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# Root nodules, yield and quality of soybean (*Glycine max* L. merrill) as influenced by foliar application of growth regulator

**Raut SG, Vaidya PH, Arsud PB and Aundhakar AV**

**Abstract**
A field experiment was conducted during kharif season of 2015-16 on, yield and quality of soybean as influenced by growth regulator, at farm department of soil science and agricultural chemistry, college of agriculture Latur. This experiment was laid out in randomized block design with eight treatments of foliar application of growth regulator (NAA and GA) and $KNO_3$ with RDF. The maximum no of root nodules, fresh and dry weight of root nodules, yield and quality attributes of soybean was found at application of RDF+ NAA @ 40 ppm + $GA_3$ @ 40 ppm (20 and 35 DAS) + $KNO_3$ @1% (30, 45 and 60) was found significantly superior over RDF alone. This showed that the foliar application of growth regulator NAA @ 40 ppm + $GA_3$ @ 40 ppm (20 and 35 DAS) + $KNO_3$ @1% (30, 45 and 60) along with RDF enhancing root nodules, yield and quality attributes of soybean.

**Keywords:** Soybean, growth regulator, root nodules, yield attributes and quality attributes

## Introduction
Plants growths regulators are known to enhance the source-sink relationship and stimulate the translocation of photo assimilate there by helping in effective flower formation, fruit and seed development and ultimately enhance productivity of the crops. Plants growths regulators can improve the physiological efficiency including photosynthetic ability and can enhance the effective partitioning of accumulate from source and sink in field crops (Singh and Rathore, 1988) [8]. Plant growth regulators so far have emerged as "magic chemicals" that could increase agricultural production at an unprecedented rate and help in removing and circumventing many of the barriers imposed by genetics and environment. Plant growth regulators when added in small amounts modify the natural growth regulatory system right from seed germination to senescence in several crop plants. Plant growth regulators (promoters, inhibitors or retardants) play key role in contributing internal mechanisms of plant growth by interacting with key metabolic process such as, nucleic acid metabolism and protein synthesis. The yield of soybean can be enhanced through physiological growth manipulation by way of foliar application of growth regulators like NAA. The synthetic auxins, naphthalene acetic acid (NAA) promotes rooting in soybean hypocotyls. Therefore, the present investigation was undertaken to understand the effect of foliar application of growth regulator and KNO3 on yield and quality of soybean.

## Materials and methods
The experiment was conducted at farm College of Agriculture, Latur during *kharif* season 2015-2016 under Inceptisol and was laid out in randomised block design with eight treatments replicated three times. The treatments were: RDF + NAA @ 60 ppm (20 & 35 DAS), RDF + $GA_3$ @ 60 ppm (20 & 35 DAS), RDF + $KNO_3$ @ 1 % (30,45 & 60 DAS), RDF + NAA @ 40 ppm + $GA_3$ @ 40 ppm (20 & 35DAS), RDF +$GA_3$@60 ppm (20 & 35 DAS) + $KNO_3$ @ 1 % (30,45 & 60 DAS), (RDF + NAA @ 40 ppm + $GA_3$ @ 40 ppm (20 & 35 DAS) + $KNO_3$@1% (30,45 & 60 DAS), (RDF + Water spray a (30, 45,60 DAS), and RDF alone. The fertilizers urea, single super phosphate and muriate of potash and variety JS- 335 of soybean was used for this experiment. The biometric observation is to be recorded were number of nodules, fresh weight of nodules, dry weight of nodules, number of pods per plant, grain and straw yield and quality parameters like test weight, protein content and oil content was carried out as per standard procedure.

## Result and discussion

### Effect of growth regulator on root nodules

The data pertaining to number of root nodules, fresh and dry weight of nodules per plant of soybean is presented in table 1. The maximum number of root nodules (41.4 number plant$^{-1}$), fresh weight of nodules (0.31gm plant$^{-1}$) and dry weight (0.053 gm plant$^{-1}$) was found in treatment $T_6$ (RDF + NAA @ 40 ppm + $GA_3$ @ 40 ppm (20 & 35 DAS) + $KNO_3$ @1 % (30, 45 & 60 DAS) and which was significantly superior over treatment $T_8$ (RDF) while dry weight of nodules at par with treatment $T_1$, $T_2$, $T_3$, $T_4$ and $T_5$.Generally, nodulation activity in leguminous plant refers to number of root nodules per plant. It has pronounced influenced on growth and development of leguminous plant. Developments of root nodule are mainly dependent on phosphorous availability and enhance the function of root nodule forming bacteria. Growth regulators cause increase in activity of root system and enhances biotic activities in the rhizosphere. Similar findings were reported by Ketki and Thakare (2006) [5] that the foliar application of nutrients (DAP) and growth regulators found to increase in the morpho-physiological parameters, number of root nodules plant$^{-1}$ and dry weight of nodule in soybean by the foliar application of hormones and nutrients with RDF.

