 ppm GA, 50 ppm IAA, 1000 ppm CCC or tap water 45 days after planting and again 15 days later. Early planting resulted in the greatest seed stalk height and diameter. Umbel diameter and average, number of flowers per Umbel. Delaying the time of planting of the last 10 days of November reduced seed yield compared with the other 2 planting date treatments. Percentage germination of the seed produced and 1000 seed weight tended to decrease with delay in bulb planting date. Spraying plants with GA₃ and IAA increased these seed yield and quality parameters as compared with controls while CCC reduce them.

Ray *et al.* (1996) found that the effect of Ethrel (ethephon) (1.25 or 2.5 ml/litre of 40% Ethrel), NAA (103 or 2 x 103 mg/litre), 2-4, 5-7 (5 x 102

or 103 ml/litre or Malic hydrazide (2 x 103 or 3 x 103 mg/litre) on the storage behaviour of onion (cv. Sanchi) were investigated. Onions were stored in wooden boxes at ambient temperature for 8 months. MH was the most effective at reducing weight loss, rotting and sprouting during storage NAA and enhanced rotting. Ethrel was the most effective in reducing the greening of bulbs.

Kawai *et al* (1997) reported that sprays of 100 ppm GA₃ was the most effective concentration to reduced the incidence of internal root browning in Japanese radish.

Banerjee *et al.* (1999) studied the effects of presoaking seed treatments with GA₃, IAA, IBA and NAA at 10⁻⁴-10⁻⁷ M on seed germination and seedling growth of radish GA₃ (10⁻⁴, 10⁻⁶ m), IBA (10⁻⁶ m) and NAA (10⁻⁶, 10⁻⁷ m) increased germination and 10⁻⁷ m IBA produced the highest seed vigour.

Singh (1999) observed that the IBA and NAA applied at 250-500 ppm promoted rooting in tomatoes. Higher net returns were observed in the treatment with IBA at 500 ppm alone or in combination with 250 or 500 ppm NAA.

Bhople *et al.* (1999) carried out a field experiment in 1997-98 at Akola, India, to study the effects of triacontanol (2.5, 5.0, 7.5 or 10.0 ppm), NAA (25, 50 or 75 ppm) and gibberellic acid (25, 50 or 75 ppm) on onion (cv. Local white) seed production. Each of the plant growth regulators improved length of flower stalk, number of flowers per plant, number of seeds per umbel, seed yield (per plant and per hectare), seed weight and germination percentage. The highest seed yield per plant and per hectare were obtained with GA₃ at 75 ppm.

Abu-Grab and Ebrahim (2000) investigated the effect of gibberellic acid (GA₃), indole-acetic acid (IAA), indole-butyric acid (IBA), alpha-naphthalene-acetic acid (NAA), uniconazole (UC) and cycocel (CCC) on growth, chlorophyll content, nutritional status and seed yield and quality of onions. Results revealed significant difference among the studied growth regulators in dry weight per plant, Chl a, Chl a+b total carbohydrates,

mineral contents (N, P and K), scape length, seed yield (per plant and per plot), 1000-seed weight and seed germination. Also, plant treated with GA₃ showed the highest value of scape length, while application of NAA induced the highest increase in the other parameters, except K content and scape length, more than CCC. In contrast, no significant difference were observed in all studied parameters, except K content and percentage seed germination, under the effect of concentration within substances. In this regard, plants sprayed with 50 ppm of NAA showed the highest seed yield (19.2 q/plant and 860.25 q/plot), seed index (3.8 g) and seed germination (90.9%), whereas control plants had the lowest values (15.8 g/plant and 693.75 q/plot), (3.5 g) and (80.9%) in the same order.

Galal and Bana (2001) investigated the pathogenicity of *S. cepivorum* isolates (OWR₁, OWR₂, OWR₃, OWR₄, OWR₅ and OWR₆). All isolates were pathogenic to onion cv. Giza 6 plants, with OWR₃ being the most pathogenic. The effects of the plant growth regulators (PGRs) abscisic acid, ATP, gibberellic acid, IAA, Kinetin and zeatin (at 25, 50 and 100 ppm) on OWR₃- infected onion plants and on sclerotia of this isolate were studied. Two-month-old onion transplants dipped for 48 h in various concentration of plant growth regulator were inoculated with the isolate before transplanting in the field (Egypt during 1998 and 1999), while sclerotia were soaked in PGRs for 48 h under aseptic conditions. Generally, dipping of onion transplants in PGRs induced resistance to *S. cepivorum* especially at the highest concentration tested. However, variations in the efficacy of abscisic acid and ATP, and between kinetin and zeatin, were not significant. Gibberellic acid induced the highest resistance to *S. cepivorum*, i.e. 33.1, 57.9 and 70% reduction at 25, 50 and 100 ppm, respectively. In sclerotial treatments, only gibberellic acid consistently reduced *S. cepivorum* severity with the increase in its concentration. ABA at 100 ppm and zeatin at 50 and 100 ppm, also reduced *S. cepivorum* infection. However, IAA (25 ppm) and ATP (all concentrations) enhanced onion susceptibility to *S. cepivorum*. Kinetin did not exhibit significant effect toward sclerotia virulence.

Gupta *et al.* (2001) were reported the maximum plant height of tomato at 75 DAT was 82 cm and maximum number of branches 30 at 60 DAT significantly observed with 75 ppm NAA along with 2000 ppm NAA and Humaur (P_3M_2) as 28 days as compared to control. Minimum days for fruit setting in tomato plant was 42 DAT observed significantly with the treatment of 25 ppm NAA along with Humaur (P_3M_2).

Alam and Khan (2002) reported that the spray of NAA at variable concentration significantly increased the fruit yield of tomato, as compared to control. The nutrient contents were also increase majority of cases.

Singh *et al.* (2002) studied the effects of growth regulators on the performance of onion cv. Kalyanpur Red Round were Studied in Kanpur, Uttar Pradesh, India during there rabi season of 1997/98. The roots of 6-week-old seedlings had been immersed in the aqueous solution of gibberellic acid (GA). NAA, IAA, IBA or Ethrel (ethephon) at 10, 50 or 100 ppm for 8 hours prior to transplanting. Data on growth and bulb production were recorded at 90 days after transplanting. The growth regulators at 10 and 50 ppm significantly enhanced growth and yield; the higher concentration (100 ppm) resulted in the substantial reduction in all parameters. The plants treated with 100 ppm GA recorded the greatest plant height (44.04 cm), number of leaves per plant, bulb diameter (4.36 cm) and bulb yield (120.69 quintal/ha).

Kanaujia *et al.* (2002) conducted experiment and onion seeds (cv. Red Round Kalyanpur) were either stratified at 10°C for 8 hour or soaked in plant growth regulators (IAA and IBA at 100 and 200 ppm each, and TIBA and gibberellic acid (GA_3) at 20 and 40 ppm each) for 8 hour. Standard tests for germination and vigour were conducted for first count of germinated seeds, seedling, shoot and root length, seedling dry weight and germination and vigour indexes. Soaking of seeds in 20 ppm GA_3 gave the highest values for seed germination (79.25%), Shoot length (7.735 cm), seedling length (9.175 cm) and vigour index (727.11), whereas seeds soaked in 100 ppm IAA recorded the highest values for the first count of germinated seeds (74.50%), seedling dry weight (35.00 mg) and germination index (14.331). seeds soaked in IBA at 100 ppm had the

highest root length (2.850 cm). Stratification resulted in a vigour index of 530.26 and a germination index of 11.468.

Gupta *et al.* (2003) found that the largest fruit size was observed with 75 ppm NAA along with multiplex at maturity stage of tomato and gave maximum yield.

Singh and Bhonde (2003) conducted a laboratory experiment to determine the effect of plant growth regulators on the viability and vigour of seed of onion cultivars Agrifound light Red and Agrifound Dark Red, having initial germination percentage of 68 and 66%, respectively. The seeds were soaked in Cycocel (chlormequat) at 250 ppm, TIBA at 100 ppm, gibberellic acid at 50 ppm, thiourea at 100 ppm, sodium thiosulfate at 100 ppm and sodium phosphate at 100 ppm, separately for 6 hour at room temperature. Seeds soaked only in distilled water were maintained as the controls. The seed germination and vigour in both cultivars increased considerably in all the treatments, except in the control, after 3 months of storage. The highest percentage germination (82.66%) and vigour (1046.47) was sodium phosphate, followed by sodium thiosulfate (81.66% and 995.16, respectively) in Agrifound Light Red. These treatments also recorded the highest percentage germinant (72.66 and 72.00%) and vigour (825.28 and 775.19) in Agrifound Dark Red. The root length, shoot length and 100-seedling weight, in general, increase in all the treatments compared with the control. The trend of highest germination was continued up to February 2000 (i.e. 10 months after the treatment) in both cultivars. However, the level of standard germination in Agrifound Light Red was maintained up to May 2000, i.e. 10 months in sodium phosphate (77.66%), which was followed by TIBA (72.33%) and thiourea (70.33%). Thereafter, there was a gradual reduction in germination, vigour and other parameters in all the treatments.

Subimal *et al.* (2003) applied NAA at 200, 300 or 400 ppm and gibberellic acid (GA3) at 20, 40 or 60 ppm were to onion by seed soaking, root dipping and foliar spraying in field experiment conducted in Mohanpur, West Bengal, India, during the rabi season of 1999-2000. The

growth and yield of onion treated with either plant growth regulator at different concentrations were the highest.

Russo (2003) pointed out that the exogenously applied plant growth regulators may affect development of onion, but little is known about how concentration or timing of application can effect bulb grade and quality. Two concentrations of the growth regulators abscisic acid (1 and 2 mm), gibberellic acid (7.5 and 15.0mm), indole-acetic acid (60 and 120 mm), jasmonic acid (0.075 and 0.150 mm), kinetin (11.5 and 23.0 mm) and maleic hydrazide (0.5 and 1.0m) and water controls, were applied at the 7 and 20 leaf stages to the middle of the leaf whorl in greenhouse grown onion plants. Leaf and bulb weights were lighter and bulb diameters were smaller, from plants treated with growth regulators applied at the 7 leaf stage than those from plants treated at the 20 leaf stage. Bulbs produced on plants treated with individual growth regulators.

Sharma *et al.* (2004) conducted an experiment to evaluated the effects of certain plant growth regulators applied through dry permeation technique on the viability of onion seed genotypes N-53 and RO-1. Observation were recorded at 0.6 and 12 months after storage. The results revealed that germination percentage and germination relative index (GRI) decreased with the advancement of storage period in both the genotypes. Prestorage soaking of seed with gibberellic acid, benzyladenine IBA and putrescine at 75, 150 and 225 mm concentration significantly increased the germination percentage and GRI over the untreated and acetone-soaked control at all the storage period. GA 150 was found most effective. On the basis of germination percentage and GRI, genotype RO-1 was superior over N-53.

Zhao *et al.* (2004) cultured eight parental lines of Chinese cabbage *in vitro*. The effects of growth regulator combinations, different genotypes, seedling age, cotyledon sampling place and explants on shoot and plant regeneration from cotyledon explants were studied. Maximum shoot regeneration was obtained in MS medium supplemented with 6-benzylradenine, naphthalene acetic acid and AgNO₃ at 2, 0.5 and 5 mg/litre, respectively. The best medium for rooting was MS medium

supplemented with aphthalene acetic acid at 0.2 mg/litre. The survival rate of transplanted plantlets was as high as 90% in spring.

Subimal and Shukla (2005) studied the effect of GA3 (gibberellic acid) and NAA on the yield and yield components of onion (cv. N-53) were studied in Raipur, Chattisgarh, India, during 1999-2000. The treatments consisted of 200 (T₁), 300 (T₂) or 400 (T₃) ppm NAA applied through seed soaking for 8 h (SS); 20 (T₄), 40 (T₅) or 60 (T₆) ppm GA3 through SS; 200 (T₇), 300 (T₈) or 400 (T₉) ppm NAA applied through root dipping for 18 h (RR); 200 (T₁₀), 300 (T₁₁) or 400 (T₁₂) ppm GA3 through RR; 200 (T₁₃), 300 (T₁₄) or 400 (T₁₅) ppm NAA applied as foliar spray (FS) and 200 (T₁₆), 300 (T₁₇) or 400 (T₁₈) ppm GA3 through FS. All treatments significantly enhanced the bulb diameter over the control. The average weight of randomly selected bulbs was lowest under T₁, T₇, T₁₃, T₁₄, T₁₆, T₁₈ and T₁₉ and was similar under the other treatments (36.98-43.95 g). The average weight of larger bulbs was greatest (89.72 g) under T₆. The number of scales per bulb was lowest under T₁₄, T₁₅, T₁₆ and T₁₉ and was similar under the other treatments (11.50-13.13). The lowest yield of marketable bulbs were recorded for T₁, T₁₃, T₁₄, T₁₆, T₁₈ and T₁₉ the yields of marketable bulbs recorded for the other treatments were on a par (237.30-283.50 q/ha). The highest yield of undersized bulbs were obtained under T₅ (21.36 q/ha), T₇ (20.31 q/ha), T₁₀ (20.03 q/ha), T₁₂ (20.92 q/ha), T₁₆ (23.14 q/ha), T₁₇ (22.33 q/ha) and T₁₈ (23.26 q/ha). The total yields were lowest under T₁, T₇, T₁₃, T₁₄, T₁₆, T₁₈ and T₁₉ and were similar under the other treatments (268.20-302.06 q/ha).

Khamparia and Tiwari (2006) conducted a field experiment at Tikamgarh (M.P.) to evaluate the best growth regulator on yield and qualities of onion bulb. NAA (30 ppm) applied through solution soaking method for eight hours gave the maximum bulb yield (335.4 q/ha) and net return (Rs.46,702/ha). The second best treatment combination was IAA (30 ppm) with solution soaking method giving 311.4 q/ha bulb yield and Rs.41,885/ha net return. NAA gave the lowest carbohydrate content and the highest pyruvic acid, sulphur content as well as storage qualities of onion bulb, however the reverse was true in case of control treatment.

Mishra (2006) concluded from the study that Krishna and then Kranti hybrid varieties of cabbage performed the best in comparison to Golden Acre and Pride of India. The mixture of GA₃ + NAA growth substances played an important role in increasing the growth, yield net income and quality of cabbage varieties. Krishna (hybrid) treated with 15 ppm GA₃ + NAA concentration brought about the highest production (688.50 q/ha) with maximum net income up to Rs.1,05,792/ha.

Soni (2007) found that among the concentrations of plant growth regulators mixture, the application of 20 ppm of GA₃ + NAA produced the significantly higher fruit yield up to 433 q/ha as well as highest yield components of tomato varieties. The net return was highest up to Rs.104829 along with highest benefit:cost ratio (5.28). The variety Pusa Early Dwarf with 20 ppm GA₃ + NAA mixture produced the highest yield (552 q/ha) as compared to all other combinations, the net return being up to Rs.142461/ha with highest B:C ratio up to 7.19.

MATERIAL AND METHODS

CHAPTER-I

MATERIAL AND METHODS

The materials used and methods adopted during the course of investigation are described under the following heads:

Experimental site

This study was carried out at instructional farm of Department of Horticulture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, College of Agriculture, Rewa-486001, M.P., India during winter season of 2007-08. The district Rewa is located at latitude of 24°-30' North, a longitude of 81°-50 East and at an elevation of 365.7 m above mean sea level.

