Seedling Growth (Seedling Emergence): Gelmond et al. (1972) demonstrated that small cotton seeds were inferior to large ones in potential germination and emergence, also in the weight of fresh and dry material produced up to 10 days after emergence. Germination and emergence at 15 and 18°C were also highest in large seed. When tested under optimum conditions, emergence ability of hand threshed and combined threshed seed was similar; however, under stress conditions hand threshed seed was markedly superior in emergence, fresh weight and dry weight of material produced up to 10 days after emergence and other indirect tests of seed vigour. Gupta (1976) opines that seed size plays an important role in deciding the quality of soyabean. Larger seeds contain more food material but are subjected to severe field weathering and mechanical injuries during harvesting, processing and handling. Physiological as well as genetic factors both influence the seed size. Abdul-Baki and Anderson (1973) proved inferiority of small seeded variant in seedling vigour because lower rate of respiration is associated with low vigour in soyabean. Austin and Longden (1967) had shown the superiority of large seeds in producing more vigorous and better plants. It is more pronounced in
the case of deeper planting or unfavourable conditions in the early stages of growth, when the seedlings have a greater dependence on the food reserves of seed. But under favourable conditions and/or with the advance in the growth stage, the differences are generally less marked diminishing and in certain cases completely levelled off. The results of numerous studies on barley indicate that large seed produced plants of more vigorous growth in the initial stages than that of the small seeds (Baniaameur Iouzir and Caddel, 1976). Oexeman (1942) showed that importance of seed weight seems to the greatest during the earlier stages of plant growth. Edje and Burris (1971) demonstrated that large seeds and grading of soyabean showed no significant difference once the stand was established. Vasubramanian and Ramkrishnan (1977) concluded that the hundred seed weight of different size grades showed a close correlation with the size of seed in sunflower. Similarly the specific gravity also registered a progressive increase with the increase in seed weight and specific gravity. The top four grades were distinctly superior to the last two grades which consisted of unfilled, half filled and damaged seeds. The high percentage of germination and field emergence recorded by large size viable seeds could be ascribed to the stage food reserve contained in them. The seed size, seed weight.
and specific gravity may therefore, serve as indices of field emergence potential. The dry matter produced by the seedlings raised from the top grades was also high and a feature of interest was that the relative differences in growth and vigour were maintained throughout the crop period. Grading the seeds on the basis of size and weight in sunflower is therefore, desirable and may help to improve quality. Nazeer Ahmed (1977) revealed in his study that high germination percentage in seed lots is not the only criterion for measuring the physiological quality but the use of other supplemental tests viz accelerated ageing, cold test, seedling growth etc. may also be undertaken for assessment of seed vigour. This study also demonstrated that prolonged ageing beyond 72 hours under 45°C and 100 percent relative humidity is detrimental to sorghum seed. Lowering the period of stress or minimising the subjected temperature and relative humidity may bring back the normal ageing conditions for this kind of seed. Harper and Obeid (1967) demonstrated the importance of seed size in influencing field stand (uniform crop growth) and showed that size difference in seeds influence germination; seedling vigour, plant growth and yield characteristics in varieties of fibre and oil seed flax. Zapryanov and Popova (1975) concluded that investigations of seeds of two barley cultivars showed that
micro injuries to the endosperm and in embryo region delayed and decreased germination and decreased the number of primary rootlets and seedling height during early growth. Large seeds increased mainly the vigour of seedlings (their height and number of primary rootlets and a lesser extent, percentage and uniformity of germination). Hillon et al. (1976, c) showed that it was proved in many cases that large seeds take more time to emerge, as calculated according to Fick's second law of diffusion (soyabean, barley and maize). But this did not hold good in the case of groundnut. Hillon et al. (1976, a) also showed that the large seed take more time to emerge as calculated according to Fick's second law of diffusion in case of three soyabean varieties. The small seeds showed the highest and the large seeds the lowest emergence capacity even though the differences were not significant. Edward and Hartwig (1971) studied the seedling vigour in different isogenic lines. They found that small seeded isogenic lines had more seedling vigour than the large seeded isogenic lines. Johnson and Lendders (1974) concluded that seeds of different size did not show significant differences on emergence in soyabean (Glycine max (L.) Herr). Verma and Gupta (1975) observed differences in hypocotyl length in different soyabean varieties. Physiologically small seeded
