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RESEARCH PAPER

# Nutritional effect on different growth functions in soybean

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***Abstract*** **:** Soybean [*Glycine max* (L.) Merrill.] is a native of China. It is considered as both pulse as well as oilseed. It was introduced in India during the year 1970-71 mainly for rich protein and edible oil. The experiment was laid out in Randomized Block Design (RBD) with three replications. There were eight treatments of different nutrient application. The mean leaf area per plant increased up to 60 DAS and after it declined. The rate of dry matter accumulation was slow during initial stage up to 30 days, fast thereafter up to harvest. The effect of nutrient on dry matter accumulation was noticed after 45 days onwards. This might be due to participation of reproductive parts. Leaf area index of soybean was slow up to 30 days. It was increased rapidly up to 60 DAS then it was decreased. The treatments $T_4$ showed greater leaf area index (100% RDF + 5 t FYM/ha) over the control. The reduction in leaf area under control may be due to more soil moisture stress as compared to nutrient and FYM application. Various growth parameters like absolute growth rate for height, absolute growth rate for dry matter and relative growth rate for height were recorded from 30 DAS up to harvest at 15 days of interval. The growth parameters showed more value in nutrient application over the control. This might be due to more availability of nutrients and soil moisture under other treatments. Based on the results it can be concluded that treatment $T_4$ (100 % RDF + 5 t FYM/ha) was found beneficial in improving growth, yield of soybean as compared to other treatments.

***Key Words*** **:** RGR, AGR, LAI, Harvest index, Biological yield, Soybean, Nutritional effect

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## INTRODUCTION

Soybean [*Glycine max* (L.) Merrill.] is a native of China. It is consider as both pulse as well as oilseed. It was introduced in India during the year 1970-71 mainly for rich protein and edible oil. Soybean contains high amount of protein *i.e.* 40.00 per cent and oil 20.00 per cent. Soybean oil contains more percentage of unsaturated fat and it is cholesterol free. Therefore, it is recommended to heart patients. Soya milk is prepared from soybean which is easy to digest than cow milk. Several snacks and sweets are prepared from soya milk. The soybean oil is recommended in stomach disease and diabetes. It is also used as raw material in production of drying oil and soups.

In India, though area is large but the productivity is very low *i.e.* 900 kg $ha^{-1}$ as compared to world productivity 1900 kg $ha^{-1}$. Average consumption of soybean in India is 4812 thousand metric tonne gaining the sixth rank in largest consumer of soybean in world (Anoymous, 2010). Maharashtra ranks second in production of soybean after Madhya Pradesh in the country. Soybean has profitably replaced the main pulses of state and other legume like mung bean and black gram. Fertilizer play an important role in crop production. A substantial increase in production can be obtained by use of fertilizers. However, due to high cost of fertilizers only a few farmers can afford to apply chemical fertilizers as per recommended doses. With this view in mind, the present investigation entitled nutritional effect on different growth function in soybean was carried out at A.I.C.R.P., Dry land, M.A.U., Parbhani

## MATERIALS AND METHODS

The present experiment was laid out in Randomized

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Block Design (RBD) with three replications. The treatments consisted of two sources of nutrients *i.e.* RDF and FYM. The allotment of treatments to various plot in replication was done by randomization. Treatment details (Fertility level 8), $T_1$ – 75 per cent RDF without FYM, $T_2$–75 per cent RDF with FYM @ 5 t/ha, $T_3$–100 per cent RDF without FYM, $T_4$–100 per cent RDF with FYM @ 5 t/ha, $T_5$-125 per cent RDF without FYM, $T_6$–125 per cent RDF with FYM @ 5 t/ha, $T_7$–FYM @ 10 t/ha, $T_8$–Absolute control, RDF (100%) = 30 : 60 : 30 kg NPK/ha.

Breeder seed of soybean (MAUS-71) was procured from AICRP on Dryland Agriculture. The germination percentage was more than 80 per cent for soybean.Soybean crop was sown on 9th July, 2009. The sowing was done by drilling at a distance of 45 cm x 5 cm at about 2.5 cm depth. The emergence of seed was started from 5 days after sowing and completed by 12 days. Spraying of endosulphan for the control of pest and murate of potash to save the crop from dry spell was carried out.