### Effect of growth regulators on quality of soybean

Data on test weight, protein and oil content of soybean, as influenced by various treatments presented in table 2 revealed that application of growth regulators and potassium nitrate found significant effect on test weight. The treatment $T_6$ - RDF + NAA @ 40 ppm + $GA_3$ @ 40 ppm (20 & 35 DAS) + $KNO_3$ @1 % (30, 45 & 60 DAS) recorded significantly highest test weight (112.28 gm ) which was at par with T1,T2,T3,T4 and T5 and was found lowest test weight found in treatment $T_8$ -RDF(99.23gm 100$^{-1}$). This indicated that the application of growth regulators increased the test weight of soybean. This might be due to mark increased the vegetative growth, photosynthetic pigment which could increased in photosynthesis and increased the seed weight. The similar observation reported by Sapkal *et.al* (2011) [7] the application $GA_3$ @50 ppm increased seed weight in soybean. The foliar application of $GA_3$, $KNO_3$, and DAP increased the test weight (Vikaria *et al*. 2013, Anandha Krishnaveni 2004) [9, 1]. The application of $KNO_3$ to soybean crop was found to be significant in influencing the protein content. However, protein content was found maximum (33.50%) with application $T_6$. RDF + NAA @ 40 ppm + GA3 @ 40 ppm (20 & 35 DAS) + $KNO_3$ @1 % (30, 45 & 60 DAS) and which was at par with treatment $T_4$ and $T_5$ while, significant over rest of treatment. The minimum protein (31.00 %) was recorded with RDF (T8).similar finding observed by Singh and Rathore (1988) [8] more protein content in seed might be due to improvement the translocation of photosynthates to the seed. The oil content was found statistically significant with the application of different combination of growth regulators. The maximum oil content (18.23 %) was found in treatment $T_6$ (RDF + NAA @ 40 ppm + $GA_3$ @ 40 ppm (20 & 35 DAS) + $KNO_3$ @1 % (30, 45 & 60 DAS) while, it was at par with treatment $T_4$ and $T_5$. The lowest oil content was recorded in treatment $T_8$ (RDF).The foliar application of growth regulators *viz.*$GA_3$, NAA along with RDF increased the oil content in soybean. This might be due to increased vegetative growth and nutrient uptake by plant. Similar observation was reported by Deotale *et al*. 2013 increased the oil content in soybean with the application of NAA @ 50 ppm similarly finding were also observed by (Jayapaul *et al*. 1987) [4] in the treatment foliar spray of $GA_3$@125 ppm increased oil content.

### Effect of growth regulators on yield attributes

The data on seed weight, seed yield, straw yield and biomass yield as affected by various treatments and presented in table 3. The highest seed weight per plant (10.32 g plant$^{-1}$), seed yield (1137.53 kg ha$^{-1}$), straw yield (1352.21 kg ha$^{-1}$) and biomass yield (1675.96 kg ha$^{-1}$) was recorded at harvest when soybean crop was supplied with $T_6$ RDF + NAA @ 40 ppm + $GA_3$ @ 40 ppm (20 & 35 DAS) + $KNO_3$ @ 1 % (30, 45 & 60 DAS) and it was at par with $T_5$ (RDF + $GA_3$ @ 60 ppm (20 & 35 DAS) + $KNO_3$ @ 1 % (30, 45 & 60 DAS) while, it was significantly superior over to all other treatments. Minimum seed weight, seed yield, straw yield and biomass yield was recorded when soybean crop was supplied with $T_8$ (RDF). The foliar application of growth regulator increased in seed weight and seed yield. It might be due to marked increased in the number of branches per plant. Which gave a chance to the plant to carry more flowers, pods and hence more seeds, marked increase in the photosynthetic pigment content which could lead to increase in photosynthesis, resulting in greater transfer of assimilates to the seed and causing increase in their weight. Similar observations were recorded by Kothule *et al.* (2003) [6] reported that the foliar application of $GA_3$ @ 200 ppm shows significant effect on increased in the seed and dry matter yield of soybean.

From the above results however, concluded that the application of 30:60:30 N: $P_2O_5$: $K_2O$ with foliar application of NAA @ 40 ppm + $GA_3$ @ 40 ppm (20 & 35 DAS) + $KNO_3$@1% (30, 45 & 60 DAS) to soybean was found beneficial for increasing in no of root nodules, fresh and dry weight of root nodules, yield and quality attributes of soybean and followed by application of RDF +$GA_3$@60 ppm (20 & 35 DAS) + $KNO_3$ @ 1 % (30, 45 & 60 DAS).