Climate

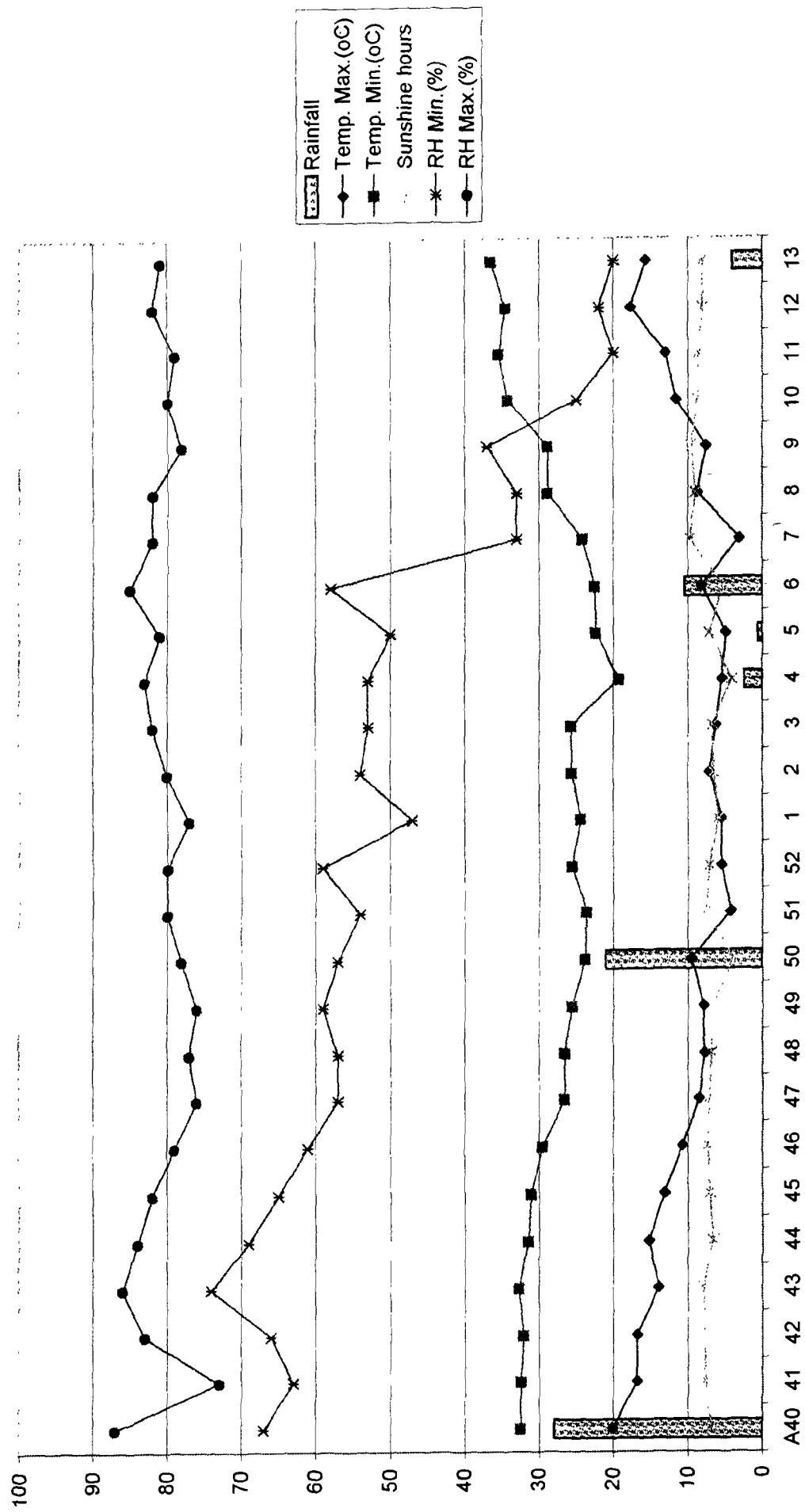
The climate of region, Kymore plateau and Satpura hills in which Rewa is located is sub-tropical moderate with hot and dry summer and cold winter. The rainy season starts withon set of monsoon in middle of June and lasts up to middle of September. The winter season runs from November to middle of the March followed by summer season up to mid June. October is the transitory month between rainy and winter seasons. The maximum precipitation of rains occur in the month of July and August. May and December are the hottest and coolest month, respectively.

Meteorological observations during the cropping season of the year 2007-08 are mentioned in Table 3.1. The maximum temperature was in between 36.5 to 19.2 °C while, the minimum temperature ranged from 3.1 to 20.1 °C during the cropping season. Total rain received during the crop growth was 66.4 mm in 6 rainy days. The range of highest and lowest humidity was in 87 and 20 per cent, respectively.

**Table 3.1 Meteorological data during the crop growth period
(October to March 2007-08)**

Meteorological weeks		Temperature (°C)		Rainfall (mm)	No. of rainy days	Sunshine hours	Relative humidity(%)	
		Min.	Max.				Min.	Max.
40	Oct. 01-07	20.1	32.5	28	1	6.8	67	87
41	Oct. 08-14	16.9	32.4	0	0	7.7	63	73
42	Oct. 15-21	16.8	32.1	0	0	7.8	66	83
43	Oct. 22-28	13.9	32.7	0	0	7.9	74	86
44	Oct.29-Nov.04	15.3	31.5	0	0	6.6	69	84
45	Nov.05-11	13.1	31.1	0	0	7.0	65	82
46	Nov.12-18	10.7	29.5	0	0	7.3	61	79
47	Nov.19-25	8.5	26.6	0	0	7.2	57	76
48	Nov.26-Dec.02	7.8	26.5	0	0	6.8	57	77
49	Dec.03-09	7.9	25.6	0	0	6.6	59	76
50	Dec.10-16	9.5	23.8	21	1	3.9	57	78
51	Dec.17-23	4.2	23.6	0	0	7.6	54	80
52	Dec.24-31	5.5	25.6	0	0	7.1	59	80
1	Jan.01-07	5.5	24.4	0	0	5.9	47	77
2	Jan.08-14	7	25.6	0	0	6.5	54	80
3	Jan.15-21	6.3	25.7	0	0	6.7	53	82
4	Jan.22-28	5.4	19.3	2.4	0	4.1	53	83
5	Jan.29-Feb.04	4.9	22.4	0.6	0	7.1	50	81
6	Feb.05-11	8.2	22.5	10.4	1	5.3	58	85
7	Feb.12-18	3.1	24.1	0	0	9.7	33	82
8	Feb.19-25	8.7	28.9	0	0	9.0	33	82
9	Feb.26-Mar.04	7.5	28.8	0	0	9.5	37	78
10	Mar.05-11	11.6	34.2	0	0	8.7	25	80
11	Mar.12-18	13.0	35.4	0	0	8.5	20	79
12	Mar.19-25	17.7	34.5	0	0	8.0	22	82
13	Mar.26-Apr.01	15.7	36.5	4	1	8.1	20	81
	Total	-	-	66.4	6	-	-	-

Fig.3.1 Meteorological data during crop season (October 2007 to March 2008)



Soil

The soil of the experimental field was clay loam. It was fairly rich in organic matter and had good water holding capacity. The source of irrigation was electric pump well.

Details of the chemical analysis of the soil is given below:

Table 3.2: Fertility status of the soil

	Soil Constituents	Analysis value
A-	Physical Properties	
	Sand (%)	30.0
	Silt (%)	37.4
	Clay (%)	32.6
B-	Chemical properties	
	pH	7.5
	Organic carbon (%)	0.56
	Electrical conductivity (ds/m)	0.39
	Available Nitrogen (Kg/ha)	238.33
	Available Phosphorus (Kg/ha)	118.00
	Available Potash (kg/ha)	304.00

Cropping history of the field :

The crops grown during the period 2002-03 to 2007-08 were as shown in following table.

Table 3.3: Cropping history of the field

S. No.	Year	Crop season	
		Kharif	Rabi
1.	2002-03	Fallow	Fallow
2.	2003-04	Fallow	Tomato
2.	2004-05	Fallow	Onion
4.	2005-06	Fallow	Onion
5.	2006-07	Fallow	Onion
6.	2007-08	Fallow	Cabbage (Experimental plot)

Details the experiment

The experiment was laid out in randomized block design (factorial) with three replications. Each replication consisted of twelve treatments. All the treatments were randomized separately in each replication. The plan of layout is given in Fig. 3.2. The details are given below:

Varieties (Three)

1. Sumit

2. Pride of India

3. Golden Acre

SymbolsV₁V₂V₃**Plant growth substances****Application of NAA treated seed (Four)**

1. 0 ppm

2. 10 ppm

3. 20 ppm

4. 30 ppm

SymbolsC₀C₁C₂C₃

Treatment combinations for the experiment are:

V ₁ C ₀	V ₂ C ₀	V ₃ C ₀
V ₁ C ₁	V ₂ C ₁	V ₃ C ₁
V ₁ C ₂	V ₂ C ₂	V ₃ C ₂
V ₁ C ₃	V ₂ C ₃	V ₃ C ₃

Design	:	Factorial R.B.D.
Replication	:	3
Treatment combinations	:	12
Total number of plots	:	36
Gross plot size	:	223.36 sqm
Net plot size	:	14.4 x 14.4 m
No. of rows/plot	:	4
No. of plants/plot	:	16
Spacing	:	60 x 45cm ²
Plot border	:	40 cm
Replication border	:	1.0 m
Irrigation channel	:	75 cm
Total length of experimental trial	:	14.8 m
Area of the experimental trial	:	323.36 m ²

PLAN OF LAYOUT

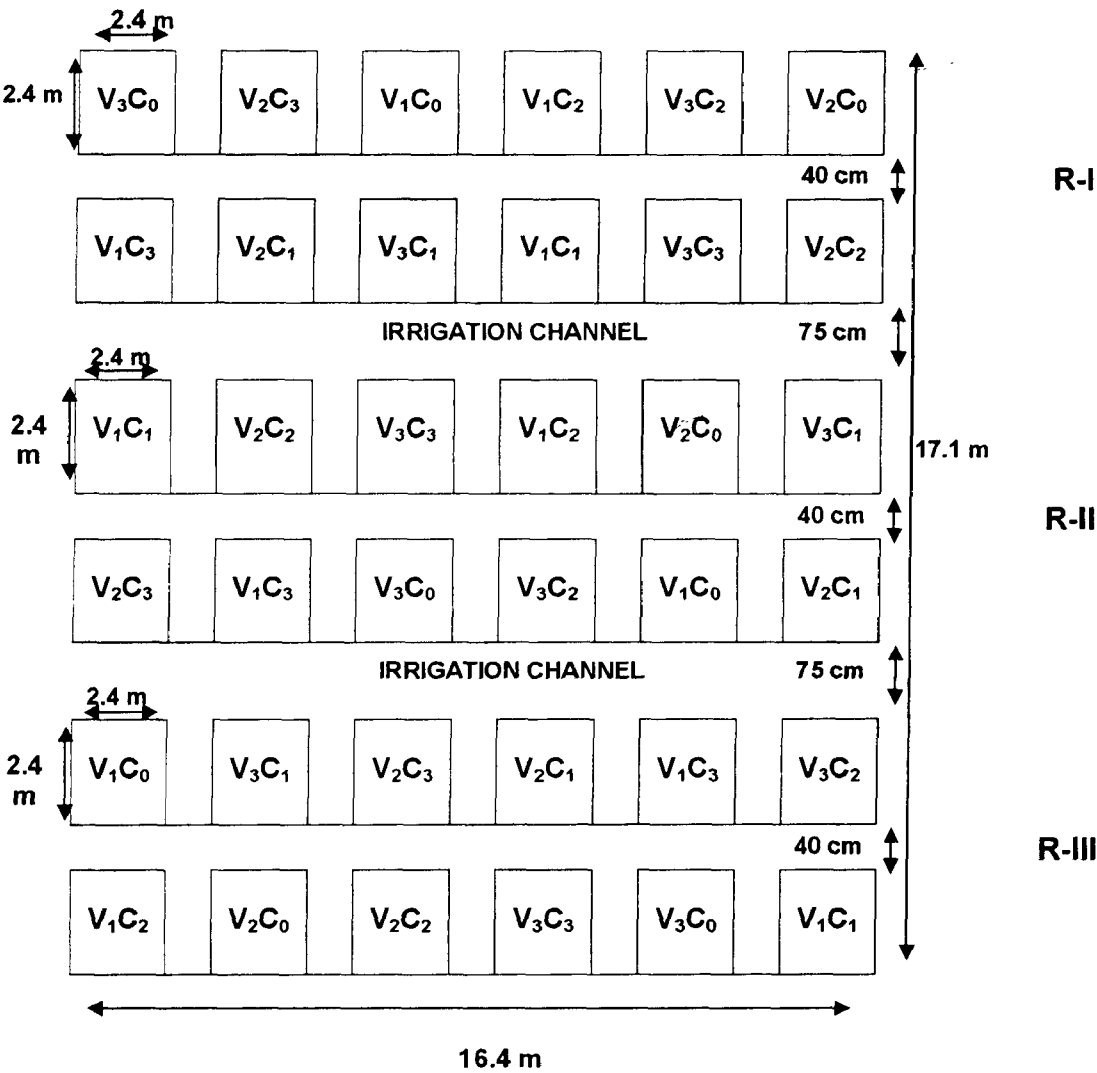
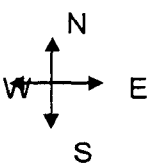


Fig. 3.2 : Plan of layout

Material used

Three varieties namely Sumit (hybrid), Pride of India and Golden acre and plant growth substances mixture of NAA were used as seed treatment during the experiment.

Method of preparation of hormonal powder

For preparing the hormonal powder of NAA 10, 20 and 30 ppm separate weighings were taken for each concentrations by electrical balance very carefully and then after they were put in separate test-tube. The 95% proved ethyl alcohol was taken and added in each test-tube to dissolve NAA. Then after 1 kg tyre powder was taken separately for each concentrations and dissolved plant growth substances solutions of test-tubes were added in the powder and stirred with glass rod and put them open for drying.

Method of seed treatment with hormonal powder

The seeds of different varieties of cabbage were treated treatmentwise by hormonal powder before sowing. For the seed treatments, the seeds of different varieties were lightly moist and treated with prepared powder of different concentrations separately by dusting the powder on moist seeds so that powder may adhere properly on the seed and then kept the seeds in open for 2 hours to remove the moisture before sowing in nursery beds. But the control treatments were treated in the tyre powder only.

Application of fertilizer

The following major nutrients were applied in the form of fertilizers as basal dressing 2 days before transplanting. Nitrogen @ 150 kg/ha, P_2O_5 @ 80 kg/ha and potash @ 75 kg/ha were applied as top dressing. In addition to these fertilizers a basal dose of FYM (200 q/ha) was also applied at the time of field preparation.

FIELD OPERATIONS

(A) Pre-transplanting operations

The nursery beds were prepared before 4 days of sowing. The seeds were sown in well-prepared nursery bed on 18th October 2007 and the essential care was taken to protect the seedlings in nursery beds. The field was prepared by ploughing once by moldboard plough and lifting the weeds by hand. After this the field was again cross-ploughed by Deshi plough. The layout of the experiment was carried out on 16th November, 2007 and fertilizer was applied as basal dose in individual plots.

(B) Post-transplanting operations

(1) Transplanting

The transplanting of the seedling was performed as per plan of layout in the afternoon of 16th November, 2007. The row to row and plant to plant distance was maintained at 60 and 45 cm, respectively.

(2) Irrigation

Nine irrigations were given to the crop as per requirements.

(3) Control against insect pests

Rogor 35 EC @ 1 ml/litre water was sprayed twice during the crop season so that insect pests can be controlled.

(4) Earthing and other operations

Interculture operations were done during crop season at 30 DAT.

(5) Harvesting

The heads which were of proper size and shape, fit for marketing, were harvested. The harvesting was continued for 12 days starting from 6th February, 2008 to 17th February, 2008.

Sampling of plant for recording detailed observations

The observations on the characters of growth and development of plants were recorded at 30 days interval i.e. 30 DAT, 60 DAT and at maturity on five randomly selected plants from each treatment in each replication. The selected plants were tagged for recording the details of observations. The observations recorded are given as below:

CHARACTER STUDIED

(a) Pre-harvest observations

(1) Plant height

The height of the plant was measured from the ground upto the height of apical bud with the help of metre scale and the average values were worked out.

(2) Leaves per plant

The open leaves of selected plants were counted and the average was calculated.