Data on important biometric observation were collected on fixed five randomly selected healthy plants in each treatment throughout the crop life. The leaf area was calculated by using plant up rooted for dry matter accumulation studies from each net plot periodically. All the leaves were detached and grouped in three groups *viz.*, small, medium and big. The grade wise leaves were counted and their frequency was recorded, the maximum length and breadth of two average size leaves from each group was measured and mean was workout. The leaf area was calculated by using the formula for each grade.

$$A = L \times B \times N \times K$$

where,

A = Leaf area in $cm^2$

L = Maximum length of leaf in cm

B = Maximum breadth of leaf in cm

N = Number of leaves

K = Leaf area constant (0.6910)

The summation of leaf area of all three grades in $dm^2$ per plant was calculated.

**Total dry matter :**

One representative plant from each net plot was selected randomly and uprooted at every growth stage *i.e.* 30, 45, 60, 75, 90 DAS and at harvest for dry matter studies. Roots were discarded for dry matter studies. Plant was air dried in hot air oven at $65^0$C until constant weight was obtained.

**Plant growth analysis :**

Data on growth characters *viz.*, AGR for height and AGR for dry matter per plant were further analyzed for the growth function. Data on these growth functions were statistically analyzed inferences were drawn on mean value.

**Absolute growth rate (AGR) :**

AGR values for plant height and dry matter weight per plant were calculated by using the following formula:

$$\text{Mean AGR (Plant height)} = \frac{H_2 - H_1}{t_2 - t_1} \times 100$$

$$\text{Mean AGR (Dry matter)} = \frac{W_2 - W_1}{t_2 - t_1}$$

where,

$H_1$, $H_2$ and $W_1$, $W_2$ refers to the plant height (cm) and dry matter weight (g) at the time $t_1$ and $t_2$, respectively.

Absolute growth rate is the total gain in height and weight by plant within a stipulated time interval.

**Relative growth rate (RGR) :**

The relative growth at which a plant adds new material into its substance is measured by relative growth rate (RGR) of dry matter accumulation. Blackman (1919) pointed out that increase in the dry matter weight of plant is continuous process of compound interest where the increment at any interval adds to the capital for subsequent growth. The rate of increment was called as relative growth rate. It was computed by following formula and expressed in g/g/day.

$$RGR = \frac{\log_e W_2 - \log_e W_1}{t_2 - t_1}$$

where,

$W_1$ = Weight of dry matter (g) at time $t_1$

$W_2$ = Weight of dry matter (g) at time $t_2$

$t_1$ = Initial time of observation

$t_2$ = Final time of observation

$\log_e$ = Natural logarithms (logaithms to the base of 2.3026)

RGR = Increase in dry matter weight in g/g/day

**Leaf area index (LAI) :**

Since the crop yield is to be assessed for unit of area instead of per plant, therefore, leaf area existing on one plant was considered as leaf area produced on unit ground area (actual area of one plant) this was proposed by Watson (1952). The measure is known as leaf area index (LAI), which was calculated by following formula.

$$LAI = \frac{\text{Leaf area per plant } (cm^2)}{\text{Ground area per plant } (cm^2)}$$

LAI expressed the ratio of leaf surface to the ground area occupied by the crop. It is the index of the productive part of plants. The weight of whole dried produce harvested from net plot, before threshing was recorded as a biological yield and multiplied with hectare factor.

**Harvest index:**

It is the per cent ratio of the economic yield to the total biological yield. Harvest index reflects the proportion of

assimilate distribution between economic and total biomass. It is computed by the following formula.

$$\text{Harvest index} = \frac{\text{Economic yield (kg)}}{\text{Biological yield (kg)}} \times 100$$

**Statistical analysis :**

Results obtained were statistically analyzed as per the methods given by Panse and Sukhatme (1967). The total variance and degree of freedom were partitioned into possible sources. The variance due to treatment was compared against variance due to error to find out 't' value and the significance at p = 0.05. Whenever, the result was significant, standard error (SE) and critical difference (CD) at 5 per cent level of probability were worked out for comparing the mean of treatment. The data have been suitably illustrated at appropriate place.