varieties appear to be inferior to physiologically large seed one. Hicks and Dabney (1896) showed that heavier or larger seeds exhibited superior emergence, embryo size and fresh weight of roots, shoots and total plants. Large seeds performed better in terms of seedling vigour of three forage legumes (Carleton and Cooper, 1972). Godoy et al. (1974) concluded that seeds of soyabean or Santa Rosa, Vicoza and IAC-2 were divided into large, medium and small seeds and stored under controlled conditions at 25°C and 35% R.H. stored in laboratory conditions. Germination was proportional to seed size and decreased with storage time; the decrease being greatest in the small seed. Vigour measured by accelerated ageing was highest in small seed. Beillon (1973) concluded that in soyabean small seeds gave relatively better emergence than the large seeds. Large seeds exhibited a superiority over the small seeds in dry matter production of three week old shoots in the growth chamber and in the field. But the superiority was lost with respect to the dry weight of roots, total dry matter production and root shoot ratio at four weeks of age in the growth chamber. Significantly, taller plant at three weeks and non significantly taller at four weeks of age and final plant height stage, were produced by the large seeds, which showed some increase in the seed weight. These attributes
had no significant influence on the grain yield. Seed
(1977) found that the seedling raised from the bold seeds
were more vigorous, high yielding and aggressive than those
produced from the smaller seeds in broad beans (Vicia faba
L.). Bremner et al. (1973) proved the superiority of larger
seeds (in producing more vigorously and better plants) is
more pronounced in the case of deeper planting or unfavourable
conditions in the early stages of growth when the seedlings
have a greater dependence on the food reserves of the seed.
Newson (1964) demonstrated the superiority of larger
seeds separated on volume and weight could be related to the
initial capital which exhibited an initial advantage over
smaller ones in some crops. In sweet clover there is greater
emergence of small seeds (Raskins and Gorz, 1975). They also
showed that in varieties of fibre and oil seed flax large
seeds have been reported to give higher germination (Raskins
and Gorz, 1975). Gelmond (1972) carried out the studies to
evaluate the relationship of seedling vigour to population
density showed size differences in seeds influence germination
and seedling vigour in Gossypium hirsutum. It was shown that
the dry matter content depended upon the rapidity with which
the seedlings were able to grow and reach the autotrophic
stage. He reported greater increase in dry weight due to seed
size in *Gossypium hirsutum*. Thillon et al. (1976) concluded that there is greater emergence of small seeds. Seed size appears to influence the seedling establishment depending upon the protein content of the seed. Seeds with higher protein content produce more vigorous seedlings in *Phaseolus aureus*. Eogler (1954) showed that small seeds of crested wheat grass gave practically the same percentage of emergence, but at lower depths, large seeds gave relatively better emergence than the small seeds. Kneeborne and Gremner (1955) concluded that large seed produced plants of more vigorous growth in the initial stage than that of small seeds in some native grass species. Townsend (1972) concluded that seedling emergence in two milk vetch species performed better in large seeds. Bandhawa (1972) demonstrated that decrease in the emergence of small seeds of wheat (cv. Kalyan sona) under late sowing (unfavourable conditions due to low temperature) was observed despite no differences in the germination capacity of various seed grades in the laboratory. Smith and Camper (1975) opine that seeds of different seed size of soyabean did not show significant differences on emergences. Burris et al. (1971) concluded that heavier or larger seeds exhibited superior emergence, embryo size and fresh weight of roots, shoots
and total plants. They observed that although larger seeds produced larger embryos, relatively dry matter accumulation did not vary appreciably in soyabean. Black (1956) demonstrated that the reduced and slower seedling emergence with increase planting depth was obviously due to increased soil pressure upon the emerging cotyledon by which some of them failed to emerge in want of emergence force or it may be due to increased ethylene content in hypocotyl at deeper planting in subterranean clover (*Trifolium subterraneum*, L.). It was further shown that in herbage legumes large seed produced plants of more vigorous growth in the initial stages than that of small seeds. Zhvvarlinskaya (1976) demonstrated that the seedlings of dwarf wheats had shorter epicotyl than those of tall wheat. Sowing at greater depth produced longer epicotyl than sowing at shallow depth in both types of wheat. Seedlings grown from small seeds had shorter epicotyl than those grown from larger seeds of the same cultivars. Tiwari et al. (1976) demonstrated that the two categories of soyabean seeds (cv. Punjab) viz. small (ranging from 4.5 mm to 5.0 mm in diameter and 140 mg to 150 mg per seed) and bold (6.0 mm to 6.5 mm in diameter and 150 to 160 mg per seed) were grown under 2.5, 5.0 and 7.5 cm depth at the rate of 0.2, 0.4 and 0.6 million seeds/ha to study their influence on seedling emergence. The small
seeds exhibited significantly higher emergence potential (85.58%) than bold seeds (72.74%). Emergence capacity was reduced significantly at 7.5 cm depth, while 2.5 and 5.0 cm depth planting had higher emergence performance. Seedling emergence was significantly increased with the seedling rates. Significant interaction was noted only between seed size and planting depth. Blillon (1974) demonstrated that in field, glasshouse and growth chamber experiments in 1972-73 seed size in soyabean had no effect on the data at which vigorous growth stages were reached except that seedlings from small seeds in the glasshouse took longer to reach the 1st trifoliate leaf stage. Small seed had the highest germination capacity and rate but had smaller cotyledon area at three weeks old than the large seeds.