(3) Length of leaf

The leaves were measured from the petiole up to the leaf opened and the average values were worked out at 30 DAT.

(4) Width of leaf

The broadest portion of the leaves was measured by tape and the average was calculated at 30 DAT.

(5) Circumference of head

The circumference of head was also measured and the average values were taken into account.

(B) Post-harvest observations

(6) Weight of untrimmed head

The fresh weight of untrimmed head was taken at the time of harvest.

(7) Weight of trimmed head

The open leaves and stalk were removed and the head were weighted.

(8) Grading of head

The grading head was worked out according to the shape, size and weight of the head and graded as 'A', 'B' and 'C'. The head having diameter from 4 to 6 cm were selected as 'A' grade, 2 to 4 cm were graded as 'B' grade. The head having diameter below 2 cm were kept in the category of 'C' grade.

(9) Yield of head

The yields received plot-wise of head in kilogram and were converted into quintal per hectare and the mean values were statistically analyzed.

Statistical analysis

The data were analyzed by the procedure as described by Chandel (1971). The skeleton of analysis of variance is given in the Table 3.4.

Table 3.6 Skeleton of anova for the design of the experiment

Source of variation	d.f.	S.S.	M.S.S.	F calculated	<u>"F" tabulated at</u>	
					5%	1%
Replication	2					
Concentrations (C)	3					
Varieties (V)	2					
Interaction (C x V)	6					
Error	22					
Total	35					

The 'F' test was needed for judging the significance of the treatment mean sum of squares. The significance between different means were judged by using differences at 5% and 1% level of significance which calculated as following:

Standard errors:

The standard error was calculated as under

$$S. Ed = \sqrt{\frac{2 \times \text{Error variance}}{\text{Replication (3)} \times \text{Varieties (3)}}}$$

S.Ed and C.D. for varieties (V)

C.D. = S.Ed. x t (5% at error d.f.).

S.Ed and C.D. for concentrations (C)

$$S. Ed = \sqrt{\frac{2 \times \text{Error variance}}{\text{Replication (3)} \times \text{Concentrations (4)}}}$$

C.D. = S.Ed. x t (5% at error d.f.).

S.Ed and C.D. for interaction (V x C)

$$S. Ed = \sqrt{\frac{2 \times \text{Error variance}}{\text{Replication (3)}}}$$

C.D. = S.Ed. x t (5% at error d.f.).

RESULTS

CHAPTER-IV

RESULTS

In the experimental observation data recorded on growth and yield attributing characters from different cabbage varieties and application of different concentrations of NAA for seed treatment as well as their interactions were statistically computed. Based on these data, the separate as well as combined effect of varieties and plant growth substance concentrations are being tabulated and presented with suitable illustrations.

4.1 Pre-harvest studies

4.1.1 Plant height

4.1.1.1 Plant height at 30 DAT

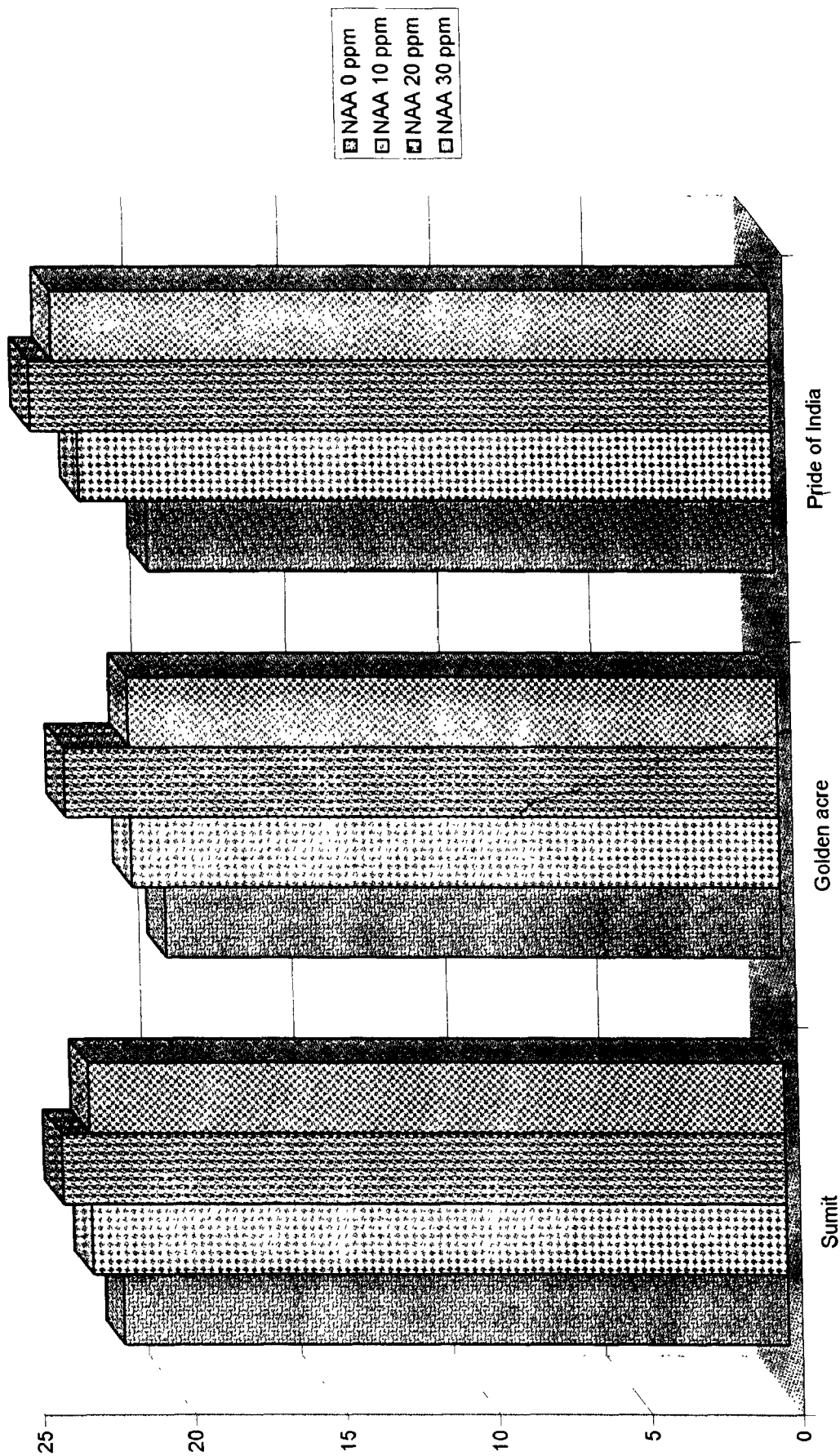
The data in Table 4.1 and Fig. 4.1 indicate that the plant height at 30 days after transplanting (DAT) was found to deviate significantly due to different treatments. Interactions were not significant.

Table 4.1 Plant height (cm) at 30 days after transplanting as influenced by varieties, PGS concentrations and their interactions

NAA concentrations (seed dressing) (ppm)	Varieties			Mean
	Sumit	Golden acre	Pride of India	
0	21.83	20.17	20.50	20.83
10	22.83	21.23	22.67	22.24
20	23.77	23.37	24.23	23.79
30	22.83	21.23	23.47	22.51
Mean	22.82	21.50	22.72	

	Varieties	Concentrations	Varieties x Concentrations
SEm±	0.135	0.156	0.270
C.D.(5%)	0.382	0.441	NS

Fig. 4.1 Plant height (cm) at 30 DAT



Among the varieties, Sumit (hybrid) recorded significantly maximum plant height (22.82 cm) over Golden Acre variety. However, the Pride of India resulted statistically at par with plant height (22.72 cm) of Sumit followed by Golden acre (21.50). Increasing plant growth substance concentrations up to 20 ppm increased this parameter significantly, the maximum height being 23.79 cm as against 20.83 cm in control. Interactions were not significant.

4.1.1.1 Plant height at 60 DAT

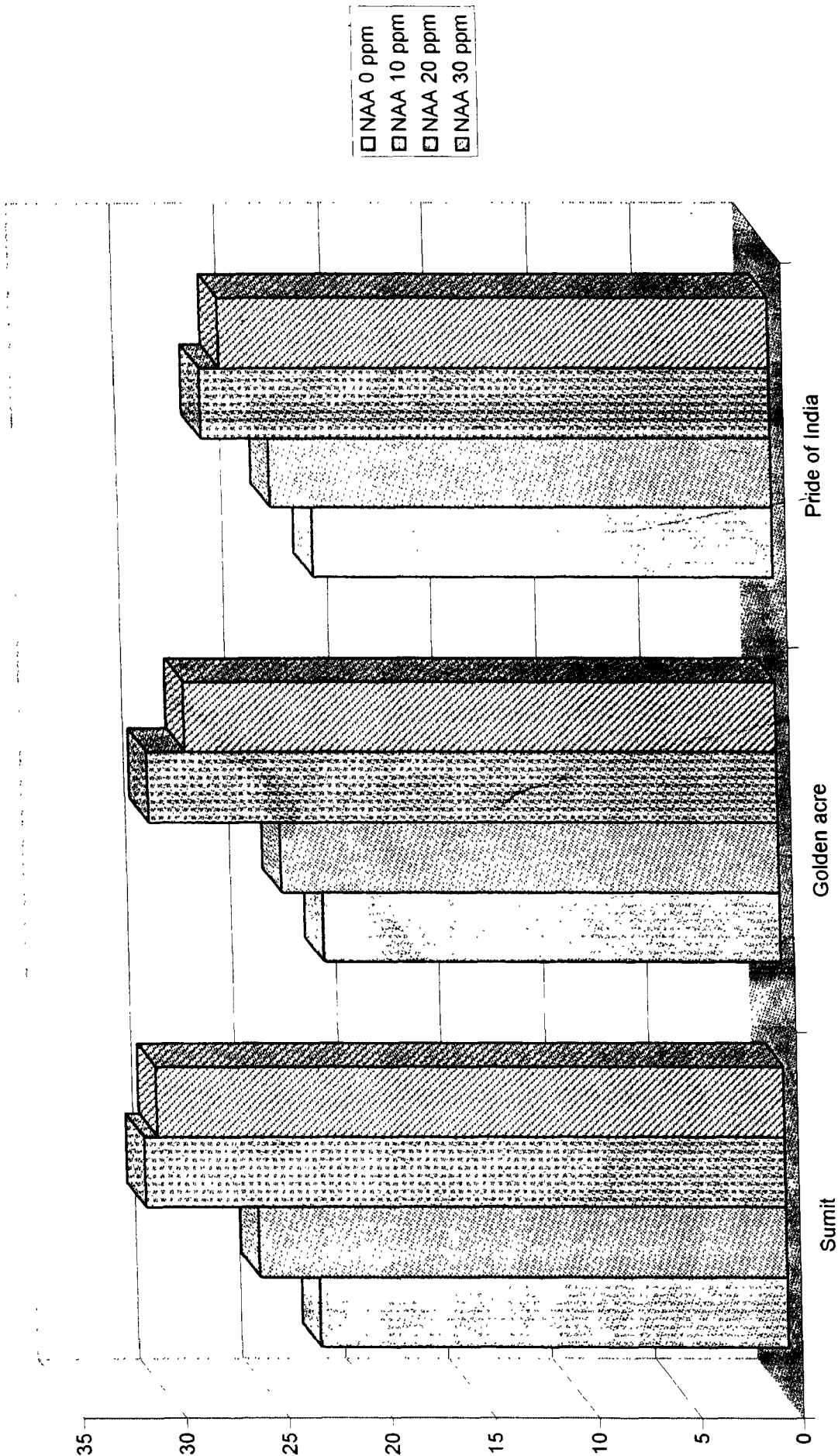
The data in Table 4.2 and Fig. 4.2 indicate that the plant height at 60 DAT was found to deviate significantly due to different treatments. Among the varieties, Sumit (hybrid) recorded significantly higher plant height (27.43 cm) which was superior over rest of the two varieties. Increasing plant growth substance concentrations up to 20 ppm increased the height significantly, the maximum height being 29.64 cm as against 22.35 cm in control. Interactions were not significant.

Table 4.2 Plant height (cm) at 60 days after transplanting as influenced by varieties, PGS concentrations and their interactions

NAA concentrations (seed dressing) (ppm)	Varieties			Mean
	Sumit	Golden acre	Pride of India	
0	22.70	22.11	22.23	22.35
10	25.60	24.10	24.23	24.64
20	31.03	30.43	27.47	29.64
30	30.37	28.57	26.50	28.48
Mean	27.43	26.30	25.11	

	Varieties	Concentrations	Varieties Concentrations	x
SEm±	0.120	0.139	0.241	
C.D.(5%)	0.341	0.393	NS	

Fig. 4.2: Plant height (cm) at 60 DAT



4.1.2 Number of leaves per plant

4.1.2.1 Number of leaves per plant at 30 DAT

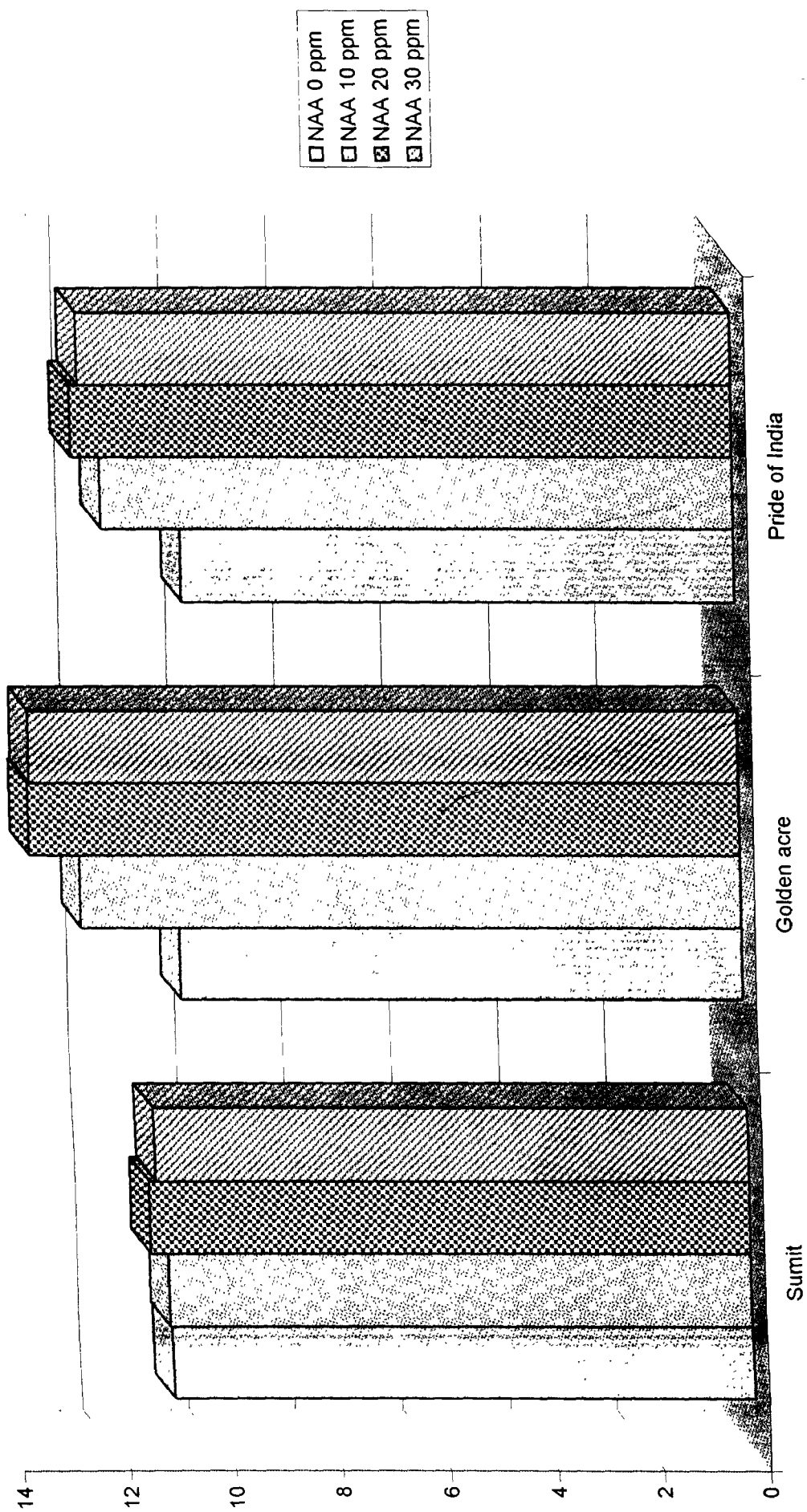
The number of leaves per plant was influenced significantly due to varieties and plant growth substance concentrations. (Table 4.3 and Fig. 4.3). Among the varieties, Golden acre recorded the maximum leaf number (12.36/plant), being significantly superior to other two varieties. These two varieties attained the identical position with regard to this growth character (11.03 and 11.66/plant).

