INFLUENCE OF GROWTH REGULATOR AND VEGETABLE PICKING ON SEED YIELD AND QUALITY IN CHILLI (*Capsicum annuum* L.)

BY

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THESIS

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DECLARATION

I hereby declare that this thesis entitled **"Influence of growth regulator and vegetable picking on seed yield and quality in chilli (*Capsicum annuum* L.)"** is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title, of any other university or society.

Ann Napoleon

Vellayani,
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CERTIFICATE

Certified that this thesis, entitled "**Influence of growth regulator and vegetable picking on seed yield and quality in chilli (*Capsicum annuum* L.)**" is a record of research work done independently by Ms. Ann Napoleon under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to her.

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Dedicated to my beloved parents

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LIST OF ABBREVIATIONS

CD	Critical difference
cm	Centimetre
d.a.a.	Days after anthesis
DAF	Days after flowering
DAS	Days after sowing
et al.	and others
Fig.	Figure
FYM	Farmyard manure
g	Gram
GA	Gibberellic acid
ha	Hectare
kg ha^{-1}	kilogram per hectare
LAD	Leaf area duration
LAI	Leaf area index
m	Metre
mg l^{-1}	Milligram per litre
MH	Maleic hydrazide
NAA	Naphthalene acetic acid
ppm	Parts per million
SE	Standard error of mean
TIBA	Tri ido benzoic acid
VI	Vigour index

INTRODUCTION

1.INTRODUCTION

Vegetables are so common in human diet that a meal without a vegetable is supposed to be incomplete in any part of the world. Vegetables play an important role in human nutrition by providing carbohydrates, proteins, minerals and vitamins. Keeping in view the largest demand of vegetables for domestic consumption and enormous scope of exports, the yield can be increased manifold and there is a possibility of increasing the productivity by 200 to 300 per cent by using advanced technologies.

India is the second largest producer of vegetables in world next to China with a production of 66.5 million tonnes from an area of 5.08 million hectares. But the demand for vegetables in our country is 110 million tonnes. India is the largest producer of chillies contributing to 25 per cent of world's production. It is cultivated in an area of 5.73 lakh ha (Attavar, 2000) with a production of 8.21 lakh tones (Peter, 2000) as per 1997-98 data. The total area under vegetables in Kerala is 15,250 ha and chilli occupies an area of 610 ha (FIB, 1999).

Good seed forms the basic but the cheapest and most remunerative input in any crop production programme. Among the several factors contributing to productivity of vegetables, quality seed constitute the important input. Quality seed alone can assure 25-30 per cent increase in productivity of vegetables in any crop production programme. The present requirement of vegetable seeds in the country is 48,000 tones per annum of which only 20,200 t is supplied by authorized agencies (Prabhakar, 1999). In Kerala the seed requirement is 72 t of which only 20-25 per cent is supplied by authorized agencies (KAU, 1991).

Non availability of quality seeds due to inadequate production is the major constraint in vegetable cultivation in India especially in Kerala. Due to enormous requirement of vegetable seed, the production has to be stepped from the present level to ensure the timely supply of seeds in adequate quantities to the growers. It is a common practice among farmers to sell the best produce and to keep the worst and last formed fruits for seed. Such practices lead to rapid decline in productivity of the crop and quality of produce. Combining vegetable production with seed production may be possible as periodical removal of early formed fruits as vegetable stimulates the growth of the crop and there by increasing the yield capacity.

Recent findings in seed technology have indicated that the use of plant growth regulators as seed treatment in increasing growth and yield of many vegetable crops. Application of these potent chemicals at appropriate concentration requires care and technical knowledge. The possibility of pre-treating the seed before being distributed to the cultivators does not seem to have been explored and hence the present investigation was designed to study the residual effects of NAA at different concentrations.

In addition to all these factors the seed maturity at the time of fruit harvest is an important factor that determines the quality of seed. Harvesting the fruits at optimum stage of physiological maturity not only minimises the loss in vigour and viability but also reduces the damage due to insect and fungal attack. Pre-harvest factors such as degree of seed maturity influence the germinability and vigour which inturn affect the potential longevity of seeds.

Seed position in fruit also have profound influence on seed yield and quality aspects. Seeds formed in varying position of fruit attain physiological maturity based on their seed reserves.

However the scientific information available on these aspects is much limited and hence the present investigation was conducted in chilli with the following objectives.

1. To assess the effect of number of vegetable pickings on fruit yield, seed yield and quality.
2. To study the effect of growth regulators on seed yield and quality.
3. To study the economics of the different treatments
4. To standardise the physiological stages of maturity and seed position in chilli for quality seed production.

REVIEW OF LITERATURE

2. REVIEW OF LITERATURE

Quality seed is the most important input in any cop production programme and it can be achieved by vegetable pickings, use of growth regulators, stage of maturity of fruit at the time of harvest and based on position of seeds in fruit. The available literature on these aspects are reviewed in this section.

2.1. Effect of vegetable picking

Only limited research efforts on the effect of vegetable harvests on seed yield and quality in chillies and hence the information available on other crops are also included.

2.1.1. Effect of vegetable picking on growth characters

Significant influence of vegetable harvests on plant growth has been reported by several authors.

Velumani and Ramaswamy (1980) in an experiment to find out the effect of vegetable harvest on plant height and seed yield in bhindi observed decrease in height of plants when the first formed twelve fruits were harvested as vegetable. Increase in plant height with increasing number of green fruit picking was also reported by Wankhade and Morey (1981) in chilli.

Khan and Jaiswal (1988) reported that green fruit pickings had no effect on the plant height of bhindi. Stunted growth of plant was observed when all the fruits were left to mature for seed purpose without green fruit harvest in bhindi (Garris and Hoffmann, 1946; Shanmughasundaram, 1950; Kolhe and Chavan, 1967; Kamalanathan *et al.*, 1968; Bhuibar *et al.*, 1989)

Nataraj *et al.* (1989) observed that plant height increased with nitrogen level and fresh fruit picking. Sheeba (1995) reported that plant height at 90 DAS varied significantly with vegetable harvests in okra. Bhat and Singh (1997) observed that in okra plant height and number of nodes per plant showed inconsistent trends when two seed harvest was done.

Six vegetable harvest treatment recorded the highest value of plant height which was superior to four, two and zero vegetable harvests in bitter gourd (Devi, 1999). Sindu (2000) observed that in cucumber increase in number of vegetable harvest caused the elongation of vine, number of branches and leaf area index.

In general better plant growth could be observed with vegetable harvesting.

2.1.2. Effect of vegetable harvests on fruit yield and yield attributes

2.1.2.1. Yield of green fruits

Green fruit yield was proportionately high in bhindi when more vegetable harvests were done (Rao, 1953). Grewal *et al.* (1974) reported a linear increase in the number as well as weight of green fruits per plant and a decrease in length of pods with each picking in bhindi.

Bhuibar *et al.* (1989) observed that when 0,1,2,3 and 4 pickings were done, the highest yield of green fruits was obtained with four pickings in bhindi. Cucumber, summer squash, bitter gourd and other cucurbits grown for their immature fruits are more productive if the fruits are harvested frequently and not allowed to become large. Large fruits act as a sink for nutrients and inhibit the development of additional fruits on the plant (Robinson and Decker – Walters, 1997).

Devi (1999) reported that the bearing capacity of bitter gourd plant was imporved by frequent picking of green fruits. Sindu (2000) observed that number and weight of green fruits per plant and green fruit yield were increased significantly by increase in number of vegetable harvest.

2.1.2.2. Yield of mature fruits

Highest number and weight of dried fruits were obtained under no green fruit picking in bhindi by Grewal *et al.* (1974) and Bhuibar *et al.* (1989). Maximum number of dried fruits per plant was observed with three green fruit pickings in bhindi (Pandey *et al.*, 1976).

Khan and Jaiswal (1988) reported that the number and weight of dried fruits per plant were significantly influenced by fruit picking over no picking and the maximum weight and number of fruits were obtained under two pickings in bhindi. Similar results were also obtained by Bhat and Singh (1997) in bhindi. Sheeba (1995) reported highest mature fruit yield when no green fruit picking was done.

According to Devi (1999) ripe fruit yield increased up to two vegetable harvests in bitter gourd and maximum yield for mature fruit was obtained for treatment with two vegetable harvest. Sindu (2000) reported that weight of mature fruits per plant and mature fruit yield showed significant reduction with increase in number of vegetable harvests.

2.1.2.3 Total number of fruits per plant

In bhindi plants in which maximum number of fruits were harvested for vegetable produced more number of fruits (Shanamugahsundaram, 1950). Similar results were reported by Perkins *et al.* (1952), Grewal *et al.* (1974) and Velumani and Ramaswamy (1980). Kolhe and Chavan (1967) concluded that allowing fruits to mature right from the beginning for seed reduced the number of fruits to one third. Tyagi and Khandelwal (1985) observed that three pickings produced higher number of fruits over the control of no fruit picking in bhindi.

Sheeba *et al.* (1998) observed that maximum number of fruits per plant was observed with six picking and this was nearly twice produced under no fruit picking. Sindu (2000) observed that total number of fruits harvested per plant was influenced by number of harvests. Two vegetable harvest recorded highest number of fruits. Thus it is evident that periodical removal of green fruits stimulates fruit production in vegetables.

2.1.3 Effect of vegetable picking on seed characters

2.1.3.1. Number of seeds per fruit

Rode (1979) observed maximum number of seeds per fruit in bhindi plants which were left to mature for seeds without vegetable harvests. Similar results have been obtained in bhindi by Velumani and Ramaswamy (1980), Deshmukhe and Tayde (1986) and Bhuibar *et al.* (1989). Devi (1999) has also reported similar results in bitter gourd.

Wankhade and Morey (1981) reported that in chilli green fruit picking had no significant effect on number of seeds per fruit. The same trend was observed by Khan and Jaiswal (1988) in bhindi. Similar result was reported by Sheeba (1995). Sindu (2000) reported that number of seeds per fruit decreased with increase in number of harvests. Maximum number of seeds per fruit was produced under zero vegetable harvest in salad cucumber.

2.1.3.2. Weight of seeds per fruit

The weight of seeds per fruit was found to be superior with zero or two green fruit pickings compared to four, six, eight, ten and twelve fruit pickings in bhindi. (Velumani and Ramaswamy, 1980). In chilli no significant influence of green fruit picking on the weight of seeds per fruit (Wankhade and Morey, 1981).

Kanwar and Saimbhi (1987) reported that in bhindi the number of mature seeds and seed weight per fruit were highest at 35 days after anthesis. Further delay in harvesting increased the number of damaged seeds and decreased the seed weight per fruit.

Deshmukhe and Tayde (1996) observed lowest seed weight per fruit in bindi plants with no green fruit picking. Naik *et al.* (1996) observed that in chilli the percentage of seeds in the fruit (by weight) was lowest in the first fruit (2.92%) and increased in successive fruits to reach a maximum in the last fruit (5.51%).

Sindu (2000) reported that in cucumber highest weight of seeds per fruit and per plant were recorded from the plant which were left as such without green fruit picking.

2.1.3.3. 1000 seed weight

Grewal *et al.* (1973) observed significantly lower 1000 seed weight in okra plants when three to four green fruit pickings were done. However the same authors observed no appreciable difference in 1000 seed weight due to one or two green fruit pickings. Similar reports on the progressive decrease in seed weight with increase in the number of fruits harvested for vegetable were given by Velumani and Ramaswamy (1980), Khan and Jaiswal (1988) and Bhuibar *et al.* (1989) in okra.

Dharmatti *et al.* (1990) reported that in tomato 1000 seed weight increased over the first four pickings then decreased although the difference were not significant. Sheeba (1995) observed that the effect of vegetable harvest on 1000 seed weight was not significant however two vegetable harvests recorded the highest value in bhindi. Significant influence of vegetable harvest on thousand seed weight in bitter gourd was reported by Devi (1999). Two vegetable harvest recorded the highest value which was on par with zero vegetable harvests. Sindu (2000) reported that in cucumber 1000 seed weight was not influenced by number of harvests.

2.1.3.4. Seed yield

In cucumber, the quantity and quality of seeds were best when seeds were collected from the first formed fruits on the plant. With a rise in number of fruits per plant (ie, greater than 9 to 15 fruit) seed weight tend to decrease but other quality criteria were unaffected. Within the above range seed bearing fruits per mother plant and seed yield from single fruit were not dependent on the number of fruits per plant or on their size (Men'kova, 1974). In bhindi Pandey *et al.* (1976) observed a significant increase in seed yield up to two pickings of fruits and the yield from these green fruit pickings was on par with the control of no fruit picking. Four pickings of fruits significantly reduced seed yield.

In bhindi seed yield was significantly high when the first formed two fruits were harvested as vegetable and this was on par with no green picking (Velumani, 1976). Maksoud *et al.* (1982) observed that picking fruits once at 68 days after transplanting in brinjal increased the seed yield by 40 per cent over control but picking twice decreased the yield by 16 per cent. Duczmal *et al.* (1984) reported that in *Capsicum* highest yields of seeds of good quality was obtained by picking the fruits as they ripened on the plant.

Tyagi and Khandelwal (1985) recorded highest seed yield in okra plants without any green fruit picking. Khan and Jaiswal (1988) also obtained maximum seed yield with two pickings of green fruits followed by one, zero and three pickings in okra. Two green fruit pickings significantly increased the number and weight of dried fruits and seed yield in bhindi. (Singh and Kanwar, 1995).

Sheeba (1995) reported that in bhindi highest seed yield was observed with zero vegetable harvest which was on par with two green fruit pickings. Taya *et al.* (1995) found that fruit thinning 0,1,2,3 or 4 fruits picked per plant decreased the yield of seeds. Maximum yield (10.79 Q/ha) was observed with no fruit thinning. Venkata Reddy *et al.* (1997) reported that retaining 12 fruits per plant gave maximum seed yield in bhindi compared to 6, 8, 10 or all fruits.

Bhat and Singh (1997) observed that two harvests gave the highest value for seed yield and yield components. Devi (1999) reported that in bittergourd seed yields increased significantly up to two vegetable harvests. Sindu (2000) reported that in cucumber maximum seed yield were recorded from plant which were left as such without green fruit picking.

2.1.3.5. Seed quality

Boose (1966) reported that limiting the number of fruits left for seed production is one of the ways of improving the quality of seeds in cucumber. Grewal *et al.* (1973) found that in plants in which no green fruit picking was done gave the highest germination percentage in bhindi.

Seeds from early formed fruits gave a higher germination percentage in cotton (Selvaraj and Ramaswamy, 1976) and in chilli (Murthy, 1979 and Dharmatti and Kulkarni, 1988) Velumani (1976) reported germination to be maximum in fourth picking with decreased values in the previous and subsequent pickings when all fruits were allowed to mature for seed.

Vadivelu *et al.* (1983) has shown that in tomato the field emergence declined from 86 per cent for seeds from first picking to 56 per cent for those of 11^{th} picking. According to Tyagi and Khandelwal (1985) picking of first formed fruits (1,2,3 and 4) in okra for vegetable had no effect on germination percentage. Asokmehta and Ramaskrishnan (1986) reported that seeds of chilli var CO-1 from second and third pickings showed superiority after 12 months of storage. Bhuibar *et al.* (1989) observed a reduction in germination percentage as the number of green fruit pickings increased from one to four in okra.

Dharmatti *et al.* (1990) reported that in tomato first seven pickings were recommended to maximise seed quality. Sreemathi and Dharmalingam (1994) reported that cowpea seeds from early pickings were found better for seed purpose than late pickings. In bhindi germination percentage, 1000 seed weight, 100 seed volume, seed protein and seed moisture content were not significantly influenced by vegetable harvests (Sheeba, 1995). Devi (1999) reported that in bitter gourd germination percentage was not significantly influenced by vegetable harvests, but 100 seed weight was higher for two vegetable harvest treatment which was on par with zero vegetable harvests.

2.1.3.6. Seedling characters

Velumani (1976) observed that the shoot and root length of the seedlings, vigour index and dry weight of seedlings recorded maximum values in the fourth picking with lower values in the previous and subsequent pickings in pure seed crop of bhindi.

Asokmehta and Ramakrishnan (1986) found no significant variation in the root length of chilli seedlings with fruit pickings in two varieties (CO-1 and CO-2) tried, while the shoot length of first three pickings were on par in CO-1, the highest being in third picking. In CO-two also the third picking showed the highest shoot length, this being on par with that of sixth picking. Vigour index in CO-1 was highest in second picking which was on par with that of other picking. The seeds of CO-2 showed the highest vigour index in third picking and the lowest in first picking.

Dharmatti *et al.* (1990) reported that in tomato germination and field emergence percentage decreased from the sixth picking onwards. In bhindi there was no significant difference in the seedling root and shoot length and vigour index when the early formed fruits up to four green fruits were harvested for vegetable compared to no vegetable harvesting (Nataraj *et al.,* 1989).

Sheeba (1995) observed that in bhindi vegetable harvests had significant effect on seedling root and shoot length and vigour index. These parameters were maximum in two vegetable harvests which was significantly superior to four vegetable harvests. Sindu (2000) observed no significant variation on seedling characters by the number of vegetables harvests in cucumber.

2.2 Effect of growth regulators

The role of plant growth regulators in various physiological and biochemical processes in plants is well known. Growth regulators are found to have a profound influence on increasing the fruit and seed yield and also the seed quality parameters on various crops. The available literature on this aspect is reviewed here.

2.2.1 Effect of growth regulators on growth

Nanjappa (1965) studied the effect of GA, IAA, NAA at different concentrations in chilli and reported that foliar spraying of GA 50 ppm increased height of plant and reduced the number of flowers produced subsequent to spraying. Das and Prusty (1972) observed that egg plant seeds treated with 10, 50 or 100 ppm GA_3 advanced germination, increased plant height, internode length and leaf number while the same concentrations of CCC retarded all the above growth parameters.

Singh (1982) observed increase in plant growth with NAA (100 ppm) through increase in height and number of primary and secondary branches per plant in bell pepper. In a study carried out by Maurya and Lal (1987) when roots of seven week old chilli seedlings were dipped in aqueous solution of GA 150 ppm and transplanted, the plants showed maximum plant height (62.66 cm) and seedlings dipped in NAA 50 ppm showed the minimum plant height (51.28 cm).

Doddamani and Panchal (1989) found that in Byadagi chilli (*Capsicum annuum* Linn var. accuminatum) foliar spray of NAA 10 ppm before flowering gave the highest plant height (99.36) and fruit set (29.83%). Krishnamohan *et al.* (1993) reported a LAI value of 0.36 at 45 DAT in chillies sprayed with IAA at 25 ppm during flowering. NAA 40 ppm applied as foliar spray at 40 and 60 DAT resulted in greatest increase in leaf area (Singh *et al.* 1993).

Tomar and Ramagiry (1997) observed that tomato seedlings soaked with GA_3 50ppm for 30 minutes showed significantly greater plant height, number of branches per plant and number of fruits per plant than untreated control.

2.2.2. Effect of growth regulators on fruit yield

Devadasan (1965) reported that in *Capsicum fruitescens* GA applied at 25 ppm or low concentration during flowering stage resulted in increased yield. Maximum yield in chilli was obtained with two foliar sprays of NAA 10 ppm one at 25 DAT and other 50 DAT (Chandra and Shivraj, 1972).

In four cultivars of chilli, Sankeshwari 32, Deglur, Walha and Dharmabad sprayed with NAA (10, 25 or 50 ppm) at full bloom and 20 days later effectively controlled flower drops in all cultivars except Dharmabad and increased yields up to 41 per cent. The optimum concentration noted here was 50 ppm (Mote *et al.*, 1975). Chattopdhyay and Sen (1974) reported an increased fruit set and yield in chilli by foliar application of NAA 50 ppm.

Highest fruit yield was observed in chilli by foliar sprays of GA at 50 mg per litre at fruit setting (Sinha. 1975). Similar results were also observed in chilli by NAA at 10 mg per litre twice (at flowering and five weeks later) (Chandra *et al.*, 1976; Pandita *et al.*, 1980; Yamagar *et al.*, 1986; Patil *et al.*, 1985).

