CHAPTER II

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Agronomic practices viz., seed-bed preparation, sowing methods and fertilizer application have great concern to improve the productivity of soybean crop. The augmentation of these practices in cultivation of soybean according to the suitability of soil type and weather conditions cause their variable influence on its productivity. Research workers have reported many valuable findings from their investigations made on these aspects. The available literature with regard to work done within or outside the country is briefly elucidated here :-

EFFECT OF TILLAGE OPERATIONS ON GROWTH AND YIELD:

Tillage means loosening of compact soil surface which provides favourable seed bed conditions for proper germination of seeds, good growth and development of plants and ultimately good yield of crops. Excessive tillage many a time may lead to deterioration of soil structure which may result in poor growth and yields. Moreover, excessive tillage requires extra energy and increases the investment in crop production.

Hughes and Baker (1977) reported that tillage operations by rotary implements decreased the stability
of soil structure to more extent than those of conventional tillage operations made by ploughs and harrows.

In East Virginia, Buss and Camper Junior (1981) postulated that sowing of soybean in no-tilled plot was an acceptable alternative to conventional sowing (sowing after ploughing followed by harrowing) provided weeds were controlled adequately before sowing. Similarly, Carter and Randall (1981) from South Minnesota (USA), also reported that seed yields of soybean did not differ between tilled and no-tilage treatments. They further mentioned that seed yields reduced by lack of adequate weed control with the no-tilage treatments. However, Tyler and Overton (1981) have found that germination of seeds, 100-seed weight and seed yields were superior in no-tilage treatment when compared with conventional tillage method at Wisconsin (USA).

Sidiras et al. (1983) made their studies over three years to compare the effect of no-tilage, chiesel ploughing and conventional tillage on water retention capacity, available water content and yield of soybean (Glycine max. L.) in Brazil. From the results they concluded that the yields of soybean (average of three years) were 2593, 2149 and 1948 kg/ha under no-tilage, chiesel plough and conventional tillage respectively.

Jain et al. (1984) studied the influence of different tillage operations including zero tillage on
upland drilled rice (*Oryza sativa* Linn.) at Jabalpur (M.P.) and from the results they concluded that unploughed seed-bed treated with paraquat before sowing enable direct seeding of crop by killing all the existing weeds emerged on the field. It gave an yield at par to normally ploughed plots, showing the preparatory tillage can be eliminated. They also mentioned that yield was too low in the plot of unploughed seed bed followed by direct sowing without destroying the existing weeds. The poor yield in this plot was mainly because of high weed competition with the crop since the begining but not due to absence of tillage.

Influence of different tillage operations on soybean during rainy season was studied in U.S.A. for seven years by Wrucke and Arnold (1985). The results revealed that soybean yields were equal under three tillage systems namely no-tillage, tillage with disc harrow and conventional tillage (with plough).

The results of an experiment carried out in Lousiana (USA) during 1984-86 revealed that soybean yields were higher with conventional tillage than conservation and no-tillage. Low yields in conservation and no-tillage plots were associated with poor crop stand and higher weed population (Anonymous, 1986). But according of another field experiments conducted at Winnsboro, Lousiana in 1982-86, it was emphasized that seed yields of soybean were unaffected by different tillage operation treatments.
(Anonymous, 1986). Confirming to above views, Knight and Lewis (1986) stated that zero-tillage did not delay maturity nor did it result in reduced yields except when there was excessive competition for perennial grassy weeds.

Oliveira (1986) reported that the conventional ploughing with mould board plough produced significantly better seed yield and 100-seed weight over the other tillage methods viz., direct drilling, tillage with harrowing, minimum tillage and conventional discing in soybean. On the contrary, Wiley (1986) reported that seed yields of soybean was comparatively higher with no-tillage over conventional tillage particularly when sowing was done in weed free seed beds by destroying the weeds with herbicide (Gramaxone). Dhillon et al. (1987) have also emphasized that rainy season maize crop did well under no-tillage condition compared with conventional tillage at Ludhiana in Punjab (India). Similar results have been reported by Dudas and Pelikan (1987) from Czechoslovakia.

