CHAPTER II

REVIEW

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Intensive efforts are being made to enhance the production of oilseed crops by adopting improved production technology. Although, Linseed is a common crop in India, but research findings of morpho-physiological aspects of growth and yield with respect to synthetic plant growth regulators are limited. All most all the relevant literature available inside and out side the country on linseed with particular reference to the influence of synthetic growth regulators on morpho-physiological aspects of growth and productivity have been reviewed in this chapter.

In derth of relevant literature on these aspects pertaining to linseed crop, the concerned literature available on other oilseed crops have been also taken into consideration and reviewed under the following categories:

2.1. Influence of synthetic growth regulators on morpho-physiological parameters, yield and yield attributes/some physiological findings.

Watson (1952) concluded that for dry matter production and translocation to particular specified important plant parts are the major component of yield in any crop.

Ishihara (1956) found that spraying the foliage with Triiodobenzoic acid (TIBA) ten days before bloom increase flower production and ultimately final yield in soybean.

Kamel (1959) reported that dry matter increased with increasing light intensity at all stages of development. The ratio between leaf area and dry weight increased during first 47 days of growth and afterwards decreased.
Humphreys (1963) recorded increased branching in mustard by spraying of chlorochlolene chloride (CCC or cycoceol) as growth regulating materials in England.

Greer and Anderson (1965) suggested that spraying of soybean plant with TIBA at beginning of flowering caused the plant to change from vegetative to reproductive development more rapidly than normal, treatment also reduced the plant height, increased branching, dry matter and finally seed yield. This application altered canopy, morphology and allowing better light distribution.

Shibles and Weber (1965) suggested that great genetic variation exists in particular variety of crop with regards to the capacity of total dry matter, soil type and other environmental condition.

Jee Burton and Curley (1966) reported in field study of soybean, an application of one ounce/Acre of TIBA during early bloom period, reduced plant height by 16% increased branching, shortered leaf petiole. Pod number were increased by 4 to 15% and were concentrated on the lower branches; lodging was minimal.

Singh (1966); Shibles and Weber (1966) reported that the higher net assimilation rate might be due to increased photosynthetic efficiency through conversion of solar energy.

Adedipe et. al. (1968) and Reid and Crozier (1970) studied the effect of CCC and found that CCC at lower concentration promoted plant height but at higher concentrations reduced plant height.

Vetter et.al. (1970) found in linseed that 100-300 ppm TIBA solution when applied to linseed, inhibits appical dominance and break lateral bud dormancy, but the timing of treatment was critical. The optimum time of application to give a significant increase in the number of lateral bolls was 6-8
weeks after sowing. Lira and Freytag (1971) reported addition of 5 ppm. TIBA reduced shoot height and fresh weight in soybean.

In soybean Clapp (1973) concluded that 38 g TIBA/ha applied at the 4, 6 or the 2, 4 and 6 trifoliate leaf stage, average seed yields without TIBA were 2.3 t/ha and TIBA gave yield increase of 7-9.8% with no marked difference between single and multiple application. TIBA reduced plant height by up to 13.3%.

Lovett and Campell (1973) reported that plant height and dry weight of stem reduced due to use of CCC in sunflower grown under moisture stress condition in New South wales (Australia). Again he suggested 4000 ppm chlormequat at the 2 leaf stage increased stem and petiole width and decreased internode length and total photosynthetic area in sunflower.

Rajput and Saxena (1973) studied in soybean that foliar application of 40 g TIBA/ha application at the preflowering stage decreased height, reduced lodging, increased chlorophyll contents and pod number, decreased seeds/pod and 1000 seed weight and increased seed yield.

Pandeya et.al. (1974) noted that CCC spraying as 0.2% solution on mustard increased the LAI at 66 days after sowing mainly due to reduced competetion of raw materials.

Chu and Cheng (1975) observed in soybean, that TIBA, particularly at higher rate (240 mg TIBA/l at pre and post flowering) decreased plant height and leaf area compared with untreated control. Post flowering application of 80 mg TIBA/l increased seed yield from 2.69 t/ha in untreated control to 2.78 t/ha.

Orchard (1976) applied 4000 ppm chlormequat as foliar spray on sunflower and found that this application reduced mature plant height and decreased transpiration for 2 week after application. Chlormequat resulted in an
immediate reduction in growth followed by a more rapid growth rate. It was suggested that higher seed yield were due to delayed leaf senescence and that chlormequat, by inhibiting leaf expansion imparted drought avoidance ability.

**Rahman et.al. (1977)** recorded in decapitated seedlings of flax and peas, with intact or reduced cotyledons, dry matter production by axillary bud of the cotyledons increased with the reduction in cotyledons size. Application of GA and BA promoted drymatter production by axillary buds, whereas IAA and TIBA inhibit it.

**Harti et.al. (1977)** found in soybean that a foliar spray of 56 g TIBA/ha gave seed yield of 2.51 t/ha compared with 2.25 t with inoculation + NPK, 1.95 t with inoculation + TIBA, 1.45 t with inoculation, 0.9 t with TIBA and 0.56 t without them.