Table 4.3 Number of leaves/plant at 30 DAT as influenced by varieties, PGS concentrations and their interactions

NAA concentrations (seed dressing) (ppm)	Varieties			Mean
	Sumit	Golden acre	Pride of India	
0	10.87	10.50	10.33	10.57
10	10.90	12.33	11.80	11.68
20	11.23	13.27	12.33	12.28
30	11.10	13.23	12.17	12.20
Mean	11.03	12.36	11.66	

	Varieties	Concentrations	Varieties x Concentrations
SEm±	0.244	0.282	0.480
C.D.(5%)	0.691	0.798	NS

Fig.4.3: Number of open leaves per plant (30 DAT)



The increasing plant growth substance concentrations up to 20 ppm resulted in significant increase in this parameter, thus the highest leaf count being up to 12.28/plant. Further increase in concentration up to 30 ppm did not encourage the leaf formation. Interactions were found non-significant.

4.1.2.2 Number of leaves per plant at 60 DAT

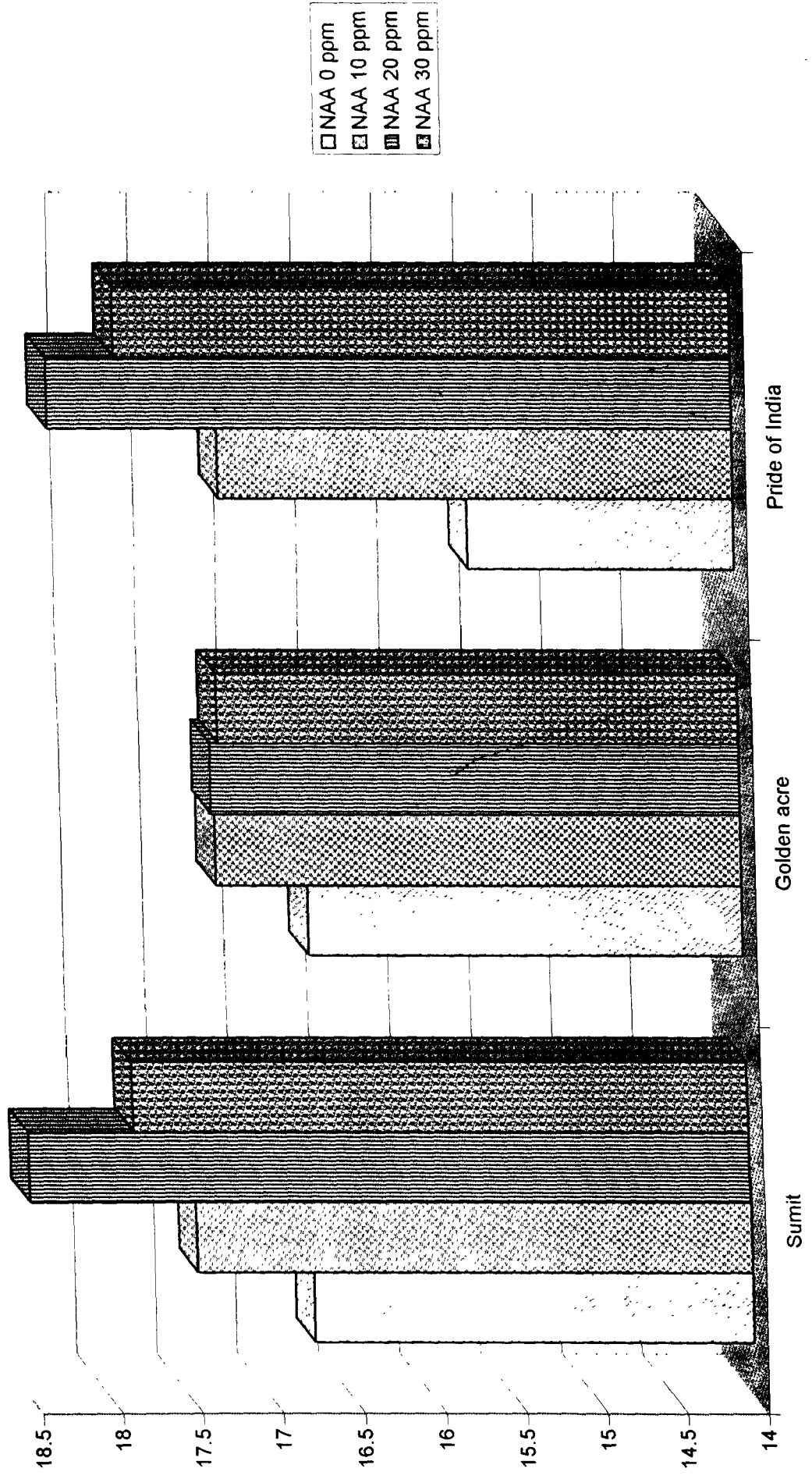
The number of leaves per plant was influenced significantly due to varieties, plant growth substance concentrations as well as their interactions (Table 4.4 and Fig. 4.4).

Table 4.4 Number of leaves/plant at 60 days after transplanting as influenced by varieties, PGS concentrations and their interactions

NAA concentrations (seed dressing) (ppm)	Varieties			Mean
	Sumit	Golden acre	Pride of India	
0	16.71	16.68	15.65	16.35
10	17.43	17.24	17.17	17.28
20	18.46	17.26	18.22	17.98
30	17.80	17.21	17.80	17.60
Mean	17.60	17.10	17.21	

	Varieties	Concentrations	Varieties x Concentrations
SEm±	0.164	0.189	0.320
C.D.(5%)	0.465	0.537	NS

Fig.4.4: Number of open leaves per plant (60 DAT)



Among the varieties, Sumit hybrid recorded the maximum leaf number (17.60/plant), being significantly superior to Golden Acre. These two varieties viz., Pride of India and Golden attained 17.21 and 17.10/plant open leaves, respectively with regard to this growth character. The increasing plant growth substance concentrations up to 20 ppm resulted in significant increase in this parameter, thus the maximum leaf count being up to 17.98/plant. Further increase in concentration up to 30 ppm did not encourage the leaf formation.

4.1.3 Length of leaf

4.1.3.1 Length of leaf at 30 DAT

The data on this parameter has been highlighted in Table 4.5 and in Fig. 4.5. The length of leaf was influenced due to different treatments.

The variety Sumit hybrid measured the maximum leaf length up to 18.54 cm which was found significantly superior to the Golden Acre variety. Pride of India recorded significantly higher leaf length (18.37 cm) over Golden acre (17.78 cm). The increasing plant growth substance concentrations only up to 20 ppm proved significantly superior in raising the length of leaf. Thus, the maximum value at 20 ppm was 19.41 cm as against the lowest value of 16.62 cm in case of control.

Table 4.5 Length of leaf (cm) at 30 DAT as influenced by varieties, PGS concentrations and their interactions

NAA concentrations (seed dressing) (ppm)	Varieties			Mean
	Sumit	Golden acre	Pride of India	
0	16.67	16.53	16.67	16.62
10	18.27	17.87	18.27	18.13
20	20.20	18.50	19.53	19.41
30	19.01	18.20	19.01	18.74
Mean	18.54	17.78	18.37	

	Varieties	Concentrations	Varieties x Concentrations
SEm±	0.173	0.200	0.347
C.D.(5%)	0.490	0.566	NS

4.1.3.1 Length of leaf at 60 DAT

The data on this parameter has been highlighted in Table 4.6 and in Fig. 4.6. The length of leaf was influenced due to different treatments. The variety Sumit hybrid measured the maximum leaf length up to 23.33 cm which was found significantly superior to the remaining two varieties. Golden acre recorded significantly higher leaf length (22.19 cm) over Pride of India (21.39 cm).

Fig. 4.5: Length of leaf at 30 DAT (cm)

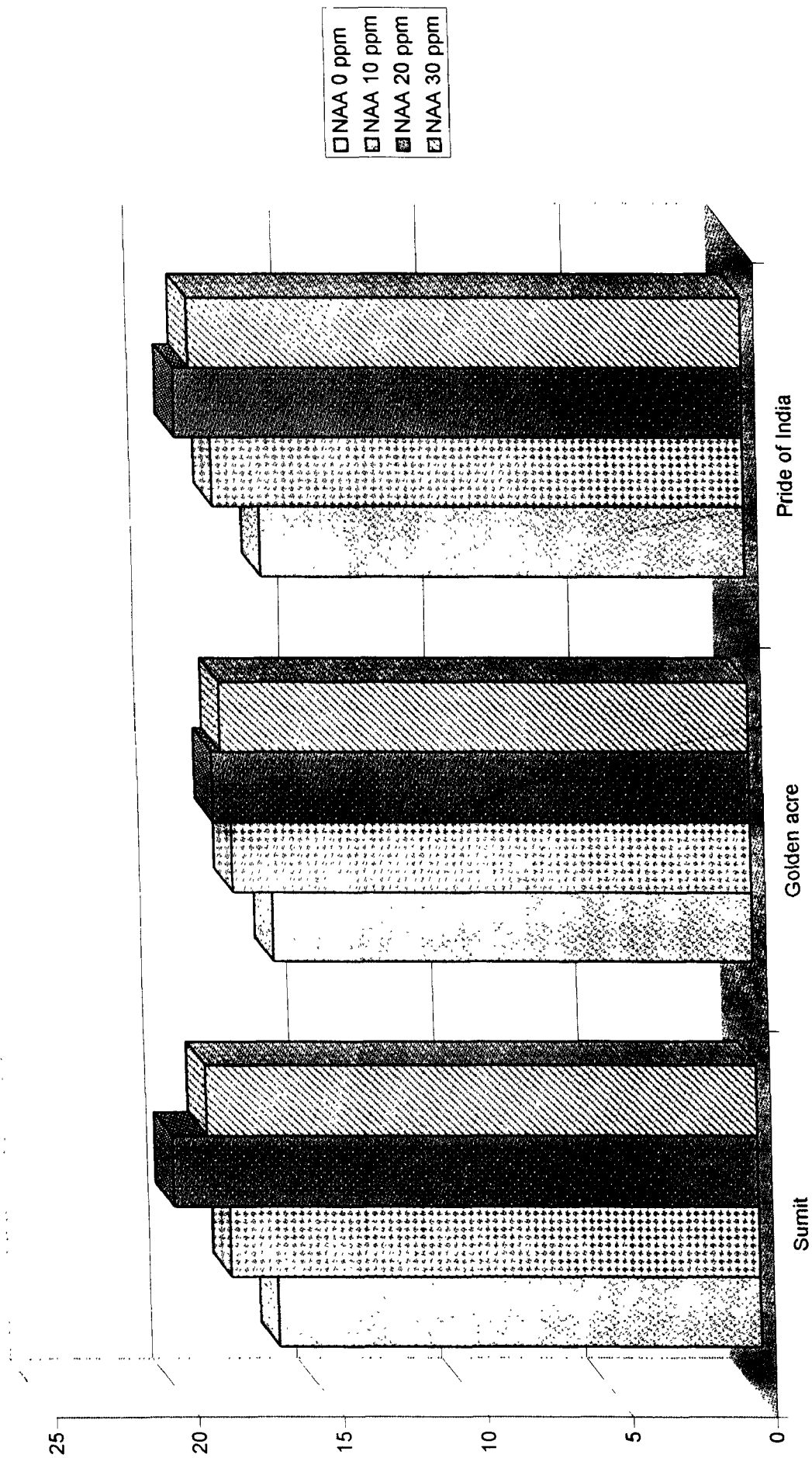


Table 4.6 Length of leaf (cm) at 60 DAT as influenced by varieties, PGS concentrations and their interactions

NAA concentrations (seed dressing) (ppm)	Varieties			Mean
	Sumit	Golden acre	Pride of India	
0	21.20	19.50	19.50	20.07
10	22.43	20.97	20.55	21.32
20	25.37	25.13	24.00	24.83
30	24.33	23.17	21.50	23.00
Mean	23.33	22.19	21.39	

	Varieties	Concentrations	Varieties x Concentrations
SEm±	0.141	0.163	0.284
C.D.(5%)	0.401	0.463	NS

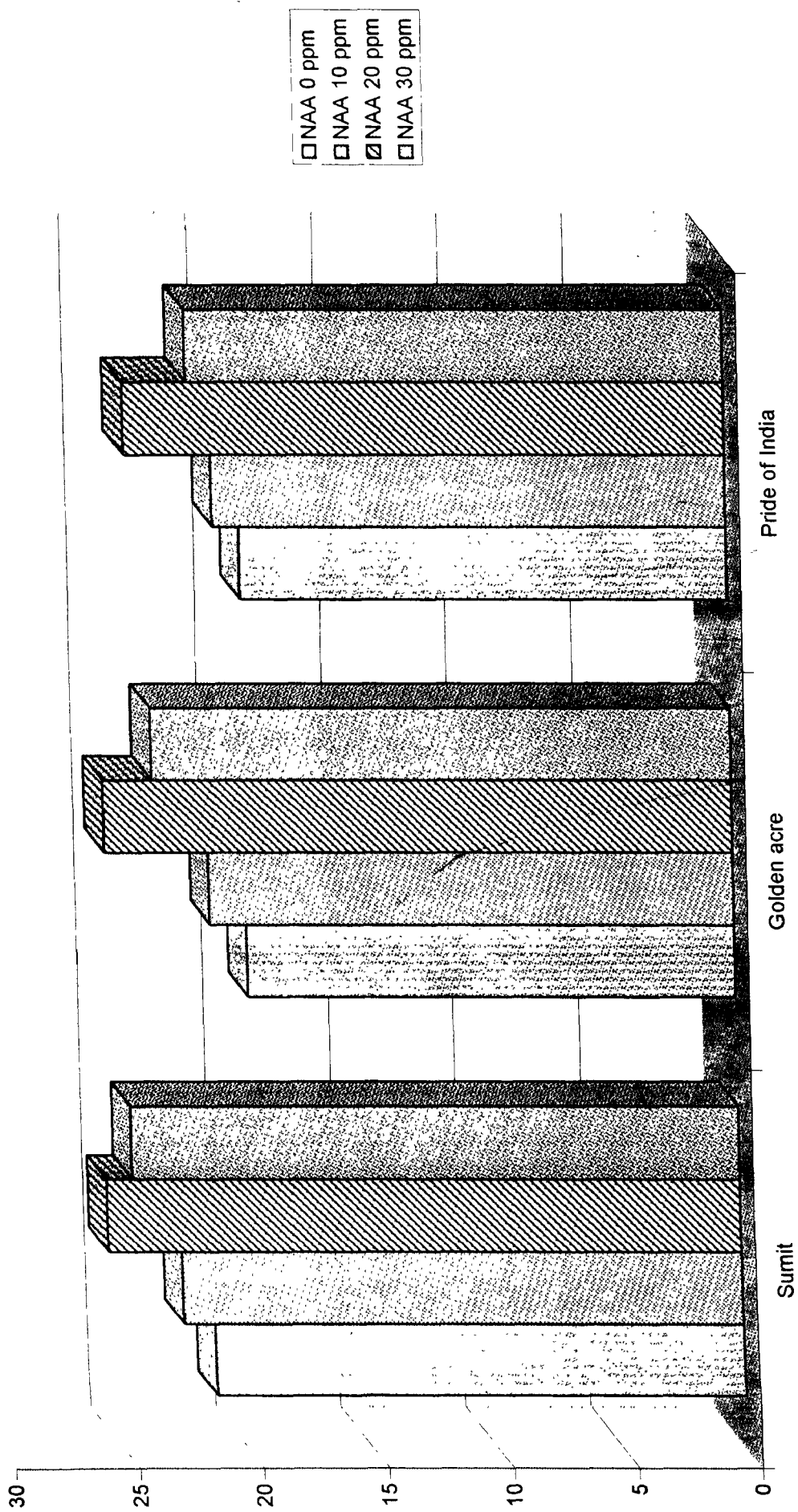
The increasing plant growth substance concentrations only up to 20 ppm proved significantly superior in raising the length of leaf. Thus, the maximum value at 20 ppm was 24.83 cm as against the lowest value of 20.07 cm in case of control.