## RESULTS AND DISCUSSION

The summarized data as influenced by different treatments presented in this chapter under appropriate tables .

**Mean leaf area:**

Data on mean leaf area of soybean recorded at various growth stages are presented in Table 1.

The leaf area was significantly increased very fast from 30 to 60 DAS. Thereafter, it was decreased due to leaf senescence. Treatment $T_4$ (100 % RDF with FYM 5 t/ha) recorded significantly more leaf area than other treatments at 30 and 45 DAS. At 60 DAS treatment $T_4$ was at par with treatment $T_5$ and $T_6$ at 60 DAS, thereafter treatment $T_4$ recorded significantly higher leaf area than rest of the treatments.

**Mean dry matter per plant :**

Data on mean dry matter accumulation per plant (g) recorded at various growth stages of the crop are presented in Table 2.

Data from Table 2 revealed that mean dry matter accumulation was increased progressively at every stages of crop growth. Rate of increase was faster during 45-60 DAS. Dry matter accumulation at 45 DAS was greater under treatment $T_4$ over the rest of treatments. At 45 DAS treatment $T_4$ recorded significantly more dry matter accumulation, but it was at par with treatment $T_6$. Similar trend was observed thereafter upto harvest. But at harvest, treatment $T_4$ was also at par with the treatment $T_6$ and $T_7$

**Growth function:**

*Absolute growth rate (AGR) for height :*

Data on mean absolute growth rate (plant height) as influenced by different treatments at various growth stages (cm/day/plant) presented in Table 3.

At 0-30 and 31-45 DAS treatment $T_4$ (100 % RDF + FYM 5 t $ha^{-1}$) had more absolute growth rate than other treatments. At 46-60 DAS treatment $T_8$ *i.e.* absolute control showed more absolute growth rate. At 61-75 DAS treatment $T_4$ (100% RDF + FYM 5 t $ha^{-1}$) recorded more absolute growth rate than other treatments. At 76-90 DAS and at harvest treatment $T_7$ (FYM 10 t $ha^{-1}$) recorded more absolute growth rate than other treatments.

*Absolute growth rate (AGR) for dry matter:*

Data presented in Table 4 revealed that the rate of dry matter accumulation increased at every stage. Maximum dry matter was observed at 60 DAS (1.05 g/day/plant) under treatment $T_4$ which showed more dry matter value at all growth stages of crop.

*Relative growth rate (RGR) for height:*

Relative growth rate (RGR) for plant height as influenced by different treatments at various growth stages (cm/day/plant) is presented in Table 5.

Table 5 revealed that higher mean relative growth rate

**Table 1 : Mean leaf area ($dm^2$) of soybean influenced by different treatments at various growth stages of crop**

| Treatments | Days after sowing | | | | |
|---|---|---|---|---|---|
| | 30 | 45 | 60 | 75 | 90 |
| $T_1$-75% RDF without FYM | 3.20 | 10.05 | 31.80 | 27.93 | 16.30 |
| $T_2$-75% RDF with FYM @ 5 t/ha | 3.30 | 10.93 | 30.97 | 29.27 | 16.07 |
| $T_3$-100 % RDF without FYM | 3.60 | 10.15 | 30.37 | 28.37 | 16.97 |
| $T_4$-100% RDF with FYM @ 5 t/ha | 4.92 | 14.30 | 37.30 | 35.93 | 23.23 |
| $T_5$-125% RDF without FYM | 3.65 | 11.22 | 33.70 | 29.27 | 17.50 |
| $T_6$-125% RDF with FYM @ 5 t/ha | 4.15 | 12.15 | 33.80 | 30.23 | 20.47 |
| $T_7$-FYM @ 10 t/ha | 4.03 | 11.60 | 32.53 | 29.57 | 18.60 |
| $T_8$-Absolute control | 3.15 | 10.03 | 26.37 | 22.80 | 15.40 |
| S.E. $\pm$ | 0.23 | 0.66 | 1.52 | 1.69 | 0.89 |
| C.D. (P=0.05) | 0.72 | 2.02 | 4.61 | 5.14 | 2.70 |
| Mean | 3.75 | 11.30 | 32.10 | 29.17 | 18.07 |