While studying the influence of four levels of ploughing and four herbicides on fodder juar (Sorghum bicolor Moench) at Jhansi (U.P.), Singh (1987) observed that all the treatments receiving tillage operations reduced the weed infestation and gave significantly higher fodder yields over no-tilled treatment. Additional tillage over and above one ploughing without herbicide was not found to be statistically significant. However four plough-
ings produced maximum fodder yields. He further added that heavy tillage operations with machineries deteriorated the soil structure.

Sumarno (1987) found that soybean grown in tilled plot with weeding gave more yield than the crop grown without tillage and weeding at Bogor (Indonesia).

From the field experiments carried out on soybean at Palmira (Colombia) in a clay soils in 1984-85, Terreros et al. (1987) postulated that conventional tillage achieved most important of the soil physical conditions and best weed control followed by minimum and then no-tillage. Seed yield and yield components were greatest with conventional tillage. Minimum and no-tillage treatments produced lower initial plant density and greater mortality of plants than did conventional tillage.

In U.S.A., Webber et al. (1987) studied the inter-relation of tillage and weed control on soybean for three consecutive years during 1982, 1983 and 1984. From the results they concluded that when the rainfall was above to normal during 1982 the conventional tillage gave significantly greater seed yield of soybean than no-tillage for all weed control treatments except pre-emergence only herbicide treatment. Yields within the tillage systems and between weed control treatment in 1982 were not significantly different, but in 1983 and 1984 the yield from
no-tillage were equal or significantly greater than those of conventional tillage due to better retention of moisture which was utilized by soybean at most critical stage of pod filling in periods of drought years.

Vasilas et al. (1988) established from their investigation made in U.S.A. that seed yields of soybean were similar for mould board ploughing, chiesel ploughing and discing systems but were lower for no-tillage system.

Verma et al. (1988) emphasized that soybean gave more yield with higher benefit-cost ratio under no-tillage than conventional tillage under agro-climatic conditions of Ranchi in Bihar.

Yields and yield attributes of mungbeans were not much influenced by different tillage treatments including no-tillage at Hissar (Haryana) as reported by Gupta et al. (1990).

Under agroclimatic conditions of Sehore (M.P.), yield of soybean was significantly influenced by the various tillage methods and the highest soybean yield was noted in conventional tillage method which was numerically higher than minimum tillage and the lowest seed yield was noted in zero tillage (Anonymous, 1991).

Field experiments have been carried out at Jabalpur (M.P.) to evaluate the effects of tillage and
no-tillage on soybean. Results revealed that one hand weeding at 20 DAS or gramaxone 2 l/ha as post emergence on weeds and fluchloralin 1 kg/ha as pre plant incorporation or gramoxone post emergence on weeds and metribuzin 0.25 kg/ha pre emergence gave higher seed yield and lower dry weed biomass (Anonymous, 1991).

EFFECT OF SOWING METHODS ON GROWTH AND YIELD:

Placing of seeds inside the soil in such a manner to get favourable conditions for germination and then growth of the plants is called sowing. Both line and broadcast sowing methods are in vogue depending on the socio-economic status of farmer and agro-climatic conditions as well. These methods of sowing have their own merits and demerits as stated below :-

Chauhan et al. (1971) observed that weed infestation was one of the major problems for cultivation in kharif crops in Garsa Kulu (H.P.). They further noted that yields did not differ between line sowing and broadcast sowing methods, but line sowing provided easiness for weeding particularly during weeding peaks particularly at early stage of soybean crop.

At Pantnagar, Singh (1971) observed that depth of sowing from 3 to 5 cm provided best emergence of seeds. Sowing of soybean deeper to 5 cm restricted the emergence of seeds, while sowing shallower than 3 cm allowed poor
germination under soil moisture stress and also facilitated the damage of seeds by birds. He pointed out that it was difficult to maintain the proper depth of sowing under broadcast method of sowing, which resulted into slightly poor crop stand. Seed yields were statistically at par under both methods of sowing besides additional investment on elimination of weeds under broadcast method.

Koranne et al. (1975) reported that sowing of soybean on flat beds in rows 45 cm apart was significantly superior over broadcast method of sowing at Dehradun (U.P.) with regard to growth characters, yield attributing characters and yields.