**Baylin and Dicks (1978)** noticed that NAA has increased the photosynthetic activities in groundnut.

**Chowdhury et.al. (1978)** noticed that foliar application of 50 mg TIBA/l to soybean increased all yield components except for 100 seed weight. Maximum increases in number of pods/plant (67.1%) and number of seeds/plant (53.8%), weight of seeds/plant (70.2%) and 100 seed weight (5.9%) were obtained.

**Gej and Wlodkowski (1978)** recorded the foliar application of 3 mg chlormequat/plant increased grain yield, DM yields by 14-17%, increased the number of grains/ear by 26-29% and increased the translocation of assimilates to the grains from other plant parts in wheat.

**Orcutt et.al. (1978)** applied 0, 5 and 10 kg CCC/ha on sunflower plants 36 days after sowing and recorded, the seed yield and oil content were increased by the application of CCC under dry soil condition. It was observed that where differences existed in oil content as a result of application rate, time of
application, there was an inverse relationship between non structural carbohydrate and oil content.

Oritani (1978) stated that TIBA reduced leaf expansion and increased photosynthesis activity. The effect of TIBA were greatest under condition where leaf expansion tended to be large. From the results it was concluded that photosynthetic activity of soybean leaves is regulated through protein metabolism and this in turn, is under the control of hormones that are concerned with leaf expansion.

Shrivastava et.al. (1978) reported in pot trial, two linseed cultivars were given 50-150 ppm TIBA as spray at 5 growth stages beginning 15 DAS. TIBA especially in 50 and 100 ppm concentration increased the number of primary and secondary branches, seed weight/plant, 100 seed weight and seed yield. Flowering was delayed upto 20 days at the concentration 100 ppm when sprayed at 15 DAS. It is interesting to note the number of fruiting branches which are not developed otherwise is made to develop by TIBA application. However, the increase in yield by TIBA application is not entirely due to increase in fruiting branches, but also due to larger seed size.

Arvindakshan et.al. (1979) found that NAA improved fruit set compared with control. NAA 20 ppm gave 28.2% fruit set. Fruit set at 10 and 30 ppm was 27.8 and 24.0% respectively and in control it was 19.28 in mustard crop.

MC Cormick and Poll (1979) showed in soybean that crop heihgt was reduced in each year by 3-20% through shortening of the internodes with the greatest height reduction at the 47g TIBA/ha. Yield of soybean showing normal to above normal growth vigour at flowering could reasonably be expected to be increased 15% by TIBA application at 19 g/ha.
Patel and Singh (1979) recorded higher seed yields and water use efficiency in sunflower with 0.03% cycoceol spray applied at the 7th leaf stage.

Sharma and Shah (1979) found that foliar spray with NAA (6.25 ppm) increased grain yield by 40% which appeared to be associated with the increase in the number of seeds/pod in sunflower.

Berthakur (1980) sprayed soybean crop with 25, 50 and 100 g TIBA/ha at 25 and 45 DAS and concluded that the concentration increased yield by 18, 18 and 23.7% respectively in 1st year and by 38, 33.7 and 33.6% in second year. TIBA significantly increased number of branches and pod/plant and plant dry weight.

Eweida et al. (1980) in soybean reported that plant height, number of pods/plant and 100-seed weight were maximum with 15 kg P2O5/feadan and 50 ppm CCC.

Pain and Sarkar (1980) found in soybean that with increasing concentration (10 to 100 ppm) of NAA, plant height, and leaf area decreased and stem diameter, root length, chlorophyll content, 1000-seed wiehgt seed oil content increased. NAA accelerated different growth stages and maturation.

Welebir and Bigelow (1980) elucidated that application of TRIA caused an increase in fresh weight, earlength, number of ears and thereby the economic productivity of beans. As reported by Yadav and Patil (1980) MH, B-9 and CCC as foliar spray inhibit cell division. Maximum retardation of shoot length by 10,000 ppm B-9 followed by 5000 ppm MH and 10,000 ppm CCC respectively.

In sunflower Bhattacharjee and Gupta (1981) found that 500 mu g CCC/cm2 produced a significant reduction in plant hieght leaf number and stem diameter., CCC at lower concentration increased the stem diameter.
Sharma and Shah (1981) reported that seed yield was significantly increased to 901 kg/ha with 6 ppm NAA applied as a foliar spray.

Singh et al. (1981) studied the effect of CCC and Kaolin on grain yield and water use efficiency in dwarf wheat. They reported that CCC (40 ppm) increased the wheat yield by 17%. The magnitude of benefit being higher in the year of low rainfall.

Akao et al. (1982) tested B995, daminozide, CCC and bromocholine bromide in soybean. The results revealed that all growth retardants decreased growth of the main stem. CCC decreased the number of nodes on the main stem. Retardants suppressed petiole growth.

Bachyne (1982) suggested that $10^{-2}$ m CCC was more effective for reducing plant height and internode length in Brassica. Whereas it increased stem thickness, pod weight and final seed yield.