Germination - Seed has high degree of internal organization, both anatomical and physiological (Pollock, 1959). Pollock (1959) concludes that catabolic processes concerned with nutrient supply are localized in the cotyledons and/or endosperm which constitute the bulk of the seed. Anabolic processes associated with synthesis and growth are mostly localized in the very small embryonic axis. Since methods are available to enable us to work with the small amounts of the material present in the embryo axis, much more efforts
should be made to study the localization of processes within the seed (Pollock, 1959). This subject has been reviewed from time to time quite exhaustively (Carr, 1967; King, 1972; Heydacker, 1973; Mayer and Poljakoff-Mayer, 1975; Bewley and Black, 1978; Khan and Tao, 1978; Chin and Roberts, 1980; Saxena, 1981; Saxena and Singh, 1981).

Physiological effects of gibberellins and kinetin are well known in the literature (Thimann, 1963; 1972; Fales, 1965; Brian, 1966; Wilkins, 1969; Carr, 1970; Phillips, 1971; Steward, 1972; Krishnamoorthy, 1975; Kefeli, 1978; Leopold and Kriedemann, 1979; Moore, 1979; Skoog, 1979). Balcraya (1970) has very critically examined control of growth under the influence of gibberellic acid (GA) and kinetin (KN).

**Nucleic acid metabolism:**

During the early stages of germination there is a net increase in the RNA content of peanut cotyledons (Marcus and Feeley, 1962; Cherry, 1963, 1963a). It has been suggested by Barker and Douglas (1960) that the RNase of the growing tissues is involved in the synthesis of RNA.

There is a several-fold increase in RNase of the wheat endosperm (Matsushita, 1959, 1959a) and of barley endosperm (Le-doux et al. 1962), during the germination.

Natra et al. (1966) working with germination of wheat
seeds have revealed that during germination a loss of RNA and acid soluble nucleotides take place from the endosperm with a concomitant increase of RNA and soluble nucleotides of the embryo and seedling portions. However, they conclude that the microsomal RNA synthesized in embryo during imbibition and germination phase is of messenger RNA.

Similarly Hadi (1966) has shown in case of gram that there is 25% decline in both RNA and DNA contents during first three days of germination with concomitant increases in the specific activities of RNase and DNase.

Barker and Hollinshead (1964) also report a fall in the RNA content of the cotyledons during the first two weeks of germination in pea seeds. Fujisawa (1966) has also studied the role of nucleic acid and protein metabolism in growth and initiation of germination. Beavers and Guernsey (1966) observed that pea cotyledons had an initially high RNA content which declined during germination while the embryo axis RNA increased.

Varner (1965) concludes that during germination seed proteins are hydrolysed in the endosperm or cotyledon into peptides and amino acids which are translocated to the growing axis. The maximum rate of hydrolysis of the storage proteins coincides with the maximum rate of growth of the
seedling. Cherry (1963) has shown that during the germination of peanut seed over 60% of the dry weight of cotyledon and 70% of the protein is depleted. Uota et al. (1953) also concluded that the proteins which are a frequent reserves material in the seed are often broken down during germination with concomitant rise in amino acids and amides followed by de novo protein synthesis in the growing part of the embryo.

Josef et al. (1966) have recorded a decrease in protein content in germinating seeds of Phaseolus vulgaris L.