Prasad and Prasad (1977) reported that in tomato best results with regard to yield (1.56 kg per plant) and fruit quality were obtained with NAA at 15 ppm. NAA used as seed treatment and pre-bloom spray increased production of flowers and fruit set (Warade and Singh, 1977, Menon, 1981, Patil and Ballal, 1980). Rao and Rao (1979) reported that in chilli a foliar spray of urea (1 per cent) along with NAA (10 ppm) increased both vegetative growth and yield of fruits.

NAA (10 ppm) was superior to its formulations in improving germination, number of branches and fruit set in four chilli cultivars (Menon, 1981). Desai *et al.* (1987) observed that seeds treated with CCC 600 ppm, and NAA at 10 ppm gave highest germination in sweet pepper. In chilli cv. KAU cluster highest reduction in flower drop were obtained in summer season with triacontanol as Vipul at one milli litre per two litre water and in monsoon season with NAA at 15 ppm (Usha and Peter, 1988).

Mozarkar *et al.* (1991) observed that highest fruit yield was obtained with Pusa early dwarf in tomato by seed treatment with NAA, GA, IAA and IPA. In tomato highest yield was obtained by foliar application of NAA at 20 ppm (Phookan *et al.,* 1991). Lyngdon *et al.* (1992) concluded that highest number of fruit set per plant, number of fruits per plant at harvest, fruit weight and yield per plant were obtained with 75 ppm NAA treatment.

Sharma *et al.* (1992) found that significant increase in yield was obtained with whole plant sprays of 50 ppm NAA or seed treatment with 100 ppm GA_3 in brinjal. In chilli high fruit yields were observed following treatment with NAA at 40 ppm or 2,4-D at 1 ppm and produced 89.6 and 97.2 Q/ha respectively (Singh and Lal, 1995). Vijayarghavan (1999) reported that in bhindi seed treatment of GA 50 ppm recorded the highest germination percentage, total dry matter production, number of fruits per plant and yield of fruits.

2.2.3. Effect of growth regulators on seed yield and quality

Beneficial effect of growth regulators have been reported in seed production of tomato, red pepper, egg plant, cauliflower and various cucurbits.

The use of plant growth regulator in vegetable seed production has been reviewed by Mangal *et al.* (1980). Ethephon at 250 mg/l sprayed at flowering and full bloom stages increased the seed yield in cauliflower variety Snowball-16(Sinha, 1974). Singh *et al.* (1975) reported that in *Cucurbita pepo* significantly higher seed yields were obtained by the application of 150 ppm ethrel at the time of initiation of primary floral stalks. Other parameters like number of seeds per siliqua, seed yield per plant and germination percentage were also highest for this treatment.

Suryanarayana and Araffuddin (1978) reported that treatment of okra seeds with GA at 150 ppm concentration resulted in the higher percentage of seed germination and highest pod yield. GA at 25-50 mg/l improved seed yield but delayed maturity in cauliflower (Mangal *et al.*, 1980). Mahmoud (1982) reported highest seed yields from sweet pepper plants treated with 600 ppm ethephon in early growth stages.

IAA and GA (10 mg/l) gave the best seed yields in pea when compared to the untreated control (Dawale, 1983). In chillies Hariharan and Unnikrishnan (1983) reported that seed soaking with NAA (30 and 50 ppm)for 4-5 days produced larger fruit with more number of seeds but 70 ppm did not produce any effect.

Edelstein *et al.* (1985) found that in *Cucurbita pepo* application of 500-600ppm of ethephon at two, four and six leaf stages and again about a month later at fruit set resulted in significantly higher seed yield but germination percentage was unaffected. Kene *et al.* (1995) reported that in sunflower highest seed yield, 100 seed weight were obtained by presoaking the seeds with GA at 20 ppm.

In sunflower foliar application of GA at 15 and 30 ppm resulted in significantly higher seed weight and seed yield per hectare at flowering stage (Kene *et al.*, 1995 a).

Singh and Lal (1995) found that in chilli higher seed yields were observed in Pant C-1 following treatment with NAA at 20 ppm and in Pusa Jwala following treatment with 2,4-D at 1 ppm (58.5 and 57.5 gram per plant respectively). Application of TIBA increased leaf area index, dry matter and seed yield per hectare with concentrations up to 600 ppm at 60, 80 and 100 DAS in safflower (Deotale *et al.*, 1996). Si Ya Ping *et al.* (1996) observed that in brinjal presowing treatment of aubergine seeds with gibberellins improved seed vigour and germination rate.

Aged seeds of okra when soaked in 50 or 100 ppm GA_3 for 24h significantly increased the seed yield and seeds per fruit. Seed yield increased from 8.23 to 18 per cent (Kumar *et al.*,1996). Bhople *et al.* (1998) obtained that GA or NAA at 50, 75 or 100 ppm obtained highest seed yield, 1000 seed weight and percentage germination by spraying plants with 100 ppm NAA as bolting began in radish. Gedam *et al.* (1998) observed that in bittergourd fruit maturity was earliest in plants treated with 50 ppm NAA or 4 ppm boron, fruit and seed yields were also highest in these treatments.

Singh *et al.* (1999) observed that treatment of okra seeds with 150 ppm GA_3 and 20 ppm NAA applied by seed soaking increased seed yield by 66.4 and 55 per cent respectively. Vijayaraghavan (1999) obtained highest germination and seedling establishment with 50 ppm GA_3 in okra.

2.3 Studies on physiological maturity of seeds

One of the most important factors contributing to crop production per unit of land is the use of good quality seeds. According to Helmer *et al.* (1962) seeds attain maximum quality at their physiological maturity. Harvesting at this optimum stage of maturity not only minimise the loss in viability and vigour of the seeds but also protect the seeds from field damages due to adverse environmental conditions as well as from insects and fungus.

2.3.1. Seed characters based on maturity

Odland (1937) revealed that if the fruits of cucurbits were allowed to remain on the vine until over ripe, the seed will germinate promptly but if the fruits were picked at ripe stage the germination could be delayed for several weeks. According to Garris and Hoffmann (1946) and Mc Alister (1943) prolonged field exposure after the stage of maturity would result in losses in germinability, longevity and vigour of seedling.

Usually physiological maturity reached on the plant when no further increase in dry weight occurs (Austin, 1972). According to Nassar *et al.* (1972) mature red fruits of *Capsicum* provided the most viable seeds of best quality. Seed development and maturation refers to the morphological, physiological and functional changes that occur from the time of fertilization until the mature seeds are ready for harvest (Delouche, 1973). Quagliotti (1977) observed that the seeds collected from fruits of pepper cvs Corno di bue and Di Cuveo at three stages of ripeness (green, market ripe and physiologically ripe) germination was best with seeds from physiologically ripened fruits. Number of seeds per fruit and weight per 100 seeds were lower with green fruits than with others.

Studies conducted at TNAU have shown that physiological maturity of seed was obtained at 60 d.a.a. in ribbedgourd and 27 d.a.a. in bittergourd (Varatharaj, 1979). Lysenko and Butkevich (1980) reported that in *Capsicum* cultivars Podrak Moldovy and Gogoshary mestnge, reddening of fruit which occurs about 50 days after flowering was established as marking the beginning of fruit biological maturation and seed germination was optimal at this stage of fruit maturity.

According to Pereira *et al.* (1982) egg plant fruits should be harvested 80 d.a.a. for high quality seeds. Metha (1983) reported that in chilli, physiological maturity of seed was attained at 48 d.a.a. and seeds from fruits harvested before attaining physiological maturity after storage for twelve months possessed relatively low germination and field emergence potential and produced seedlings with poor growth and vigour.

Vadivelu (1985) observed that in tomato cultivars CO-1 and CO-2, the seeds obtained from fully mature fruits with red skin recorded the highest value ie. 93 per cent. Ashokmehta and Ramakrishnan, (1986) observed that seeds of chilli variety CO-1 harvested with reduced moisture contents on the 48th day and at subsequent periodic intervals up to 120 days after anthesis could remain highly germinable and vigorous as they possessed well mature and sound embryos and endosperm with sufficient nutrient resources, enzymes, vitamins and organelles.

According to Dharmatti and Kulkarni (1988) fruits of bell pepper cultivar California Wonder harvested 52 d.a.a. have the highest germination. Edward and Sundstorm (1987) reported that seeds extracted from red fruits had a significantly greater germination rate and final germination percentage than seeds from orange fruits in *Capsicum fruitescens*.

Doijode (1988,a) studied about the seed viability and seedling vigour in relation to five stages (immature green, mature green, breaker, ripe and over ripe) of fruit maturity in chilli cultivar Pant C – 1 and Bydagi local, seeds harvested at the ripe (fourth) fruit stage showed high germination capacity and seedling vigour. Jayabharathi *et al.* (1990) reported that brinjal fruits should be harvested at full yellow stage for maximum seed yield, germination and vigour parameters. Harvesting the fruits prior to this stage was found to record low yield and quality of seeds.

Choudhari *et al.* (1992) found that in tomato percentage germination, 100 seed weight, seedling height and vigour index increased with fruit maturity and were highest for seeds extracted from fruits at the red ripe stage. Katiyar and Dubey (1992) reported superior values for root and shoot length, total seedling growth and vigour index with seeds stored from harvest at physiological maturity in chickpea. Demir and Ellis (1992, a) observed that in *Capsicum annuum* cv California Wonder mass maturity (defined as the end of seed filling phase) occurred 49-53 d.a.a. when seed moisture content was 51-53 per cent. According to Sanchez *et al.* (1993) seeds from red (50 d.a.a.) and over mature red fruits of (60 d.a.a) capsicum cultivars Calwonder, Resistant giant No. 4, VR 2 and Yolo Wonder generally had greater dry weight and higher germination percentage than seeds from less mature fruits. According to Barbedo *et al.* (1994) observed that seeds from fruits harvested at full red stage recorded highest mean germination, field emergence, seedling root and shoot length and vigour index.

Rodriguez *et al.* (1994) harvested the fruits of *Capsicum* cultivar Jarocho at 40-45 days (green) 55-60 days (green-red) or 80-85 days (red) after flowering and the seeds were extracted in each case 1, 10 or 20 days after harvest. The green-red and the red fruits gave the highest percentage of good quality seeds (93-96%) on three extraction dates. The best germination was obtained in seeds from green-red fruits extracted 10 days after harvest (92 & 94% respectively).

Demir (1995) reported that maximum seed quality assessed as germination and emergence percentage was recorded in okra pods harvested 52 d.a.a. and delaying harvest to 59 d.a.a. resulted in marked seed loss by shattering. Naik *et al.* (1996) found that in *Capsicum* the seed yield per fruit, 1000 seed weight, germination percentage, root and shoot lengths and seedling dry weight were highest for seeds collected from fully mature shrinking fruits. Kannath (1996)studied the seed quality parameters in ash gourd cv. BH –21 and it was observed that seeds attained maximum dry weight, seed germination and vigour at 70 d.a.a.

Studies on seed quality parameters in okra cv. Arka Anamika showed that seeds attained physiological maturity at 36 d.a.a. and the germination percentage, vigour index, speed of germination, root length and shoot length were maximum at this stage (Anitha,1997). Liji (1998) observed that optimum stage of harvest for seed purpose of chilli var Jwalasakhi is at 45-50 d.a.a. Rakeshseth *et al.* (1999) observed that in fodder cowpea the maximum germination percent and seed weight occurred at 17 d.a.a. which coincides with the physiological maturity. Sindu (2000) observed that seed viability, germination percentage and speed of germination increased steadily with the advancement of days of harvest recording maximum values at 45 DAF in cucumber .

2.3.2. Seed characters based on position

The position of the seed within the fruit exert a great influence on the quality of seed in vegetable crops. Slobodjanik (1950) reported that the tomato seeds from the lower half of the fruit were larger and denser and gave rise to more productive plants than those from upper half. Chauhan and Bhandari (1971) observed difference in germination from apical, middle and basal portions of fruits in bhindi.

Abdol and Shivashankar (1980) observed that in maize cob the seeds from bottom portion of cob exhibited higher germination percentage followed by middle and top although difference were not statistically significant. Varis and George (1987) observed that in tomato cv. Moneymaker there was no marked effects of fruits position on the germination and seedling vigour of seeds. In brinjal cv. Arka Neelkant the seeds located in the middle of the fruit ie, leaving the first and last quarter may be chosen for quality seeds (Naik *et al.,* 1987). Dharmalingam *et al.* (1988) observed that in coffee significant differences were noticed in vigour index due to different position of seeds. Seeds collected from lower one third tier recorded the maximum value followed by middle one third and top one third tiers.

Doijode (1990) observed that chilli seeds from basal region of fruit exhibited higher germination and seedling vigour than those from tip and middle postion of fruit. Sreemathi and Ramaswamy (1992) reported that the seed size, weight, germination and vigour of seeds collected from the distal and other portions of cowpea pods did not vary widely excepting the reduced vigour of seedlings of small sized seeds. The distal end seeds recorded the higher germination and lower vigour compared to others.

Muthuswamy and Thangavelu (1993) observed that in sesamum seed weight per capsule in different position namely lower, middle and top capsules in the central axis differed significantly. The seed yield in the top most position was significantly lower indicating that it had not matured completely. The seeds of bitter gourd collected from the proximal one third position registered higher seed weight, germination percentage, shoot length and hundred embryo weight. The seeds from the distal one third portion was of poor quality which was due to the poor seed development (Vijakumar *et al.*, 1994).

Shekhargouda *et al.* (1997) observed that seeds from different concentric whorls in sunflower cv. Ec 68414 differed significantly in quality. The outer 17 whorls produced more filled seeds with higher seed weight and density whereas inner whorls contained more shrivelled seeds. Devi (1999) observed that germination percentage, seedling root length and vigour index were significantly influenced by different seed position in bittergourd fruit. Seeds from the middle portion recorded the highest and seeds from the proximal end position the lowest values. Doijode (2000) reported that in brinjal especially long fruited cultivars it is advantageous to select seeds from basal portion of fruit for getting higher viability and vigour during ambient storage conditions.

MATERIALS AND METHODS

3. MATERIALS AND METHODS

The present investigation was conducted at College of Agriculture, Vellayani during the period from 18-12-2000 to 29-3-2001 for assessing the effect of periodical harvest and growth regulator on seed yield, quality and vigour of chilli seed and for standardizing the physiological stage of maturity of the seed. Two experiments were conducted with the following objectives.

1. To study the influence of growth regulator and vegetable picking on seed yield and quality.

2. Standardisation of physiological maturity stage.

The details of the materials used and methods adopted are present in this chapter.

3.1 Materials

3.1.1. Experimental site

The experiment was conducted at the instructional farm attached to College of Agriculture, Vellayani situated at 8.5^0 N latitude, 76.9^0 E longitude and at an altitude of 29 m above mean sea level.

3.1.2. Soil

The soil of the experimental site was sandy clay loam, belonging to the taxonomical order oxisol. The physico chemical properities of the experimental site are presented in table-1.

Table 1:- Physico – chemical properties of soil

A Physical composition

Sl. No.	Parameter	Content (%)	Methods used
1.	Coarse sand	36.35	Bouyoucos
2.	Fine sand	15.00	Hydrometer method
3.	Silt	17.50	(Bouyoucos, 1962)
4.	Clay	30.50	

B. Chemical composition

Sl. No.	Parameter	Content	Ranking	Methods used
1.	Available N (kg ha^{-1})	23.8	Low	Alkaline permanganate method (Subbiah and Asija, 1956)
2.	Available P_2O_5(kg ha^{-1})	32.8	Medium	Bray Colorimetric method (Jackson, 1973)
3.	Available k_2O (kg ha^{-1})	160	Medium	Ammonium acetate (Jackson, 1973)
4.	Organic Carbon (per cent)	1.7		Walkley & Black rapid titration method (Jackson, 1973)
5.	Soil reaction (pH)	4.8	Acidic	1:2:5 Soil solution ratio using pH meter with glass electrode (Jackson, 1973)

3.1.3. Cropping history of the field

The experimental area was under a bulk crop of vegetable cowpea prior to the lay out of the experiment.

3.1.4. Season

The experiment was conducted during December to March of 2000-2001.

3.1.5. Weather parameters

The weekly averages of temperature, relative humidity and weekly total of rainfall during cropping period collected from the meteorological observatory at the College of Agriculture are presented in Appendix-I and Fig-1.

3.1.6. Variety

The variety used was Jwalasakhi, a newly released high yielding variety of vegetable chilli evolved by Kerala Agricultural University by crossing Vellanotchi, a popular local cultivar of south Kerala with Pusa Jwala. It has got high yield potential, ideal for culinary purpose and suited for high density planting.

3.1.7. Seed

The seed material was obtained from Instructional Farm, College of Agriculture, Vellayani.

3.1.8. Growth regulator

NAA (98.5 per cent) which is chemically 2- Naphthalene acetic acid was used for the experiment.

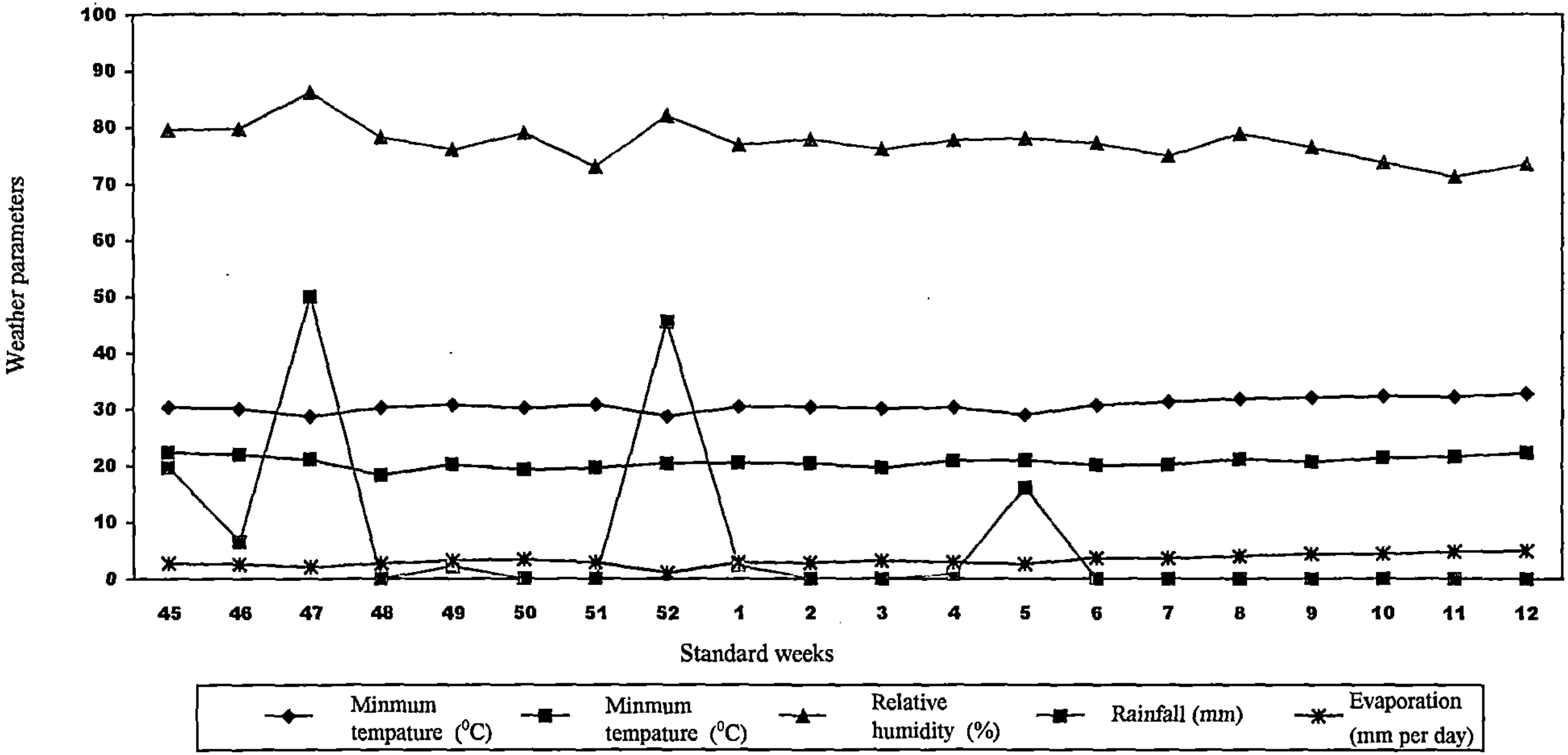


Fig. 1. Weather parameters during the cropping period (November 2000 to March 2001)

3.1.9. Manures and Fertilizers

FYM (0.4 per cent N; 0.2 per cent P; 0.3 per cent K) was used as the organic manure. Urea (46 per cent N), mussorie rock phosphate (20 per cent P_2O_5) and muriate of potash (60 per cent k_2O) were used as the source of inorganic fertilizers.

