Available online at www.ijpab.com

DOI: http://dx.doi.org/10.18782/2320-7051.5565

ISSN: 2320 – 7051

Int. J. Pure App. Biosci. **5 (4):** 1548-1554 (2017)

Research Article

International Journal of Pure & Applied Bioscience

OPEN ACCESS

Effect of Sulphur and Nitrogen Application on Growth Characteristics and Yield of Soybean (*Glycine max* (L.) Merrill)

D. Anil[1*], G. E. CH. Vidya Sagar[1], G. Sreenivas[2] and S. Harish Kumar Sharma[3]

[1]Deptt. of Agronomy, PJTS Agri. University, Rajendranagar, Hyderabad - 500 030

[2]Agro Climate Research Centre, Agricultural Research Institute, Rajendranagar, Hyderabad-500 030

[3]Dept of Soil Science, PJTS Agri. University, Rajendranagar, Hyderabad - 500 030

*Corresponding Author E-mail: anil.deva001@gmail.com

Received: 12.07.2017 | Revised: 23.07.2017 | Accepted: 24.07.2017

ABSTRACT

A Field experiment was carried out to study the "Response of soybean (Glycine max L.) to sulphur levels with inorganic and organic sources of nitrogen". the study revealed that the growth parameters like plant height, dry matter accumulation, leaf area and seed yield were significantly increased with the treatment 75% RDN through urea, 25% nitrogen through FYM and 40 kg S ha^{-1} which was on par with T_4 is RDN 100% through urea with 40 kg S ha^{-1} and T_3 is RDN 100% through urea with 30 kg S ha^{-1} but was significantly higher over rest of the treatments. The tratment T_1 is RDN 100% recorded the lowest values of all treatments regarding to growth parameters and yield.

Key words: *Sulphur, Nitrogen, Yield, Soybean.*

INTRODUCTION

Soybean [Glycine max (L.) Merill] is a miracle crop of the world due to excellent nutritional quality, as it stands surrogate for nutritional security for large section of vegetarian people being a leguminous crop rich in high quality protein (40-42 %), oil (18-20%) and other nutrients like calcium, iron and glycine. It is a good source of is flavones and therefore it helps in preventing heart diseases, cancer and HIV's[12]. In India, Andhra Pradesh, stands fifth in the area and production covering an area of about 2.84 lakh ha with the production and productivity of 3.47 lakh tones and 1225 kg/ha, respectively[2]. Soybean , unlike other legumes, is both a pulse and oil seed crop .though a major part of nitrogen required is contributed by symbiotic N fixation, at least 30 percent of its requirement has to be met through external application of resources containing N. The information available so far indicates that a part of the N needed particularly at the early vegetative growth and seed development stages. Sulphur play an outstanding role in formation of Sulphur containing compounds is concerned. Important role of Sulphur in plant metabolism which involved in synthesis of glucosides and proteins that promotes nodule formation, chlorophyll and oil.

Cite this article: Anil, D., Vidya Sagar, G.E.CH., Sreenivas, G. and Sharma, S.H.K., Effect of Sulphur and Nitrogen Application on Growth Characteristics and Yield of Soybean (*Glycine max* (L.) Merrill), *Int. J. Pure App. Biosci.* **5(4):** 1548-1554 (2017). doi: http://dx.doi.org/10.18782/2320-7051.5565

Therefore, the present study was undertaken to evaluate the effect of sulphur and nitrogen application on growth characteristics and yield of soybean.

MATERIALS AND METHODS

The experiment was conducted during *Kharif* season of 2013 at College farm, Rajendranagar, Hyderabad having $17^0 19'$ N Latitude, $78^0 23'$ E Longitude and 542.3 m above mean sea level. The soil of the experimental site was sandy loam in texture, neutral in reaction, medium in available nitrogen, phosphorus and high in available potassium. The experiment was laid out in randomized block design with ten treatments combination with different ratios of organic manures and inorganic fertilizers with sulphur levels. Each treatment was replicated thrice. Crop was fertilized with a uniform dose of phosphorous @ 60 kg P_2O_5 ha^{-1} through Triple super phosphate (TSP) and potassium @ 40 kg K_2O through murate of potash (MOP) was applied basally to all the treatments. The elemental sulphur was used as source of sulphur it is also applied as basal. The FYM is applied 2 weeks before sowing as per the treatments and recommended dose of nitrogen was applied basally through urea as per the treatments. Weeding, gap filling, thinning, irrigation and pesticide application were done and when necessary. The plants selected for growth studies were also utilized for recording the growth parameters such as plant height, dry matter accumulation, leaf area and yield components such as number of pods per plant, number of seeds for pod and seed yield per plant. Grain yield and straw yield altogether were considered as biological yield. Harvest index denotes the ratio of grain yield to biological yield multiplied by 100.