Amylase: The enzymes concerned with carbohydrate metabolism have been studied with particular attention to the amylase. Roller et al. (1962), Brown (1965) and Bonner and Verner (1965) have reviewed the work on changes in amylase activity during germination. Fleming et al. (1960) concluded that germination time was the most important factor influencing enzyme production in wheat. Hofmann et al. (1963) have pointed out that amylase increased approximately 3 to 4 fold during seedling development and then diminished. Kotel (1965) reports very little amylase activity in the air dry seeds of peanut, as well as in the initial stages of germination i.e. upto 3rd day. Thereafter the activity increased considerably with the increase in the period of germination.
Catalase and peroxidase: Siegel (1955) has pointed out the broad hydrogen donor specificity of plant peroxidases. It can act as mixed function oxidase (hydroxylase) and as an oxygenase (Buhler and Mason, 1961; and Nicholls, 1962). The enzyme has been implicated in respiration (Chance, 1964; Hackett, 1963), in synthesis (Riddle and Hazellis, 1964) and in breakdown (Goldacre, 1951) of IAA.

Peroxidase has been put forward as a constituent of terminal oxidation (Alexander, 1964), as an agent in the oxidation of metabolites by means of $H_2O_2$ byproduct (Bruton and Simmonds, 1963) and as a key component of the IAA O system (Ray, 1958; Mc Cune, 1961). Kaspevin (1964) concludes that when there was intense growth caused by GA, there was a greater peroxidase and lesser catalase activity in treated plants than in controls. Yokoyama (1956) has studied the relation of catalase activity the mitochondrial respiration and has pointed out that catalase directly effects the oxidation and reduction of cytochrome C oxydase system.

Stanislawski (1966,a) concludes that no statistically significant differences have been found in catalase activity between vernalized winter wheat seeds and nonvernalized seeds of both spring and winter wheat germinated to the same size.
Metabolism (Biochemical aspects): Tseng (1976) showed that in two indeterminate and three determinate soyabean cultivars, larger seeds contained a greater proportion of cotyledons and a smaller proportion of seed coat than small seeds. In indeterminate but not in determinate cultivars, protein and oil contents of the cotyledons and seed coats decreased with decreasing seed size. Kaufmann and Guitard (1967) showed that seeds with higher protein contents produce more vigorous seedlings and higher grain yield in barley. Milon et al. (1976,b) concluded that in *Phaseolus vulgaris* seed size appears to influence the seedling establishment and grain yield depending upon the protein content of the seed. Seed with higher protein contents, produces more vigorous seedling and higher grain yield. Boyd et al. (1971) showed that seed with higher protein content produces more vigorous seedlings and higher grain yield in barley. Demirlicakmak et al. (1963) concluded that seeds with higher protein content produce more vigorous seedlings and higher yield.

Morphological/anatomical studies: Grachchaninova (1975) showed that length and width of leaves, number of vascular bundles in then, number of stomata/cm² and their size increased from the tillering stage to the earing stage, whereas leaf thickness decreased. The widely spread *Triticum aestivum* and *T. durum* and their ecological groups
could hardly be distinguished by leaf anatomy. In the anatolian ecological group, *T. monococcum* differed from other species of the group (*T. durum*, *T. dicoccum*, *T. turgidum*, and *T. aestivum*) in having narrow leaves and greater number of longer sized stomata on the lower leaf surface which was ascribed to its more xerophytic nature. Yoshida (1976) demonstrated in seven barley cultivars differing in stomatal frequency, analysis of variance, showed significant differences in stomatal frequency and photosynthetic rate but not in transpiration rate. Positive correlations were found between stomatal frequency and photosynthetic rate (*r* = 0.94) and between stomatal frequency and transpiration rate (*r* = 0.86). For an increase of 1 stomata/mm² the hourly rate of photosynthesis increased by 0.207 mg CO₂/dm². Stomatal resistance tended to decrease as stomatal frequency increased. Transpiration was more affected by stomatal resistance to water vapour diffusion than photosynthesis. Correlations were found between stomatal frequency and heading data (*r* = 0.92) and stomatal frequency and plant height (*r* = 0.32). It was concluded that stomatal frequency can be used as indicator of photosynthetic capacity.