3.2. Methods

3.2.1. Design and Lay out

3.2.1.1. Experiment – I

The field experiment was laid out in strip plot design. The lay out of the experiment is given in Fig. 2. The experimental details are given below.

3.2.1.1.1. Treatments

The treatments consisted of combinations of varying number of vegetable pickings and different concentrations of growth regulator.

A – Vegetable pickings

h_0 – Zero vegetable harvest (entire crop left for seed collection)

h_1 – First two vegetable harvest and the rest for seed collection

h_2 – First two seed harvest and rest for vegetable harvest.

B. Levels of NAA (ppm)

g_0 – 0 ppm

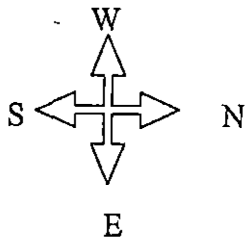
g_1 – 30 ppm

g_2 – 50 ppm

g_3 – 70 ppm

Seed soaking for three hours

Fig. 2 Lay out of Experiment I



Replication I

h_1g_1	h_1g_3	h_1g_0	h_1g_2
h_2g_1	h_2g_3	h_2g_0	h_2g_2
h_0g_1	h_0g_3	h_0g_0	h_0g_2

Replication II

h_1g_3	h_1g_0	fuh_1g_2	h_1g_1
h_0g_3	h_0g_0	h_0g_2	h_0g_1
h_2g_3	h_2g_0	h_2g_2	h_2g_1

Replication III

h_0g_1	h_0g_2	h_0g_0	h_0g_3
h_2g_1	h_2g_2	h_2g_0	h_2g_3
h_1g_1	h_1g_2	h_1g_0	h_1g_3

3.2.1.1..2. Treatment combinations

$T_1 : h_0g_0$	$T_7: h_1 g_2$
$T_2 : h_0g_1$	$T_8: h_1 g_3$
$T_3 : h_0g_2$	$T_9: h_2 g_0$
$T_4 : h_0g_3$	$T_{10}: h_2 g_1$
$T_5 : h_1g_0$	$T_{11}: h_2 g_2$
$T_6 : h_1g_1$	$T_{12}: h_2 g_3$

Number or treatment combinations	=12
Number of replications	= 3
Total number of plots	=36
Gross plot size	=3.15 x 3.15 m
Net plot size	=2.7 x 2.7 m
Spacing	= 45 x 45 cm

3.2.1.2 Experiment – II

The experiment was laid out as a factorial experiment in Randomised Block Design. The layout of the experiment is shown in Fig. 3 The experimental details are given below.

3.2.1.2.1 Treatments

A : Seed harvesting stages

s_1 : Mature green stage

s_2 : Colour breaker stage

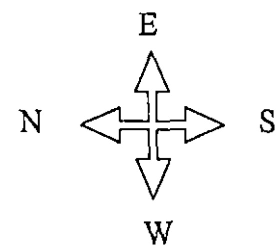
s_3 : Fully red ripe stage

B. Position of seeds

p_1: Bottom portion

p_2: Top portion

Fig. 3 Layout of Experiment II



s_3p_2	s_2p_1	s_1p_2
s_1p_1	s_1p_2	s_3p_2
s_1p_2	s_1p_1	s_2p_2
s_2p_2	s_2p_2	s_3p_1
s_2p_1	s_3p_1	s_1p_1
s_3p_1	s_3p_2	s_2p_1
⟺ R_1	⟺ R_2	⟺ R_3

3.2.1.2.2. Treatment combinations

$T_1 : s_1 p_1$

$T_2 : s_1 p_2$

$T_3 : s_2 p_1$

$T_4 : s_2 p_2$

$T_5 : s_3 p_1$

$T_6 : s_3 p_2$

Number of replications	= 3
Total number of plots	= 18
Spacing	= 45 x 45 cm
Gross plot size	= 3.15 x 3.15 m
Net plot size	= 2.7 x 2.7 m

3.2.2. Cultural operation

3.2.2.1. Seed soaking

Growth regulator (NAA) of various concentrations ie, 30, 50, and 70 ppm along with control (water soaked) were prepared and chilli seeds 50g each were soaked in above solutions. Time of soaking was three hours and later they were dried and broadcasted.

3.2.2.2. Nursery

Seeds were sown in well prepared nursery beds of 1.2m width and 15 cm height with channels around them to facilitate the drainage. The seeds were sown on 8-11-2000. The seedlings were irrigated everyday. Hand weeding and plant protection measures were undertaken periodically as per the package of practices recommendations. The seedlings were ready for transplanting in 42nd day.

3.2.2.3. Field culture

The main field was ploughed, clods broken, cleared off stubbles and plots were laid out with bunds of 30 cm width all round. Individual plots were again dug and perfectly levelled. Ridges and furrows were formed 45 cm apart. Well decomposed FYM was applied at the time of land preparation and mixed well with the soil.

3.2.2.4. Application of manures and fertilizers

The manures and fertilizers were applied as per package of practices recommendations of KAU (KAU, 1996) and the recommended management practices were adopted uniformly to all the treatments.

3.2.2.5. Transplanting

The seedlings were ready for transplanting in 42^{nd} day. They were pulled out and kept in trays. Planting was done at a spacing of 45 x 45 cm. Plants were given uniform irrigation. Nursery shade was also provided for the first four days after planting using coconut fronds.

3.2.2.6. After cultivation

Gap filling was done with healthy seedlings. Regular irrigation and weeding were carried out.

3.2.2.7. Plant protection

Ekalux was sprayed against grass hopper. As a prophylatic measure against leaf curl, Rogor was sprayed repeatedly at 14 days interval for getting satisfactory fruit and seed yield.

3.2.2.8. Harvesting

The crop was ready for first harvest 55 days after transplanting and subsequently harvests were made at an interval of seven days for vegetable picking and ten days for seed purpose. The green fruits were harvested at vegetable maturity stage as judged by visual observations. The ripe fruits were harvested when the fruit colour turned red.

For second experiment fruits were harvested according to the treatment at mature green, colour breaker and fully red ripe stage and seed extraction was done from the bottom and top portions of the fruits respectively.

3.2.3. Observations recorded

Five plants per plot were selected for the purpose of taking observations – parameters considered and methods followed are briefly stated below.

3.2.3.1. Growth characters

This observation was taken from five plants at random in each plot after eliminating border rows. The height of the plants was measured from the base to the growing tip of the plants at three stages viz, 30, 60, and 90 DAT. The mean plant heights were worked out and expressed in cm.

3.2.3.1.2. Number of branches per plant

The total number of branches per plant at three growth stages viz. 30, 60 and 90 DAT were recorded from five observational plants and mean values recorded.

3.2.3.1.3. Canopy spread (E-W and N-S)

The canopy spread was measured as the maximum lateral diameter through the main stem of each plant both in east-west and north-south direction and expressed in cm.

3.2.3.1.4. Leaf area index (LAI)

LAI was worked out at three stages ie, 30, 60 and 90 DAT and expressed in square centimeter. LAI was worked out using the equation given by Watson (1952).

$$\text{Leaf area index} = \frac{\text{Total leaf area}}{\text{Land area}}$$

3.2.3.1.5. Leaf area duration (LAD)

LAD was calculated using the formula given by Power et al. (1967)

$$\text{LAD} = \frac{Li + (Li + 1) \times (t_2 - t_1)}{2}$$

Li = LAI at first stage

Li + 1 = LAI at second stage

t_2 - t_1 = Time interval between these stages

3.2.3.1.6. Date of 50 per cent flowering

Total number of days taken for 50 per cent of the plant population to flower in each treatment was recorded.

3.2.3.1.7. Setting percentage

This was calculated by dividing the total number of fruits formed on the plant with the total number of flowers produced in the same plant and it was worked out in five observational plants in each plot.

3.2.3.2. Yield observations

3.2.3.2.1. Number of green fruits per plant

From the total number of fruits harvested as vegetable from the observational plants, the per plant fruit number was calculated.

3.2.3.2.2. Length and breadth of fruits (cm)

Length of randomly selected 10 fruits were measured with twine and scale and mean worked out and expressed in cm. Fruits used for measuring length were used for recording the girth also. It was measured at the broadest part of fruits and expressed in cm.

3.2.3.2.3. Weight of green fruits per plant

The weight of green fruits obtained from the observational plants were recorded at each harvest. The total weight of fruits per plant from the vegetable harvests was worked out and the mean calculated.

3.2.3.2.4. Mature fruit yield

The total weight of mature fruits obtained from the net plot area was recorded and yield in kg ha^{-1} was computed.

3.2.3.2.5. Total number of fruits harvested per plant

The total number of fruits harvested from the observational plants were calculated at the end of the cropping season and the mean recorded

3.2.3.2.6. Shelf life of fruit

The fruits collected from different treatments were kept under ambient conditions and the days up to which quality was maintained without deterioration ie, change in colour, shrinkage, microbial growth etc were recorded.

3.2.3.3. Seed characters

3.2.3.3.1. Number of seeds per fruit

Seeds from the fruits of observational plants were collected, the number of seeds were counted and seed number per fruit was calculated.

3.2.3.3.2. Weight of seeds per fruit

The fruits used to record the number of seeds per fruit were used for noting the weight of seeds per fruit. The weight of seed from each fruit was recorded and the mean worked out.

3.2.3.3.3. Fruit to seed ratio

The fruit to seed ratio was worked out at each harvest by dividing the weight of all fruits from observational plants with the weight of seeds of the respective fruits and the mean worked out.

3.2.3.3.4. 1000 seed weight

100 seeds were counted at random from the observational plants and weighed. These values were multiplied by 10 to obtain the 1000 seed weight and expressed in gram.

3.2.3.3.5. Seed yield per hectare

The total weight of seeds from the net plot area was calculated at the end of the cropping season and the yield in kg ha^{-1} computed.

3.2.3.3.6. Germination percentage

Pure seed fraction of the different treatments were tested for germination. Sixty seeds per treatment were sown on Whatman paper in petridishes of nine cm size. The paper was kept moist until the final count was taken on the 14^{th} day. The number of seeds germinated were counted on the last day and the percentage worked out.

3.2.3.3.7. Seedling shoot length

Twenty seeds collected at random from each treatment were sown in germination trays with sand as the medium. The seeds were allowed to sprout with daily watering and after 14^{th} day they were uprooted and the length of shoots were measured from the collar region to the base of terminal bud, the mean worked out and expressed in cm.

3.2.3.3.8. Seedling root length

The seedlings used for measuring shoot length were used for this purpose also. The root length was measured from the collar region to the root tip. The average was worked out and recorded in cm.

3.2.3.3.9. Vigour index of Seedling

Seedling vigour index (VI) was calculated by adopting the formula suggested by Abdul – baki and Anderson (1973) and expressed as a number.

$$VI = \text{Germination percent} \times (\text{Root length} + \text{shoot length})$$

The data recorded on observations 3.2.3.3.6., 3.2.3.3.7. and 3.2.3.3.8. were used for the purpose. The mean was calculated and expressed as seedling vigour.

3.2.3.3.10. Speed of germination

From the samples kept for determination of shoot and root length, the number seedlings emerged was recorded daily until the final count (14 days after sowing). The speed of germination was then calculated by adding the quotients of the daily count divided by the number of days of germination.

3.2.3.3.11. Seedling dry weight

The seedling used to measure root and shoot length were dried at 105^0 C in air oven for 17 ± 1 hours and the dry weight was noted. The mean dry weight was worked out and expressed as mg per seedling.

3.2.3.3.12. Seed viability

Seed viability test was done using Topographical Tetrazolium Chloride method. Twenty seeds of each treatment were pre-conditioned by soaking in water for 12h, dissected longitudinally through the embryo and then kept in 0.1 percent colourless tetrazolium chloride solution. Living tissues attained a red stain in tetrazolium solution indicating the viability of seeds.

3.2.4. Economics of cultivation

The economics of cultivation was worked out based on the various input costs.

$$\text{Net income (Rs ha}^{-1}\text{)} = \text{Gross income} - \text{cost of cultivation}$$

$$\text{Benefit : cost ratio} = \frac{\text{Gross income}}{\text{Cost of cultivation}}$$

3.2.5. Statistical analysis

The data generated from the experiment were subjected to Analysis of Variance (ANOVA) technique as applied to strip plot design (Cochran and Cox, 1965) for experiment I and ANOVA technique as applied to RBD for experiment II. When effects were found to be significant, critical differences were calculated for effecting comparison among treatments.

RESULTS

4. RESULTS

The present investigation entitled "Influence of growth regulator and vegetable picking on seed yield, quality and vigour in chilli" was conducted to study the effect of growth regulator and vegetable picking on seed yield and quality of chilli fruits. The study also aimed at standardising the stage of physiological maturity and seed position. The study was conducted as two seperate experiments. The results obtained are presented under the following sections.

4.1. Experiment-I

Influence of growth regulator and vegetable picking on seed yield, quality and vigour in chilli.

4.1.1. Growth characters

The influence of growth regulator, vegetable picking and their interactions on various growth characters are presented in tables 4.1.1.1 to 4.1.1.5.

4.1.1.1. Plant height

Plant height at 30 DAT was highest in plants with vegetable harvests. Height of the plant was maximum (15.57 cm) in h_2 (first two seed harvest and then vegetable) which was significantly superior to h_0 (zero vegetable harvest) but was on par with h_1 (first two vegetable harvest and rest for seed).

Growth regulator had no significant influence on plant height at 30 DAT.

The interaction H x G was not significant.

Height of the plant at 60 DAT was maximum in h_2 (33.78 cm) when more number of vegetable harvest were done which was significantly superior to h_0 (3078 cm) and was on par with h_1(32.63 cm).

Table. 4.1.1.1.a Average main effect of vegetable pickings and growth regulator on plant height.

Treatments	Plant height (cm)		
	30 DAT	60 DAT	90 DAT
h_0	14.28	30.78	41.40
h_1	14.96	32.63	43.16
h_2	15.57	33.78	43.04
$F_{2,4}$	162.23*	9.50*	67.12**
SE	0.16	0.49	0.12
CD	0.630	1.922	0.47
g_0	15.33	33.38	43.84
g_1	15.01	32.76	42.72
g_2	14.83	32.04	42.21
g_3	14.56	31.41	41.36
$F_{3,6}$	4.03^{ns}	7.55*	60.31**
SE	0.16	0.31	0.13
CD	-	1.075	0.463

** - Significant at 1 per cent level
* - Significant at 5 per cent level
ns - Not significant

Table. 4.1.1.1.b Interaction effect of vegetable pickings and growth regulator on plant height.

Treatments	Plant height (cm)		
	30 DAT	60 DAT	90 DAT
h_0g_0	14.60	31.87	42.17
h_0g_1	14.33	31.27	41.70
h_0g_2	14.13	30.33	41.37
h_0g_3	14.03	29.67	40.37
h_1g_0	15.30	33.27	44.33
h_1g_1	15.13	32.7	43.13
h_1g_2	15.0	32.33	42.93
h_1g_3	14.4	32.23	42.23
h_2g_0	16.1	35.0	45.03
h_2g_1	15.57	34.30	43.33
h_2g_2	15.37	33.47	42.33
h_2g_3	15.23	32.33	41.47
$F_{6,12}$	0.16^{ns}	0.39^{ns}	0.79^{ns}
SE	0.11	0.62	0.53

ns - not significant

Growth regulator caused reduction in height of plants. Maximum plant height (33.38 cm) was recorded in g_0 (0 ppm) and it was significantly superior to g_2 (50 ppm) and g_3 (70 ppm) but was on par with g_1 (30 ppm) at 60 DAT.

The interaction effect of harvest and growth regulator was not significant. Maximum plant height (43.16 cm) at 90 DAT was recorded in treatment h_1 (first two vegetable harvest and rest for seed purpose) and was significantly superior to h_0 (41.4 cm) but was on par with h_2 (43.04 cm). There was no significant difference in plant height at harvests mentioned in h_1 and h_2 but significant increase is observed in comparison with h_0.

Increasing growth regulator concentration reduced plant height. Maximum plant height (43.84 cm) at 90 DAT was recorded in g_0 (0 ppm) which was significantly superior to g_3 (70 ppm), g_2 (50 ppm) and g_1 (30 ppm).

Interaction effect of H x G was not significant at 30, 60 and 90 DAT.

4.1.1.2. Number of branches per plant

Vegetable picking had no significant influence on number of branches per plant at any stages of the crop growth.

Growth regulator showed significant influence on number of branches only at 60 DAT. Growth regulator applied at 70 ppm (g_3) recorded the highest number (13.89) and was found significantly superior to those recorded at zero ppm (11.0) but on par with those registered at 30 ppm (g_1) and 50 ppm (g_2).

H x G interaction was not significant in all above cases.

4.1.1.3 Canopy spread (E-W and N-S)

Main effect of vegetable picking and growth regulator had no significant influence on canopy spread in both directions.

Interaction H x G was also not significant.

4.1.1.4. Leaf area index

Vegetable picking had no significant influence on LAI at any of the growth stages.

Application of growth regulator caused a significant increase in LAI both at 30 DAT and 90 DAT.

At 30 DAT highest LAI value of 0.18 was recorded by g_2 (50 ppm) which was significantly superior to g_1 (30 ppm) but on par with g_o and g_3.

But at 90 DAT highest LAI value of 0.81 was recorded by 30 ppm growth regulator (g_1) and was significantly superior to 0 ppm (g_0) but on par with g_2 and g_3.

Significantl interaction effect of vegetable picking and growth regulator on LAI was observed at 90 DAT. The highest LAI value of 0.86 was observed in h_2g_3 which was significantly superior to h_2 g_0 but on par with all other combinations.

4.1.1.5. Leaf area duration (First and Second stage)

Leaf area duration was not significantly influenced by the treatments.

4.1.1.6. Date of 50 per cent flowering

Either the vegetable picking or the growth regulator had no significant influence on date of 50 per cent flowering. Interaction effect was also absent.

Table. 4.1.1.2.a Main effect of vegetable pickings and growth regulator on number of branches per plant.

Treatments	Number of branches per plant		
	30 DAT	60 DAT	90 DAT
h_o	3.08	11.67	21.25
h_1	3.42	13.75	22.67
h_2	3.33	13.0	21.67
$F_{2,4}$	1.31 ^{ns}	2.13 ^{ns}	1.26 ^{ns}
SE	0.15	0.72	0.65
g_0	3.0	11.0	20.56
g_1	3.0	12.67	20.56
g_2	3.79	13.67	23.0
g_3	3.33	13.89	23.3
$F_{3,6}$	2.9 ^{ns}	7.48 **	4.12 ^{ns}
SE	0.21	0.48	0.75
CD	-	1.664	-

** - significant at 1 per cent level
ns - not significant

Table. 4.1.1.2.b Interaction effect of vegetable pickings and growth regulator on number of branches per plant.

Treatments	Number of branches per plant		
	30 DAT	60 DAT	90 DAT
h_0g_0	3.33	10.33	20.0
h_0g_1	2.67	13.0	20.33
h_0g_2	3.0	11.0	22.33
h_0g_3	3.33	12.33	22.33
h_1g_0	2.67	11.3	23.0
h_1g_1	3.33	12.33	21.0
h_1g_2	4.0	16.0	23.3
h_1g_3	3.67	15.33	23.3
h_2g_0	3.0	11.33	18.67
h_2g_1	3.0	12.67	20.33
h_2g_2	4.33	14.0	23.33
h_2g_3	3.0	14.0	24.33
$F_{6,12}$	0.96^{ns}	2.11^{ns}	1.17^{ns}
SE	0.49	0.85	1.11

ns – not significant

Table. 4.1.1.3.a Average main effect of vegetable pickings and growth regulator on canopy spread.

Treatments	Canopy spread	
	E-W (cm)	N-S (cm)
h_o	11.35	10.89
h_1	12.12	12.58
h_2	11.42	10.58
$F_{2,4}$	0.70^{ns}	2.43^{ns}
SE	0.51	0.43
g_0	11.02	11.08
g_1	11.73	12.04
g_2	11.44	10.43
g_3	12.31	11.84
$F_{3,6}$	1.19^{ns}	1.50^{ns}
SE	0.50	0.60

ns – Not significant

Table. 4.1.1.3.b Interaction effect of vegetable pickings and growth regulator on canopy spread.