was recorded during 60 to 75 DAS. At 0-30 DAS treatment $T_4$ recorded highest RGR for plant height but during 31-45 DAS treatment $T_2$ recorded highest RGR. Treatment $T_8$ (absolute control) recorded highest RGR during 46-60 DAS. During 61-75 treatment $T_3$ (100 % RDF without FYM) recorded higher RGR for plant height. At 76-90 DAS Treatment $T_7$ (FYM 10 t $ha^{-1}$) recorded higher RGR for plant height. At harvest treatment $T_3$ (100 RDF without FYM) recorded more RGR for plant height.

**Mean leaf area index :**

The 5 mean values of leaf area index obtained at various stages of crop growth are presented in Table 6. Leaf area index was less up to 30 DAS. It increased rapidly up to 60 DAS then it decreased.

**Table 2 : Mean dry matter (g) in soybean influenced by different treatments at various growth stages of crop**

| Treatments | Days after sowing | | | | | At harvest |
|---|---|---|---|---|---|---|
| | 30 | 45 | 60 | 75 | 90 | |
| $T_1$-75% RDF without FYM | 1.10 | 4.55 | 19.93 | 29.23 | 30.90 | 31.60 |
| $T_2$-75% RDF with FYM @ 5 t/ha | 1.20 | 4.94 | 19.82 | 31.29 | 36.29 | 37.82 |
| $T_3$-100 % RDF without FYM | 1.26 | 6.43 | 20.61 | 33.27 | 34.60 | 36.60 |
| $T_4$-100% RDF with FYM @ 5 t/ha | 1.94 | 10.50 | 26.30 | 40.40 | 42.07 | 43.73 |
| $T_5$-125% RDF without FYM | 1.50 | 6.90 | 21.07 | 33.60 | 34.60 | 35.93 |
| $T_6$-125% RDF with FYM @ 5 t/ha | 1.49 | 9.69 | 23.47 | 36.50 | 38.17 | 39.17 |
| $T_7$-FYM @ 10 t/ha | 1.65 | 8.30 | 21.80 | 34.90 | 36.73 | 39.07 |
| $T_8$-Absolute control | 0.80 | 4.50 | 17.79 | 27.97 | 29.63 | 30.47 |
| S.E. $\pm$ | 0.07 | 0.32 | 1.02 | 1.37 | 1.65 | 1.73 |
| C.D. (P=0.05) | 0.22 | 0.97 | 3.09 | 4.17 | 5.01 | 5.27 |
| Mean | 1.36 | 6.97 | 21.34 | 33.33 | 35.37 | 36.77 |

**Table 3 : Mean absolute growth rate for plant height (cm) as influenced by different treatments**

| Treatments | Days after sowing | | | | | At harvest |
|---|---|---|---|---|---|---|
| | 0-30 | 31-45 | 46-60 | 61-75 | 76-90 | |
| $T_1$-75% RDF without FYM | 0.389 | 0.282 | 0.268 | 0.360 | 0.334 | 0.046 |
| $T_2$-75% RDF with FYM @ 5 t/ha | 0.414 | 0.226 | 0.308 | 0.452 | 0.416 | 0.088 |
| $T_3$-100 % RDF without FYM | 0.404 | 0.271 | 0.282 | 0.584 | 0.397 | 0.133 |
| $T_4$-100% RDF with FYM @ 5 t/ha | 0.483 | 0.283 | 0.298 | 0.574 | 0.180 | 0.110 |
| $T_5$-125% RDF without FYM | 0.441 | 0.283 | 0.332 | 0.462 | 0.290 | 0.088 |
| $T_6$-125% RDF with FYM @ 5 t/ha | 0.409 | 0.280 | 0.330 | 0.332 | 0.567 | 0.066 |
| $T_7$-FYM @ 10 t/ha | 0.386 | 0.268 | 0.338 | 0.266 | 0.595 | 0.156 |
| $T_8$-Absolute control | 0.346 | 0.169 | 0.417 | 0.418 | 0.298 | 0.056 |
| Mean | 0.408 | 0.257 | 0.321 | 0.431 | 0.385 | 0.092 |