Photosynthetic efficiency and leaf area studies: Burris et al. (1973) reported that plants from smaller seeds of soyabean exhibited higher photosynthetic rate, however, the
largest seed size showed overall greater emergence percentage, leaf area and height in the field and yielded significantly more than the small size when grown at uniform populations. Black (1958) demonstrated that distinctly lower leaf area values registered in plants raised from small seeds had revealed its linear relationship to seed size in subterranean clover (Trifolium subterraneum). Growth development and yield: The relationship between seed size and crop development appears ambiguous. Large seeds generally take longer to emerge in accordance with Pick's second law of diffusion. Seedling vigour and yield of cereals and legumes (except soyabean) seem to be positively related to higher seed crude protein content. As small seeds tend to have high crude protein content it may be possible to obtain higher yield in most crops by using small seeds. But in the case of oil seeds (groundnut and soyabean) low crude protein contents were related to higher seedling vigour and yield. Plants from smaller seeds appear to be more efficient because of a better root system, rhizosphere or phyllosphere or higher photosynthetic capacity (Dhillon and Kler, 1976). Studies on wheat showed that the large seeds gave slightly more height, more tillers, higher number of grains and greater grain and straw yields, when grown on equal number of seed basis under competition (Dorovice, 1965).
Brenchley (1923), supported the earlier conclusions for short lived annual plants and reported that in seasons very suitable for the growth of cereals the benefit of increased crop yields, from larger seeds was not always demonstrated. Kelsted (1917) reported that the basal seeds and seeds in one seeded pods of soyabean which were the heaviest produced the poorest plants. Hies and Iverson (1973) showed that seed size appears to influence the seedling establishment and grain yield depending upon the protein content of the seeds. Seeds with higher protein content produce more vigorous seedlings and higher grain yield. But wheat is exception to this. Robinson (1974) showed that yield of sunflower was not found to be related with the seed size. Schmidt (1923) concluded that there was less variability in buck wheat, plants grown from seeds of the high to medium weight produced better plants. Myoung et al. (1974) reported that increase in seed weight as influenced by its size in sorghum. Lenkov (1975) showed that when the tall wheat cv. Kaukas and the dwarf cv. Burgas-2 were sown in mixed stands with the same number of seeds of different sizes for each cultivars, the cultivar with large seeds (2.8 mm) suppressed the growth of the other cultivar with small seeds (2 mm) irrespective of whether the other cultivar was tall or dwarf. The two cultivars in mixed stands gave higher grain yields.
especially under unfavourable weather conditions, than in pure stands. Shukla and Misra (1979) showed that sowing large (> 2.7 mm) medium (2.5 - 2.7) small (< 2.5) and ungraded seeds of two wheat cultivars gave similar grain yields. Sowing at 60, 80 and 100 kg/ha gave 2-year average yields of 3.82, 3.98 and 4.05 t/ha respectively. Payyan sona and C-306 gave yields of 3.28 and 3.62 t/ha respectively. Wahab et al. (1976) demonstrated that in field trials at Minia, Egypt in 1968-70 wheat cv. Giza 155 seed of 49.6, 43.1 and 36.5 g 1000 seed weight was sown at rates of 153, 214, 286, 357, 429, 500 and 571 seeds/m². Seed weight had no significant effect on yield or yield components. Grain yield increased with sowing rate in 1968-69 from 10.67 ardele/feddan at the lowest rate to max. of 429 seeds/m² than decreased with higher rates. Straw yield increased steadily with all sowing rates from 2.9 ton/feddan at the lowest rate to 4.13 ton/feddan at the highest rate corresponding maximum grain and straw yields in 1969-70 were 13.18 ardele/feddan and 4.12 ton/feddan respectively. Number of ears/plant, grains/ear, grains/spikelet, ear length, plant height, 1000-grain weight and grain volume all decreased with increased sowing rate in both year. Gilioli (1979) concluded that seed of soyabean cv. Prana, vicogja and sacluis were divided into large medium and small fractions, seed size had no effect
on emergence, survival or seed yield. In the early growth stages plant height was related to seed size. Plant height at flowering and yield varied with cultivars. Aguiar (1979) demonstrated that seed of soya bean cv. Bragg, Dare and Lee 68 was divided into 8 size classes with diameter from 11/64 to 18/64 inch. Quality of the large seed and small seed sizes was generally lower than that of seed in the size classes at or near the average size. Seeds of low quality represented only a small proportion of the seed lots and their removal did not significantly increase the quality of the batch. Wetzel (1979) demonstrated that processing of seed lots to give uniform seed size could not be used to increase yields in soya bean. Kalubarme and Pandey (1979) concluded that values for GGR, RGB, BAR, LAI, LAR and specific leaf weight (SLW) were determined in five Vigna radiata cultivars to understand the physiological causes of differences in their yields. The differences between cultivars for RGR and NAR were not significant; differences in GGR were observed at 28-35, 35-42 and 42-49 days after sowing. The changes in GGR, NAR, LAR and SLW were markedly pronounced with advancement of the developmental stages. During the flowering and early seed filling stages of different cultivars there was a marked decline in RGR and GGR accompanied by a decline in NAR, it was possible due to
an increase in the leaf area and consequent mutual shedding.