At Pilwai (Gujrat), Mehta et al. (1976) observed that Isabgol (Plantago ovata Forst) when sown in rows gave higher yield than broadcast sowing because of superior germination resulting in to higher crop stands.

Singh and Modgal (1979) emphasised that drilling of seeds in rows provided easiness for manual weeding and intercultural operations, mainly during kharif season where severity of weed infestation was acute. They further stated that yields did not differ between line sowing and broadcast methods of sowing, if weeding could be done timely. Moreover, broadcast method certainly needed higher investment in weed control operations.

Field experiments were conducted for three years
(1972-1974) on clay loam soils of Jabalpur to see the effects of different methods of sowing on soybean. Results revealed that line sowing on flat-beds or ridges or flat-beds followed by ridging or cross bidirectional sowing gave significantly higher seed yields over broadcast sowing as a result of superior plant growth (Anonymous, 1980).

According to Beera (1980) broadcast method of sowing was easy, cheap and time saving and appeared to be equally good to line sowing method in respect of yield, if weed free environment was provided in wheat crop.

Results of field experiments conducted at Sagar (M.P.) revealed that line sowing method in soybean gave seed yield of 17.63 g/ha which was nearly 4 quintals more over broadcast method of sowing. This increase in yield in line sowing may be due to higher crop stand and suitability of better management particularly for weeding and interculture as compared to broadcast method of sowing (Anonymous, 1982).

From Jabalpur, Raghu and Choubey (1982) emphasized that line sowing was more remunerative than the broadcast sowing for different kharif crops like soybean, smaller millets, kodo (Paspalum scorbiculatum L.), kutki (Panicum miliare Lamk.) and urid (Vigna mungo L. Hepper) because of good plant population per unit area and effective utilization of fertilizer nutrients.
From the results of field experiments conducted at Panthnagar, Chandel and Saxena (1986) summarised that sowing of soybean in rows with the help of 'seed drill' or behind the desi plough with 'Pora' was preferably better than broadcast sowing. They further pointed out that broadcast method of sowing did not give uniform germination and it was difficult to do interculture operations in it.

While comparing the performance of various sowing methods in wheat at Mandsaur (M.P.), Jain et al. (1989) emphasized that seeds got uniform distribution and placement at desirable depth resulting in uniform crop stand and higher yields under line sowing method than that of broadcast sowing.

Rajput et al. (1989) established that different kharif legumes did well under line sowing method in respect of growth and yields than broadcast sowing at Morena (M.P.).

From Jabalpur, Sharma and Thakur (1989) reported that line sowing of soybean gave higher seed yield than broadcast method of sowing mainly because of higher crop stand as a result of good germination. As a consequence, line sowing method fetched significantly greater returns and energy output than broadcast method of sowing.

While studying on production factors limiting yield attributes and yields of rainfed upland rice at Ranchi (Bihar), Singh et al. (1991) postulated that variation
in yield and yield components was not pronounced between line and broadcast sowing in farmers' practice. This might be due to poor growth of the crop at low management level. However, in complete package, line sowing was most efficient in improving yield components and yield of crop as compared to broadcast. This low yield in broadcast seeding in complete package was due to uneven stand, poor growth rate and inefficient utilization of applied fertilizer nutrients.

EFFECT OF RHIZOBIUM INOCULATION AND NITROGEN APPLICATION ON GROWTH AND YIELD:

In general, it is the established fact that plants of leguminous crops fix atmospheric nitrogen by symbiosis. *Rhizobium* bacteria develop on root nodules and fix the atmospheric nitrogen. Part of this nitrogen is utilized by the bacteria themselves and partially used by the host plant or left in soil which may be utilized by the succeeding crop after mineralization. It is also well known that there are different strains of *Rhizobium* for different legume crops. During kharif season different legume crops viz., cowpea (*Vigna sinensis* Savi), green-gram (*Vigna radiata* L. Wilzeck), blackgram (*Vigna mungo* L. Hepper), tuar (*Cajanus cajan* Millsp.) and guar (*Cyamopsis tetragonoloba* (L.) Taub) etc. are popularly cultivated besides the soybean.