**Table 4 : Mean absolute growth rate (dry matter) as influenced by different treatments at various growth stages of crop (g/day/plant)**

| Treatments | Days after sowing | | | | | At harvest |
|---|---|---|---|---|---|---|
| | 0-30 | 31-45 | 46-60 | 61-75 | 76-90 | |
| $T_1$-75% RDF without FYM | 0.036 | 0.230 | 1.025 | 0.620 | 0.111 | 0.046 |
| $T_2$-75% RDF with FYM @ 5 t/ha | 0.040 | 0.249 | 0.992 | 0.764 | 0.333 | 0.088 |
| $T_3$-100 % RDF without FYM | 0.042 | 0.344 | 0.945 | 0.844 | 0.088 | 0.133 |
| $T_4$-100% RDF with FYM @ 5 t/ha | 0.064 | 0.570 | 1.05 | 0.940 | 0.111 | 0.110 |
| $T_5$-125% RDF without FYM | 0.050 | 0.360 | 0.944 | 0.335 | 0.066 | 0.088 |
| $T_6$-125% RDF with FYM @ 5 t/ha | 0.049 | 0.546 | 0.918 | 0.868 | 0.133 | 0.066 |
| $T_7$-FYM @ 10 t/ha | 0.055 | 0.443 | 0.900 | 0.840 | 0.155 | 0.156 |
| $T_8$-Absolute control | 0.026 | 0.246 | 0.886 | 0.678 | 0.110 | 0.056 |
| Mean | 0.045 | 0.373 | 0.957 | 0.798 | 0.138 | 0.92 |

The treatment $T_4$ showed significantly greater leaf area index than other treatments.

**Grain, straw, biological yield and harvest index :**

Data on grain, straw, biological yield and harvest index are presented in Table 7.

Data presented in Table 7 showed that treatment $T_4$ (100 per cent RDF + 5 t/ha FYM) recorded significantly more grain yield than other treatments. But, it was at par with treatments $T_1$, $T_2$, $T_3$, $T_6$ and $T_7$. Straw yield also in the treatment $T_4$ (100 per cent RDF + 5 t/ha FYM) (2923.33 kg/plot) was significantly more over the control treatment. Treatment $T_8$ showed less straw yield over the rest of treatments. Data presented in Table 7 show that treatment $T_4$ (100 per cent RDF + 5 t/ha FYM) showed more biological yield (4531.66 kg/ha) which was significantly superior over rest of treatments. The harvest index in treatment

**Table 5 : Mean relative growth rate (Plant height) as influenced by different treatments at various growth stages of crop (cm day/plant)**

| Treatments | Days after sowing | | | | | At harvest |
|---|---|---|---|---|---|---|
| | 0-30 | 31-45 | 46-60 | 61-75 | 76-90 | |
| $T_1$-75% RDF without FYM | 0.89 | 0.64 | 0.61 | 0.82 | 0.78 | 0.10 |
| $T_2$-75% RDF with FYM @ 5 t/ha | 0.95 | 0.65 | 0.71 | 1.05 | 0.95 | 0.10 |
| $T_3$-100 % RDF without FYM | 0.93 | 0.62 | 0.64 | 1.35 | 0.76 | 0.14 |
| $T_4$-100% RDF with FYM @ 5 t/ha | 1.11 | 0.57 | 0.76 | 1.32 | 0.53 | 0.03 |
| $T_5$-125% RDF without FYM | 1.01 | 0.65 | 0.76 | 1.06 | 0.66 | 0.08 |
| $T_6$-125% RDF with FYM @ 5 t/ha | 0.94 | 0.64 | 0.79 | 0.76 | 1.32 | 0.05 |
| $T_7$-FYM @ 10 t/ha | 0.89 | 0.61 | 0.77 | 0.61 | 1.37 | 0.05 |
| $T_8$-Absolute control | 0.79 | 0.37 | 0.96 | 0.95 | 0.07 | 0.05 |
| Mean | 0.93 | 0.59 | 0.75 | 0.99 | 0.88 | 0.07 |