El-Zahab and Zahran (1976) concluded that large, medium, small and ungraded seeds of soyabean cv. (a) Ford, (b) Horsey and (c) Jackson were sown at Giza and Kafir El Sheikh in 1974. Large seeds produced the best early growth, more pods/plant and highest 100-seed weight and yield, 610 g/plot, compared with 343 g for small seeds. Cultivars did not yield significantly differently (506, 512, and 529 g/plot for (a), (b) and (c) respectively), though higher average yields were produced at Kafir El Sheikh (542 g/plot) than at Giza (488 g/plot). Hussain et al. (1973) demonstrated that the effect of seed size (small, medium and large) on germination percentage and yield of wheat cv. mexipak-65 was examined in a trial in 1968-69. Germination percentages were 60.4, 74.8 and 85.2% and grain yields were 29.53, 33.0 and 33.55 maunda/acre for crop grown from small, medium and large seeds respectively. Maddens (1976) showed that in trials in 1970-75 in west flanders, barley seed separated into size classes of (a) 2.2 - 2.5 mm (b) 2.5 - 2.8 mm and (c) > 2.8 mm with 1000 grains weight of 31.00, 39.63, 47.12 g, respectively was sown at 250 seeds/m². Average over experiments, grain yields of (b) and (c) were 3.6 and 4.5 % respectively higher than (a).

Simha and Kailasanathan (1976) showed that maximum number of shoot per m² was obtained from the very small sized...
seeds of wheat whereas the largest size seed produced only 414 shoots m\(^2\). However there was little difference in the dry matter production. This indicated that the individual shoot weight in very small was lowest, whereas it was maximum in treatment (i.e. big size). The grain yield was also maximum in big size wherein the largest sized seeds were sown. The grains produced from the small sized seeds were smaller than those from the bulk material, largest and middle sized seeds. This apparently, suggests that the small sized seeds once sown at the normal rate are likely to reduce the yield and also produce small size without influencing the genetic potential. It may be mentioned here that the maximum yield of Kalyan sone obtained when there are 400 shoots per meter square. Increase in number of shoots possibly can lead to competition.

Larger (heavier) seeds give rise to more vigorous plants and better yields, particularly when equal number of seed per unit area are planted. However if planted on equal weight basis the small seeds out-yield than large due to increased number of plants per unit area (Clark and Peck, 1968). Verma and Gupta (1975) proved the superiority of larger or heavier seeds in soyabeen varieties, particularly when equal number of seeds per unit area were planted. Evans (1973) proved in some common pasture species that large seeds performed better.
Kaufmann and McFadden (1963) concluded that the studies on barley showed that the large seeds gave slightly more height, more tillers, higher number of grains and greater grain and straw yields, when grown on equal number of seed basis under competition. Miller and Fanel (1901) demonstrated that there is greater emergence of small seeds and also proved the superiority of larger or heavier seeds in some leguminosae, particularly when equal number seeds per unit area were planted. Hicks and Dabney (1896) showed that larger or heavier seeds excelled in vigour, height, stem diameter, number of branches and pods per plant, dry weight, grain yield and in producing lesser number of barren plants. But the tap root length was reported to be longer in seedlings produced by small seeds. Dhillon and Kler (1978) demonstrated that the field studies conducted with a view to evaluate the effect of seed size on the growth and development of *Triticale* indicated that the seed size did not significantly influence its yield. The small seeds showed slightly higher capacity and significantly higher emergence rate than the large seeds. The extra time taken by the large seeds to attain a particular level of emergence was quite close to the Fick's second law of Diffusion. Sowing depth of 2.5 and 7.5 cm did not affect the growth and ear character, but sowing at 7.5 cm depth significantly lowered the yield. The results showed the possibility of obtaining slightly
higher yields and saving 30-35 kg/ha seed by using small seeds which pass through the sieve with a mesh size of 3.5 mm. Gupta (1976) concluded that physiologically large seeded variant is better in seed quality than small seeded one. However, the same cannot be said about the seed quality of genetically controlled variants in soyabean (*Glycine max* (L.) Merr).