Inoculation of artificial culture (appropriate
rhizobium strain for a particular legume) on the dry seed surface just before sowing had shown promising influence on nitrogen fixation which resulted into good growth and ultimately the higher yields. These bacteria are decomposed in the soil after the harvest of crop, thus inoculations of the bacterial culture on seed surface become essential every year.

Nitrogen fixation can be much active, if the crop is healthy and the nutrient supply is adequate. The amount of nitrogen fixed per hectare by a leguminous crop depends on the number of nodules per hectare, their size and longevity, and the bacterial strains present in them. In turn, it also depends on the conditions of growth and management of the crop, and in particular on the availability of water and the nutrient status of the soil. Little is known about the effect of drought on the rate of nitrogen fixation by the legume crops, except that the nodules are shed from the roots of many legumes shortly after the onset of a drought, and this effect is particularly marked for many legumes in tropical and subtropical regions of globe.

Cartter and Hartwig (1962) stated that generally leguminous crops grown for seed purposes viz., beans, soybean, blackgram, greengram, chickpea, pigeonpea etc. reduced the nitrogen content of soil and the legumes grown for their leaf or fodder purposes like clovers (Medicago
spp.), *Trigonella* spp., lucerne (*Medicago Sativa* L.) and berseem (*Trifolium alexandrinum* L.) etc. increased the nitrogen content, though they did not necessarily.

In an agronomic investigation on soybean at Sabour (Bihar), highest seed yield, pod/plant and test-weight were obtained with the application of 120 kg N/ha. Seeds treated with bacterial culture affected significantly seed yields and pods/plant while test-weight of seed remained unaffected (Thakur and Hassan, 1972).

Weaver and Fredrick (1972) recorded that CGR increased with the use of bacterial culture inoculation in soybean. The results also suggested that the increase in the magnitude of CGR may be due to increased rate of nitrogen fixation, DM accumulation and higher LAI. But Singh and Saxena (1973) observed increase in DM content with the application of nitrogen up to 20 kg N/ha only and further increase in N supply did not cause positive effect on this parameter.

Hatfield *et al.* (1974) emphasized that efficiency of applied N in soybean could be improved due to artificial inoculation of seed with the bacterial culture before sowing in terms of initial good growth of plants.

Namdeo and Ghatge (1976) did not find marked changes in root nodules number due to rhizobium inoculation in black-gram at Rewa (M.P.). The inoculant proved
partially effective in increasing plant height, leaves, pods and seed yields, but it caused significant effects when applied in combination with phosphorus. They further added that rhizobium inoculation raised the yield only by 18% as against 22% increase through 20 kg N/ha over control (11.9 g/ha). Both inoculum as well as nitrogen helped in raising the protein contents of the seed. Regarding economics, the inoculum alone gave the maximum profits over per rupee of investment.

At Poona (M.S.), Sabale and Khuspe (1976) also observed that protein content tended to increase with the application of nitrogen but oil content showed declining trend with increasing levels of N. On the contrary, Chasney (1973) reported that protein and oil contents in soybean seeds were unaffected due to application of N.

According to Patil et al. (1976), two soybean varieties viz., bragg and Clark-63 responded well to nitrogen application. These varieties significantly responded to inoculum in the first year, however the response was not significant in the succeeding year. Inoculum with nitrogen and 80 kg P₂O₅/ha and inoculum with phosphorus and 60 kg N/ha gave yields at par.

Sorensen and Panas (1978) reported that seed yield, seed size and plant N-content were linearly related with the rate of nitrogen application upto 224 kg N/ha in U.S.A.
Shahidullah and Hossain (1980) while studying the effect of inoculum and N on soybean in Bangladesh, observed that nodulation was maximum when 40 kg N/ha was given to the crop.

Adrelean and Morea (1981) from Romania, reported that the capacity to form active nodulation (over 4 mm in diameter) in large number was a varietal characteristic in soybean. They also mentioned that nodulation activity was superior in high yielding varieties than that of low yielding varieties and it further increased with the use of bacterial inoculation or nitrogen application.

Khamparia et al. (1981) from Jabalpur (M.P.), noted that inoculation of rhizobium bacteria on dry seed surface in green gram at the time of sowing gave significantly higher seed yield over no inoculation (control).