Daniels et al. (1982) emphasized that spraying of CCC at preflowering stage on mustard enhanced seed yields mainly due to reduction in vegetative growth and improvement in pod and seed setting ability in plants having indeterminate growth habit.

Madhusudana Rao and Reddy (1982) recorded significant reduction in plant height and increase in bolls/plant when rainfed cotton was grown with the use of CCC at 55, 75 and 95 days growth stage at Bapatala (A.P.).

Peat and Jeffcoat (1982) reviewed the work on TIBA and suggested that yield increase were not because it reduced flower number and seed abscission but because it changed the partitioning of assimilate in favour of sink. Rama Rao et al. (1982) reported that use of growth regulators viz; NAA and CCC significantly reduced the plant height and dry matter production of groundnut.
Castro et al. (1983) concluded that 0.05 mg Triacontanol/liter reduced DW to 11.7 g but promoted flowering, thus increasing reproductive growth at the expense of vegetative growth in sunflower.

Ries and Houtz (1983) reported when TRIA applied exogenously, it have been shown to regulate several physiological and biochemical processes in plants to cause increase in the yield. TRIA moves very rapidly into plant tissue and it is suggested that carbohydrate metabolism may be involved in the response of plant to TRIA mainly.

Wingham (1983) found that number of capsules per unit area is a function of total nodes and number of capsules per node.

Spaeth et al., (1984) suggested that the right approach to increase the seed yield is the improvement in total biological yield and for harvest index.

Synder and Carlson (1984) emphasized that the photosynthetic rates varied with genotypic variation in LAI which were major determinant of total biomass accumulation and the quantity of photosynthates available for economic yield.

Pando and Shrivastavsa (1985) studied the effect of 3000 and 5000 ppm cyococel (CCC) applied to sunflower at the pre or post flowering stage. The results revealed that plant size and leaf area were decreased when CCC was applied at any stage. An increase in yield and Harvest index was noted with 3000 ppm CCC applied at the preflowering stage. CCC 3000 ppm increased the translocation of sucrose from the leaf to the capitulum.

Prakash and Ram (1986) applied NAA 50 ppm on mango and found the highest increase in fruit retention over the control (360-400%). Generally NAA was the most effective auxin tried.
Basuchaudhuri et al. (1986) reported that decapitation and foliar spray treatment of 20 and 40 ppm CCC (15 days before flowering) given to soybean and results revealed that decapitation and 40 ppm chlormequat significantly increased seed yield.

Zang et al., (1986) reported that the rate of photosynthesis in leaves varied with growth stages, leaf position and growth year.

Ashraf et al. (1987) emphasized that when seeds of Raya soaked in 1000 ppm CCC, seed germination increased from 71.3 to 84.9% and yield from 20.4 to 20.9 g/plant. Number of branches, flowers and pods/plant also increased.

Cheema et al. (1987) found that application of cycocel, and Ehteral Ethephone on mustard responded upto 500 ppm concentration when crop was fertilized with higher rates of N, but spraying at the rate of 250 ppm concentration was quite enough with lower rate of N. They emphasized that CCC could be successfully sprayed in conjunction with insecticides required to control the insects in the crop.

Gaur et al. (1987) recorded that spraying of safflower plant with 400 ppm Miraculan, 50 ppm NAA or 50 ppm. Atrazine30 and 45 days after sowing increased seed yield by 16.4, 7.2 and 4.2% respectively from 1.13 t/ha without growth regulators.

Jadhav et al. (1987) concluded that a foliar spray of 0.5 ppm traicontanol decreased flower drop and increased the number of filled fruits/plant, seeds and seed weight/fruit, harvest index and seed yield by 13% in Lablab purpureus and 156% in Brassica juncea.

Pando and Shrivastava (1987) reported in pot trial with sunflower, application of foliar spray of 3000 ppm of cycocel (chlormequat) at
pre or post flowering stage increased seed yield/plant, 100-seed weight and seed oil content.

Saini et.al. (1987) concluded that CCC sprayed at the rate of 80 ml/ha in mustard at flower initiation stage significantly increased seed yield which was 4.5 q/ha higher over control (11.68 q/ha).

Knapp and Harms (1988) reported that application of CCC spray at the rate of 0.5% helped to improve grain yield of rainfed wheat and oat.

Kumari and Bharti (1988) studied the effect of foliar application of 20 or 40 mM CCC on sunflower. Results revealed that CCC increased relative water content and Leaf water potential but decreased osmotic potential and thus maintained positive turgor compared with control plants. Achenes were bold and 100 seed weight was significantly higher in plants treated with CCC compared with control plants.

Ravi Kumar and Kulkarni (1988) found that foliar application of 20 ppm NAA., 100 ppm CCC or 40 ppm TIBA to 3 Cv. of soybean at the 50% flowering stage had no effect on protein and oil content as compared to control. NAA increased the 100-seed weight. The seed from plants treated with NAA and CCC were slightly superior to those from plants treated with TIBA, in germination percentage, field emergence and seedling vigour index.