Treatments	Canopy spread	
	E-W (cm)	N-S (cm)
h_0g_0	11.13	10.5
h_0g_1	11.07	12.43
h_0g_2	10.2	9.03
h_0g_3	13.0	11.60
h_1g_0	11.73	13.33
h_1g_1	12.07	13.87
h_1g_2	12.77	11.27
h_1g_3	11.90	11.83
h_2g_0	10.2	9.40
h_2g_1	12.07	9.83
h_2g_2	11.37	11.0
h_2g_3	12.03	12.10
$F_{6,12}$	1.20^{ns}	0.99^{ns}
SE	0.78	1.33

ns – Not significant

Table. 4.1.1.4.a Main effect of vegetable pickings and growth regulator on Leaf area index (LAI).

Treatments	Leaf area index		
	30 DAT	60 DAT	90 DAT
h_0	0.16	0.64	0.77
h_1	0.16	0.64	0.79
h_2	0.17	0.65	0.79
$F_{2,4}$	1.86^{ns}	6.83^{ns}	0.30^{ns}
SE	0.005	0.03	0.02
g_0	0.16	0.58	0.72
g_1	0.14	0.65	0.81
g_2	0.18	0.66	0.80
g_3	0.17	0.66	0.79
$F_{3,6}$	6.28^{*}	1.40^{ns}	6.32^{*}
SE	0.006	0.03	0.02
CD	.028	-	0.061

* - Significant at 5 per cent level

ns - Not significant

Table. 4.1.1.4.b Interaction effect of vegetable pickings and growth regulator on Leaf area index (LAI)

Treatments	Leaf area index		
	30 DAT	60 DAT	90 DAT
h_0g_0	0.17	0.64	0.80
h_0g_1	0.14	0.71	0.81
h_0g_2	0.17	0.58	0.73
h_0g_3	0.16	0.61	0.73
h_1g_0	0.14	0.59	0.74
h_1g_1	0.14	0.63	0.80
h_1g_2	0.17	0.69	0.85
h_1g_3	0.18	0.62	0.77
h_2g_0	0.16	0.52	0.62
h_2g_1	0.15	0.63	0.83
h_2g_2	0.19	0.71	0.84
h_2g_3	0.17	0.73	0.86
$F_{6,12}$	1.64^{ns}	2.88^{ns}	3.02^{*}
SE	1.05	0.04	0.04
CD	-	-	0.133

* - Significant at 5 per cent level
ns - Not significant

4.1.1.7. Setting percentage

Vegetable picking had significant influence on setting percentage of plants. First two vegetable harvests and rest for seed purpose ie, h_1 gave the highest setting percentage (46.33%) which was significantly superior to h_0 (40.67%) but on par with h_2. (44.08)

Growth regulator had no significant influence on setting percentage.

The interactions H x G was also not significant.

4.1.2. Yield and yield attributes

The results on fruit yield and yield attributes are presented in tables 4.1.2.a.and 4.1.2.b.

4.1.2.1. Number of green fruits harvested per plant

Vegetable pickings significantly influenced the number of green fruits. The plants with first two seed harvests followed by vegetable harvests (h_2) recorded highest number of fruits (34.25) compared to those harvested initially for vegetable purpose h_1(23.92). h_2 recorded 43 percent increase in number of green fruits per plant over h_1.

Growth regulator had no significant influence on number of green fruits per plant.

Interaction H x G was not significant.

4.1.2.2. Weight of green fruits per plant

Vegetable pickings had no significant influence on weight of green fruits per plant.

Table. 4.1.1.5.a Main effect of vegetable pickings and growth regulator on Leaf area duration (LAD), Date of 50 per cent flowering and setting percentage

Treatments	Leaf Area Duration		Date of 50 per cent flowering	Setting percentage
	First stage	Second stage		
h_0	11.99	21.14	32.92	40.67
h_1	11.91	21.56	31.83	46.33
h_2	12.26	21.589	30.67	44.08
$F_{2,4}$	0.18 ns	0.18 ns	1.25 ns	8.30 *
SE	0.43	0.59	1.01	0.99
CD	-	-	-	3.890
g_0	11.17	19.63	32.44	41.0
g_1	12.05	22.38	31.22	42.88
g_2	12.61	22.05	32.22	46.22
g_3	12.38	21.65	31.33	44.67
$F_{3,6}$	2.20 ns	4.08 ns	0.83 ns	2.52 ns
SE	0.43	0.61	0.68	1.42

* - Significant at 5 per cent level
ns- Not significant

Table. 4.1.1.5.b Interaction effect of vegetable pickings and growth regulator on Leaf area duration (LAD), Date of 50 per cent flowering and setting percentage.

Treatments	Leaf Area Duration		Date of 50 per cent flowering	Setting percentage
	First stage	Second stage		
h_0g_0	12.25	21.75	34.67	36.3
h_0g_1	12.81	22.85	32.0	38.67
h_0g_2	11.3	19.8	33.0	43.67
h_0g_3	11.6	20.15	32.0	44.0
h_1g_0	11.0	20.0	33.33	42.67
h_1g_1	11.5	22.25	31.0	44.67
h_1g_2	13.05	23.15	31.67	50.67
h_1g_3	12.10	20.85	31.33	47.33
h_2g_0	10.25	17.15	29.33	44.0
h_2g_1	11.85	22.05	30.67	45.33
h_2g_2	13.50	23.20	32.0	44.33
h_2g_3	13.45	23.95	30.67	42.67
$F_{6,12}$	2.77^{ns}	2.94^{ns}	0.49^{ns}	0.96^{ns}
SE	0.66	1.22	1.65	2.53

ns - Not significant

Highest weight (187.58 g) was recorded in g_2 (50 ppm) and was superior to g_0 (0 ppm) but on par with g_1 and g_3. There was increase in weight of green fruits per plant up to 50 ppm but a further increase in growth regulator concentration to 70 ppm (g_3) did not show a positive effect.

Interaction between growth regulator and vegetable picking was not significant.

4.1.2.3. Total number of fruits harvested per plant

Vegetable picking had significantly influenced the number of fruits harvested per plant. Highest number of fruits (57.42) was recorded when first two seed harvest followed by vegetable harvest was practiced (h_2) and it was significantly superior to zero vegetable harvest h_0 (48.75) but on par with h_1 (55.42) ie., h_1 and h_2 resulted in more or less the same number of fruits per plant.

Among various concentrations of growth regulators tried g_1 (30 ppm) recorded maximum number of fruits harvested per plant (59.56) and was significantly superior to go (50.89) and g_3 (48.11) but on par with g_2 (57.56).

The interaction effect of vegetable picking and growth regulator showed that when no vegetable harvest was done (h_0) the total number of fruits harvested was only 43.67 at zero ppm NAA (g_0) which increased to 52.3 at 30 ppm (g_1) and it was on par with 50 ppm (g_2) and further increase in concentration produced a negative effect. The same trend was observed in h_1 and h_2 also.

Among various treatment combinations tried h_2g_1 gave the highest number (65.67) which was significantly superior to all treatments except h_1g_1 and h_1g_2.

Table. 4.1.2.a Main effect of vegetable pickings and growth regulator on fruit yield and yield at tributes

Treatments	Number of green fruits harvested per plant	Weight of green fruit per plant (g)	Total number of fruits harvested per plant	Mature fruit yield (t ha^{-1})
h_0	-	-	48.75	12.49
h_1	23.92	162.05	55.42	11.25
h_2	34.25	182.34	57.42	9.91
$F_{2,2}$	70.86*	12.96 ns	30.26**	4.50ns
SE	0.87	3.98	0.86	0.61
CD	5.282	-	3.38	-
g_0	30.17	154.37	50.89	8.79
g_1	25.33	167.28	59.56	12.93
g_2	30.83	187.58	57.56	13.04
g_3	30.0	179.58	48.11	10.10
$F_{3,6}$	4.01ns	5.12*	12.73**	75.32**
SE	1.26	6.42	1.52	0.24
CD	-	22.219	5.247	0.841

** - Significant at 1 per cent level
* - Significant at 5 per cent level
ns - Not significant

Table. 4.1.2.b Interaction effect of vegetable pickings and growth regulator on fruit yield and yield attributes

Treatments	Number of green fruits per plant	Weight of green fruits per plant (g)	Total number of fruits harvested per plant	Mature fruit yield t ha^{-1}
h_0g_0	-	-	43.67	9.13
h_0g_1	-	-	52.3	14.56
h_0g_2	-	-	52.3	15.6
h_0g_3	-	-	46.67	10.66
h_1g_0	24.33	145.14	58.67	9.33
h_1g_1	20.67	159.9	60.67	12.93
h_1g_2	25.67	169.74	56	12.07
h_1g_3	25.0	173.43	46.3	10.66
h_2g_0	36.0	163.59	50.3	7.91
h_2g_1	30.0	174 .66	65.67	11.28
h_2g_2	36.0	205.41	64.3	11.44
h_2g_3	35.0	185.73	51.3	9.0
$F_{3,6}$	0.28^{ns}	0.68^{ns}	3.74 **	1.88^{ns}
SE	1.31	9.06	2.26	0.67
CD	-	-	6.982	1.03

** - Significant at 1 per cent level

ns - Not significant

4.1.2.4. Mature fruit yield

Vegetable picking had no significant influence on mature fruit yield and it was highest when zero vegetable harvest was done.

Growth regulator alone influenced the mature fruit yield. Highest mature fruit yield of (13.04 t ha^{-1}) was obtained when growth regulator was used at 50 ppm (g_2) and was significantly superior to g_o (8.79 t ha^{-1}) and g_3 (10.10 t ha^{-1}) but was on par with g_1 (12.93 t ha^{-1}). Increasing growth regulator up to 50 ppm increased the mature fruit yield but further increase in concentration did not show a positive influence.

H x G interaction was not significant.

4.1.3. Fruit characters

The results on fruits characters are presented in table 4.1.3.a and 4.1.3.b.

4.1.3.1. Length of green fruit (cm)

Vegetable picking had no significant influence on length of fruit. But length of fruit was influenced by growth regulator.

Different concentrations of NAA showed that g_3 (70 ppm) produced longest fruits (7.3 cm) and it was significantly superior to g_0 (5.8 cm) and g_1 (6.42 cm) but on par with g_2 (7.08 cm). The length of g_2 treated fruits was significantly higher than that of untreated ones.

Interaction of growth regulator and vegetable picking had no significant influence on length of green fruits.

Table. 4.1.3.a Main effect of vegetable pickings and growth regulator on fruit characters

Treatments	Length of green fruit (cm)	Girth of green fruit (cm)	Shelf life of green fruit (days)
h_1	6.88	2.93	3.59
h_2	6.44	3.01	3.41
$F_{2,2}$	0.21^{ns}	0.11^{ns}	0.21^{ns}
SE	0.68	0.18	0.26
CD	-	-	-
g_0	5.82	2.45	3.5
g_1	6.42	3.48	3.17
g_2	7.08	3.12	3.5
g_3	7.30	2.85	3.83
$F_{3;6}$	7.63*	5.01*	0.91^{ns}
SE	0.25	0.19	0.29
CD	0.856	0.673	-

* - Significant at 5 per cent level
ns - Not significant

Table. 4.1.3.b Interaction effect of vegetable pickings and growth regulator on fruit characters.

Treatments	Length of green fruit (cm)	Girth of green fruit (cm)	Shelf life of green fruit (days)
h_1g_0	5.73	2.4	3.67
h_1g_1	6.73	4.4	3.3
h_1g_2	7.3	2.5	3.67
h_1g_3	7.77	2.4	3.67
h_2g_0	5.9	2.5	3.33
h_2g_1	6.1	2.56	3.0
h_2g_2	6.87	3.73	3.3
h_2g_3	6.90	3.26	4.0
$F_{3,6}$	0.27^{ns}	10.43**	0.57^{ns}
SE	0.60	0.30	0.31
CD	-	1.031	-

** - Significant at 1 per cent level
ns - Not significant

4.1.3.2. Girth of green fruit (cm)

Girth of green fruit was not affected by different vegetable harvests.

Growth regulator caused significant variation in the girth of fruit. Girth of fruit was highest in g_1 (3.48 cm) and was superior to g_0 (2.45 cm) but on par with g_2 and g_3.

The interaction of growth regulator and vegetable picking produced significant differences in girth of fruit. Girth was maximum in combination h_1g_1 (4.4 cm) and was significantly superior to all other combinations except h_2g_2.

4.1.3.3. Shelf life of green fruits

Either vegetable picking or growth regulator and their interaction had no significant influence on shelf life of green fruits.

4.1.4. Seed yield and yield attributes

The results are presented in tables 4.1.4.a and 4.1.4.b.

4.1.4.1. Number of seeds per fruit

Different vegetable pickings did not influence the number of seeds per fruit.

The effect of growth regulator had shown that number of seeds per fruit increased from 58.22 for g_0 (zero ppm) to 65.44 for g_1 (30 ppm) and 66.78 for g_2 (50 ppm) with 12 and 14 per cent increase respectively over g_0. But with further increase in concentration to 70 ppm (g_3) there was a significant reduction in seed number to 60.22 causing 10 per cent reduction over g_2.

The interaction effect was significant. When plants were left for seed collection without vegetable harvest (h_0) growth regulator treatment at 50 ppm (g_2) resulted in significant increase in seed number per fruit (70.67) over g_1 (66.33) and

Table. 4.1.4.a Main effect of vegetable pickings and growth regulator on seed yield and yield attributes.

Treatments	Number of seeds per fruit	Weight of seeds per fruit (mg)	Fruit to seed ratio	Seed yield per ha (kg)
h_0	64.17	25.92	89.64	67.55
h_1	62.0	21.57	98.79	63.49
h_2	61.83	22.25	113.98	38.93
$F_{2,4}$	0.69^{ns}	5.02^{ns}	85.95^{**}	45.27^{**}
SE	1.58	1.05	1.33	2.30
CD	-	-	5.205	9.037
g_0	58.22	20.79	95.42	48.10
g_1	65.44	23.99	102.41	61.71
g_2	66.78	26.55	103.24	63.06
g_3	60.22	21.53	102.03	53.76
$F_{3,6}$	58.29^{**}	8.86^{*}	3.09^{ns}	11.52^{**}
SE	0.54	0.89	2.06	2.07
CD	1.856	3.084	-	7.167

* * - Significant at 1 per cent level

* - Significant at 5 per cent level

ns - Not significant

Table. 4.1.4.b Interaction effect of vegetable pickings and growth regulator on seed yield and yield attributes.

Treatments	Number of seeds per fruit	Weight of seeds per fruit (mg)	Fruit to seed ratio	Seed yield per ha (kg)
h_0g_0	60.33	22.26	86.57	59.72
h_0g_1	66.33	27.10	98.09	70.10
h_0g_2	70.67	31.36	87.23	77.81
h_0g_3	59.30	22.96	86.65	62.58
h_1g_0	60.00	19.89	91.07	49.90
h_1g_1	64.67	21.74	97.63	74.29
h_1g_2	64.00	23.41	102.76	69.84
h_1g_3	59.30	21.23	103.70	59.94
h_2g_0	54.30	20.23	108.63	34.67
h_2g_1	65.3	23.13	11.80	40.73
h_2g_2	65.67	25.20	119.73	41.53
h_2g_3	62.00	20.43	115.73	38.77
$F_{6,12}$	4.49*	0.81 ns	1.23 ns	2.33 ns
SE	1.21	1.64	4..48	3.11
CD	3.725	-	-	-

* - Significant at 5 per cent level

ns - Not significant

g_0 (60.33). A further increase in concentration to 70 ppm (g_3) caused a significant reduction in seed number (59.3). The same trend was observed with h_1 and h_2.

Among the treatment combinations highest seed number per fruit of 70.67 was recorded in h_0g_2 which was significantly superior to all other combinations.

4.1.4.2. Weight of seeds per fruit (mg)

Effect of vegetable picking on weight of seeds per fruit was not significant.

Various concentrations of growth regulators caused variation in weight of seeds per fruit. There was an increase in weight of seeds from 20.79 in g_0 to 26.55 mg in g_2 with increase in concentration from o to 50 ppm but it was on par with 30 ppm (23.99 mg). Further increase in growth regulator concentration to 70 ppm did not produce any significant effect on weight of seeds per fruit.

Growth regulator and vegetable picking had no significant influence on weight of seed per fruit.

4.1.4.3. Fruit to seed ratio

Fruit to seed ratio increased with increase in vegetable harvest. Fruit to seed ratio was 89.64 for h_0 (zero vegetable harvest) increased to 98.79 for h_1 and 113.98 for h_2 recording 10.2 and 27.2 per cent increase respectively over h_0.

Growth regulator did not cause any significant effect on fruit to seed ratio.

Interactions of vegetable picking and growth regulator application was also absent.

4.1.4.4. Seed yield per ha (kg)

Significant variation is seed yield was observed with vegetable picking. Highest seed yield of 67.55 kg per ha was observed in zero vegetable harvest (h_0)

and was superior to h_2 (first two seed harvest and rest vegetable harvest) by 74 per cent but on par with h_1 (first two vegetable harvest and rest for seed collection).

Growth regulator also caused significant variation in seed yield. Highest seed yeild of 63.06 kg was recorded in g_2 (50 ppm) followed by g_1 (61.71 kg) and was significantly superior to g_0 (48.10 kg) and g_3 (53.76 kg) recording 31 and 17 per cent increase over g_o.

Seed yield per hectare was not significantly influenced by interaction of growth regulator and vegetable harvest.

4.1.5. Seed quality

The results are presented in tables 4.1.5.a and 4.1.5.b.

4.1.5.1. Germination percentage

The effect of vegetable picking, growth regulator and their interactions on germination percentage was not significant.

4.1.5.2. Speed of germination

Vegetable pickings, growth regulator and their interactions had no significant influence on speed of germination.

4.1.5.3. Seed viability

Seed viability was not influenced by the number of vegetable pickings, growth regulator and their interactions.

4.1.5.4. 1000 seed weight (g)

Zero vegetable harvest (h_0) recorded the highest 1000 seed weight value of 4.17 g and it was significantly superior to h_1 (first two vegetable harvest followed by seed harvest) which recorded 3.29 g but on par with h_2 (first two seed harvest and then vegetable harvest).

Table. 4.1.5.a Main effect of vegetable pickings and growth regulator on seed quality parameters.

Treatments	Germination percent	Speed of germination	Seed viability	1000 seed weight (g)
h_0	84.25	23.80	97.58	4.17
	(66.77)		(81.31)	
h_1	80.75	23.12	97.5	3.29
	(64.0)		(81.22)	
h_2	81.75	23.98	97.75	3.93
	(64.75)		(81.62)	
$F_{2,4}$	$(2.13)^{ns}$	0.52^{ns}	$(0.10)^{ns}$	7.69 *
SE	(0.98)	0.64	(0.65)	0.16
CD	-	-	-	0.64
g_0	79.67	23.32	97.67	2.92
	(63.27)		(81.49)	
g_1	82.89	24.62	97.78	4.29
	(65.61)		(81.61)	
g_2	83.78	23.33	97.33	4.13
	(66.33)		(80.69)	
g_2	82.67	23.24	97.67	3.84
	(65.48)		(81.55)	
$F_{3,6}$	$(2.49)^{ns}$	0.65^{ns}	$(0.20)^{ns}$	11.90 **
SE	(0.84)	0.84	(0.72)	0.18
CD	-	-	-	0.611

* * - Significant at 1 per cent level
* - Significant at 5 per cent level
ns - Not significant
Figures in parenthesis denote transformed % in angles

Table 4.1.5.b Interaction effect of vegetable pickings and growth regulator on seed quality parameters.