Rastogi et al. (1981) conducted field experiments on soybean at Powarkheda (M.P.) to assess the influence of rhizobium inoculation. From the results they concluded that the inoculum did not affect root weight and volume significantly. However, there was significant increase in number of nodules and dry matter production of plant. More number of nodules per plant and rapid vegetative growth were noticed due to inoculated seeds. Plant height seemed to be influenced a little but differences were not significant. There was significant increase in number of pods per plant, number of seeds per plant and 100-seed weight
due to inoculation of seeds with rhizobium bacteria over no inoculation but there was no significant effect on average length of pods. Seed yields significantly increased due to inoculation in Bragg and Clark-63 varieties of soybean over no inoculation.

According to Joshi et al. (1982) application of nitrogen and phosphorus in black soybean had beneficial effect on nitrogen and phosphorus contents of plant at 45 days stage. While at maturity, application of nitrogen positively affected the nitrogen content (expressed as protein) of soybean seed as well as yield of soybean seed.

On the basis of results of two years field experimentation on soybean in clay-loam soils of Jabalpur (M.P.), Bisen et al. (1983) concluded that use of bacterial inoculation alone gave significant increase in primary and secondary branches in the first year of experimentation and significant increase in grain yield per plant in both the years. They further added that application of 25 Kg N/ha resulted in significant increase in all yield attributing characters like primary and secondary branching, number of pods per plant and grain yield per plant in both the years.

Chamber (1983) reported that increasing rates of N supply in soybean crop differentially reduced mean nodule number/plant under inoculation receiving treatment
while it was unaffected under uninoculated treatment. But dry weight of nodules/plant was reduced with increase in rate of N application under both inoculated and uninoculated treatments.

In Brazil, Scholles et al. (1983) postulated that nitrogen application to soybean decreased the nodule dry weight. They also recorded that nitrogen application raised the available nitrogen content in the soil during the first year of experimentation, but it had no such influence in the next year.

According to Sharma and Pahalwan (1983), there was significant increase in number of nodules/plant, seed yield and nitrogen contents in seed, when soybean seeds were sown by inoculation of rhizobium culture over no inoculation at Kharagpur (West Bengal).

In Romania, Prodan and Prodan (1986) studied the effect of application of 0 to 180 Kg N/ha on soybean without inoculation and inoculation with *Rhizobium japonicum* for four years. From the results they summarised that seed yields increased from 2.60 to 2.79 t/ha (at 0 kg N/ha) with uninoculated seed and from 2.89 to 3.08 t/ha (at 120 kg N) with inoculated seed.

Bisen (1986) has recorded maximum seed yield of soybean at Jabalpur with the application of 30 kg N/ha
along with 60 kg P₂O₅ mainly because of increased DM Production/plant, pods/plant and seeds/plant.

At New Delhi, Kothari and Saraf (1987) recorded that seed inoculation with Rhizobium culture along with Azotobacter chroococcum increased seed yield of green gram by 16.9% over no inoculation and was superior to inoculation with either Rhizobium alone or in combination with Azospirillum brasilense.

While studying the effect of bacterial inoculation and nitrogen application on the yields and yield attributing characters of soybean at Mymensingh (Bangladesh), Alam et al. (1988) found that the combined effect of inoculum and nitrogen application produced significantly highest plant height, leaf area, branches, pods and seeds per plant, 100-seed weight, protein contents and yields per unit area over all treatments. The effect of inoculum alone was found to be higher for leaf area per plant, number of branches, leaves, nodules and seeds per plant and seed yield over application of nitrogen alone.