**Table 6 : Mean leaf area index (LAI) of soybean as influenced by different treatments at various growth stages of crop**

| Treatments | Days after sowing | | | | |
|---|---|---|---|---|---|
| | 30 | 45 | 60 | 75 | 90 |
| $T_1$-75% RDF without FYM | 1.42 | 4.46 | 14.13 | 12.41 | 7.24 |
| $T_2$-75% RDF with FYM @ 5 t/ha | 1.46 | 4.85 | 13.76 | 13.00 | 7.14 |
| $T_3$-100 % RDF without FYM | 1.60 | 4.57 | 13.49 | 12.60 | 7.54 |
| $T_4$-100% RDF with FYM @ 5 t/ha | 2.18 | 6.35 | 16.57 | 15.96 | 10.32 |
| $T_5$-125% RDF without FYM | 1.62 | 4.98 | 14.97 | 13.00 | 7.77 |
| $T_6$-125% RDF with FYM @ 5 t/ha | 1.84 | 5.40 | 15.02 | 13.43 | 9.09 |
| $T_7$-FYM @ 10 t/ha | 1.79 | 5.15 | 14.45 | 13.14 | 8.26 |
| $T_8$-Absolute control | 1.40 | 4.45 | 11.72 | 10.13 | 6.85 |
| Mean | 1.66 | 5.02 | 14.26 | 12.95 | 8.02 |

**Table 7 : Mean grain yield, straw yield, biological yield (kg/ha) and harvest index of soybean as influenced by different treatments at various growth stages of crop**

| Treatments | Grain yield (kg/ha) | Straw yield (kg/ha) | Biological yield (kg/ha) | Harvest index (%) |
|---|---|---|---|---|
| $T_1$-75% RDF without FYM | 1466.67 | 2233.33 | 3700.00 | 39.63 |
| $T_2$-75% RDF with FYM @ 5 t/ha | 1408.33 | 2353.33 | 3761.66 | 37.43 |
| $T_3$-100 % RDF without FYM | 1500.00 | 2343.33 | 3843.33 | 39.02 |
| $T_4$-100% RDF with FYM @ 5 t/ha | 1608.33 | 2923.33 | 4531.66 | 35.48 |
| $T_5$-125% RDF without FYM | 1233.33 | 2463.33 | 3696.66 | 33.36 |
| $T_6$-125% RDF with FYM @ 5 t/ha | 1358.33 | 2498.33 | 3856.66 | 35.22 |
| $T_7$-FYM @ 10 t/ha | 1275.00 | 2436.67 | 3711.67 | 34.35 |
| $T_8$-Absolute control | 766.67 | 2110.00 | 2876.67 | 26.65 |
| S.E. $\pm$ | 117.87 | 115.24 | 178.96 | |
| C.D. (P=0.05) | 354.53 | 349.60 | 542.90 | |
| Mean | 1327 | 2420.00 | 3747.28 | 35.14 |

$T_1$ (39.63) was more than any other treatments.

The mean leaf area per plant (Table 1) increased up to 60 DAS and after it declined. This may be due to leaf senescence. The treatment $T_4$ (100 % RDF + 5 t FYM/ha) recorded more leaf area than absolute control. Application of 100 per cent RDF and 5 t FYM/ha recorded more leaf area due to adequate supply of nutrients and soil moisture. Zhao and Wang (1998) conducted experiment at Quizhali (China) and observed that the leaf area index and plant height were increased by nitrogen and phosphorus with potassium. The number of pod per plant, was higher with NPK, while 100 seed weight was also increased by nitrogen and potassium application. Similar findings were reported by Verma *et al.* (2000).