Treatments	Germination per cent	Speed of germination	Seed viability	1000 seed weight (g)
h_0g_0	80.0 (63.61)	22.76	98.0 (82.02)	2.62
h_0g_1	85.0 (67.27)	25.26	97.67 (81.40)	5.16
h_0g_2	87.67 (69.43)	24.23	97.0 (80.42)	4.96
h_0g_3	84.33 (66.73)	22.97	97.67 (81.40)	3.94
h_1g_0	79.0 (62.72)	22.77	98.0 (82.02)	2.64
h_1g_1	80.67 (63.90)	23.73	97.67 (81.40)	3.31
h_1g_2	80.67 (63.90)	24.43	97.0 (80.42)	2.97
h_1g_3	82.67 (65.47)	24.93	97.0 (80.42)	4.23
h_2g_0	80.0 (63.47)	24.43	97.0 (80.42)	3.51
h_2g_1	83.0 (65.66)	24.93	98.0 (82.02)	4.40
h_2g_2	83.0 (65.66)	22.86	97.3 (81.22)	4.46
h_2g_3	81.0 (64.24)	23.7	97.67 (82.82)	3.53
$F_{6,12}$	$(1.30)^{ns}$	0.85^{ns}	$(0.24)^{ns}$	4.76^{*}
SE	(1.6)	0.77	(1.84)	0.33
CD	-	-	-	1.019

* - Significant at 5 per cent level
ns - Not significant
Figures in parenthesis denote transformed % in angles

Growth regulator also had significant effect on 1000 seed weight. Highest 1000 seed weight of 4.29 g was recorded in g_1 (30 ppm) and was significantly superior to g_0 (2.92 g) but on par with g_2 (50 ppm) and g_3 (70 ppm).

Interaction effect of growth regulator and vegetable picking produced significant effect on 1000 seed weight. Highest 1000 seed weight of 5.16 g was obtained in h_0g_1 (zero vegetable harvest plot with 30 ppm growth regulator) which was on par with h_0g_2, h_1g_3, h_2g_1 and h_2g_2.

4.1.6. Seedling characters

The results are presented in tables 4.1.6.a and 4.1.6.b.

4.1.6.1. Root length (cm)

Vegetable pickings did not cause any significant influence on root length.

Application of growth regulator at 30 ppm (g_1) recorded a root length of 3.68 cm which was significantly superior to g_3 at 70 ppm (3.22 cm) but was on par with g_2 (50 ppm) and g_0 (0 ppm).

H x G interaction was not significant.

4.1.6.2. Shoot length (cm)

Effect of vegetable pickings, growth regulators and their interactions had no significant influence on shoot length.

4.1.6.3. Vigour index of seedling

Harvest and growth regulator application had no significant influence on vigour index of seedling.

Interactions of vegetable pickings and growth regulators had significant influence on vigour index of seedling. Treatment combination h_0g_1 was significantly superior to all other combinations except h_0g_2. Vigour index of seedling was maximum for zero vegetable harvest with 30 ppm growth regulator.

Table 4.1.6.a. Main effect of vegetable pickings and growth regulator on seedling characters.

Treatments	Root length (cm)	Shoot length (cm)	Vigour index of seedling	Seedling dry weight (mg)
h_0	3.50	4.99	710.03	19.83
h_1	3.53	4.67	665.95	19.83
h_2	3.51	5.04	692.7	20.0
$F_{2,4}$	6.06 ^{ns}	2.05 ^{ns}	0.90 ^{ns}	0.01 ^{ns}
SE	6.06	0.14	23.44	0.77
g_0	3.54	4.86	668.16	19.67
g_1	3.68	5.01	726.33	20.0
g_2	3.60	4.74	688.92	20.2
g_3	3.22	4.99	674.82	19.67
$F_{3,6}$	7.59*	1.11 ^{ns}	2.86 ^{ns}	0.23 ^{ns}
SE	0.07	0.12	15.36	0.56
CD	0.251	-	-	-

* - Significant at 5 per cent level
ns - Not significant

Table. 4.1.6.b Interaction effect of vegetable pickings and growth regulator on seedling characters.

Treatments	Root length (cm)	Shoot length (cm)	Vigour index of seeding	Seedling dry weight (mg)
h_0g_0	3.15	4.76	631.9	19.0
h_0g_1	3.80	5.26	779.27	20.67
h_0g_2	3.80	4.73	728.43	19.67
h_0g_3	3.23	5.2	700.50	20.0
h_1g_0	3.96	4.93	702.97	19.67
h_1g_1	3.66	4.80	702.87	19.0
h_1g_2	3.43	4.50	618.20	20.67
h_1g_3	3.03	4.43	669.6	20.0
h_2g_0	3.5	4.86	696.87	20.3
h_2g_1	3.56	4.97	698.87	20.3
h_2g_2	3.56	5.0	698.57	20.3
h_2g_3	3.40	5.3	705.77	19.0
$F_{6,12}$	2.47 ^{ns}	1.64 ^{ns}	5.22 **	0.55 ^{ns}
SE	0.18	0.20	19.32	1.04
CD	-	-	59.59	-

* * - Significant at 1 per cent level
ns - Not significant

4.1.6.4. Seedling dry weight

Main effect of vegetable pickings, growth regulator and their interactions had no significant influence on seedling dry weight.

4.1.7. Economics of cultivation

The results are presented in tables 4.1.7.a and 4.1.7.b.

4.1.7.1. Net income

Highest net return (Rs: 100840. 2/ha) was obtained with zero vegetable harvests (h_0) which was significantly superior to h_1 and h_2.

The effect of growth regulator on net income had shown that as the concentration of growth regulator increases the net income also increases from Rs: 52723.89 for g_0 to Rs: 1,23,773.10 for g_2. Further increase of growth regulator to g_3 (70 ppm) did not gave a positive effect.

Among the interactions h_0g_2 (zero vegetable harvest with 50 ppm growth regulator) gave the highest net income which was significantly superior to all other combinations.

4.1.7.2. B:C ratio

Vegetable picking had significant effect on B:C ratio. Highest B:C ratio (1.74) was recorded with zero vegetable harvest (h_0) which was significantly superior to h_1 and h_2.

Growth regulator showed significant variation on B:C ratio. Highest B:C ratio of 1.92 was obtained at g_2 (50 ppm) and found significantly superior to all other concentrations ie, g_0 (0 ppm) g_1 (30 ppm) and g_3 (70 ppm). An increasing trend in B:C value was observed by increasing the concentration of growth regulator from

Table. 4.1.7.a Main effect of vegetable pickings and growth regulator on economics of cultivation.

Treatments	Cost of cultivation (Rs: ha^{-1})	Gross returns (Rs: ha^{-1})	Net returns (Rs: ha^{-1})	B:C ratio
h_0	134696.10	235536.3	100840.2	1.74
h_1	130024.8	218714.0	88689.2	1.68
h_2	128591.2	206277.30	77686.15	1.60
$F_{2,4}$	-	-	174.34 **	67.91
SE	-	-	879.08	0.07
CD	-	-	3451.136	0.032
g_0	127286.9	180010.8	52723.89	1.41
g_1	132511.60	241380.3	108868.70	1.82
g_2	134221.70	257994.8	123773.10	1.92
g_3	130329.0	201317.6	70988.53	1.54
$F_{3,6}$	-	-	919.10 **	331.33 **
SE	-	-	1084.72	0.01
CD	-	-	3753.756	0.043

** - Significant at 1 per cent level

Input cost

Cost of NAA - Rs: 6 g^{-1}

Cost of seed - Rs: 1.5 g^{-1}

Output cost

Cost of green chilli - Rs: 12 kg^{-1}

Cost of seed - Rs: 1500 Kg^{-1}

Table. 4.1.7.b Interaction effect of vegetable pickings and growth regulator on economics of cultivation.

Treatments	Cost of cultivation (Rs: ha^{-1})	Gross returns (Rs: ha^{-1})	Net returns (Rs: ha^{-1})	B:C ratio
h_0g_0	126555.3	177671.0	51115.77	1.40
h_0g_1	136739.5	268822.4	132083.0	1.97
h_0g_2	141907.3	295621.6	153714.3	2.08
h_0g_3	133382.2	200030.2	66648.04	1.50
h_1g_0	128671.3	186364.8	57693.45	1.44
h_1g_1	129917.8	226342.4	96424.63	1.74
h_1g_2	131880.4	248742.5	116862.10	1.85
h_1g_3	129629.5	213406.3	83776.75	1.65
h_2g_0	126634.2	175996.7	49362.45	1.38
h_2g_1	130877.6	228976.0	98098.38	1.75
h_2g_2	12877.4	229620.4	100742.90	1.78
h_2g_3	127975.4	190516.3	62540.83	1.46
$F_{6,12}$	-	-	26.80 **	9.88 **
SE	-	-	3053.13	0.03
CD	-	-	9408.429	0.100

* * - Significant at 1 per cent level

'0' to 50 ppm but a further increase in concentration did not produce a positive effect.

H x G interaction was significant. Among the interaction h_0g_2 (zero vegetable harvest with 50 ppm growth regulator) recorded significantly superior B:C ratio of 2.08 compared to all other treatment combinations.

4.2. Experiment II

The effect of stages of seed harvest and position of seeds in fruit on seed yield and quality.

4.2.1. Seed yield and yield attributes

The results are presented in tables 4.2.1.a and 4.2.1.b.

4.2.1.1. Number of seeds per fruit

Number of seeds per fruit did not differ significantly based on physiological maturity stages of fruit.

Based on position of seeds, the number varied considerably in top and bottom portions of the fruit. Bottom portion (p_1) recorded five times increase in seed number (56.22) over top portion (11.11).

Interactions of stages of seed harvest and position of seeds in fruit was insignificant.

4.2.1.2. Weight of seeds per fruit

Seed harvesting stages had no significant effect on weight of seeds per fruit.

Position of seeds in fruit was found to influence the weight of seeds per fruit. It was observed that the bottom portion seeds had about five times weight (22.57 mg) than seeds in top portion (4.06 mg) of fruit.

Table. 4.2.1.a Main effect of seed harvesting stages and position of seeds on seed yield and yield attributes.

Treatments	Number of seeds per fruit	Weight of seeds per fruit (mg)	Fruit to seed ratio	Seed yield per ha (kg)
s_1	34.5	12.44	97.17	25.52
s_2	34.0	13.42	92.63	36.16
s_3	32.5	14.08	93.23	38.64
$F_{2,10}$	0.68 ^{ns}	1.88 ^{ns}	2.08 ^{ns}	0.81 **
SE	1.26	0.60	1.71	2.44
CD	-	-	-	7.68
p_1	56.22	22.57	103.67	54.59
p_2	11.11	4.06	85.02	12.29
$F_{1,10}$	950.62 **	712.15 **	89.55 **	22.59 **
SE	1.03	0.49	1.39	1.9
CD	3.259	1.545	5.376	6.27

* * - Significant at 1 per cent level
ns - Not significant

Table. 4.2.1.b Interaction effect of seed harvesting stages and position of seeds on seed yield and yield attributes.

Treatments	Number of seeds per fruit	Weight of seeds per fruit (mg)	Fruit to seed ratio	Seed yield per ha (kg)
s_1p_1	56.0	21.56	106.57	36.89
s_1p_2	13.0	3.23	87.77	8.39
s_2p_1	56.3	22.29	101.3	57.98
s_2p_2	11.67	4.54	83.93	14.33
s_3p_1	56.3	23.84	103.1	68.90
s_3p_2	8.67	4.31	83.37	14.15
$F_{2,10}$	0.87^{ns}	0.59^{ns}	0.12^{ns}	1.50^{**}
SE	1.79	0.85	2.41	3.45
CD	-	-	-	10.87

* * - Significant at 1 per cent level
ns - Not significant

Interaction of seed harvesting stages and position of seeds was not significant.

4.2.1.3. Fruit to seed ratio

Seed harvesting stages had no significant influence on fruit to seed ratio.

Fruit to seed ratio was significantly highest (103.67) in bottom portion of fruits which recorded 22 per cent increase compared to top most portion (85.02) of fruit.

Interaction of seed harvesting stages and position of seeds in fruit to seed ratio was not significant.

4.2.1.4. Seed yield per hectare

Seed yield per hectare varied significantly with various seed harvesting stages. Maximum seed yield was recorded in red ripe stage s_3 (38.65 kg/ha) and was significantly superior to mature green stage s_1 (25.52 kg/ha) but on par with colour breaker stage.

Considering the position of seeds the maximum seed yield was recorded from bottom portion of fruit (54.59 kg) ie., three times increase over seeds from top portion (12.29 kg).

Interaction of seed harvesting stages and position of seeds in fruit have shown that seeds from fully red ripe, situated in bottom position of fruits (s_3p_1) recorded maximum yield (68.90 kg/ha) compared to all other treatment combinations.

4.2.2. Seed quality

The results are presented in tables 4.2.2.a and 4.2.2.b.

Table. 4.2.2.a Main effect of seed harvesting stages and position of seeds on seed quality parameters.

Treatments	1000 seed weight (g)	Germination percent	Speed of germination	Seed Viability
s_1	2.43	78.17	20.07	53.67
		(62.17)		(47.09)
s_2	3.60	84.17	24.20	84.5
		(66.56)		(66.85)
s_3	4.09	83.83	26.03	96.67
		(66.28)		(79.63)
$F_{2,10}$	10.87 **	(10.03)**	17.89 **	(247.68)**
SE	0.26	1.07	0.72	1.44
		(0.78)		(1.04)
CD	0.820	3.38	2.27	4.54
		(2.24)		(3.28)
p_1	3.83	82.67	22.23	79.33
		(64.54)		(65.39)
p_2	2.92	81.44	8.41	77.22
		(64.54)		(63.66)
$F_{1,10}$	9.27 *	(1.06)^{ns}	8.41 **	(2.07)^{ns}
SE	0.21	(0.63)	0.59	(0.85)
CD	0.668	-	1.856	-

* * - Significant at 1 per cent level
* - Significant at 5 per cent level
ns - Not significant
Figures in parenthesis denote transformed % in angles

Table. 4.2.2.b Interaction effect of seed harvesting stages and position of seeds on seed quality parameters.

Treatments	1000 seed weight (g)	Germination percent	Speed of germination	Seed Viability
s_1p_1	2.64	78.67	20.83	55.3
		(62.51)		(48.06)
s_1p_2	2.21	77.67	19.31	52.0
		(61.83)		(46.13)
s_2p_1	3.83	84.67	24.93	85.3
		(66.95)		(67.50)
s_2p_2	3.63	83.67	23.47	83.6
		(66.16)		(66.20)
s_3p_1	5.61	84.67	28.17	97.3
		(66.94)		(80.61)
s_3p_2	3.17	83.0	23.9	96.0
		(65.63)		(78.64)
$F_{2,10}$	2.37^{ns}	(0.05)^{ns}	1.23^{ns}	(0.03)^{ns}
SE	0.37	1.52	1.02	2.04
		(1.10)		(1.47)

Figures in parenthesis denote transformed % in angles
ns – Not significant

4.2.2.1. 1000 seed weight

Thousand seed weight was significantly more in red ripe stage s_3 (4.09 g) compared to mature green stage s_1 (2.43 g) but was on par with colour breaker stage s_2 (3.60 mg).

Position of seeds also affected 1000 seed weight. Seeds in the bottom portion recorded maximum seed weight (3.83 g) than seeds in top portion (2.92 g).

Seed position and seed harvesting stages of fruit had no significant interaction effect on 1000 seed weight.

4.2.2.2. Germination percentage

Germination percentage varied significantly based on ripeness of fruit. Seeds from colour breaker stage (84.17%) was superior to seeds from fully mature green stage (78.17%) but it was on par with red ripe stage (83.83%).

Seed position did not significantly influence the germination percentage of seeds.

Interaction of seed position and stages of seed harvesting on germination percentage was not significant.

4.2.2.3. Speed of germination

Seed harvesting stages affected the speed of germination of seeds. Seeds at red ripe stage (26.03) recorded significantly higher value than mature green stage (20.07) but it was on par with colour breaker stage (24.2) and significantly low at s_1 (20.07).

Position of seeds also affected speed of germination. Germination speed was the highest (22.23) for seeds located in bottom portion of fruit while it was only 8.41 for seeds in top portion.

s x p interaction was not significant.

4.2.2.4. Seed viability

Seed viability was high in fully red ripe stage (96.67) which gave 80 per cent increase over mature green stage (53.67) and 14 per cent increase over colour breaker stage (84.5).

Seed position in top and bottom of fruit did not influence the viability of seeds.

No interaction was observed between the above factors.

4.2.3. Seedling characters

The results are presented in tables 4.2.3.a & 4.2.3.b.

4.2.3.1 Root length of seedlings

Highest root length values were recorded in colour breaker stage s_2 (3.75 cm) which was significantly superior to mature green stage s_1 (3.12 cm) but on par with red ripe stages s_3 (3.62cm).

Seed position was not influenced by the root length of germinated seedlings.

Interaction effects of seed position on fruit and seed harvesting stages were not significant.

Table. 4.2.3.a Main effect of stages of seed harvesting and position of seeds on seedling characters.

Treatments	Root length (cm)	Shoot length (cm)	Vigour index of seedling	Seedling dry weight (mg)
s_1	3.12	4.73	614.75	19.83
s_2	3.75	4.95	732.4	18.67
s_3	3.62	5.58	772.03	20.67
$F_{2,10}$	8.14 **	3.86 ns	8.84 **	1.07 ns
SE	0.12	0.22	27.5	0.97
CD	0.362	-	86.679	-
p_1	3.58	5.27	733.73	19.67
p_2	3.14	4.91	679.06	19.78
$F_{1,10}$	1.57 ns	1.88 ns	2.96 ns	0.01 ns
SE	9.4	0.18	22.46	0.79

* * - Significant at 1 per cent
ns - Not significant

Table. 4.2.3.b Interaction effect of stages of seed harvesting and position of seeds on seedling characters.

Treatments	Root length (cm)	Shoot length (cm)	Vigour index of seedling	seedling dry weight (mg)
s_1p_1	3.17	4.67	617.23	20.0
s_1p_2	3.07	4.8	612.27	19.67
s_2p_1	3.73	5.4	772.97	18.3
s_2p_2	3.77	4.5	691.83	19.0
s_3p_1	3.83	5.7	811.0	20.67
s_3p_2	3.40	5.4	733.07	20.67
$F_{2,10}$	1.09 ^{ns}	1.33 ^{ns}	0.63 ^{ns}	0.07 ^{ns}
SE	0.16	0.32	38.90	1.37

ns – Not significant

4.2.3.2. Shoot length of seedlings

Shoot length of seedling was not influenced either by stages of seed harvesting or by position of seeds.

4.2.3.3. Vigour index

Highest vigour index of 772.03 was observed when the fruits were harvested in red ripe stage (s_3) which was significantly superior to mature green stage s_1 (614.75) but on par with colour breaker stage.

Seed position on fruit and their interactions with seed harvesting stages had no significant effect on vigour index.

4.2.2.4. Seedling dry weight

Main effect of stages of seed harvesting, seed position and their interactions had no significant influence on seedling dry weight.

DISCUSSION

5. DISCUSSION

The results of the investigation "Influence of growth regulator and vegetable picking on seed yield and quality and also to standardise the stage of physiological maturity and seed position in chilli" conducted at College of Agriculture, Vellayani are discussed here under.

In vegetables among the several factors that account for the yield and quality of seeds, the number of vegetable pickings had profound influence. The response of chilli to plant growth regulators depends on a number of factors. The efficacy of a chemical on a particular crop has to be tested under specific conditions as there are number of problems like lack of sensitivity of effects and differences in varietal response. These factors may some time lead to undesirable side effects. So the best chemical and best concentration on a particular variety of plant species has to be standardised for different conditions. Growth regulators especially auxin is reported to have a significant influence on seed yield in many vegetable crops especially solanaceous vegetables.

The mode of action of auxin is such that it acts through fundamental processes like nucleic acid synthesis, enzyme synthesis and activation (Usha, 1988). Seed soaking treatment with growth regulator besides promoting germination and vigour of seeds also improve their field performance and productivity (Vijayakumar *et al.*, 1988)

5.1 Effect of vegetable picking and growth regulator on seed yield and quality.

5.1.1. Growth characters

Height of the plant at 30 DAT (15.57 cm) and 60 DAT (33.78cm) was highest in h_2 (first two seed harvest and rest for vegetable purpose) while it was highest (43.16cm) in h_1 (first two vegetable harvest rest for seed collection) at 90 DAT. The lowest values of plant height at all the three stages (30,60 and 90 DAT) of plant growth was noticed in zero vegetable harvest. This is in agreement with the work of Devi (1999) in bittergourd and Sindu (2000) in cucumber. The increase in plant height may be due to the stimulation of apical growth in plants with periodical removal of fruits by which the photosynthates get translocated to the growing tip instead of accumulating in fruits. Kamalanathan *et al.* (1968) reported that in bhindi if the pods are left to mature without green fruit picking the plants become stunted which explains the significant reduction in plant height at zero vegetable harvest. Similar results were also observed by Garris and Hoffman (1946) in bhindi.