Different field experiments were conducted at Sehore (M.P.) to study the effects of rhizobium inoculation and nitrogen application on soybean for two years. Results revealed that inoculation of seeds with rhizobium culture gave 3.62% higher seed yield over control (1037 kg/ha). Seed yields obtained with the application of 20 kg N/ha was statistically at par to rhizobium culture treatment.
But rhizobium inoculation supplemented with 20 kg N/ha proved better than inoculation alone or 20 kg N/ha alone. It was further noted that split application of 20 kg N/ha (half at sowing and half at 30 DAS) with rhizobium inoculation of seeds was found to be suitable for increasing the soybean yield. In another experiment different rhizobium inoculants viz. Parbhani, Pantnagar, NAFED, IARI-2 and Bangalore were compared for their efficiency on nitrogen fixation in soybean. The results indicated that the highest seed yield (10.35 q/ha) was recorded by the Parbhani inoculant followed by IARI-2 (9.38 q/ha). All the inoculants produced significantly higher seed yields over no inoculation treatment mainly due to increase in number of nodules and dry weight of nodules (Anonymous, 1988).

At Mandsaur (M.P.), Jain et al. (1988) found that nodules/plant and seed yield/plant increased by rhizobium inoculation in soybean and pigeonpea.

Maiti et al. (1988) reported that application of nitrogen or inoculation of seeds with rhizobium culture was equally effective in increasing the number of nodules/plant in green gram.

The results of field experiments conducted on summer green gram at Navsari (Gujrat), indicated that application of 10 kg N + rhizobium inoculation and 20 kg N/ha were at par but gave significantly higher seed yield and
values of plant attributes than control. Beneficial effect of rhizobium inoculation on yield attributes and nodulation can be expected to exert the same influence on final yield. This suggested that seed inoculation with efficient rhizobium culture helped in reducing the inorganic N-requirement of green gram crop to the extent of 10 kg/ha (Patel et al., 1988).

On sandy loam soils of New Delhi, increase in level of N-application upto 40 kg N/ha increased the total number of developed pods/plant in groundnut, although their dry weight did not record similar trend. The pod yield responded significantly to nitrogen application only upto 20 kg/ha. The oil content increased significantly only upto 20 kg N/ha. Whereas marked increase in protein content was recorded with each increase in N dose upto 40 kg/ha. Test-weight was unaffected by inoculation as well as nitrogen application (Roshanlal and Saran, 1988).

Findings of Shaktawat (1988) revealed that seed inoculation with rhizobium produced significantly higher seed yield of cowpea over uninoculated seed.

Agrawal and Bhati (1989) reported that the seed yield of kidney bean (Vigna aconitifolia (Jacq.) Marechal) significantly increased with application of nitrogen and the maximum seed yield was produced with 20 kg N/ha in a two years field experimentation. The yield attributes
increased with increasing dose of nitrogen up to 20 kg N/ha. Seed inoculation with rhizobium culture did not influence the seed and fodder yields significantly.

Field experiment was conducted for two years during 1981 and 1982 in sandy loam soils of Agra (U.P.) on cluster bean (*Cyamopsis tetragonoloba* L. Taub). Results indicated that application of 20 kg N/ha along with seed inoculation produced significantly more seed yield over control (no inoculum and no nitrogen) or 20 kg N/ha alone but at par with seed inoculation alone during both the years. The seed yield was mainly influenced by number of nodules/plant and number of pods/plant. Increase in protein content of seed as a result of more uptake of nitrogen was also noticed with the application of nitrogen with inoculant or inoculant only (Singh and Singh, 1989).

According to Jayapaul and Ganesaraja (1990), application of 40 kg N/ha in soybean varieties recorded marked increase in seed yields over control, but was comparative with 20 kg N/ha mainly due to taller plants, increased number of pods/plant, seeds/pod and test-weight. Protein content also increased due to increased rate of nitrogen application.

At Bapitala (A.P.), Reddy et al. (1990) found that application of 60 kg N/ha resulted in higher seed yield of soybean and it was significantly superior to all other levels of nitrogen (20 kg or 40 kg N/ha).
From Mahanpur, Nadia (West Bengal), Pal and Jana (1991) reported that rhizobium inoculation significantly increased the pods/plant, seeds/pod and test-weight which in turn resulted in increased seed yield of summer green gram over uninoculated treatment.

At Anand (Gujrat), Patel and Patel (1991) recorded more number of nodules/plant at 15, 30 and 45 DAS growth stages of green gram and more protein yield at harvest due to seed inoculation with rhizobium culture. They did not observe the marked influence of rhizobium culture on yield components like plant height, branches/plant, pods/plant, seeds/pod, seed yield/plant and test-weight.