Singh et.al. (1988) studied the influence of CCC foliar spray on rainfed Mustard. Results indicated that seed yield/plant and per hectare showed rising trend due to CCC application upto 500 ppm concentration. Mainly due to improvement in siliquea/plant, seed index (100 seed weight) and HI. The oil content of seeds also improved with CCC application. Further increase in CCC concentration exhibited reduction in seed yield and oil content.
Al-Gharib and Yousif (1989) concluded that chlormequat (CCC) increased seed oil content in sunflower. There were significant interactions between urea rates and growth regulators.

Bisht and Chandel (1989) reported that at 30-45 days after sowing NAR and CGR were highest of soybean. Optimum plant stand for the highest NAR was 0.4 million plants/ha.

According to Imsande (1989) crop growth rate has been shown to reflect canopy assimilatory capacity of source strength and pod number determined shortly after R5, represented potential sink capacity at the start of the effective filling period.

Kar et al. (1989) found in safflower that CCC and 500, 1000 or 2000 aeg/ml increased the number of branches/plant when applied at 40 DAS but decrease them when applied at 70 DAS. CCC increased yield especially when applied at 40 DAS. This retardant maintained the level of chlorophyll, Protein and RNA content at a higher level for a long duration which would delay senescence.

Sahoo et al. (1989) concluded that foliar application of 20 ppm NAA, GA or IAA, 25 and 40 days after sowing increased RGR, NAR and plant DW in sesamum.

According to Singh et al. (1989), CCC spraying at 100 ppm on mustard at 30 and 60 DAS significantly gave higher seed yield under rainfed conditions. On an average, CCC gave 50% higher seed yield over control. On the other hand Subba Rao (1989) revealed significant increase in seed yield of green gram with TRIA.

Uppar and Kulkarni (1989) expressed that foliar application of 250 ppm TIBA, 15 ppm Kinetin or 2500 ppm cycocel (CCC) gave yields of 816, 593 and 475 kg/ha respectively. 120 kg N plus TIBA gave the highest yield of
1.24 t/ha. The values for 1000 seed weight and protein and oil contents were higher with TIBA than chlormequat (CCC) on kinetin in sunflower.

Devendrappa and Hoshamani (1990) observed that spraying of TIBA 75 ppm during 50% flowering, and 14 days after this date increased seed yield of sunflower. TIBA increased yield/plant, 100-seed weight, filled seeds/capitulum, and percentage seed set.

Kumari and Bharti (1990) studied the effect of cycocel (chlormequat) applied at the 7 to 8 leaf growth stage of sunflower and concluded that CCC reduced plant height and had no effect on root length, root; shoot ratio or leaf area. Chlorophyll, protein, amino acids total soluble sugars and starch contents were increased by CCC treatment. Santosh Kumari et.al. (1990) found same results with CCC application of sunflower.

Ghose et.al. (1991) tested the influence of the growth regulators Miraculan (a triacontanol based stimulant), Nutron (1-triacontanol) plantfox (alpha NAA), l Paras or mixtalol (long chain Alcohol) and N-triacontanol on selected oilseed crops. The results revealed that Miraculan and Nutron increased seed yield of Brassica campestris and B. juncea in 1984-85, while the combination of N-triacontanol with Paras or planofix increased DM accumulation of B. juncea in 85-86 and seed yield of this species in 86-87. Sesame seed yield were increased by Miraculan, Nutron and Planofix in 84-87 and by paras in 85. These growth regulators also increased linseed yield in 1986-87 and safflower yield in 1985-86.

On Sunflower, Kene et.al. (1991) tried some growth regulators viz NAA (10, 20, 30 ppm) MH (100, 200 and 300 ppm) ethrel or ascorbic acid or were not sprayed at 35 DAS. The results revealed that with all growth regulators the highest application rates produced the highest seed and oil yield. Growth regulators increased the percentage filled seeds from 69% to 74-85%. The
number of filled seeds/capitulum was highest and the number of hollow seeds lowest in crops treated with 30 ppm NAA or 300 ppm MH.

**Kene et.al. (1991)** tested two growth regulators viz Planofix (NAA-10 to 60 ppm) and cycocel (CCC 250 to 1500 ppm) on sunflower sprayed at bud stage and revealed that seed and oil yields, and HI were increased by both growth regulators, and were highest at the highest application rates. Plant height decreased by CCC but increased by higher rates of NAA. DM yield was increased more by CCC than by NAA. Both the growth regulators increased the number of filled seeds/capitulum, percentage filled seeds, 100-seed weight and oil concentration in the seeds.

**Ravi Chandran and Ramaswami (1991)** conducted a field trial with soybean and sprayed the plant with TIBA at 25, 50, 75 and 100 ppm at preflowering stage. The results of the study revealed that 50 ppm foliar spray of TIBA increased source-sink component relationships. It had a curvilinear response of the DM accumulation. The source size in terms of LAI showed an increase of 11%. The application of TIBA decreased the LAI and 100-seed weight. This may be due to the improve crop architecture brought through the chemical manipulation. The increased RGR and NAR to the magnitude of 60% was observed. The foliar application of 50 ppm TIBA increased seed yield considerably by increasing seeds/pod and number of pods/plant.