A proportionate reduction in height of the plant was observed by increasing the concentration of NAA at all stages of plant growth. Highest plant height was recorded in zero ppm and shortest in 70 ppm in all stages of plant growth. Similar results of reduced vine length by the application of growth regulator was reported by Kumar and Peter (1986) in *Cucumis* sp, Das and Das (1996) in pumpkin and Sindu (2000) in cucumber. Application of other growth regulators like MH also caused reduction in vine length in cucurbits (Suresh and Pappiah, 1981). According to Singh *et al.* (1975) the reduction in vine length by the application of growth regulators is mainly due to the reduction in synthesis of gibberellins in tissues which is a major promoter of cell division in meristematic region.

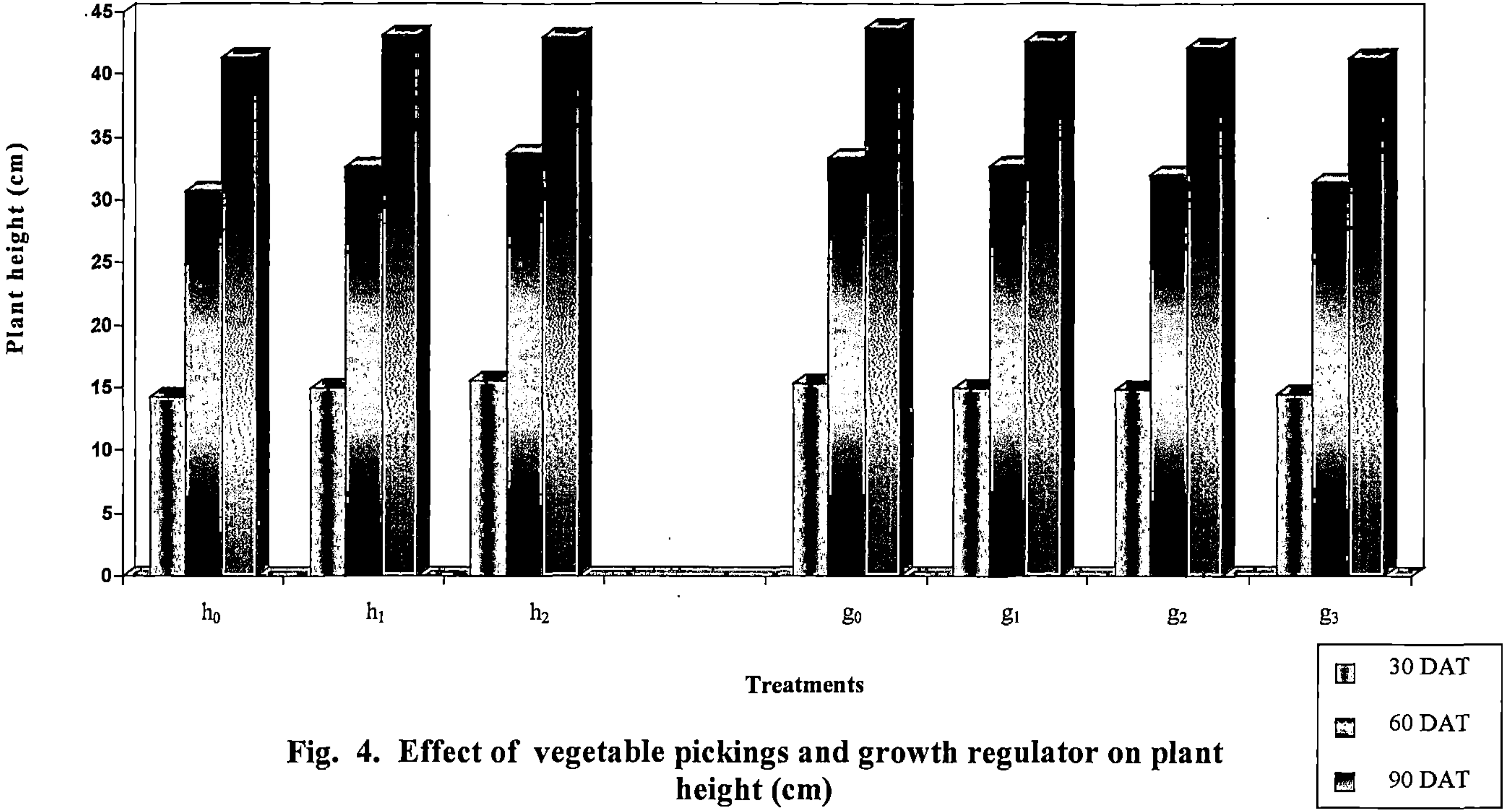


Fig. 4. Effect of vegetable pickings and growth regulator on plant height (cm)

Vegetable picking increased the number of branches per plant. Though not significant, the highest number of branches was observed in treatment with more vegetable harvests and lowest in zero vegetable harvests. Simialr results were observed by Sindu (2000). Growth regulator significantly influenced the number of branches per plant at 60DAT and not at 30 and 90 DAT but an increase in branches were noted by increasing the concentration of growth regulator. Similar increase by growth regulators were also reported by Suresh and Pappiah (1981) in bittergourd were more number of branches are due to ability of ethylene to break apical dominance. The NAA might have produced the effect through its universally accepted phenomenon of cell elongation (Usha, 1988).

Though not significant LAI of the crop was increased by increasing the number of vegetable harvests especially at 90 DAT. Expansion of leaf area is reported to be a reflection of periodic removal of fruits (Sheeba, 1995). Production of more number of leaves with periodic picking of green fruits in bhindi is reported by Bhuibar *et al.* (1989). If a sink is available, the plants show a general tendency to translocate the photosynthates to the source. In zero vegetable harvest since the fruits (sink) are not removed periodically, the photosynthates always get accumulated in fruits and only less amount of photosynthates will be available for the source development.

Application of growth regulator had significant effect on LAI especially at 90 DAT. LAI increased from 0.72 at zero ppm to 0.81 by 30 ppm NAA. The leaf area develops at an exponential rate in annuals (Gardner *et al.*, 1985). Increase in LAI may be due to the production of more number of leaves per plant and due to increased number of branches. Maclure and Guilfoyle (1989) observed that accelerated activity of auxin in plants induces primordial growth leading to more of vegetative growth.

Vegetable picking significantly influenced the setting percentage of fruits. Highest value was recorded in h_1 (first two vegetable harvest) and lowest in h_0 (zero vegetable harvest). Mature fruits acts as a sink for nutrients and inhibit the development of additional flowers and fruits (Robinson and Decker –Walters, 1997). Devi (1999) reported that the bearing capacity of bittergourd plant is improved by frequent picking of green fruits.

5.1.2. Fruit yield and yield attributes

Increase in number of vegetable harvests (h_3) caused a sharp increase in the number of green fruits per plant, total number of fruits harvested per plant and weight of green fruits per plant (Table. 12) . This result is in accordance with the findings of Perkins *et al.* (1952), Rao (1953), Khalil and Hamid (1964), Sheeba (1995) in bhindi, Devi (1999) in bittergourd and Sindu (2000) in cucumber. Developing and maturing fruits have an inhibitory effect on further development of flowers and fruits. In those crops where immature fruits are harvested at vegetable stage, the inhibitory mechanism will not be perceptible but in crops where ripe fruits are harvested this will be obvious. The vine strikes physiological balance at the threshold limit of maximum fruits it can carry to maturity. This is why the number of fruits per vine in a seed crop is less (Seshadiri, 1993).

Weight of green fruits per plant was maximum when more number of vegetable harvests was done (h_3) eventhough not significant. This result is in conformity with the observations of Rao (1953) Bhuibar *et al.* (1989) in bhindi and Devi (1999) in bittergourd. Periodic removal of fruits makes the cucurbits more

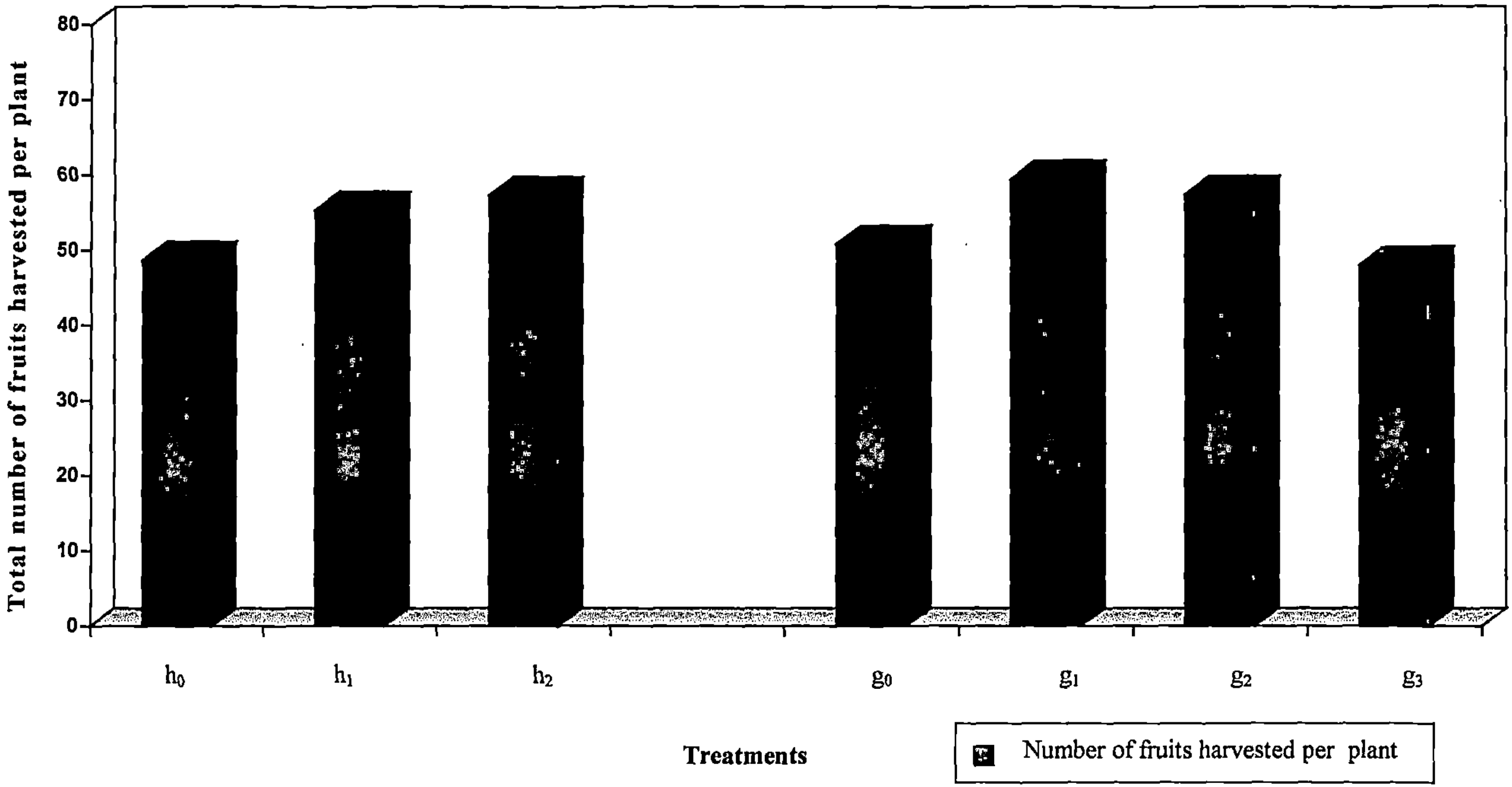


Fig. 5. Effect of vegetable pickings and growth regulator on total number of fruits harvested per plant.

productive when grown for immature fruits (Robinson and Decker Walters, 1997). They also concluded that fruits act as a sink for nutrients and inhibit the development of additional fruits in plant if not removed. Sheeba *et al.* (1998) also observed that increase in weight of green fruits per plant was contributed by the increase in number of green fruits and not by the size of the fruit. Number of green fruits per plant was maximum at 50 ppm (30.83) and was lowest in 30 ppm (25.33) but not significant. Number of green fruits per plant is a principal yield attribute showing high positive correlation with yield. This must be related to the rise in carbohydrate content which in turn increases the number of green fruits harvested per picking. Niranjana *et al.* (1999) and Mamat *et al.* (1983) in tobasco pepper got similar results.

Total number of fruits harvested per plant was significantly superior in 30 ppm NAA g_1 (59.56) compared to g_3 (48.11) and g_0 (50.89) but on par with g_2 (57.56). Beringer (1978) stated that growth and yield of a crop is based on cell division, cell enlargement and the differentiation in to assimilating, transporting and storage tissues. The role of auxins in inducing cell division and cell enlargement is well known leading to more number of fruits. Osborne (1963) opined that auxins delayed senescence through maintenance of RNA synthesis and increase in synthesis of carbohydrates thus resulting in larger number of flowers. Similar results have been reported by Jayanandam *et al.* (1976) in chillies and Oenofeghara (1981) in tomato.

Although number of green fruits per plant was not significantly influenced by different concentrations of NAA, weight of green fruits per plant was maximum with 50 ppm NAA and recorded 22 per cent increase over zero ppm but on par with 30 and 70 ppm. The results are in accordance with several earlier studies (Shanmughavelu *et al.,* 1973; Verma and Choudhary, 1980; Dubey 1983; Arora *et* *al.*, 1989; Devadas and Ramadas, 1994; Elizabeth, 1998; and Sindu 2000). The increase in fruit yield by NAA is due to auxin directed translocation of nutrients and photoassimilates as reported by Krishnamurthy (1981). Singh (1999) reported that induction of early flowering, fruiting and production of maximum number of fruits are the reasons for the increase in yield by IAA treatment.

Length and girth of fruit produced difference with change in concentration of growth regulator. Length was highest (7.3cm) in g_3 (70 ppm) and lowest (5.8cm) in g_0 and on par with g_2 (50 ppm). Girth of fruit was maximum in g_1 (3.48cm) and superior to g_0 (2.45cm) but on par with g_2 and g_3. This result is in accordance with findings of Sreeja (2000) and Kaul and Sharma (1989). In chillies yield displayed significant and positive association with fruit length (Rani *et al.*, 1996). This increase in girth may be due to more photosynthate accumulation.

The significant interaction effect of vegetable pickings and growth regulator on total number of fruits harvested per plant and girth of fruits may be due to the cumulative effect of harvest and growth regulator.

Mature fruit yield per hectare showed a proportionate reduction with increase in number of vegetable harvests eventhough not significant (Table. 9). Highest mature fruit yield was in zero vegetable harvest (12.49 t ha^{-1}). This is in accordance with the work of Sheeba (1995) in bhindi and Sindu (2000) in cucumber. In cucurbits the first formed fruits will be bigger because of higher accumulation of photosynthates in early stages. Hence smaller fruits might have formed on the plant at later stages. This attributes to the higher mature fruit yield in zero vegetable harvest (Devadas *et al.*, 1999). In two and more vegetable harvests, some of the fruits were harvested at immature stage which may be attributed to lower mature fruit yield in these treatments.

Mature fruit yield recorded maximum values in 50 ppm (13.04) and it recorded 48 per cent and 29 per cent increase over zero ppm (8.79) and 70 ppm (10.10) respectively. At high concentration of NAA (70 ppm) same growth regulator exhibit inhibiting effect on physiological functions of the plant. At higher concentration more than one molecule of growth regulator is attached to a single place with substrate. It is accumulated without penetrating the tissue. As a result these are unable to break the abscission layer which may probably be responsible for severe flower and fruit drop resulting in reduced fruit setting and ultimately lower yield (Singh and Lal, 1995). Similar result was obtained by Sindu (2000) in cucumber. Leopold (1964) proved that auxins are the agents which stimulate ovaries to develop. External application of NAA might interact with low levels of auxins, leading to increased fruit set through development of more number of ovaries and retaining them till maturity and hence enhancing yield.

5.1.3. Seed yield and quality

Number and weight of seeds per fruit decreased with increase in number of vegetable harvests with highest in plants which were left as such without green fruit picking (h_0) and lowest in h_2 (first two seed harvests and rest for vegetable purpose) but the values were not significant. This is in conformity with the observations of Rode (1979), Velumani and Ramaswamy (1980) Deshmukhe and Tayde (1986) and Bhuibar *et al.*, (1989) in bhindi, Devi (1999) in bitter gourd and Sindu (2000) in

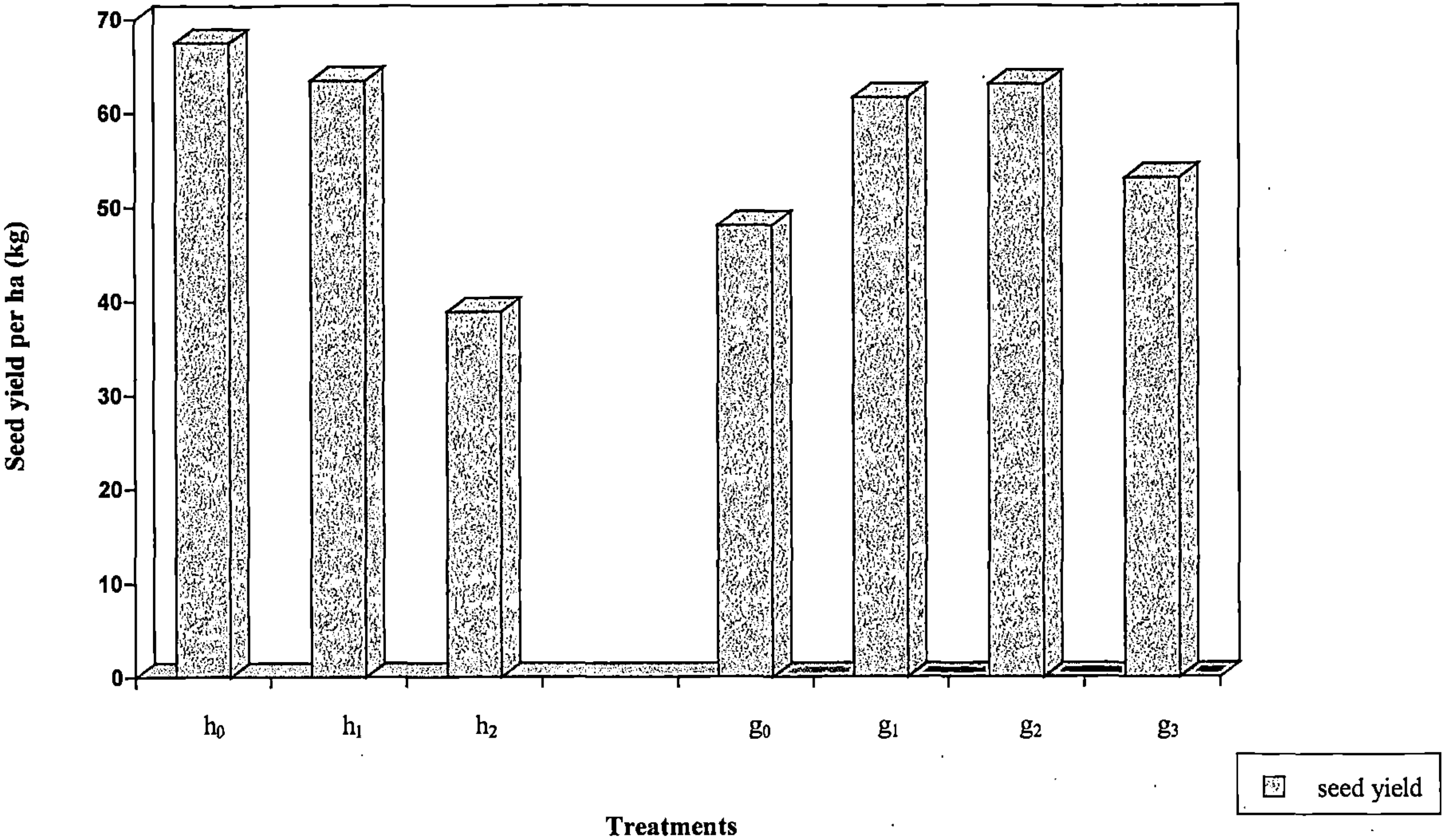


Fig. 6. Effect of vegetable pickings and growth regulator on seed yield per hectare (kg)

cucumber. More number of seeds in zero vegetable harvests may be due to the better utilization of photosynthates for seed development as the early formed fruits are retained for seed.