**Table 1:** Effect of foliar application of growth regulators on number of nodules, fresh and dry weight (g plant$^{-1}$) of nodules of soybean.

| Tr. No | Treatments | No of nodules (Plant$^{-1}$) | Fresh weight (gm plant$^{-1}$) | Dry weight (gm plant$^{-1}$) |
|---|---|---|---|---|
| $T_1$ - | RDF + NAA @ 60 ppm ( 20 & 35 DAS) | 39.6 | 0.25 | 0.042 |
| $T_2$ - | RDF + $GA_3$ @ 60 ppm ( 20 & 35 DAS) | 39.86 | 0.24 | 0.043 |
| $T_3$ - | RDF + $KNO_3$ @ 1 % ( 30,45 & 60 DAS) | 39.2 | 0.24 | 0.054 |
| $T_4$ - | RDF + NAA @ 40 ppm + $GA_3$ @ 40 ppm ( 20 & 35 DAS) | 39.13 | 0.26 | 0.046 |
| $T_5$ - | RDF +$GA_3$@60 ppm (20 & 35 DAS) + $KNO_3$ @1 % (30,45 & 60 DAS) | 40.2 | 0.27 | 0.050 |
| $T_6$- | RDF + NAA @ 40 ppm + $GA_3$ @ 40 ppm (20 & 35 DAS) + $KNO_3$ @1 % (30,45 & 60 DAS) | 41.4 | 0.31 | 0.053 |
| $T_7$- | RDF + Water spray at (30, 45, 60 DAS) | 38.8 | 0.28 | 0.043 |
| $T_8$- | RDF | 38.0 | 0.26 | 0.032 |
| | General mean | 70.26 | 0.46 | 0.08 |
| SE (m) ± | | 0.59 | 0.005 | 0.004 |
| CD AT 5% | | 1.79 | 0.015 | 0.013 |

**Table 2:** Effect of foliar application of growth regulators on test weight, oil and protein percentage of soybean

| Tr. No | Treatments | Test weight (gm $100^{-1}$) | Protein (%) | Oil (%) |
|---|---|---|---|---|
| $T_1$ | RDF + NAA @ 60 ppm (20 & 35 DAS) | 105.33 | 31.83 | 17.06 |
| $T_2$ | RDF + $GA_3$ @ 60 ppm (20 & 35 DAS) | 107.33 | 32.2 | 17.10 |
| $T_3$ | RDF + $KNO_3$ @ 1 % (30,45 & 60 DAS) | 108.00 | 32.53 | 17.23 |
| $T_4$ | RDF + NAA @ 40 ppm + $GA_3$ @ 40 ppm (20 & 35 DAS) | 109.73 | 32.76 | 17.53 |
| $T_5$ | RDF + $GA_3$@ 60 ppm (20 & 35 DAS) + $KNO_3$ @ 1 % (30,45 & 60 DAS) | 110.66 | 33.1 | 17.63 |
| $T_6$ | RDF + NAA @ 40 ppm + $GA_3$ @ 40 ppm (20 & 35 DAS) + $KNO_3$ @ 1 % (30, 45 & 60 DAS) | 112.28 | 33.50 | 18.00 |
| $T_7$ | RDF + Water spray at (30, 45,60 DAS) | 102.43 | 31.93 | 16.96 |
| $T_8$ | RDF | 99.23 | 31.00 | 16.76 |
| | General mean | 106.87 | 32.35 | 17.28 |
| | SE (m) ± | 2.98 | 0.19 | 0.18 |
| CD at 5% | | 9.01 | 0.59 | 0.54 |

**Table 3:** Effect of foliar application growth regulators on seed yield, straw yield, seed weight, and biomass yield of soybean.

| Tr. No. | Treatments | Seed weight (g plant) | Seed yield (kg $ha^{-1}$) | Straw yield (kg $ha^1$) | Biomass yield (kg ha) |
|---|---|---|---|---|---|
| $T_1$ - | RDF + NAA @ 60 ppm (20 & 35 DAS) | 7.32 | 748.12 | 1136.30 | 1884.16 |
| $T_2$ - | RDF + $GA_3$ @ 60 ppm (20 & 35 DAS) | 7.43 | 786.86 | 1250.50 | 2037.4 |
| $T_3$ - | RDF + $KNO_3$ @ 1 % (30,45 & 60 DAS) | 7.49 | 821.38 | 1215.38 | 2037.05 |
| $T_4$ - | RDF + NAA @ 40 ppm + $GA_3$ @ 40 ppm (20 & 35 DAS) | 8.97 | 908.80 | 1344.42 | 2253.14 |
| $T_5$ - | RDF +$GA_3$@60 ppm (20 & 35 DAS) + $KNO_3$ @1 % (30,45 & 60 DAS) | 9.60 | 973.19 | 1352.12 | 2335.86 |
| $T_6$- | RDF + NAA @ 40 ppm + $GA_3$ @ 40 ppm (20 & 35 DAS) + $KNO_3$ @ 1 % (30,45 & 60 DAS) | 10.32 | 1137.53 | 1359.20 | 2496.73 |
| $T_7$- | RDF + Water spray at (30, 45,60 DAS) | 6.97 | 779.32 | 1072.52 | 1851.32 |
| $T_8$- | RDF | 6.43 | 685.42 | 990.54 | 1675.96 |
| General mean | | 8.06 | 855.07 | 1215.12 | 2071.45 |
| SE (m) ± | | 0.27 | 74.84 | 4.85 | 77.71 |
| CD at 5% | | 0.81 | 225.97 | 14.64 | 234.63 |

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