4.1.4 Width of leaf

4.1.4.1 Width of leaf at 30 DAT

The width of leaf was influenced due to various treatments and their interactions as indicated in Table 4.7 and illustrated in Fig. 4.7. The variety Sumit (Hybrid) attained maximum leaf width (17.85 cm), being significantly superior to all other varieties. The increasing plant growth substance concentrations up to 20 ppm concentration increased this parameter significantly

Fig.4.6 Length of leaf (cm) at 60 DAT



(18.36 cm). Further increase in concentration up to 30 ppm did not result any increase in leaf width.

Table 4.7 Width of leaf (cm) at 30 days after transplanting as influenced by varieties, PGS concentrations and their interactions

NAA concentrations (seed dressing) (ppm)	Varieties			Mean
	Sumit	Golden acre	Pride of India	
0	15.73	14.87	13.83	14.81
10	17.10	15.89	14.62	15.87
20	19.72	18.63	16.73	18.36
30	18.83	17.64	16.65	17.71
Mean	17.85	16.76	15.46	

	Varieties	Concentrations	Varieties x Concentrations
SEm±	0.166	0.192	0.332
C.D.(5%)	0.469	0.542	NS

Sumit hybrid treated with 20 ppm plant growth substances brought higher leaf width (19.72 cm). The significantly lowest leaf width (13.83 cm) was noted in case of Pride of India without any plant growth substance concentration.

4.1.4.2 Width of leaf at 60 DAT

The width of leaf was influenced due to various treatments as indicated in Table 4.8 and illustrated in Fig. 4.8.

Fig.4.7: Width of leaves (cm) at 30 DAT

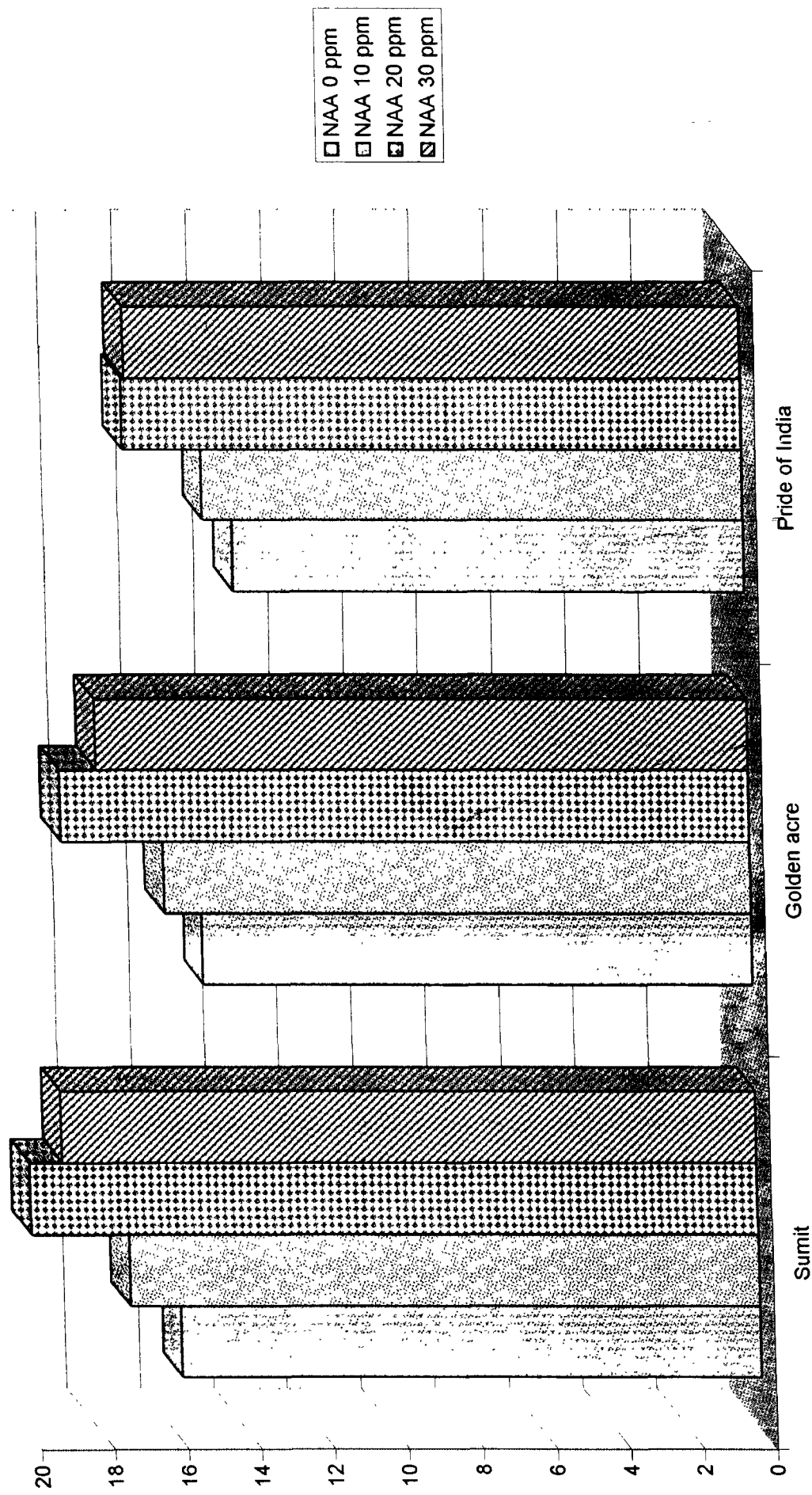


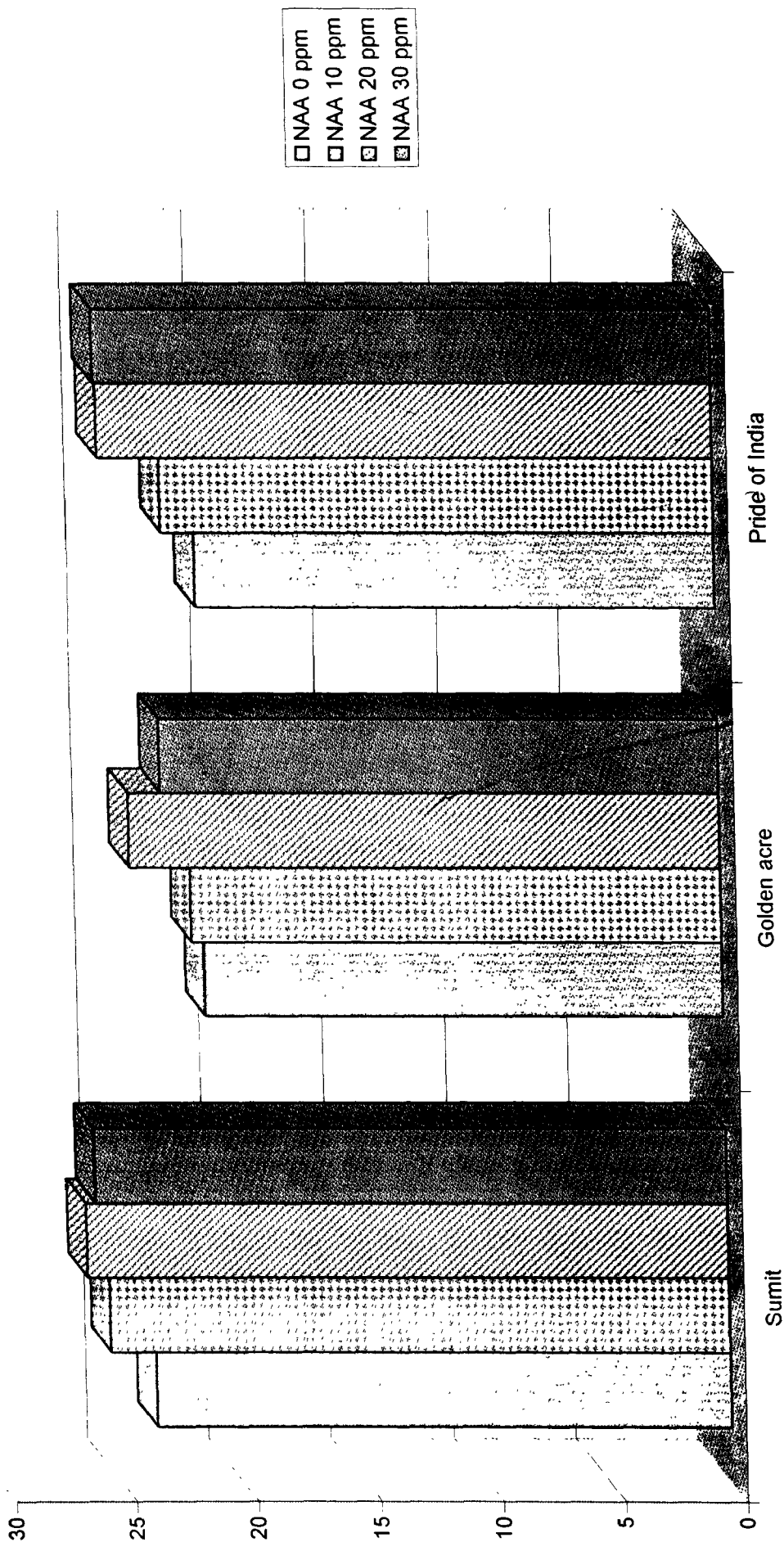
Table 4.8 Width of leaf (cm) at 60 days after transplanting as influenced by varieties, PGS concentrations and their interactions

NAA concentrations (seed dressing) (ppm)	Varieties			Mean
	Sumit	Golden acre	Pride of India	
0	23.47	21.10	21.17	21.91
10	25.33	21.60	22.53	23.16
20	26.23	24.10	25.07	25.13
30	25.83	22.77	25.17	24.59
Mean	25.22	22.39	23.48	

	Varieties	Concentrations	Varieties x Concentrations
SEm±	0.088	0.102	0.177
C.D.(5%)	0.251	0.289	NS

The variety Sumit (Hybrid) attained maximum leaf width (25.22 cm), being significantly superior to all other varieties. The increasing plant growth substance concentrations up to 20 ppm concentration increased this parameter significantly (25.13 cm). Further increase in concentration up to 30 ppm did not result any increase in leaf width. As regards with the treatment interactions, it was found non-significant.

Fig. 4.8: Width of leaves (cm) at 60 DAT



4.2 Post-harvest studies

4.2.1 Weight of untrimmed heads

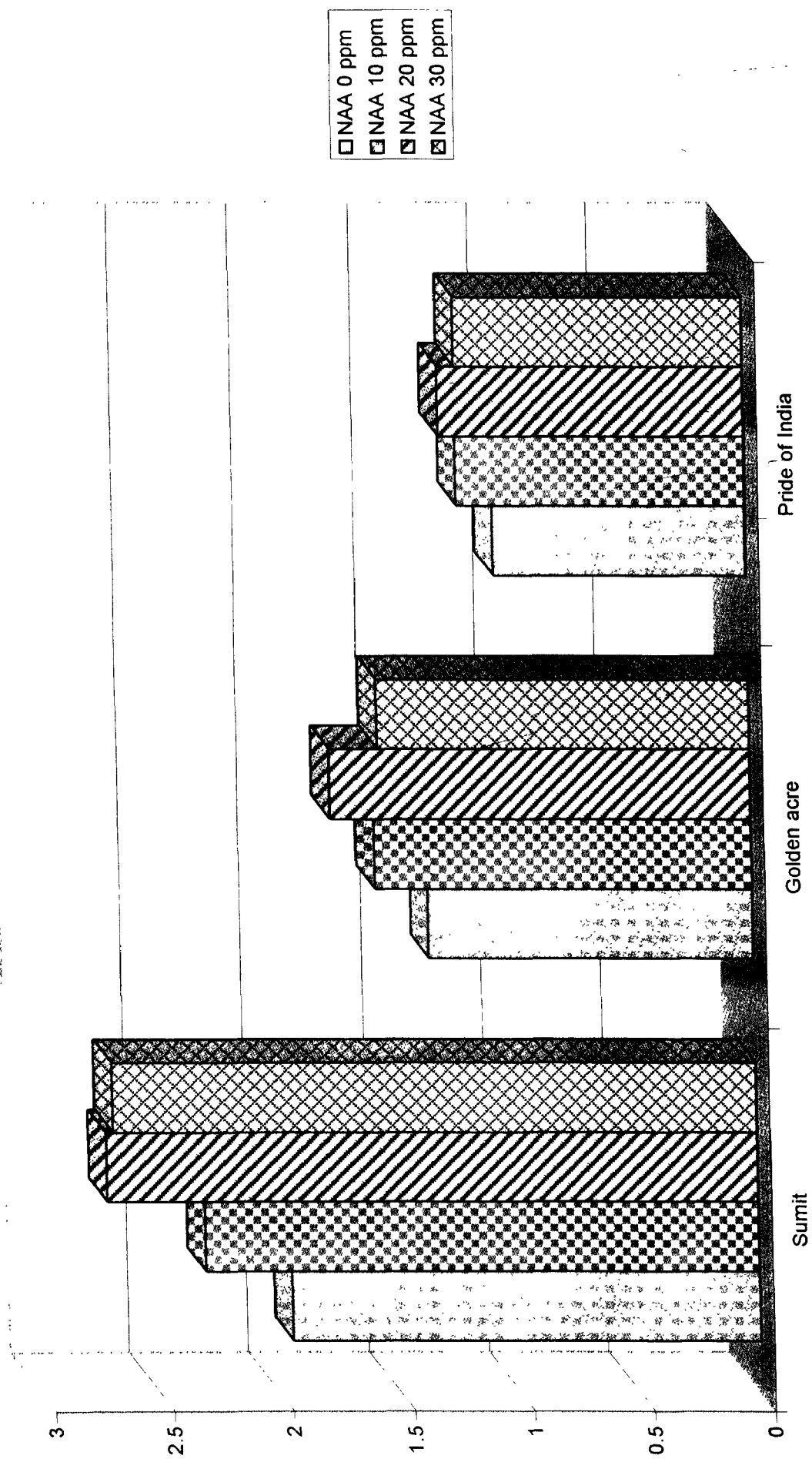
The weight of untrimmed head was found to influence significantly due to different varieties and plant growth substance concentrations (Table 4.9 and Fig. 4.9). Sumit recorded highest weight of untrimmed head (2.41 kg) and proved significantly superior to Golden acre and Pride of India. (1.55 and 1.18 kg). The variety Golden acre weighing 1.55 kg was found significantly superior to Pride of India (1.18 kg). Thus the significantly lowest heas weight was recorded from the Pride of India variety. The increasing plant growth substance concentration up to 20 ppm resulted in significantly rise in untrimmed weight of head (1.91 kg), where the lowest weight (1.45 kg) was noted in case of control. Further increase in plant growth substance concentration up to 30 ppm did not result in any increase in head weight.