A proportionate increase in number and weight of seeds per fruit was observed by increasing the concentration of NAA to 50 ppm (g_2). Number of seeds per fruit and weight of seeds per fruit recorded highest value at 50 ppm and it was on par with 30 ppm. This is in agreement with the works of Sitaram *et al.* (1989) in cucumber, Devadas and Ramadas (1994) in pumpkin, Gedam *et al.* (1998) in bitter gourd, Hariharan and Unnikrishnan (1983) in chilli, Mehta *et al.*(1989) in tomato and Sindu (2000) in cucumber. According to Uppar and Kulkarni (1989) increase in number and weight of seeds per fruit with the application of growth regulator is probably due to the inhibition of basipetal movement of auxins from fruits resulting in the proper utilization of auxins for the development of fruits and seeds by mobilization of nutrients from source to sink.

Seed yield per hectare was highest when the plants were left for seed collection without green fruit picking (Table. 16). Highest seed yield was 67.55 kg/ha for h_0 which was 74 per cent more than h_2 (first two vegetable and rest for vegetable purpose) but on par with first two seed harvest followed by vegetable purpose (h_2). This result is in agreement with the observations of Men'kova (1974) in cucumber, Sheeba (1995) in bhindi and Sindu (2000) in cucumber. This may be due to higher seed number and seed weight per fruit for the plant left for seed collection and also due to the higher mature fruit yield observed for the treatment.

Seed yield per hectare was highest with the application of 50 ppm NAA which was on par with that of 30 ppm. Seed yield of 63.06 kg/ha was obtained with the application of 50 ppm NAA with an increase of 31per cent over zero ppm. Increased seed yield due to application of growth regulator is in conformity with the reports of Sinha (1974), El-Beheidi *et al.* (1987) and Sitaram *et al.* (1989), Singh and Lal (1995) in chilli, Kumar *et al.* (1996) in okra, Bhople *et al.* (1998) in radish, Gedam *et al.* (1998) in bittergourd, Singh *et al.* (1999) in okra and Sindu (2000) in cucumber. This may be due to higher fruit yield, seed number and seed weight per fruit for the treatment. Growth promoters have been reported to increase seed yield by increasing growth (Joshi *et al.*, 1975).

Significant interaction effect of vegetable pickings and growth regulator on number of seeds per fruit may be due to cumulative effect of harvest and growth regulator in increasing the seed number per fruit.

Fruit to seed ratio was highest (113.98) in h_2 and was significantly superior to h_0 and h_1. This may be due to the increased total number of fruits harvested per plant in h_2 (57.92).

Number of vegetable harvests had significant influence on 1000 seed weight. Highest 1000 seed weight of 4.17 g was recorded in h_0 and superior to h_1 but on par with h_2. This may be due to better accumulation of photosynthates in early formed fruits. There was a progressive decrease in 1000 seed weight with increase in number of fruits harvested per plant. This is in accordance with the reports of Velumani and Ramaswamy (1980), Khan and Jaiswal (1988) and Bhuibar *et al.* (1989) in okra.

Though the effects were not significant highest speed of germination and seed viability were obtained with first two seed harvest and rest for vegetable purpose treatment (h_2) closely followed by h_0(entire crop for seed). This is supported by findings of Hariharran and Unnikrishnan (1985), Nataraj *et al.* (1998), Sheeba (1995), Singh and Kanwar (1995) in bhindi, Devi (1999) in bittergourd and Sindu (2000) in cucumber.

Growth regulator had significant influence on 1000 seed weight (Table. 18). Among the levels of growth regulator 30 ppm recorded the highest 1000 seed weight (4.29g) which was significantly superior to zero and 70 ppm and on par with 50 ppm of NAA. This is in conformity with the observations of Sitaram *et al.* (1989) in cucumber, Gedam *et al.* (1998) in bittergourd, Sindu (2000) in cucumber and Sreeja (2000) in chilli.

Seedling characters such as seedling root length, shoot length and seedling dry weight were not significantly influenced by vegetable picking. This is in conformity with the findings of Asokmehta and Ramakrishnan (1986) in chilli and Natraj *et al.* (1989) in bhindi. Vigour index of seedling was highest for zero vegetable harvest but not significant. This may be due to the higher germination percentage recorded in the treatment which is attributed to the better utilization of photosynthates for seed development as the fruits formed are retained for seed purpose only. (Sindu, 2000).

Seed quality parameters such as germination percentage, speed of germination, seedling shoot length, seed viability, seedling dry weight and vigour index of seedling were not offected by growth regulator. The non significant influence of growth regulator on these seed quality parameters were in conformity with the findings of Sitaram *et al.* (1989) in cucumber, Gedam *et al.* (1996) in bittergourd. The increased percentage of seedling establishment, the enhanced plant growth and consequent improvement in yield in treated plants were due to the stimulatory effect of NAA on shoot and root growth due to supply of readily available nutrients in easily absorbable form at the time of plant growth..

Vigour index of seedling was significantly influenced by interaction of growth regulator and vegetable picking due to the cumulative effect of these two factors namely g_1 (30 ppm) and h_0 (zero vegetable harvest) on vigour index.

5.1.4. Economics of cultivation

The net income as well as the B:C ratio were significantly influenced by the number of vegetable harvest and growth regulator. Highest net income and B:C ratio were obtained for h_0 (zero vegetable harvest) because of higher seed and fruit yield for the treatment as observed from the data (Table. 22). Highest net income of Rs: 100840.2 per ha was obtained for zero vegetable harvest which was 30 per cent more than the treatment h_1 (first two seed harvest). B:C ratio was 1.74 for zero vegetable harvest as against 1.60 for first two seed harvest.

Among the levels of growth regulator highest net return of Rs: ha^{-1}123733.10 was recorded for g_2 (50 ppm) recording 134 per cent increase over g_0 (Fig:- 7). B:C ratio was highest (1.92) for g_2. This is due to the higher fruit and seed yield observed in these treatments.

Zero vegetable harvest treatment recorded the highest net returns So in chilli instead of combining seed production along with vegetable production it is better to

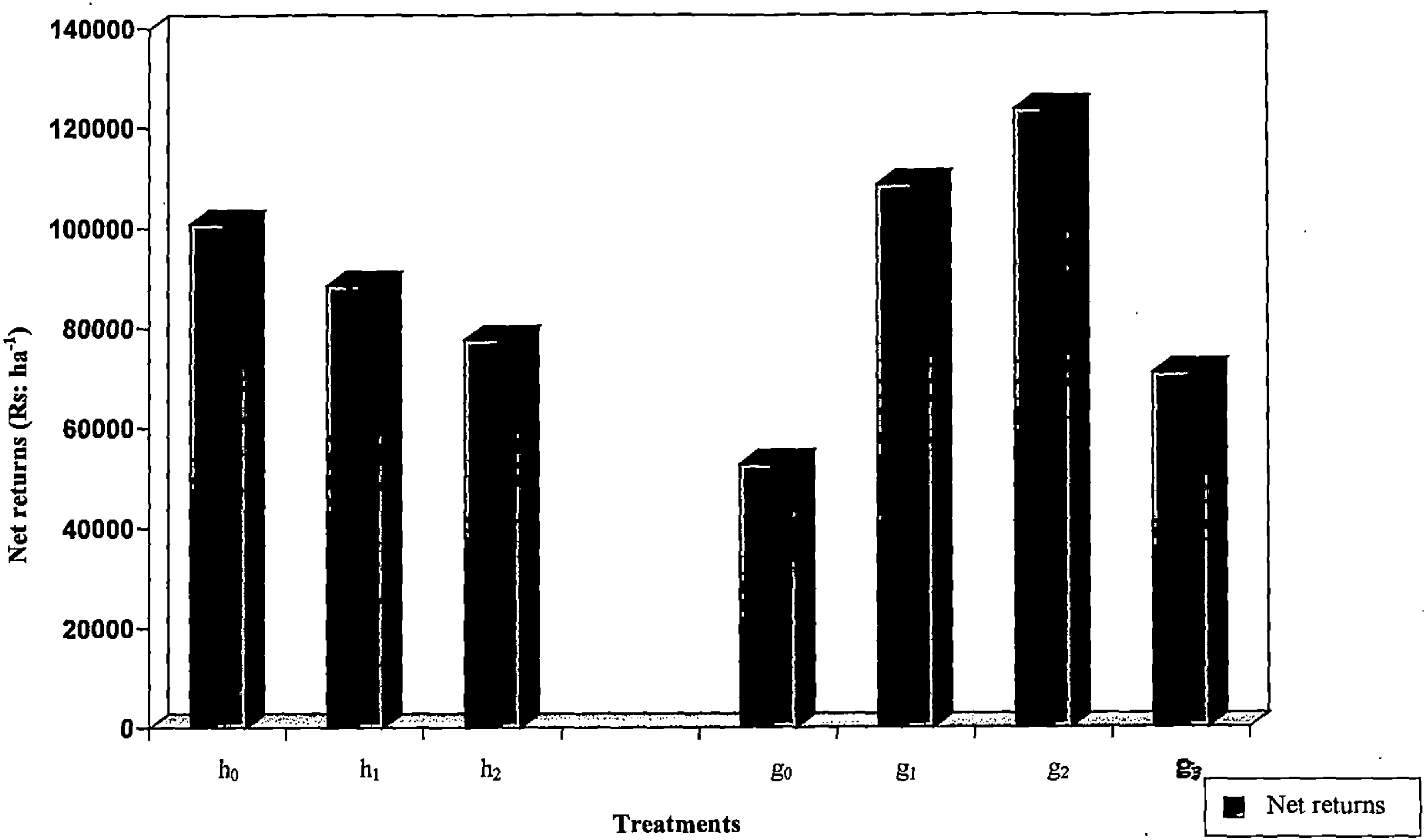


Fig. 7. Effect of vegetable pickings and growth regulator on net returns (Rs: ha^{-1})

opt for seed production alone for better returns. Sathyanarayanan and Ahamed Raza (1999) found that chilli fetched greater income both in vegetable and seed production followed by bhindi and cowpea. The income realised in seed production were 105.71%, 158.33% and 185.71% more respectively for bhindi, cowpea and chillies when compared to vegetable production. So the famers engaged in vegetable seed production may get a higher net income when compared to vegetable production.

Highest net returns of Rs: 123773.10 and B:C ratio of 1.92 was obtained with 50 ppm NAA. This is due to the higher fruit and seed yield observed in the treatment. The significant interaction effect of zero vegetable harvest and 50 ppm NAA on net return and B:C ratio may be due to cumulative effect of these two treatments.

If the farmers aim for the production of some fruit as vegetable along with seed production he can opt for first two vegetable harvest and rest of the crop for seed production without significantly affecting the seed yield and quality. Hence considering the seed quality and quantity, combination of vegetable production and seed production can be a profitable venture.

5.2. Effect of seed harvesting stages and position of seeds on seed yield and quality

High seed quality in terms of viability and vigour is essential for seedling establishment in field as well as for good crop production. This stage of seed maturity at harvest is an important factor affecting seed quality and its subsequent performance. A seed is mature when it can be removed from the plant without impairing its germination. Seeds attain maximum quality at their physiological maturity. (Helmer *et al.,* 1962). Usually it has reached a stage on the plant when no further increase in dry weight will occur. According to Harrington (1972) physiological maturity is the developmental stage at which seeds achieve maximum vigour and viability and since the nutrients are no longer entering the seeds from the plant, seed senescence begins.

Number of seeds per fruit was not influenced by the stage of harvest. Similar observations were also reported by Harrington (1959) in chilli, Buriev (1987) in Cucumber and Sindu (2000) in cucumber. Seeds in the bottom region of the fruit was significantly superior in number ie, four times more compared to top region. This may be due to increased girth of fruit in bottom region and hence can accomodate more number of seeds around the pedicel region.

Weight of seeds per fruit showed an increase from 12.44 mg to 14.08 mg with the advancement of harvest from mature green stage to red ripe stage but the increase was not significant. Increase in seed weight per fruit up to physiological maturity is in accordance with works of Patapova (1972) in cucumber, Shanmugaraj (1978) in lablab bean, Chandrasekaran (1979) in bitter gourd, Kanwar and Saimbhi (1987) in bhindi, Naik *et al.* (1996) in chilli and Sindu (2000) in cucumber. Lower seed weight per fruit from the fruits harvested at immature stage may be due to larger proportion of unfilled seeds and seeds with poor embryo development.

Position of seeds in fruit also had significant influence on weight of seeds per fruit. Seeds in bottom region was five times more in weight compared to seeds in top portion. Due to increased girth of fruits at the bottom region, seeds get more photosynthates such as carbohydrates, lipids, proteins and phosphorous containing compounds and thus develop properly contributing to more weight of seeds (Devi, 1999).

Fruit to seed ratio decreased with the advancement of stage of harvest. This may be because of larger size of the fruits harvested at mature green stage. Position also had significant influence on fruit to seed ratio. Bottom portion had 22 per cent

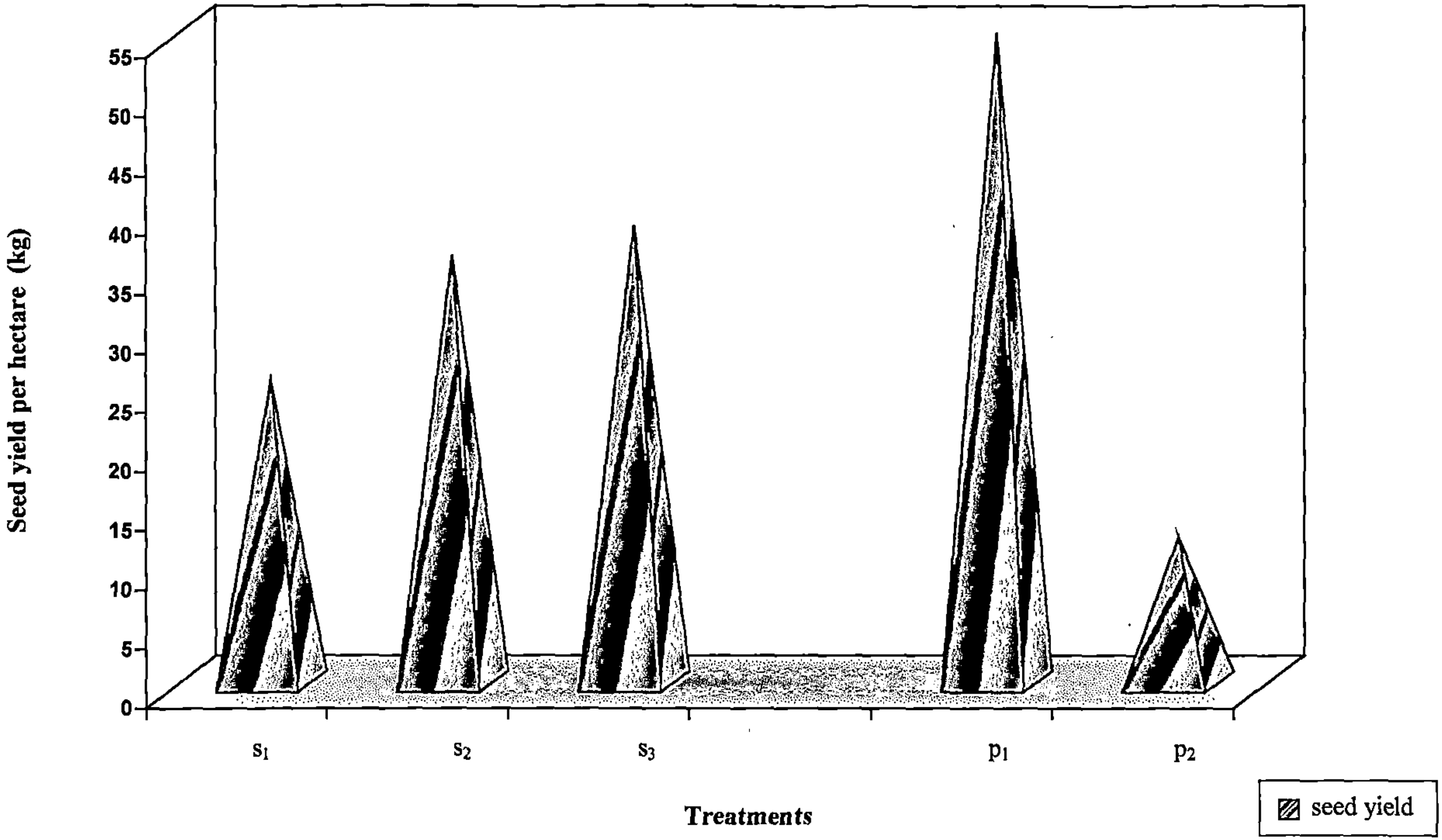


Fig. 8. Effect of seed position in fruit on seed yield per hectare at different stages of harvest.

more fruit to seed ratio than top region due to more fleshy pericarp along with more number of seeds in the upper region of the fruit.

Depending on harvesting stages seed yield varied significantly. At red ripe stage the seed yield was about 51 per cent more compared to mature green stage but on par with colour breaker stage. Dry weight of seed increases at red ripe stage because of the synthesis and deposition of seed storage materials-starch, proteins, fats, phytin etc in the seed. This is in agreement with the findings of Naik *et al.*(1996).

Bottom portion of the fruit contain more seeds and recorded three times increase in seed yield compared to seeds in top region. During seed development the reserve materials in the parent plant may be mobilized and transported more to developing seeds in the bottom region of the fruit. To obtain maximum seed yields it is essential that the leaves and other assimilatory organs of the parent plant be kept active as long as possible (Liji, 1998).

The cumulative effect harvesting the seed at red ripe stage from the bottom portion of the fruit might have contributed to the highest seed yield obtained from the combination s_3p_1.

The results also revealed marked influence in stage of fruit harvest on seed quality characteristics. There was a steady increase in 1000 seed weight from mature green stage to fully red ripe stage recording 68 per cent increase but on par with colour breaker stage. This indicated that larger amount of reserve food substances went on accumulating in chilli till the seeds reached physiological maturity stage(Ashokmehta and Ramakrishnan, 1986).

Seed quality parameters like germination percentage, speed of germination, seed viability, root length and vigour index of seedling recorded highest values in seeds from fruits harvested at red ripe stage and on par with colour breaker stage. The highest values of these parameters from the seeds harvested at physiological maturity is in agreement with the observations of Mc Alister (1943) and Garris and Hoffman (1946) in bhindi, Harrington (1959) in musk melon, Patapova (1972) in cucumber, Metha (1983) in chilli, Alavarenga *et al.* (1984) in water melon, Naik *et al.* (1996) in chilli and Rakeshseth *et al.* (1999) in fodder cowpea.