At New Delhi, **SaiRam et.al. (1991)** observed that chlorophyll (a and b) content in leaf and grain yield of wheat increased due to the foliar application of CCC under moisture stress condition.

**Baghel and Yadav (1992)** reported in Urid that NAA was significantly superior to GA and IAA in enhancing LAI, NAR and CGR at all the growth stages except CGR at pod filling. The concentration of 30 ppm was found optimum for increasing the photosynthetic capacity (NAR) and crop
growth rate, whereas photosynthetic efficiency increased up to 40 ppm as compared to control.

In U.K. Freer (1992) found that application of growth regulators viz. Chlormequat or mepiquat+ethepon on cultivar Atalante of linseed decreased plant height of linseed.

Heyland and Kammerling (1992) reported that growth regulator treatments, particularly with CCC at 0.99 kg a.i./ha, increased linseed yield but had negligible effect on fibre yield.

Kene et.al. (1992) concluded in a field experiment at Akola (Maharastra), safflower sprayed before flowering with 10, 20, 30 or 40 ppm NAA produced seed yield of 1.06, 1.11, 1.19 and 1.39 t/ha, whereas application of 100, 200, 300 or 400 ppm cycocel (chlormequat) produced seed yield of 1.31, 1.66, 1.69 and 1.73 t/ha respectively, compared with the untreated control yield of 1.04 or 1.05 t where water was sprayed. Application of growth regulators increased seed oil content.

Kumari and Bharti (1992) concluded that 20 or 40 ppm cycocel sprayed on sunflower under water stressed condition, photosynthesis rate in cycocel treated water stressed plants was higher than in control plants.

From Akola, Patel (1993) reported that spraying of triacontanol at the rate of 2.5 ppm significantly increased the number of green bolls, total drymatter, seed cotton weight/plant and test weight over control. He pointed out that seed cotton yield was higher due to less shading of bolls with application of triacontanol. The NAA application at the rate of 10 ppm also appeared to be equally good.

Guroo and Patel (1993) from Dantewada (Gujrat) elucidated that application of chlormequat in mustard resulted in significant increase in branches/plant, pods/plant nutrient uptake/plant and grain yield/plant over
control. The values were highest by spraying of 1000 ppm chlormequat at 30 DAS.

Prasad and Shukla (1993) reported that spraying of CCC in N-fertilized (80 kg N/ha) mustard crop significantly reduced plant height. It helped to increase the LAI and branches/plant and grain yield/plant. CCC spraying manifested higher percentage of increase in grain yield because of restricted excessive vegetative growth which diverted the energy towards reproductive organs.

Dashora and Jain (1994) tested foliar spray of 1 ppm triacontanol, 15 ppm GA and 2 x 10^{-5} M kinetin on soybean and found that the grain yield was 1.33, 1.30 and 1.20 t/ha respectively compared with 1.20 t in unsprayed control. Triacontanol treatment increased the rate of NPK uptake, while in combination with P it increased LAI also.

Deotale et al. (1994) found that foliar application of TIBA 1100 ppm increased seed yield by 25% and with 600 ppm it was 75% over the untreated control in safflower.

Hellstrom (1994) reported that in the high yielding B. juncea and B. napus variation in growth potential (initial relative growth rate) was the main cause of yield variation.

Kulkarni et al. (1994) carried out a field trial at Dharwad Karnataka on sunflower cv. Morden and KBSH-1 were sprayed with 250 ppm MH; 50 ppm TIBA, 1000 ppm cycocel or 100-1000 ppm Mepiquat chloride. Seed yield in untreated control was 1.79 t/ha, in mordern and 2.45 t in KBSH-1 compared with 1.81-1.93 and 2.46-2.68 t respectively in growth retardant treatments. Seed yield, number of filled seeds, 100 seed weight, seed filling percentage and HI were highest with 1000 ppm mepiquat chloride.
Mondal and Paul (1994) suggested variation in functional parameters in mustard. TDM, LAI and leaf area duration (LAD) were significantly increased at most of the stages of growth in irrigated situation. Starting from Low value, LAI, LAD reached a peak and then gradually declined. Among the growth attributes, CGR, leaf area ratio (LAR) and LWR increased significantly under irrigation. NAR decreased more in the irrigated plants than the rainfed plants at the later growth stages. LAR, and LWR declined throughout with increasing time and plant weight.

Pathak and Dixit (1994) concluded that seed yield/plant of sunflower was highest in cv-Ramson record and it was increased significantly with 250 ppm CCC spray before flower initiation. There were no further significant changes was observed at higher application rates.

Saunders et al. (1994) emphasized that chlormequat 1612.5 g/ha applied at 150 and 300 mm plant height (two stages), reduced plant height, straw weight and delayed the end of flowering. The number of fertile and infertile branches and number of capsules/plant and percentage sprouted capsules were all increased in linseed.

Shiv-kumar et al. (1994) studied the effect of TIBA on sunflower and revealed that application of TIBA increased seed yield with 500 ppm giving the greatest increases.