Table 4.9 Weight of untrimmed heads (kg) at maturity as influenced by varieties, PGS concentrations and their interactions

NAA concentrations (seed dressing) (ppm)	Varieties			Mean
	Sumit	Golden acre	Pride of India	
0	1.94	1.35	1.05	1.45
10	2.30	1.57	1.20	1.69
20	2.71	1.75	1.27	1.91
30	2.68	1.55	1.20	1.81
Mean	2.41	1.55	1.18	

	Varieties	Concentrations	Varieties x Concentrations
SEm±	0.198	0.229	0.427
C.D.(5%)	0.583	0.673	NS

Fig. 4.9 Weight of untrimmed heads (kg)



4.2.2 Weight of trimmed heads

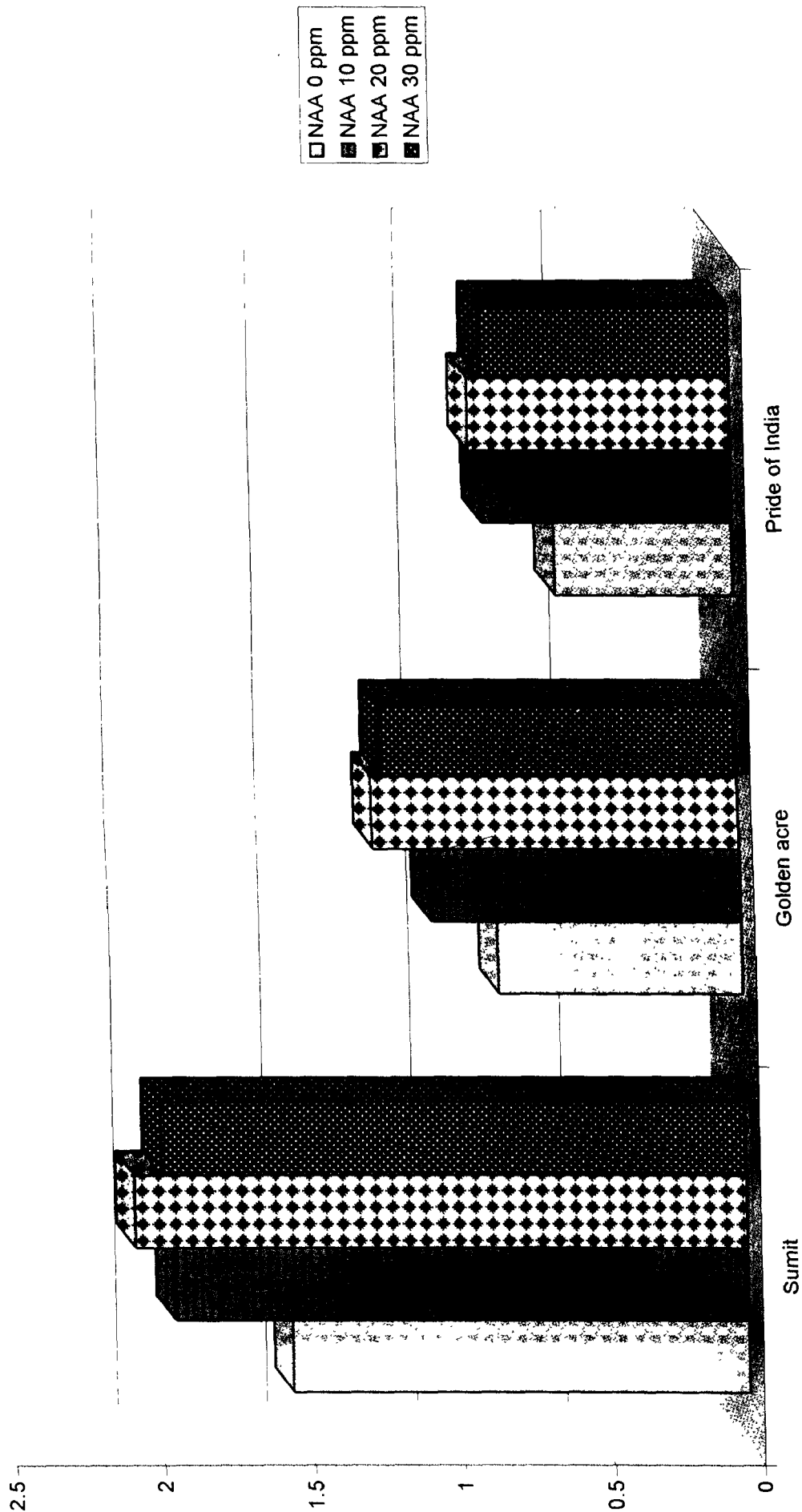
The data pertaining to weight of trimmed head are presented in Table 4.10 and diagrammatically illustrated in Fig. 10. The findings reveal that the weight of trimmed head was deviated significantly due to different treatments. The Sumit registered highest head weight (1.86 kg). The Golden acre variety gave significantly higher head weight (1.06 kg) as compared to that of Pride of India, being the lowest in head weight (0.78 kg).

Table 4.10 Weight of trimmed heads (kg) at maturity as influenced by varieties, PGS concentrations and their interactions

NAA concentrations (seed dressing) (ppm)	Varieties			Mean
	Sumit	Golden acre	Pride of India	
0	1.52	0.81	0.59	0.97
10	1.91	1.03	0.83	1.26
20	2.04	1.22	0.87	1.37
30	1.95	1.19	0.83	1.32
Mean	1.86	1.06	0.78	

	Varieties	Concentrations	Varieties x Concentrations
SEm±	0.105	0.908	1.014
C.D.(5%)	0.307	0.266	NS

Fig.4.10 Weight of trimmed heads (kg)



The head weight was found to increase significantly with the increase of plant growth substance concentration up to 20 ppm (1.37 kg), whereas the lowest curd weight (0.97 kg) noted in case of control. There was no increase in head weight when plant growth substance concentration was increased from 20 to 30 ppm. The interactions were found non-significant.

4.2.3 Yield of untrimmed heads

The yield of untrimmed heads per hectare was obtained from the yield per plot multiplied by the conversion factor. The data so obtained are presented in Table 4.11 and depicted through bar diagram as in Fig. 4.11. The cabbage variety Sumit recorded higher head yields (886.04 q/ha) and were found to be significantly superior to Golden acre and Pride of India varieties (403.92 to 584.55 q/ha). Golden acre recorded significantly higher yield (584.55 q/ha) over to that of Pride of India (403.92 q/ha). Among NAA concentrations, 20 ppm resulted in highest head yield (678.99 q/ha) which was significantly higher to zero concentration and nearer to significant over 10 ppm concentration (619.34 q/ha). Raising the concentration up to 30 ppm did not increase the head yield (661.92 q/ha) in comparison to 20 ppm concentration.

Table 4.11 Yield of untrimmed heads (q/ha) at maturity as influenced by varieties, PGS concentrations and their interactions

NAA concentrations (seed dressing) (ppm)	Varieties			Mean
	Sumit	Golden acre	Pride of India	
0	731.23	494.83	391.20	539.09
10	895.05	569.56	393.41	619.34
20	971.69	640.18	425.10	678.99
30	946.17	633.62	405.97	661.92
Mean	886.04	584.55	403.92	

	Varieties	Concentrations	Varieties x Concentrations
SEm±	12.227	14.127	24.437
C.D.(5%)	36.626	39.982	NS

4.2.4 Yield of trimmed heads

The yield of trimmed heads was found to deviate significantly due to cabbage varieties, plant growth substance concentrations (Table 4.12 and Fig. 4.12). The hybrid variety Sumit registered higher head yield (625.37 q/ha) over other two varieties. The variety Golden acre yielded significantly higher (370.75 q/ha) over Pride of India (283.73 q/ha). Thus Pride of India proved the lowest yielding variety.

Fig. 4.11 Yield of untrimmed heads (q/ha)

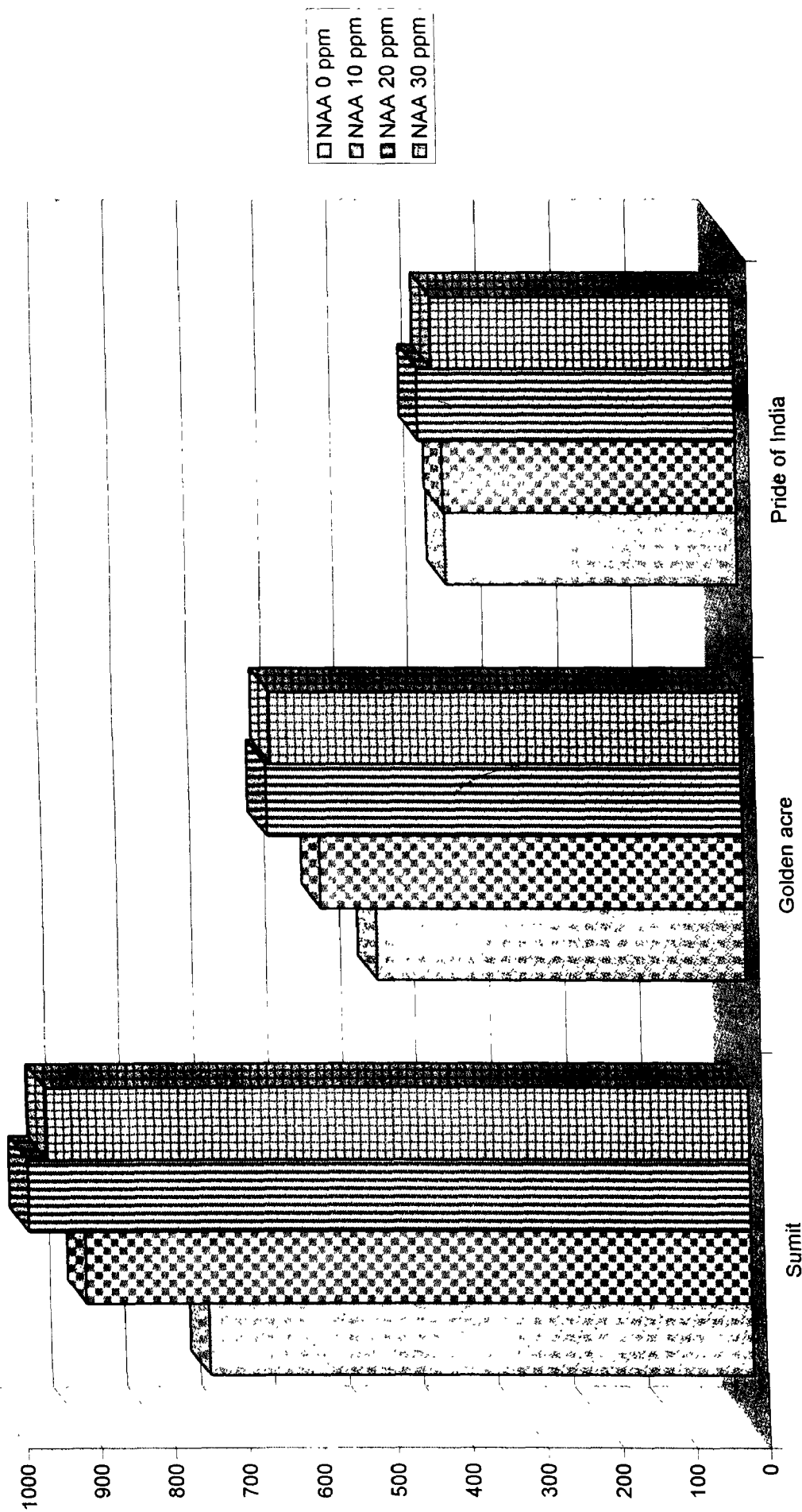


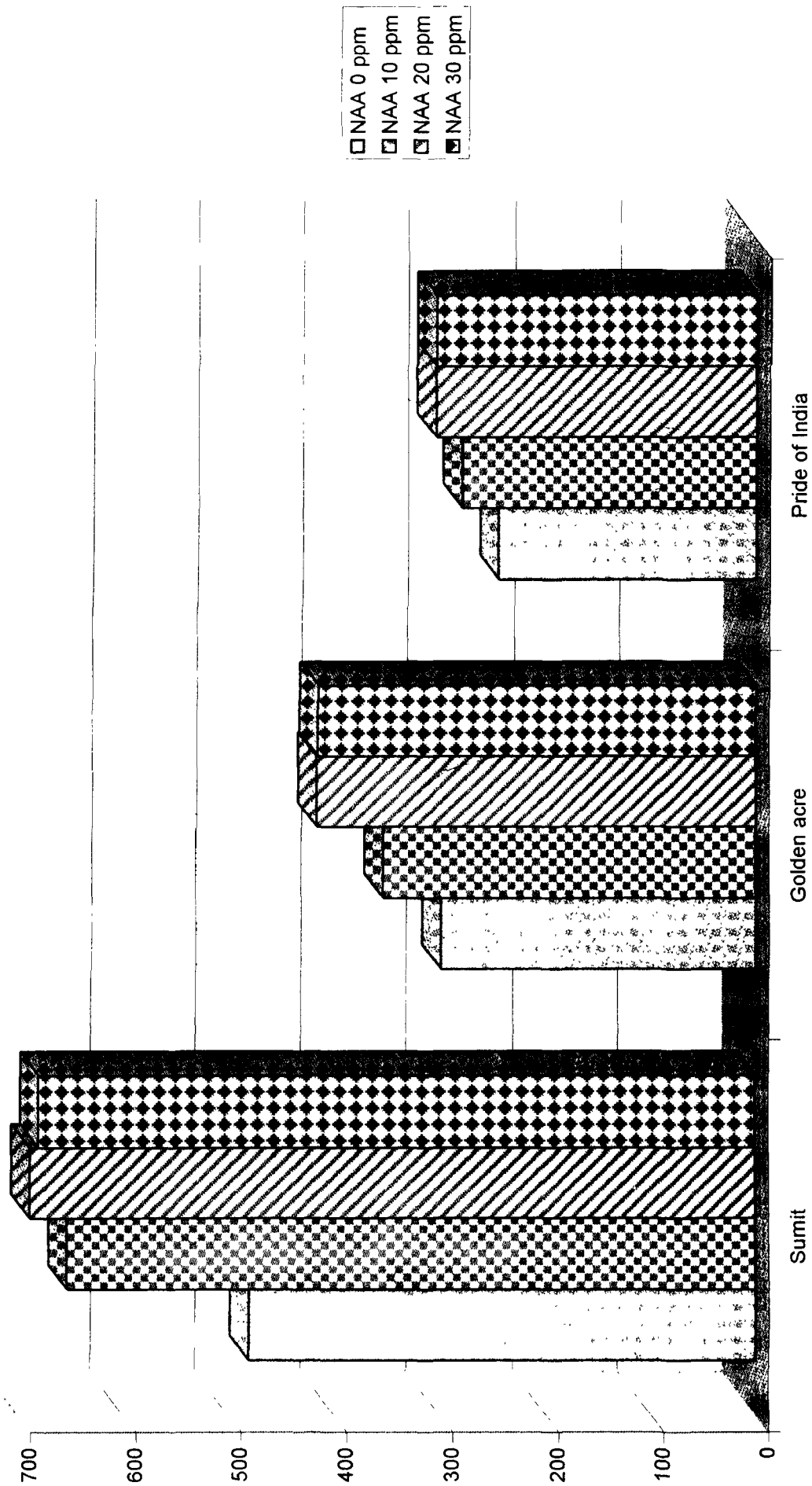
Table 4.12 Yield of trimmed heads (q/ha) at maturity as influenced by varieties, PGS concentrations and their interactions

NAA concentrations (seed dressing) (ppm)	Varieties			Mean
	Sumit	Golden acre	Pride of India	
0	480.18	298.34	245.86	341.46
10	652.67	352.75	280.17	428.53
20	688.50	416.66	304.46	469.87
30	680.11	415.25	304.46	466.61
Mean	625.37	370.75	283.73	

	Varieties	Concentrations	Varieties x Concentrations
SEm±	5.030	4.356	8.712
C.D.(5%)	14.753	12.776	NS

The plant growth substance concentration only up to 20 ppm brought about significant increase in head yield (469.87 q/ha). Further increase in concentration up to 30 ppm did not increase the curd yield (466.61 q/ha). Among the treatment interactions, Sumit treated with 20 ppm plant growth substance concentration raised the yield up to maximum (688.50 q/ha). On the other hand lowest head yield (245.86 q/ha) was obtained from Pride of India with zero concentration.