Germination percentage showed a spectacular increase from 78.17 at mature green stage to 84.17 per cent with the advancement of harvest to colour breaker stage. Seed viability showed an increase from 53.67 to 96.67 per cent from mature green to red ripe stage. Speed of germination also varied from 20.07 at mature green to 26.03 at fully red ripe stage. Root length recorded the lowest value of 3.12 cm at mature green stage to 3.75 cm at colour breaker stage and on par with red ripe stage. Vigour index of seedling varied from 614.75 at mature green stage to 712.03 at red ripe stage. Seedling shoot length and dry weight also recorded highest values at red ripe stage and lowest in mature green stage though not significant. Harvesting the seeds before the attainment of physiological maturity recorded lesser viability and vigour potentials due to the presence of more number of immature seed with relatively low degree of embryo development and high moisture content as reported by Jayaraj and Karivaratharaju (1992) in groundnut. Improvement in quality of seed with the attainment of physiological maturity is reflected in seed quality parameters like germination percentage, viability, speed of germination, seedling root and shoot length, vigour index and seedling dry weight. This indicated that the seeds are still undergoing rapid growth at mature green stage. The accumulation of large quantities

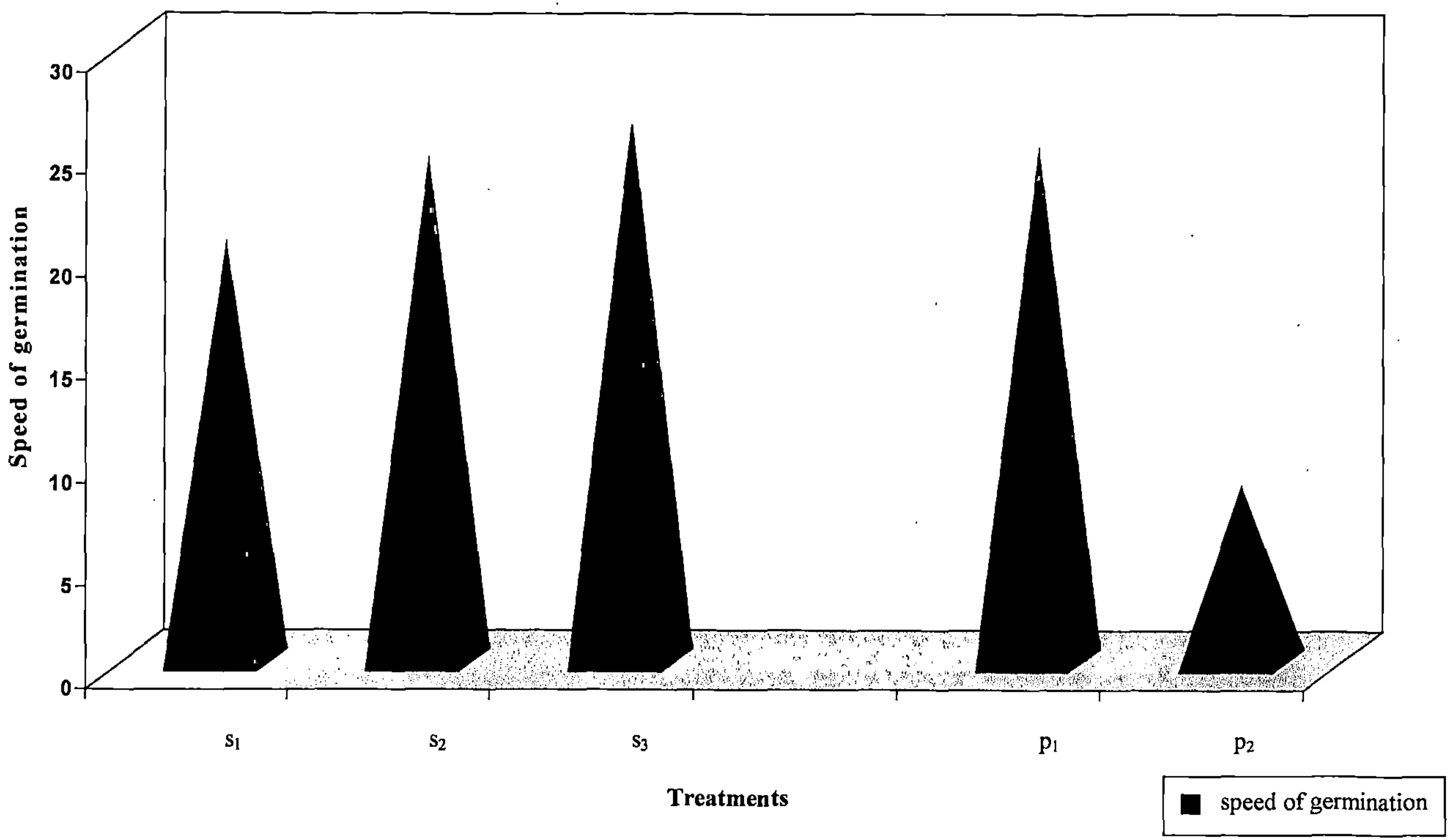


Fig. 9. Effect of seed position in fruit on speed of germination at different stages of harvest

of reserve food substances during this development process enhanced the seed weight and hence an increase in other quality parameters. Reduction in yield and quality of seeds due to early and delayed harvests was observed in several field crops (Kalavathi, 1985).

Seed quality parameters like speed of germination and 1000 seed weight recorded significantly superior values in bottom region of fruit. 1000 seed weight varied from 3.83 g in bottom region to 2.92 g in top portion recording 31 per cent increase. Speed of germination recorded 24.64 and 22.27 in bottom and top portions respectively and noted 11 per cent increase in speed of germination for seeds in the upper region of the fruit. Increase in 1000 seed weight may be attributed to the increased weight of seeds in the bottom region of the fruit contributed by the deposition of seed storage materials like proteins, fats, phytin etc. The seed position influenced the speed of germination due to differences in seed formation. Since the seeds in the top portion are late formed ones they might not have attained the physiological maturity stage contributing to higher speed of germination when compared to seeds in bottom region of the fruit.

Seedling characters like root length, shoot length, vigour index of seedling, seedling dry weight recorded higher values for seeds situated in the bottom region of the fruit but not significant. As the seed initiates embryo growth, the endosperm nutrients get translocated to the emerging axis. Storage tissues function primarily as reservoirs from which the emerging axis draw nutrients and seeds in the top portion in general have less storage tissue which may be the reason for reduced shoot length, root length and vigour index of seedling developed from these seeds (Devi, 1999). The seeds of top portion are comparatively smaller in size due to less amount of storage food in them. Muchow (1990) reported smaller seeds at the base of the

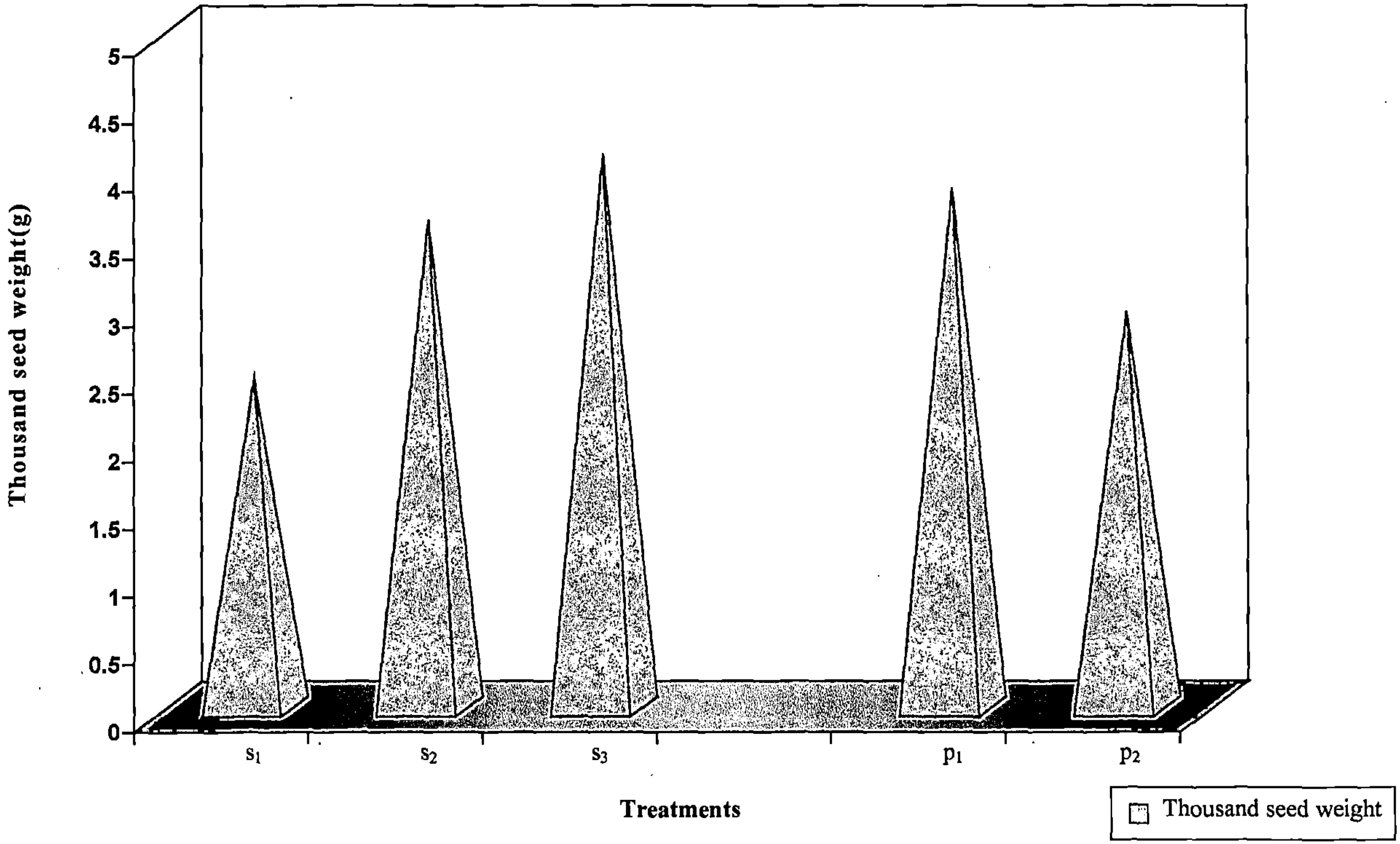


Fig. 10. Effect of seed position in fruit on` thousand seed weight (g) at different stages of harvest

sorghum panicle. In chilli seeds from the basal region of fruit exhibited higher germination and seedling vigour than those from tip and middle position due to inadequate distribution of food material (Doijode, 1990).

To obtain good quality seeds, harvesting the fruit at fully red ripe stage along with seeds from bottom portion can be recommended. If the farmer is forced to harvest the crop prior to fully red ripe stage, then colour breaker stage can also be practised without much deterioration in seed yield and quality.

SUMMARY

6. SUMMARY

An experiment was conducted at College of Agriculture, Vellayani to study the effect of growth regulator and vegetable picking on seed yield and quality in chilli. The treatments consisted three levels of vegetable pickings (zero vegetable harvest, first two vegetable harvest and rest for seed collection, first two seed harvest and rest for vegetable purpose) and four different concentrations of NAA (0, 30, 50 and 70 ppm). NAA which is chemically 2-Naphthalene acetic acid (98.5 per cent) was used for the experiment. The experiment was laid out in strip plot design with the number of vegetable pickings on horizontal strips and levels of growth regulator in vertical strips and replicated three times. The salient findings of the study are summarised below.

Increase in number of vegetable pickings caused a significant increase in height of plants. Maximum height of plants at 30 and 60 DAT was recorded in first two seed harvest followed by vegetable harvests whereas at 90 DAT, highest values were recorded in first two vegetable harvests followed by seed harvests. Vegetable picking had no significant influence on number of branches per plant, leaf area index, leaf area duration and date of 50 per cent flowering. Vegetable picking significantly influenced the setting percentage of fruits. Highest value recorded in first two vegetable harvest and lowest in zero vegetable harvest. Increase in the concentration of growth regulator caused a proportionate reduction in height of plants with highest in zero ppm and shortest in 70 ppm. Seed treatment with 70 ppm NAA caused significant increase in number of branches per plant at 60 DAT. LAI caused significant variation in 50 ppm and 30 ppm at 30 and 90 DAT respectively. Growth regulator had no significant influence on leaf area duration, date of 50 per cent flowering and setting percentage.

Number of green fruits per plant was significantly higher for h_2 (first two seed harvest and the rest for vegetable) whereas weight of green fruits per plant were not significantly affected by vegetable pickings. Growth regulator significantly influenced the weight of green fruits per plant. Highest weight was recorded in 50 ppm but on par with 30 and 70 ppm. There was no significant variation in number of green fruits per plant by growth regulator application.

Vegetable pickings did not cause any significant variation in mature fruit yield. Growth regulator caused significant increase in mature fruit yield which recorded highest at 50 ppm (13.04 t ha^{-1}) and it was on par with 30 ppm (12.93 t ha^{-1}) and the lowest was in zero ppm.

Total number of fruits harvested per plant was influenced by number of vegetable pickings and growth regulator. The treatment h_2 (two seed harvest and rest for vegetable) recorded highest number of fruits. Among the levels of growth regulator 30 ppm gave the highest number of fruits at all levels of harvest.

Number of vegetable pickings had no significant influence on length and girth of green fruits. Application of growth regulator caused significant variation in length and girth of fruits. Length maximum in 70 ppm (7.3 cm) and girth at 30 ppm (3.48cm).

Shelf life of green fruit was not influenced by number of vegetable pickings and growth regulator.

Number of seeds per fruit were not influenced by vegetable pickings. Application of growth regulator increased the seed number, producing the highest number of 66.78 with 50 ppm.

Fruit to seed ratio was increased significantly with increase in the number of vegetable picking. Highest fruit seed ratio was recorded in h_2 (first two seed harvest and rest for vegetable harvest). The influence of growth regulator was not significant.

Weight of seeds per fruit was not influenced by vegetable pickings whereas seed yield per hectare produced significant variation. Zero vegetable harvest (h_0) recorded highest seed yield (67.59 kg ha^{-1}) which was on par with h_2 (first two vegetable harvest and rest for seed). Among the levels of NAA, maximum weight of seeds per fruit was recorded in 50 ppm and was on par with 30 ppm. Seed yield per hectare recorded highest value (63.06 kg ha^{-1}) in 50 ppm and it was on par with 30 ppm.

1000 seed weight was influenced by vegetable pickings. Zero vegetable harvest (h_0)recorded highest value and was on par with h_2 (first two seed harvest and rest for vegetable harvests). Growth regulator had significant influence on thousand seed weight. Highest values was recorded in 30 ppm and was on par with 50 and 70 ppm.

Seed viability per cent, germination per cent and speed of germination were not affected by number of vegetable pickings and growth regulator.

Seedlings characters such as seedling shoot length, root length, vigour index and seedling dry weight were also not influenced by number of vegetable pickings and levels of NAA.

Economic analysis of the treatments revealed that number of vegetable pickings and growth regulator influenced the net return and B:C ratio. Highest net returns and B:C ratio were obtained under zero vegetable harvests

(Rs: 100890.3 kg ha^{-1} and 1.74 respectively). Among the levels of growth regulator 50 ppm NAA gave maximum net returns and B:C ratio (Rs: 123773.10 ha^{-1} and 1.92 respectively. At all levels of vegetable picking net return was maximum at 50 ppm NAA and the most economic combination was found to be zero vegetable harvest with 50 ppm NAA.

Cultivation of crops exclusively for seed purpose not only improves the economic benefits but also enhances the seed quality parameters. Combining vegetable harvests along with seed production (first two vegetable pickings and rest for seed) can also be practised since this favours the production of good quality seeds with comparable seed yield.

A second experiment was also conducted to study the influence of seed harvesting stages and position of seeds in fruit on seed yield and quality in chilli. The experiment was laid out in factorial randomised block design with three replications. The treatments consisted of three stages of seed harvest (mature green stage, colour breaker stage and red ripe stage) and 2 different position of seeds in fruit (bottom portion and top portion).

Number of seeds per fruit and weight of seeds per fruit was not affected by different stages of seed harvest. Different position of seeds in fruit differed the number of seeds per fruit and weight of seed per fruit. Seeds situated in the bottom region of fruit was found to be more in number compared to seeds in top region seed. Due to increased number of seeds the weight of seeds was also higher for seeds in bottom region.

Fruit to seed ratio did not differ significantly with different harvesting stages for seed purpose. Seeds located in the bottom portion recorded highest fruit to seed ratio compared to seeds located in top portion.

Seeds harvested at red ripe stage recorded highest seed yield values and was on par with fruits at colour breaker stage. Bottom portion seeds recorded highest seed yield per hectare compared to seeds in top most region. Seeds harvested at red ripe stage along with seeds in bottom portion recorded highest seed yield per ha.

Thousand seed weight increased with ripeness of fruit and based on seed position. Maximum 1000 seed weight was observed in fruits harvested at fully red ripe stage. Among the seed position in fruit, seeds from bottom region recorded highest value for 1000 seed weight.

Germination percentage, speed of germination and seed viability varied significantly with different harvesting stages of fruit for seed purpose, while only speed of germination differed significantly based on seed position in fruit. Highest germination percentage was recorded in colour breaker stage on par with red ripe stage, while highest value for speed of germination was observed in red ripe and on par with colour breaker stage. Seed viability recorded significantly superior values in red ripe stage only. Based on seed position in fruit bottom portion recorded superior values for speed of germination compared to seeds on top region.

Seedling dry weight and shoot length was not significantly influenced by seed harvesting stages and position of seeds in fruits.

Root length and vigour index of seedling was influenced by harvesting stages of fruit for seed purpose. Highest values of root length was recorded in colour breaker stage and on par with red ripe stage. Vigour index of seedling recorded superior values in red ripe stage but on par with colour breaker stage. Seed position in fruit did not cause any significant difference in vigour index and root length of seedlings.

Fruits can be harvested for better quality seeds either at red ripe or colour breaker stage. For improving the seed quality parameters, seeds located in the bottom region along with seeds collected from fully red ripe fruits was found to be best for obtaining good seed yield and better performance in field.

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* original not seen

APPENDIX

APPENDIX – I

Weather data for the crop period – weekly averages

(November 2000- March 2001)

Standard week	Max temp(^{0}C)	Min temp(^{0}C)	Relative humidity (%)	Rainfall (mm) (weekly total)	Evaporation (mm day^{-1})
45	30.46	22.42	79.6	19.8	2.78
46	30.14	21.98	79.79	6.6	2.61
47	28.74	21.14	86.21	50	2.1
48	30.4	18.34	78.29	-	2.75
49	30.86	20.27	76.07	2.2	3.24
50	30.3	19.38	79.07	-	3.44
51	30.9	19.68	73.14	-	2.91
52	28.86	20.54	82.07	45.6	1.81
1	30.56	20.63	76.93	2.4	2.94
2	30.49	20.46	77.93	-	2.84
3	30.24	19.7	76.29	-	3.28
4	30.46	21.01	77.79	0.8	2.97
5	29.1	21.04	78.14	16.2	2.63
6	30.83	20.19	77.21	-	3.74
7	31.44	20.29	75.03	-	3.71
8	31.96	21.27	79.07	-	4.07
9	32.2	20.77	76.57	-	4.46
10	32.44	21.54	73.93	-	4.51
11	32.37	21.76	71.36	-	4.89
12	32.88	22.4	73.5	-	5.04

INFLUENCE OF GROWTH REGULATOR AND VEGETABLE PICKING ON SEED YIELD AND QUALITY IN CHILLI (*Capsicum annuum* L.)

BY

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ABSTRACT OF THE THESIS

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ABSTRACT

A field experiment was conducted at College of Agriculture, Vellayani to study the influence of growth regulator and vegetable picking on seed yield, quality and vigour and also to standardise the stage of physiological maturity and seed position in chilli.

Plant height was increased with regular vegetable harvests. Other growth characters like number of branches per plant, leaf area index, leaf area duration and date of 50 per cent flowering were not affected by vegetable harvests. The bearing capacity of the plant is improved by frequent picking of green fruits, but the mature fruit yield was not affected. Highest number of green fruits per plant, total number of fruits harvested per plant and highest fruit to seed ratio was recorded in treatment h_2 (first two seed harvest and rest for vegetable harvests). Zero vegetable harvest recorded maximum weight of seeds per fruit, 1000 seed weight, seed yield per ha and B:C ratio. Seed quality is not influenced by number of harvests. To obtain maximum returns, raising crop for seed purpose alone can assure good quantity and quality seeds.

Growth regulator caused reduction in vine length but increased the number of branches and length of fruits. NAA at 50 ppm produced significant increase in LAI, weight of green fruits,weight

and number of seeds per fruit & seed yield per hectare. Growth regulator at 30 ppm increased the total number of fruit harvested and girth of fruit. Seed quality was not affected by the application of growth regulator except 1000 seed weight. Highest net return and B:C ratio was also obtained at 50 ppm NAA.

Seed harvesting stages significantly influenced the seed yield and quality. Seed quality parameters like maximum 1000 seed weight, speed of germination and seed viability were influenced by harvesting the fruit at red ripe stage and was on par with colour breaker stage. Seedling character like VI also recorded superior values. Germination percentage and root length was highest in colour breaker stage and on par with red ripe stage. Based on position of seeds in fruit, seeds located in the bottom portion of fruits obtained higher values for number and weight of seeds per fruit, fruit to seed ratio, seed yield per hectare, 1000 seed weight and speed of germination. So to obtain good quality seeds harvesting the fruit at red ripe stage and extracting the seeds from bottom region provide maximum viable seeds.