Usha Parmar et al. (1994) reported that oleic acid : linoleic acid ratio increased by CCC foliar spray. Oil percentage increased between 100 DAS and harvest at 155 DAS. Total yield was increased by the CCC treatment.

Anton et al. (1995) tried two growth regulators viz GA3 (50 and 100 ppm) and CCC (500 and 1000 ppm) at 30 and 60 DAS on safflower and established that plant height was increased by the application of both rates of GA3 but decreased by CCC. There was a positive interaction between the use of
growth regulators and N rates, with plant height, seed:blind capitulum ratio and seed yield as well as oil yields.

Arjun Sharma et.al. (1995) recorded more leaf area, LAI, LAD absolute growth rate, crop growth rate and TDM (except 30 DAS) at all crop growth stages of linseed.

According to Ghosh et.al. (1995) the highest yield of 1.34 t/ha was given by 80 kg N/ha + Tricontanol spray (21 and 42 DAS) in Indian mustard.

Kene and Sontakey (1995) evaluated NAA (10-60 ppm) and CCC (250-1500 ppm) at the bud stage and established that LAI, DM production, seed yield and seed oil content were highest with 1500 ppm CCC. Rajgopal et.al. (1995) found that Irrigation at cumulative pan Evaporation of 60 mm + foliar spray of CCC (250 ppm at peak flowering) gave the highest yield of 1.67 and 1.51 t/ha in Kharif and Rabi seasons, respectively.

Uppar et.al. (1995) concluded that TIBA (100 ppm 35 DAS) was the most effective at increasing number of filled seeds/head followed by 50 ppm TIBA. These treatments also gave higher percentage seed filling and seed yield/plant in sunflower.

Wang et.al. (1995) stated that water stress increased growth period and decreased DM, CGR, LAI, NAR and pod growth rate in soybean.

Deotale et.al. (1996) evaluated the effectiveness of 50-250 ppm TIBA and B-9 (daminozide) as foliar spray and found that CGR, Chlorophyll and N content and seed yield were increased by TIBA and B-9. The highest seed yield was obtained with 100 ppm TIBA or 250 ppm B-9 in soybean. Again Deotale et.al. (1996) Reported that the application of 600 ppm TIBA (40 DAS) gave the highest seed yield of 2.63 t/ha in safflower. TIBA application increased leaf chlorophyll and N content and crop growth rate.
Dwivedi et al. (1996) showed that LA and LAI of wheat and chickpea were higher at 60 DAS when grown after black gram and soybean, while in linseed these parameters were higher following black gram. Both SLA and SLW of linseed at 60 DAS were highest following rice. LAD and CGR in chick pea were highest and NAR at 60 DAS was lowest when grown after blackgram. CGR and NAR of linseed were highest after black gram.

In soybean Jain et al. (1996) noted that growth parameters (LAI, CGR, RGR) increased with age and decreased at ripening. Where as NAR decreased with an increase in crop growth.

According to Kumawat and Bansal (1996) grain yield of sorghum was highest with 80 kg N (3.36 t/ha). The foliar or soil application of triacontanol treatments produced similar yields of 2.90-3.05 t/ha which were significantly higher than those of untreated control (2.47 t/ha).

Kurt (1996) carried out a field trial in wales on two growth regulators. Linseed crop was given chlormequat and ethephone separately or together 28, 40 and 28 + 40 DAS. There were statistically significant effects of time of application of plant growth regulators on plant height, number of capsules/plant, number of seeds/capsule, 1000-seed weight and seed yield/plant. Merrien et al. (1996) reported that cycocel application reduced the lodging in linseed.

Refaat (1996) stated that seed yield of safflower increased with cycocel application upto 1000 ppm. Application of 1000 ppm CCC and topping at 60 DAS gave the highest seed and oil yields.

Rajput et al. (1996) found that the application of 500 ml/ha of cycocel (chlormequat) or 1.25 litres/ha of mepiquat chloride at flower initiation stage significantly reduced plant hiehgt and increased seed yield of mustard Cv. pusa bold by 38 and 32% respectively with the untreated control.
Vasudevan et al. (1996) investigated that if sunflower crop was sprayed with TIBA with or without NAA, Auxin + cytokinin or triacontanol the application of TIBA + NAA produced the highest seed yields and seed oil content.

Fayyaz-Ul-Hassan Sahi (1997) studied the growth rhythms of linseed and concluded that a progressive reduction in RGR was observed with the age of the crop giving the lowest values during maturity. A higher NAR was observed with lower densities but the magnitude of differences was smaller at later growth stages.

Kene (1997) tested 10-30 ppm NAA, 100-300 ppm MH Etherel or or ascorbic acid 35 DAS on sunflower and showed that spraying with 300 ppm M.H. produced the highest seed yield of 1.21 t/ha, followed by 1.11 and 1.05 t obtained with 30 ppm NAA and 300 ppm Etherel respectively.

Patil and Dhomne (1997) sprayed the sunflower cultivar with water or 50 ppm or 50 ppm CCC (chlormequat), TIBA or PCB (Paclorbutrazol) and noted that seed yield was highest with 50 ppm CCC or PCB.