At Vamban, Pudderakkatti (Tamil Nadu), Prabhakaran and Subramaniam (1991) found that rhizobial seed bacterification significantly enhanced the plant growth, nodulation and nodule biomass compared with the control (uninoculated) in soybean.

Response of summer cowpea to nitrogen and rhizobium inoculation was studied at Navsari (Gujrat). The results indicated that application of 20 kg N/ha gave significantly higher seed yield over no nitrogen. Higher level of 40 kg N/ha had no advantages over 20 kg N/ha. Rhizobium inoculation significantly increased the seed and dry forage yields over no inoculation. The increase being 9.25 and 9.79% for seed and dry forage yield respec-
tively mainly because of favourable effects of rhizobium inoculation on yield characters (Raj and Patel, 1991).

Singh and Gopalaswamy (1991) studied the response of soybean CV. Co. 1 in clay-loam soils of Coimbatore (Tamil Nadu). They reported that application of higher dose of nitrogen (40 kg N/ha) resulted in more LAI, pods/plant, seeds/pod and test-weight of seeds and finally yields. They further stated that the response of high dose of the applied nitrogen might be due to the presence of lesser root nodules, and thus, addition of nitrogen due to symbiotic fixation would be low.

EFFECT OF PHYSIOLOGICAL PARAMETERS ON GROWTH AND YIELD:

Growth analytical studies are the suitable methods to evaluate and interpret the effects of cultural practices, such as seed-bed preparation, sowing and manuring on net photosynthetic production in the crop stand.

Growth analysis has been considered as a promising experimental technique in eco-physiological evaluation of crop for analysing the complex characters of productivity potential. In growth analysis, over all dry matter production in a plant or plant community as a whole over a particular period are of primary concern.

Singh and Saxena (1973) reported that LAI, DM accumulation and CGR of soybean increased with rapid rate
upto about 70 to 90 DAS depending on the cultivars and thereafter they decreased.

Akiyama and Takada (1975) emphasized that the amount of leaf development regulated the dry matter production in plants. They reported positive correlations between LAI and CGR as well as LAR and CGR.

Roy and Mishra (1975) reported that application of 39 kg P₂O₅/ha the soybean increased the LAI which helped in improving the yield components and seed yields.

Tiwari et al. (1977) while studying the physiological effects of date of sowing on yield determination of soybean at Jabalpur (M.P.), determined that LAI at flowering stage and DM production/plant had strong positive relationship with seed yield/plant.

Chang and Dong (1982) reported that LAI and photosynthetic rate (CGR) were important factors in producing high seed yields as a result of stimulating effects on yield components viz, pods/plant, seeds/pod and test-weight of seed.

While studying the correlations of physiological parameters with productivity of soybean, Shrivastava et al. (1982) postulated that increase in the productivity was attributed to positive increase in LAI, CGR, RGR and NAR.

Lodhi (1985) observed that LAI was maximum at
80 DAS growth stage in soybean CV. Gaurav. He also determined that it was positively correlated to DM accumulation, pods/plant and seed weight/plant.

From Italy, Sattin et al. (1987) reported that LAI and CGR values were maximum at flowering stage in soybean. They further added that these physiological parameters had strong positive associations with productivity.

While studying weed management on soybean at Sagar (M.P.), Jain (1991) stated that LAI had positive companionships with DM production, number of branches/plant, number of pods/plant and seed yield/plant. While it was negatively related with test-weight (100-seed weight).

EFFECT OF NODULATION ACTIVITY ON GROWTH AND YIELD:

Roy and Mishra (1975) have observed strong positive relationship of number of nodules and dry weight of nodules/plant with seed yield in soybean.

According to Tiwari and Agrawal (1977) number of nodules/plant and dry weight of nodules/plant had stimulatory effects on seed yield of soybean CV. Bragg and Punjab-1.

Lodhi (1985) recorded that number of nodules/plant and dry weight of nodules/plant were maximum at flowering stage (60 DAS) in soybean CV. Gaurav (JS 72-44) at Jabalpur
(M.P.) under weed free and adequately fertilized situations. He further noted that these parameters positively increased the seed yield. Similar results were obtained by Bisen (1986) also.