Fig. 4.12: Yield of trimmed heads (q/ha)



4.3 Net return and B:C ratio

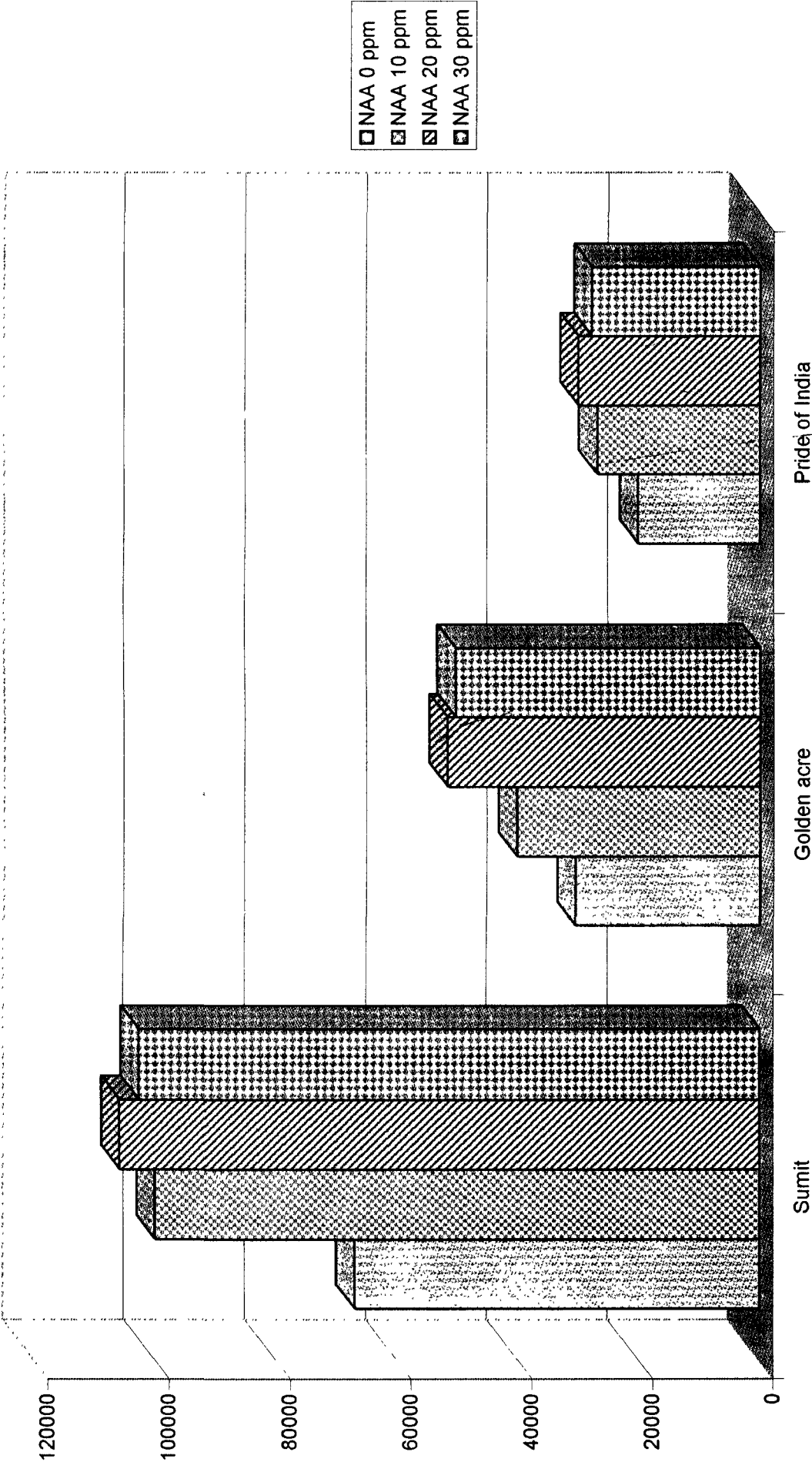
The estimated net return and B:C ratio values under various treatments are presented in Table 4.13 and diagrammatically presented in Fig. 4.13 .

Table 4.13 Net return (Rs/ha) and Benefit: cost ratio as influenced by various treatments and their interactions

NAA concentrations (seed dressing) (ppm)	Varieties			Mean
	Sumit	Golden acre	Pride of India	
Net return (Rs./ha)				
0	67052	30610	20210	39291
10	100076	40335	27002	55804
20	105890	51840	30142	62624
30	102620	50460	27851	60310
Mean	93910	43311	26301	
Benefit: cost ratio				
0	2.31	1.06	0.70	1.36
10	3.29	1.34	0.90	1.84
20	3.32	1.65	0.98	1.98
30	3.08	1.55	0.88	1.84
Mean	3.00	1.40	0.87	

From the Table 4.13, it is revealed that the variety Sumit recorded the highest net profit up to Rs.93910/ha. The net returns in case of Golden acre and Pride of India were in a very lower range i.e. Rs.43311 and Rs.26301/ha, respectively. The best plant growth substances concentration was 20 ppm which gave net return up to Rs.62624/ha, closely followed by 30 ppm concentration (Rs.60310/ha). The highest benefit cost ratio 3.00 was received from hybrid variety namely Sumit whereas lowest B:C ratio 0.87 was recorded from Pride of India.

Fig.4.13 Net return (Rs./ha)



Cost of cultivation of cabbage excluding treatment expenditure

S. No.	Particular	Rates (Rs./ha)
1	Ploughing -2	1250
2	Harrowing -1	600
3	Levelling	600
4	Seed rate/ha (375- 500 gm/ha)	4000
5	Transplanting (25 labours)	1750
6	Gap filling (8 labours)	540
7	Weeding charges (2 weeding 15 labours/weeding)	2100
8	Irrigation charges (12-14)	6000
9	F.Y.M. (manure) 200q	4200
10	150 kg N/ha (urea)	1568
11	80 kg P ₂ O ₅ /ha (S.S.P.)	1274
12	75 kg K ₂ O/ha (M.O.P.)	466
13	Harvesting-25 labours	1750
14	Transportation charges	1200
	Total	27298
15	Interest on working capital @ 5%	1590
16	Land revenue	100
	G. Total	28988



Prevailing market rates of different inputs

S. No.	Particular	Rates (Rs)
1	Ploughing /harrowing/planking (each)	600
2	Labour charges per day/labour	70
3	Purchase rate of cabbage seed (per 10 gm)	225
4	Farm yard manure (per quintal)	20
5	Urea (per quintal)	506
6	S.S.P. (per quintal)	425
7	M.O.P (per quintal)	466
8	NAA @ Rs.150/25 g	150

Cost of cultivation of cabbage including treatment expenditure

S. No.	Treatments	Total expenditure (Rs./ha)			Gross income (Rs./ha)		Net income	Benefit cost ratio
		Cost of cultivation	Treatment cost	Total	Cabbage yield/ha	Income		
	V ₁ C ₀	28988	0	28988	480.18	96040	67052	2.31
	V ₁ C ₁	28988	1460	30448	652.67	130524	100076	3.29
	V ₁ C ₂	28988	2920	31908	688.50	137798	105890	3.32
	V ₁ C ₃	28988	4380	33368	680.11	135988	102620	3.08
	V ₂ C ₀	28988	0	28988	298.34	59598	30610	1.06
	V ₂ C ₁	28988	1200	30188	352.75	70523	40335	1.34
	V ₂ C ₂	28988	2400	31388	416.66	83228	51840	1.65
	V ₂ C ₃	28988	3600	32588	415.25	83048	50460	1.55
	V ₃ C ₀	28988	0	28988	245.86	49198	20210	0.70
	V ₃ C ₁	28988	850	29838	280.17	56840	27002	0.90
	V ₃ C ₂	28988	1700	30688	304.46	60830	30142	0.98
	V ₃ C ₃	28988	2550	31538	304.46	59389	27851	0.88

4.4 Grading of heads

The grading of cabbage head was done on the basis of diameter of curd (A, B and C) and expressed in the percentage. The data so obtained have been presented in Table 4.14 and 4.15.

Table 4.14 Grading of cabbage heads as influenced by different varieties, PGS concentrations and their interactions

	Varieties			
	Percentage of "A" grade			
NAA concentrations (seed dressing) (ppm)	Sumit	Golden acre	Pride of India	Mean
0	33	22	22	28
10	44	44	33	40
20	56	67	45	56
30	44	56	45	48
Mean	44	47	36	

	Varieties			
	Percentage of "B" grade			
NAA concentrations (seed dressing) (ppm)	Sumit	Golden acre	Pride of India	Mean
0	44	33	33	37
10	33	33	33	33
20	22	11	33	22
30	33	33	22	29
Mean	33	27	30	

NAA concentrations (seed dressing) (ppm)	Varieties			Mean
	Percentage of "C" grade			
	Sumit	Golden acre	Pride of India	
0	23	45	45	38
10	23	23	34	27
20	22	22	22	22
30	23	11	33	22
Mean	23	25	33	

Table 4.15 Percentage grading of cabbage heads as influenced by different treatment interactions

Treatment interaction	*Grading categories (%)		
	A	B	C
V ₁ C ₀	33	44	23
V ₁ C ₁	44	33	23
V ₁ C ₂	56	22	22
V ₁ C ₃	44	33	23
V ₂ C ₀	22	33	45
V ₂ C ₁	44	33	23
V ₂ C ₂	67	11	22
V ₂ C ₃	56	33	11
V ₃ C ₀	22	33	45
V ₃ C ₁	33	33	34
V ₃ C ₂	45	33	22
V ₃ C ₃	45	22	33

*Based on diameter of head, 4-6 cm "A" grade, 2-4 cm "B" grade and below 2 cm "C" grade

Golden acre treated with 20 ppm concentration resulted in the maximum "A" grade heads up to 67% whereas "B" and "C" grade heads were 11 and 22%, respectively. Sumit treated with 20 ppm concentrated proved equally the second best giving 56% "A" grade heads, 22% "B" and 22% "C" grade heads. The general trend was that with the increasing plant growth substances up to 20 ppm increased the "A" grade heads whereas decreased the "B" and "C" grade heads. At zero concentration, the "A" grade heads were lowest (26%) while the "B" and "C" grade heads were in the maximum (37 to 38%).

DISCUSSION

CHAPTER-V

DISCUSSION

In the present chapter, an attempt has been made to explain the results of the experiment "**Effect of NAA treated seed on growth and yield of different varieties of cabbage (*Brassica oleracea Capitata*)**". The results obtained on growth characters, yield-attributes, yield and quality of cabbage as influenced by different treatments are briefly discussed and interpreted in the light of findings of research work done by other scientists of our country and abroad.

Weather conditions

The influence of prevailing weather conditions during the crop season played an important role in the growth, yield and quality of cabbage. The data in Table 3.1 revealed that the higher head yield was obtained during the season which may be attributed to the congenial weather conditions prevailing for the growth and development of crop.

The weather components viz., temperature, sunlight and relative humidity during the crop growth season did not vary to a great extent except rainfall, its intensity, quantity and frequency. The total rainfall received during the crop season was 60.4 mm covering 6 rainy days.

It was observed that the normal mean maximum and minimum temperature (36.5 °C and 3.1 °C), maximum and minimum humidity, clear weather with longer sunshine hours have been conducive to the higher photosynthesis which reflected through the favourable vegetative growth and reproductive yield parameters leading to higher curd productivity.

Growth parameters

Amongst the growth parameters, Sumit (Hybrid) recorded maximum plant height of 22.82 and 27.43 cm at 30 and 60 DAT, respectively whereas the lowest plant height was recorded at 30 and 60 DAT in variety Golden acre (21.50 cm) and Pride of India (25.11 cm) respectively. In case of number of open

leaves/plant at 30 DAT, maximum number (12.36) was recorded in Golden acre whereas at 60 DAT it was recorded from Sumit (hybrid) (17.29). The lowest number 11.03 and 16.94 was recorded in Sumit (hybrid) at 30 DAT and 60 DAT in Golden acre, respectively. The maximum length of leaf 18.54 and 23.33 cm was noted at 30 DAT and 60 DAT in the Sumit (Hybrid). The Golden acre recorded the lowest leaf length 17.78 at 30 DAT and Pride of India 21.39 cm) at 60 DAT. The maximum (17.85 and 25.22 cm) width of leaf was recorded in Sumit (Hybrid) whereas the lowest width was recorded in Pride of India (15.46 cm) and Golden acre (22.39) at 30 and 60 DAT, respectively. Thus, there appeared to be very wide differences among these three cabbage varieties with respect to vegetative growth characters (Summary Table 5.1). This may be due to the genetical variability among the varieties for growth characters as well as due to performance in the agro-climatic conditions. The similar variations in growth characters among the cabbage varieties have also been reported by Patil and Patil (1987), Shaikh *et al.* (2002) and Mishra (2006).

Increasing the concentrations of PGS only up to 20 ppm increased all the growth characters significantly. Further, increase in concentration up to 30 ppm did not increase these parameters. Enhancement in morphological parameters by the mixture of NAA (through seed dressing) may be due to their effect on cell enlargement, cell growth, physico-chemical properties of protoplasm, respiration, nitrogen and nucleic acid metabolism etc. NAA promoted cell division in pericycle and cortical tissues, the pattern was similar as occurring during lateral root development. Auxin is held responsible for initiating a fundamental change in enzyme system of cytoplasm. The role of auxin plays in this master reaction may be as a co-enzyme or protecting agent in an enzyme system. Alternatively, the auxin induced master reaction in nucleic acid metabolism may cause synthesis. Mobility and activation of particular enzyme systems responsible for varied effects. The beneficial influence of plant growth regulators on growth parameters of horticultural crops have also been reported by Singh *et al.* (2002), Kanaujia *et al.* (2002) and Mishra (2006).

Yield-attributes

The productivity of any crop is totally based on the yield-attributing parameters. In case of cabbage, the yield-attributes are circumference and diameter of head and the weight of untrimmed and trimmed head. The untrimmed and trimmed head of Sumit (Hybrid) attained significantly higher weight 2.41 and 1.86 kg, respectively. The lowest untrimmed and trimmed head (1.18 and 0.78 kg) was received from Pride of India. In case of Sumit (Hybrid) variety, all the yield-attributes were found in higher range. On the other hand, the variety Pride of India recorded significantly lowest range. The significant variations among the varieties with respect to yield-attributes may be due to similar positive variations recorded in case of growth attributes of cabbage varieties. Such attempts have also been made to test the performance of different cabbage varieties under varying sets of agro-climatic conditions of the country. The differential response observed by the different varieties under different sets of agro-climatic conditions is due to the effect of prevailing environmental conditions on their growth and yield-attributing characters. The photosynthesis, respiration and other metabolic processes vary due the environmental conditions from variety to variety. The differences noted in the three varieties viz., Sumit (Hybrid), Golden acre and Pride of India may be due to these reasons under the agro-climatic conditions of Kymore plateau. The present findings agree with those of Nandekar and Sawarnkar (1992), Nirmal *et al.* (1994), Abu Grab and Ebrahim (2000) and Mishra (2006).

The increasing plant growth substance concentrations through seed dressing only up to 20 ppm enhanced the yield-attributes significantly. Further increase in concentration up to 30 ppm exerted no beneficial influence. The significant increase in yield-attributes due to PGS through NAA seed dressing may be due to the significant increase in plant height, number of open leaves/plants, length and width of leaf. The present findings corroborate with those of other workers (Bahadur *et al.* (2001; Russo, 2003 and Mishra, 2006).