The process of dry matter accumulation (Table 2) was continuous from emergence to maturity of the crop. The rate of dry matter accumulation was slow during initial stage up to 30 days but fast thereafter up to harvest. The effect of nutrient on dry matter accumulation was noticed after 45 days onwards. This might due to participation of reproductive parts. The treatment $T_4$ *i.e.* (100% RDF + 5 t FYM/ha) showed more dry matter accumulation than treatment $T_8$ (Absolute control). The dry spell occurred during the crop growth stage and pod formation stage had affected more in control treatment. Dange and Kaushik (1984) conducted experiment at Akola and observed that dry matter of soybean was higher with fertilizer 25 : 60 : 00 NPK kg/ha as compared to control. Upadhayay *et al*. (1988) carried out field experiment at Akola and evaluated the effect of different sources (SSP and DAP) with level (23, 46 and 69 kg $P_2O_5$ $ha^{-1}$) indicated that 60 kg $P_2O_5$ $ha^{-1}$ gave the highest leaf area, net assimilation rate in soybean crop. Similar finding was reported by Mandal *et al.* (1998).

Various growth parameters like absolute growth rate for height, absolute growth rate for dry matter and relative growth rate for height recorded more from 30 DAS up to harvest at 15 days of interval. The growth parameters showed more value in nutrient application over the control. This might be due to more availability of nutrients and soil moisture under other treatments.

Leaf area index of soybean was slow up to 30 days. It was increased rapidly up to 60 DAS then it was decreased. The treatments $T_4$ showed greater leaf area index (100% RDF + 5 t FYM/ha) over the control. The reduction in leaf area under control may be due to more soil moisture stress as compared to nutrient and FYM application. Similar findings were reported Saxsena and Chandel (1996). Dweivedi *et al.* (1997) conducted experiment at Jabalpur (M.P.) and reported that leaf area index (LAI) and leaf area duration (LAD) increased significantly up to application 60 kg $P_2O_5$/ha. But crop growth rate (CGR), net assimilation rate (NAR) and leaf weight ratio (LWR) were maximum at 80 kg $P_2O_5$/ha. (Mandal *et al.,* 1998). Rajendra (1991) studied the effect of foliar application of DAP on growth attributes on yield of soybean and reported that diammonium phosphate at the rate of 50 kg $ha^{-1}$ as basal dose followed by foliar spraying twice significantly increased the LAI and dry matter production in soybean as compared to control.

Application of 100 per cent RDF + 5 t FYM/ha showed significantly more grain yield over the control. This treatment gave the higher grain yield because nutrient and FYM application enhanced root proliferation which help more absorption of nutrients from deeper layer of soil, resulting into significant increase in yield. Similar findings were reported by Wanjari *et al.* (1993); Kumar and Singh (1996), Jadhav *et al.* (1998), Mandal *et al.* (1998), Ravankar *et al.* (1998), Chaturvedi and Chandel (2003). Bansode (2008) conducted field experiment at Parbhani and observed that maximum grain yield (3163 kg $ha^{-1}$) was recorded when nutrient applied as RDF (30 : 60 : 30 NPK kg $ha^{-1}$), application of RDF enhanced root proliferation which helped more absorption of nutrient from deeper layer of soil resulting into significant increased in yield component and seed yield.

The treatment $T_4$ (100 % RDF + 5 t FYM/ha) showed significantly more straw yield over the rest of treatments. Similar findings were recorded by Chaturvedi and Chandel (2003). Biological yield and harvest index were also recorded more in treatment $T_4$ (100% RDF + 5 t FYM/ha), which was significantly superior over rest of treatments.

**Conclusion:**

The effect of various treatments on growth characters, yield attributes of soybean have been summarized. Leaf area index, AGR for height, AGR for dry matter and RGR were more in nutrient application than control treatment. Similarly the various yield attributes of soybean *viz.*, seed weight per plant and test weight were increased due to treatment $T_4$ (100 % RDF + 5 t FYM/ha) as compared to other. The grain and straw yield (kg/ha) of soybean increased significantly. The highest grain yield (1608.33 kg/ha) and straw yield (2923.33 kg/ha) were recorded in treatment $T_4$ (100 % RDF + 5 t FYM/ha), while, lowest under treatment $T_8$ (control).

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