Puste (1997) found that mean seed yield of rainfed safflower was 0.89 t in untreated controls and highest (1.33t) with 5 ml/litre Paras photosynth (Triacontanol and long chain alcohols) sprayed at 30 and 50 DAS and 0.25 ml/litre of planofix (NAA) at 40 and 60 DAS.

Krishnamurthy and Bhatnagar (1998) noted the DM and LAI at flowering were positively influenced by the final DM production. The effective area index of the stem was half and of pods was equal to the maximum LAI. CGR increased until flower cessation and then dropped. RGR, NAR and LAR declined constantly with the increase in age of the plants. Pod number and seed size varied with the seasons and seemed to determine final seed yield of rainfed mustard.
Leitch and Kurt (1999) studied the effect of single and repeated application of chlormequat and ethephon, either alone or mix on linseed. The results revealed that the reduction in main stem length was dependent upon the type of growth regulator and the timing of its application. Chlormequat alone was consistently more effective than ethephon alone. While a mixture of two at half rates was similar to chlormequat alone. The largest reduction in main stem length (16.6% with chlormequat and 6.1% with ethephone, averaged over the two years) were achieved when the PGRs were applied when main stems averaged 22-23 cm in length. Application of both the PGRs increased tillering and increased significantly the number of stems per unit area at maturity.

2.2. Correlation and Regression studies

Association analysis studies will give an idea about mutual association of any two variables. In this head, an attempt was made to review the nature of association of different characters of oilseeds.

Asthana and Rai (1970) reported that seed yield was positively correlated with number of pods in til.

Kandaswami (1973) studied ten characters of 38 inbred liner of niger. The yield was significantly and positively correlated with number of nodes, branches and capitula per plant.

Bagri (1973) in niger concluded that yield/plant was highly and positively correlated with all yield attributing characters except for branches. The different yield components also showed favourable positive association with each other for 1000 achens weight, with number of branches and number of heads per plant.

Yadav (1973) studied correlation in Indian mustard and revealed that number of seeds per pod was closely related with yield.
Sanjeevaih and Joshi (1974) elucidated that there were the highest positive genetic correlation between height and nodes followed by height and number of main branches. A strong genetic correlation was found between capsules and number of branches. Yield was strongly correlated with capsule number in sesame.

Mehrotra et al. (1976) reported during his experiment with Indian mustard that LAI and seed yield were highly correlated. Net photosynthetic rate was negatively correlated with yield during early growth. Number of seeds per pod and 1000 seed weight were not related to yield. Biological yield, HI and pod production per plant were positively correlated with seed yield. Profuse branching increased yields. Biological yield was an important factor in determining seed yield, also pod per plant and HI.

Tak (1976) while working on eleven brown sarson, twelve yellow sarson and thirteen toria varieties, reported that in all three forms, the seed yield was significantly correlated with number of seeds per siliqua.

Buss and Aung (1979) reported there was no significant variation in RGR or NAR amongst various soybean cultivars and none was found closely correlated with seed yield. Dunphy et al., (1979) concluded that the seed filling period was positively associated with seed yield.

Makne et al. (1979) found in safflower that seed yield showed a positive and significant genotypic correlation with height, number of capitula per plant, seeds per capitulum, capitulum size and 1000-seed weight.

Ahmed (1980) while working on two species of mustard noted that seed yield was positively correlated with pod length, number of pods per plant, number of seeds per pod and seed weight per pod.

Sharma et al. (1982) reported highly significnat and positive correlation of seed yield with NAR from pod development to physiological
maturity. LAI differed significantly amongst genotypes at pod development and physiological maturity, but was similar at flowering.

Gupta and Labana (1983) reported in sesame that seed yield was significantly correlated with flowering days, number of branches, capsule per plant, plant height and length of fruit bearing branches.

According to Egli et al., (1984) yield was strongly correlated with genetic and environmental effect on length of effective filling period. Myakushko (1984) established that number of pods per node, with number of seeds per pod and 1000-seed weight had positive correlation with number of pods producing nodes per plant in soybean.

Yao et al. (1987) reported that heritability estimates were highest for growth period, number of nodes on main stem and number of seeds per pod. Seed yield per plant showed a high genotypic correlation with growth period, nodes per main stem, pods per plant and 100 seed weight in soybean.

Khorgade (1988) in linseed, established that seed yield showed positive and significant correlation with number of branches/plant, number of capsules/plant, 1000-seed weight and oil content. Number of capsules/plant and 1000-seed weight were the most important components governing yield and were recommended as selection criteria.

Patil et al. (1989) showed that the plant height and number of capsules/plant contributed substantially to increasing linseed yield, whereas a greater number of branches/plant had an adverse effect.

Yao (1989) confirmed that HI had negative correlation with growth period and number of nodes on the main stem in soybean.

Bramm-A et al. (1990) noted in linseed that Oil yield per plant was closely correlated with total plant dryweight; 50% of the total DM was
produced during the vegetative phase and a further 30% between the appearance of 1st capsule and the end of increase in plant height.