Yield and net returns

Summary Table 5.2 highlights the overall trend with respect to influence of varieties and mixture of NAA growth substance on the cabbage yield and net return. Among the varieties, Sumit (Hybrid) proved the best giving the maximum yield of trimmed head (625.37 q/ha) and net return up to Rs.93910.00/ha with B:C ratio of 3.00. The other two varieties viz., Golden acre and Pride of India gave lowest net returns up to Rs Rs.43311 and Rs.26301/ha, respectively and B:C ratio ranging from 0.87 to 1.40 only. The cabbage yield from different varieties are differences in exactly in accordance with the yield-attributes obtained in these varieties as a result of attainment of genetically governed yielding potentiality. These findings agree with those of other workers (Patil and Patil, 1987; Rizk *et al.*, 1996; Abu Grab and Ebrahim, 2000 and Mishra, 2006).

The increasing concentration of plant growth substance through seed dressing only up to 20 ppm proved highly beneficial which enhanced the maximum yield and net income from the cabbage varieties. Accordingly, at 20 ppm concentration of NAA mixture, the highest yield of untrimmed and trimmed heads was 886.04 and 625.37 q/ha, respectively and in the same order, net return was up to Rs.93910 and B:C ratio 3.00. So much increases in yield due to 20 ppm plant growth substance concentration may be due to similar increase in growth and yield-attributes of cabbage by the applied dose of PGS concentrations. The present findings are in accordance with those of Singh *et al.* (2002), Russo (2003), Singh *et al.* (2003) and Mishra (2006). The treatment interactions were found non-significant.

Grading of heads

The summary Table 5.2 highlights the overall picture of "A", "B" and "C" grade heads obtained from different cabbage varieties as well as after treatment with different concentration of NAA mixture. Golden acre treated with 20 ppm concentration resulted in the maximum (67%) "A" grade heads. The general trend was that the increasing PGS concentration up to 20 ppm increased the "A" grade heads, whereas decreased the "B" and "C" grade heads. That is why, at

zero concentration the "A" grade heads were lowest 26%, while "B" and "C" grade heads were in the maximum range (37 to 38 %). The variations in the percentages of "A", "B" and "C" heads obtained in different varieties may be due to the genetical as well as agro-climatic and environmental variations under which the varieties are grown. Similar variations in the cabbage head qualities have also been reported by Salah and Abd (1989), Nandekar and Sawarkar (1992), Wagh and Deore (1995) and Mishra (2006).

Summary Table 5.1 Yield attributes of cabbage varieties treated with NAA concentrations (seed dressing)

Treatments (Varieties)	Plant height (cm) [30 DAT]	Plant height (cm) [60 DAT]	Number of open leaves/plant (30 DAT)	Number of open leaves/plant (60 DAT)	Length of leaves (cm) [30 DAT]	Length of leaves (cm) [60 DAT]	Width of leaves (cm) [30 DAT]	Width of leaves (cm) [60 DAT]	Weight of untrimmed heads (kg)	Weight of trimmed heads (kg)
Sumit (hybrid)	22.82	27.43	11.03	17.60	18.54	23.33	17.85	25.22	2.41	1.86
Golden acre	21.50	26.30	12.36	17.10	17.78	22.19	16.76	22.39	1.55	1.06
Pride of India	22.72	25.11	11.66	17.21	18.37	21.39	15.46	23.48	1.18	0.78
C.D. (5%)	0.382	0.341	0.691	0.465	0.490	0.401	0.469	0.251	0.583	0.307
NAA concentrations (ppm)										
0	20.83	22.35	10.57	16.35	16.62	20.07	14.81	21.91	1.45	0.97
10	22.24	25.64	11.68	17.28	18.13	21.32	15.87	23.16	1.69	1.26
20	23.79	29.64	12.28	17.98	19.41	24.83	18.36	25.13	1.91	1.37
30	22.51	28.48	12.20	17.60	18.74	23.00	17.71	24.59	1.81	1.32
C.D. (5%)	0.441	0.393	0.798	0.537	0.566	0.463	0.542	0.289	0.673	0.266
Interactions	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Summary Table 5.2 Yield and net-return from cabbage varieties treated with NAA concentrations (seed dressing)

Treatments (Varieties)	Yield of untrimmed heads (q/ha)	Yield of trimmed heads (q/ha)	Net return (Rs./ha)	Benefit :cost ratio	Percentage grading of curds		
					A	B	C
Sumit (hybrid)	886.04	625.37	93910	3.00	44	33	23
Golden acre	584.55	370.75	43311	1.40	47	27	25
Pride of India	403.92	283.73	26301	0.87	36	30	33
C.D. (5%)	2.005	14.753	-	-	-	-	-
NAA concentrations (ppm)							
0	539.09	341.46	39291	1.36	28	37	38
10	619.34	428.53	55804	1.84	40	33	27
20	678.99	469.87	62624	1.98	56	22	22
30	661.92	466.61	50310	1.84	48	29	22
C.D. (5%)	2.315	12.776	-	-	-	-	-
Interactions	NS	NS	-	-	-	-	-

SUMMARY, CONCLUSION
AND SUGGESTIONS

CHAPTER-VI

SUMMARY, CONCLUSION AND SUGGESTIONS

Summary

In the present investigation entitled "**Effect of NAA treated seed on growth and yield of different varieties of cabbage (*Brassica oleracea Capitata*)**" was taken up at the experimental area of vegetable garden, Department of Horticulture, College of Agriculture, Rewa (M.P.) during the year 2007-08. The soil was clay-loam having pH 7.5, organic carbon 0.56%, available N, P₂O₅ K₂O, 238.33, 118.00 and 304.00 kg/ha, respectively. The total rainfall received during the cropping season was 60.4 mm through 6 rainy days. The treatments comprised three varieties (Sumit hybrid, Golden acre and Pride of India) and four concentrations of NAA (seed dressing) (0, 10, 20 and 30 ppm). The experiment was laid out in a factorial randomized block design with three replications. The seeds of cabbage varieties were treated with hormonal powder.

The fertilizers were applied @ 150 kg N, 80 kg P₂O₅ and 75 kg K₂O/ha and FYM was applied @ 2 t/ha. The seedlings were transplanted on 16.11.2007 keeping row distance of 60 cm and plant distance of 45 cm. In all 9 irrigations were given. The crop was grown as per recommended package of practices. The heads of proper size and shape fit for marketing were harvested between 6 to 17 February, 2008.

The salient findings of the present experiment are mentioned as follows:

Growth parameters

Sumit (hybrid) recorded the maximum plant height (27.43 cm), length of leaves (23.33 cm), width of leaves (25.22 cm) and number of open leaves/plant (17.60/plant) whereas the Golden acre resulted in the highest number of open

leaves/plant (12.36) at 30 DAT. Pride of India measured the minimum length of leaves (21.39 cm) over other varieties.

The increasing concentration of NAA through seed dressing up to 20 ppm increased all the growth characters almost significantly. Further increase of concentration up to 30 ppm did not found effective. The combined influence of variety x concentration further encouraged the growth parameters. The treatment interactions were found non-significant.

Yield-attributes

The Sumit hybrid heads attained significantly higher weight of untrimmed and trimmed curds 2.41 and 1.86 kg/head, respectively whereas Pride of India attained lower weight of untrimmed and trimmed heads 1.18 and 0.78 kg/head, respectively. The increasing plant growth substance concentrations up to 20 ppm enhanced the yield attributes significantly. Further increase in concentration up to 30 ppm did not exert any beneficial impact. The variety x concentration interactions were found non-significant in each of the characters studied.

Yield and net returns

Sumit (hybrid) producing the maximum trimmed heads up to 625.35 q/ha and net return up to Rs.93910 q/ha with B:C ratio up to 3.00. Golden acre and Pride of India proved lower yielder i.e. 370.75 and 283.73 q/ha with net income of Rs.43311 and Rs.26301/ha, respectively. The B:C ratio in the same order was 1.40 and 0.87.

The increasing concentration of NAA only up to 20 ppm proved highly beneficial which enhanced the maximum yield and net income. Thus, the yield of untrimmed and trimmed heads at 20 ppm was 678.99 and 469.87 q/ha, respectively and in the same order, net return was up to Rs.62624/ha and B:C ratio 1.98.

The hybrid variety Sumit treated with 20 ppm concentration of NAA further augmented the yield as well as net returns. Thus, among the varieties Sumit (hybrid) recorded the maximum yield of trimmed heads whereas 20 ppm

concentration was found best among all the concentration and recorded the maximum yield of trimmed heads 688.50 q/ha) and net income (Rs.1,05,890/ha) with highest B: ratio up to 3.32. The other varieties recorded lower yield as well as net income and B:C ratio. The variety x concentration interactions were found non-significant.

Grading of heads (based on diameter)

Golden acre treated with 20 ppm concentration resulted in maximum (67%) "A" grade curds, whereas Sumit (hybrid) and Pride of India gave 56% and 45 % "A" grade heads. The general trend was that with the increasing plant growth substance concentrations up to 20 ppm increased the "A" grade heads, whereas decreased the "B" and "C" grade heads. Thus, "A" grade heads were the lowest (26%) at control, whereas "B" and "C" grade heads were in the maximum range (37 to 38 %).

Conclusion

It could be concluded from the present study that Sumit (hybrid) variety of cabbage performed the best in comparison to Golden acre and Pride of India varieties in the prevailing agro-climatic conditions of Kymore plateau of Madhya Pradesh due to the genetical as well as agro-climatic and environmental variations under which the varieties were grown. The mixture of NAA growth substance through seed dressing played an important role in increasing the growth, yield, net income and quality of cabbage varieties. Thus, among the varieties Sumit (hybrid) recorded the maximum yield of trimmed heads whereas 20 ppm concentration was found best among all the concentration and recorded the maximum yield of trimmed heads 688.50 q/ha) and net income (Rs.1,05,890/ha) with highest B: ratio up to 3.32. The other two varieties resulted low production of trimmed heads, minimum net income and B:C ratio.

Suggestions

The following relevant suggestions are being made on the basis of the findings of the present study.

1. The findings of the present investigation are based on one year's results, hence needs further confirmation by repeating the experiments in the next season.
2. More number of newly developed cabbage varieties may be tested to judge their performance under the existing agro-climatic conditions in view of different plant growth substances with varying concentrations.

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APPENDICES

APPENDICES

Appendix – I

Plant height at 30 DAT (cm)

Source of variation	d.f	SS	MSS	F value	F tab. 5%
Replications	2	0.762	0.381	1.743	3.44
Varieties (V)	2	39.640	19.820	90.716*	3.44
PGS concentrations (C)	3	15.784	5.262	24.137*	3.05
V x C	6	2.592	0.432	1.92	2.55
Error	22	4.807	0.218		
Total	35				

Appendix – II

Plant height at 60 DAT (cm)

Source of variation	d.f	SS	MSS	F value	F tab. 5%
Replications	2	1.882	0.941	3.410	3.44
Varieties (V)	2	308.584	154.292	886.906*	3.44
PGS concentrations (C)	3	46.957	15.652	89.952*	3.05
V x C	6	2.103	0.351	2.015	2.55
Error	22	3.827	0.174		
Total	35				

Appendix – III

Number of open leaves at 30 DAT (cm)

Source of variation	d.f	SS	MSS	F value	F tab. 5%
Replications	2	1.240	0.620	0.870	3.44
Varieties (V)	2	10.680	3.560	4.960*	3.44
PGS concentrations (C)	3	16.810	8.400	11.700*	3.05
V x C	6	6.620	1.100	1.540	2.55
Error	22	15.790	0.720		
Total	35				

*Significant

Appendix – IV

Number of open leaves (60 DAT)

Source of variation	d.f	SS	MSS	F value	F tab. 5%
Replications	2	0.192	0.096	0.699	3.44
Varieties (V)	2	13.199	6.599	48.097*	3.44
PGS concentrations (C)	3	3.745	1.248	9.112*	3.05
V x C	6	1.644	0.274	2.002	2.55
Error	22	3.019	0.137		
Total	35				

Appendix – V

Length of leaves at 30 DAT (cm)

Source of variation	d.f	SS	MSS	F value	F tab. 5%
Replications	2	0.54	0.27	0.75	3.44
Varieties (V)	2	3.84	1.28	3.54*	3.44
PGS concentrations (C)	3	38.24	19.12	52.93*	3.05
V x C	6	2.23	0.37	1.03	2.55
Error	22	7.95	0.36		
Total	35				

Appendix – VI

Length of leaves at 60 DAT (cm)

Source of variation	d.f	SS	MSS	F value	F tab. 5%
Replications	2	0.995	0.498	2.059	3.44
Varieties (V)	2	22.927	7.642	31.621*	3.44
PGS concentrations (C)	3	115.742	57.871	239.448*	3.05
V x C	6	4.083	0.680	2.015	2.55
Error	22	5.317	0.242		
Total	35				

*Significant

Appendix – VII

Width of leaves at 30 DAT (cm)

Source of variation	d.f	SS	MSS	F value	F tab. 5%
Replications	2	1.554	0.777	2.352	3.44
Varieties (V)	2	34.288	11.429	34.589*	3.44
PGS concentrations (C)	3	72.238	36.119	109.308*	3.05
V x C	6	1.259	0.210	0.635	2.55
Error	22	7.270	0.330		
Total	35				

Appendix – VIII

Width of leaves at 60 DAT (cm)

Source of variation	d.f	SS	MSS	F value	F tab. 5%
Replications	2	0.534	0.267	2.823	3.44
Varieties (V)	2	57.070	28.535	301.8118*	3.44
PGS concentrations (C)	3	59.864	18.288	192.505*	3.05
V x C	6	1.134	0.189	1.989	2.55
Error	22	2.080	0.095		
Total	35				

Appendix – IX

Weight of untrimmed curd (kg)

Source of variation	d.f	SS	MSS	F value	F tab. 5%
Replications	2	0.035	0.018	0.042	3.44
Varieties (V)	2	0.951	0.475	3.498*	3.44
PGS concentrations (C)	3	7.464	2.488	11564.254*	3.05
V x C	6	1.628	0.271	1.995	2.55
Error	22	3.005	0.136		
Total	35				

*Significant

Appendix – X

Weight of trimmed curd (kg)

Source of variation	d.f	SS	MSS	F value	F tab. 5%
Replications	2	0.145	0.072	0.116	3.44
Varieties (V)	2	0.871	0.435	4.391*	3.44
PGS concentrations (C)	3	7.464	2.488	29.171*	3.05
V x C	6	1.469	0.244	2.451	2.55
Error	22	2.198	0.099		
Total	35				

Appendix – XI

Yield of untrimmed curd (kg)

Source of variation	d.f	SS	MSS	F value	F tab. 5%
Replications	2	12.711	6.355	1.054	3.44
Varieties (V)	2	48.075	24.037	3.985*	3.44
PGS concentrations (C)	3	62.250	20.750	3.441*	3.05
V x C	6	66.955	11.159	1.852	2.55
Error	22	132.702	6.032		
Total	35				

Appendix – XII

Yield of trimmed curd (kg)

Source of variation	d.f	SS	MSS	F value	F tab. 5%
Replications	2	0.035	0.018	0.040	3.44
Varieties (V)	2	1817.125	908.560	3.991*	3.44
PGS concentrations (C)	3	2834.987	944.996	4.015*	3.05
V x C	6	2399.152	399.851	1.756	2.55
Error	22	5009.603	227.71		
Total	35				

*Significant

VITA

VITA

The author Sonam Singh was born on 26th Feb 1984 at village Lakonda, Distt. Sidhi (M.P.). She passed her High School Certificate Examination from ST. Jude's C.M. School, Shahdol(M.P.) and Intermediate Examination from ST. Jude's C.M. School, Shahdol (M.P.) during the year 1999 and 2001, respectively.

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