Bremner et al. (1963) proved the superiority of larger seeds in producing more vigorous and better plants is more pronounced in the case of deeper planting or the favourable conditions in the early stages of growth, but under unfavourable conditions and/or with the advance in the growth stage, the differences are generally less marked, diminishing and in certain cases completely levelled off e.g. in wheat. Dhillon et al. (1976 c) found in groundnut, soyabean and sunflower an inverse relation of protein content of the seed used with the seedling vigour and yield. Merchetti (1949) reported higher yield from the small seeds of wheat. Selmond (1972) showed that size differences in seeds influence plant growth and yield characteristics in *Gossypium hirsutum*. Erickson (1946) reported that large seeds give higher germination. Also when plants were provided enough spacing for showing the maximum potential, all the seeds gave the same height, same number of tillers and equal grains as well as straw yield in alfalfa. Dhillon et al. (1976, b) showed that
seed size appears to influence the grain yield depending upon the protein content of the seed. Seeds with higher protein content, produce higher grain yield in *Phaseolus aureus*. Lies (1971) concluded that the yield of beans was not found to be related with seed size. Sivasubramanian and Kamkrishnan (1974) demonstrated that increase in seed weight as influenced by its size was reported in ground nut. Ahmed and Zuberi (1973) concluded that plants from larger seeds produced more fruits per plant, heavier seeds and higher seed yield per plant than those from small seeds, but had fewer seeds per unit in rape seed (*Brassica campestris*).

Singh et al. (1972) did not notice any significant difference in laboratory and field germination in various grades of seeds of soyabean cv. Harsoy, Clark-63 and Bragg. Kusselbatch (1924) proved the superiority of larger or heavier seeds particularly when equal number of seeds per unit area were planted. Kotowsky (1926) reported that the productiveness of cabbage was not to be dependent on the seed size. The small seeds, however, produced better quality heads. Kirichek and Temchenko (1976) showed that correlation between seed yields and seed characters were determined in 55 pea cultivars, yield were negatively correlated with seed size \( r = -0.349 \) and seed protein content \( 0.371 \) cooking time was positively correlated with protein content and with lysine content in
protein. Vester (1964) demonstrated that plants from smaller and medium sized seeds of the bush lima beans yielded considerably more when not crowded by larger plants from the medium and larger seed and from the larger seeds in the case of plants from the medium seeds. However, the size and height of the seedlings, fresh weight of plants and yield were positively associated with the seed size. These studies indicated the possibility of increasing yields of bush lima beans by sizing the seeds before planting and by planting the various seed grades separately to eliminate the overcrowding of small plants.

Dharmalingam and Ramakrishnan (1978) reported the poor quality of off coloured seeds irrespective of seed size classes in black gram. The normal coloured seeds were superior in quality and exhibited vigour differences due to seed size. Larger seed retained by 6 and 7 wire mesh sieves were better in quality than the smaller one. The study had clearly brought out the importance of grading black gram seeds and in that process the need for the removal of off coloured seeds to obtain seeds of superior quality.