Jagadev (1990) concluded that among 20 linseed genotypes evaluated, variability for HI was high but lower for enocmic yield and biological yield. Correlation analysis indicated a positive association between HI and both economic yield and biological yield.

Song et al., (1990) observed positive association between seed weight and number of days to maturity and length of flowering period in soybean, but a negative correlation between seed weight and other agronomic traits.

In linseed Khoragade et al. (1992) found that seed yield was positively and significantly associated with seeds/capsule, capsules/plant, oil content, 1000-seed weight and branches/plant at both genotypic and phenotypic levels. These traits were also significantly associated among themselves.

Scheer-Triebal and Bartsch (1992) in linseed reported that Oil yield is dependent on seed yield, less on oil content and least on 1000-seed weight. A strong correlation between fibre yield and the components total length, technical length and straw yield was found.

During his study association of some physiological determinants with seed yield in soybean Sharma and Sharma (1992) noted positive and significant association for yield with leaf area and LAI at 1st flowering stage and with LAD at 50% flowering. Significant positive correlations were noted at all growth stages between LA, LAI; LA and LAD; dry matter and CGR; CGR and RGR; CGR and net assimilation rate; RGR and NAR; and LAI and LAD; Significant negative association was seen between leaf Area Ratio and NAR and NAR and LAD at all stages. LA, LAI, and LAD were the most important components for improvement of yield.
Amer et al. (1993) reported in flax that oil yield/plant was strongly associated with number of capsules/plant, except for early type of mutant. Positively and highly significant correlation was found between seed yield/plant and oil yield/plant or number of capsules/plant for the all genotypes. Oil content of seed was positively correlated with oil yeild/plant and seed yield/plant of the fibre type mutant. The oil type mutant showed a positive correlation between oil content and number of capsules/plant.

Chourasia and Dixit (1993) found that Plant height and 1000-grain weight were significant correlated with grain yield in linseed.

Gonzalez et al. (1993) concluded a negative correlation between yield of linseed and the duration of the sowing to flowering period (r=-0.7). The correlation found between seed weight and oil content was negative, whereas that between oil content and flowering period was positive. It appears that oil content could be increased by selecting late material.

Information derived from yield correlation by Agrawal et al. (1994) revealed that yield is highly and positively correlated with crop biomass/ha, number of capsules and capsule weight/plant, number of seeds/plant height, dry weight/plant, branches plant, test weight and seed yield (r=0.99 to 0.89). Regression analysis indicated that the most important characters contributing to seed yield/ha are seed yield/plant followed by number of branches/plant, test weight, capsule weight/plant, HI and dry weight/plant in linseed.

Mondal and Paul (1994) found in linseed that seed yield of the irrigated plants was positively correlated with preflowering LAI and the post flowering CGR and NAR. In the rainfed plants, seed yield was positively correlated with LAI and CGR at the post flowering stage and negatively with post flowering NAR and preflowering LAR.
Studies of Muduli and Patnaik (1994) on correlation and path analysis of linseed indicated that seed yield had high positive correlation with capsules/plant and moderate positive correlation with seeds/capsule, and significant negative correlation with 1000-seed weight. Path analysis revealed that capsules/plant and seeds/capsule were the major components determining yield.

In linseed Kurt (1996) found significant positive correlation between plant height and number of seeds/capsule and between number of capsules/plant and seed yield/plant.

Conclusion of Mahto and Mahto (1998) on correlation and path analysis studies in linseed revealed that seed yield/plant, number of capsules/plant, number of primary and secondary branches/plant had high genetic coefficient of variation. Seed yield/plant was correlated with days to maturity, plant height, number of primary and secondary branches/plant and number of capsules/plant. Path analysis revealed the highest direct effect on yield of number of primary branches/plant.

A correlation study of Mahto (1998) in 10 characters in Linseed (Linum usitatissimum) showed that yield was strongly and positively correlated with technical height, number of capsules, number of seeds/capsule and biological yield. The genotypes showed wide genetic divergence, substantially contributed to by the number of capsules/plant seed yield and biological yield, which were important characters in correlation.

Patil and Dhomne (1998) reported correlation of functional parameter, influenced by growth retardants. They concluded that NAR was strongly associated with RGR (r=0.696). Seed yield was also positively and significantly associated with RGR (r =0.371) in sunflower.
Popescu et al. (1998) concluded strong relationship between following pairs of characters: seed yield and number of capsules/m², oil content and oil yield, plant height and number of capsules/m², number of capsules/m² and oil content in linseed.

Leitch and Kurt (1999) reported significant correlation between main stem length and number of seeds/capsule.

Character association study of Mishra and Yadav (1999) in linseed revealed that number of seeds/plant, capsules/plant, branches/plant and seeds/capsule were positively and significantly correlated with seed yield. Seeds/plant, capsules/plant showed a high positive direct effect on seed yield.

Payasi et al. (1999) in linseed concluded that capsules/plant, secondary branches/plant and seeds/capsule had positive and days to flower initiation and days to 50% flowering had negative correlation with seed yield/plant.

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