Wilson (1977) showed that in field trials in Washington using randomly selected accession of tendril, the numbers of seed/plant, seed/pod, flowers/peduncle and peduncle/plant were greater on plants grown from 5 mm diameter or 7 mm diameter
seed. Correlation studies showed that seed yields were inversely related to seed size and plant height. Rigbe (1979) studied the effect of seed size in two hybrids CSH-1 and CSH-5. The lowest seed size was inferior to other size group in terms of seed vigour, laboratory germination and field emergence. However, the yield per plant and various yield components were not affected by seed size. However, even if the yield per plant is unaffected the inclusion of lower sized seeds results in a poor stand and this will adversely affect the yield. Seeds of soyabean cv. (a) Amsoy-71 (b) Beesoy (c) Call and (d) Clark 63 were separated into small, medium and large size and a further lot prepared by mixing equal proportions of the 3 sizes. Seed lots were sown in 1971-72 cultivar (a) yielded 42 bu/ac in 1971 and (b) (c) and (d) yielded 36, 44 and 41 bu/ac respectively, averaged over 2 years. There was no difference in yield between seed size (Johnson, 1973). Dilllon (1974) showed that in field, glass house, and growth chamber experiments in 1972-73 seed size in soyabean had no effect on the data at which vigorous growth stages were reached. At four weeks no difference in final plant height was observed, small seeds gave less lodging at maturity. At three or four weeks large seeds gave greater shoot / dm² but there was no differences in root/dm²; total dry matter or root shoot ratio at 4 weeks. In cv. Amsoy, small seeds gave higher yields than
medium or large seeds, but no significant differences were found in cv. Callord or corsey. In 1973 yields tended to increase as seed size decreased but the difference was not significant. Seed size did not affect the seed content of various elements. Bhillon et al. (1977) demonstrated that the studies conducted on the effect of seed size on the growth, yield and quality of Moong ML-1 with four seed sizes have indicated the possibility of getting slightly higher yield with significantly better protein content by using its large (> 0.36 mm) seeds. Large seeds showed the highest capacity and speed of emergence, although differences were not significant. The plants from the large seeds were taller with more leaves and dry matter accumulation than those from the small seeds. Grains produced by large seeds showed the highest germination capacity and protein content.

Presoaking treatment - Information available suggests that chemical stimulation of seed material to increase crop yield has been employed for more than 200 years. (Duhamel-du-monceau, 1763); Kidd and West (1918, 1919) examined the scientific aspects of seed treatment with chemicals and concluded that factors which influence the plant during the early stages of development may also profoundly influence its subsequent life history. They considered the size of the seed, degree of its maturity, soaking seeds in water and in solutions of various chemicals before sowing and
temperature as important factors.

Other workers have also tried the method of presoaking in solutions of nutrient salts to get an increase in yield (Tincker, 1925; Jone and Tincker, 1926; Smith and Bressman, 1930; Salim and Todd, 1968). True (1914) has reported the harmful action of distilled water on cells of various plants. Bacterial infection may probably be a contributing cause but not the main one (Tilford et al., 1924; Ouster, 1940). Exclusion of oxygen during presoaking may prevent germination (Bailey, 1933; Barton, 1950).

Comprehensive reviews on the action of auxin treatment on seed germination are given by Avery and Johnson (1947) and Kruyt (1954). Cholodny (1936) was the first to advocate hormonization of seed for accelerating germination.

Literature on the action of gibberellin on germination has been reviewed by Koller et al. (1962); Bonner and Werner (1965); Paleg (1965); Evenari (1965) and Patel (1967); Lonz (1956) and Kahn et al. (1956, 1957) were the first to demonstrate the promotive effect of gibberellin in germination of positively photoblastic seeds.

According to the findings of a number of workers, presowing treatment leads to increased tissue hydration, redistribution of nutrient reserves, heightened respiratory activity and in consequence of this enhanced seedling growth (Henkel, 1961; Korneev, 1963; Dawson, 1965).
In India presowing method was tried by Chinoy (1942, 1947) in wheat, and Harija (1943) in rice seeds. Basu and his associates (see Basu, 1976) advocate that presowing/pretreatment of the seeds with different organic solvents, phenols, inorganic salts is quite beneficial in better storage of seeds and viability of seeds is maintained better. However Harrington (1973) has shown that pretreating the seeds with salts curtails their life span.

Technique of pretreatment uniformly improves the rate of seedling emergence (Heydecker, 1973).

The absorption of nutrients and hormones by various plant parts has been revived (Baynton, 1954 and Wittwer and Teubner, 1959). Nutritional spraying of crops has been developed as an agriculture practice and has now achieved considerable prominence. There are many reports showing beneficial results if treatments are made during early flowering or fruiting (Wittwer and Teubner, 1959; Murty and Rao, 1968). Foliar application of GA has yielded better fodder yields in Sorghum (Joseph et al. 1968).

GA used as a foliar spray with different concentrations has also increased the length and weight of fruits significantly in Emin (Rao et al. 1968).

All the major growth and yield characters of a number of crop plants, such as rice, wheat, oat, barley, linseed, rye, gram, wheat-rye hybrid etc were found to be correlated with the length of growth period (see: Chinoy, 1968).