RESULTS AND DISCUSSIONS

Plant height

Marked differences were noticed among the treatments with regard to plant height at 20 DAS. The treatment T_7 (RDN (75%) + FYM (25%N) + S_{40}) registered the highest plant height (18.83 cm) which was on par with T_4 (RDN (100%) + S_{40}) (16.87 cm), T_6 (RDN (75%) + FYM (25%N) + S_{30}) (17.43 cm), T_3 (RDN (100%) + S_{30}) (16.87 cm) and T_{10} (RDN (50%) + FYM (50%N) + S_{40}) (16.00 cm), however , these treatments were significantly superoior over the rest of the treatments. The treatments next in order to increase plant height were T_2 (RDN (100%) + S_{20}) (15.33 cm), T_9 (RDN (50%) + FYM (50%N) + S_{30}) (15.20 cm), T_5 (RDN (75%) + FYM (25%N) + S_{20}) (15.20 cm), T_8 (RDN (50%) + FYM (50%N) + S_{20}) (15.17 cm) and T_1 (RDN (100%) (15.03 cm) which was the lowest of all treatments.

At 40 DAS the treatment T_7 registered the highest plant height which was on par with T_4, however these treatments were significantly superior over the rest of the treatments. The treatments next in order increase plant height were T_{10}, T_3, T_6, T_9, and T_5 all the treatments were on par with each other but significantly superior over T_2, T_8, and T_1 which was the lowest of all treatments.

At 60 DAS & harvest stages the treatment T_7 registered the highest plant height which was on par with T_4, however these treatments were significantly superior over the rest of the treatments. The treatments next in order increase plant height were T_{10}, T_3, T_6, T_9, and T_5 all the treatments were on par with each other but significantly superior over T_2, T_8, and T_1 which was the lowest of all treatments.

It was clearly indicated that there is a need for adding organic manures to the soil in conjunctive with inorganic fertilizers, which increased the availability of nutrients considerably resulting in positive effect on growth parameters. These results are in agreement with the findings of Babalad[5].

Plant height increased with increasing levels of sulphur up to maximum level of sulphur application. The increase in plant height as observed in the experiment may be due to the favorable effects of sulphur on N – metabolism and consequently on the vegetative growth of soybean plant[1]. Similar findings were also reported in groundnut[6] and linseed[7].

Leaf area

Leaf area was significantly influenced by graded levels of N and S. Increasing levels of sulpur from 0 to 40 kg S ha^{-1} progressively improved Leaf area of soybean from 20 to 60 DAS.

Marked differences were noticed among the treatments with regard to leaf area plant $^{-1}$ at 20 DAS the treatment T_7 (RDN (75%) + FYM (25%N) + S_{40}) registered the highest leaf area (76 cm^2) which was on par with T_4 (RDN (100%) + S_{40}) (74 cm^2), however these treatments were significantly superior over rest of the treatments. The treatment next in order to increase leaf area were T_3 (RDN (100%) + S_{30}) (69 cm^2), T_6 (RDN (75%) + FYM (25%N) + S_{30}) (68 cm^2), and T_{10} (RDN (50%) + FYM (50%N) + S_{40}) (67 cm^2) all the treatments were on par with each other but significantly superior over T_9 (RDN (50%) + FYM (50%N) + S_{30}) (63 cm^2) T_5 (RDN (75%) + FYM (25%N) + S_{20}) (62 cm^2), T_2 (RDN (100%) + S_{20}) (60 cm^2), T_8 (RDN (50%) + FYM (50%N) + S_{20}) (59 cm^2) and T_1 (RDN (100%) (53 cm^2) which was the lowest of all treatments.

Similar trend of leaf area of soybean was noticed at 40, 60 DAS and at harvest stage. The treatment T_7 (RDN (75%) + FYM (25%N) + S_{40}) registered the highest leaf area which was on par with T_4 (RDN (100%) + S_{40}), however these treatments were significantly superior over rest of the treatments. The lowest leaf area was observed in T_1 (RDN (100%). The profound influence of S fertilization on these parameters could be attributed to its participation in the primary and secondary metabolism as constituent of various organic compounds that are vital for functioning of plant processes, which seems to have promoted meristematic activities causing higher apical growth and expansion of photosynthetic surface that is leaf area[3]. These results are corroborating the findings of Jat[11].

Dry matter production (kg ha^{-1})

Marked differences were noticed among the treatments with regard to dry matter production gram plant^{-1} at 20 DAS the treatment T_7 (RDN (75%) + FYM (25%N) + S_{40}) registered the highest dry matter (759 kg ha^{-1}) which was on par with T_4 (RDN (100%) + S_{40}) (715 kg ha^{-1}), however these treatments were significantly superior over rest of the treatments. The treatment next in order to increase dry matter production were T_3 (RDN (100%) + S_{30}) (630 kg ha^{-1}), T_6 (RDN (75%) + FYM (25%N) + S_{30}) (628 kg ha^{-1}), and T_{10} (RDN (50%) + FYM (50%N) + S_{40}) (621 kg ha^{-1}) all the treatments were on par with each other but significantly superior over T_9 (RDN (50%) + FYM (50%N) + S_{30}) (561 kg ha^{-1}), T_5 (RDN (75%) + FYM (25%N) + S_{20}) (529 kg ha^{-1}), T_2 (RDN (100%) + S_{20}) (537 kg ha^{-1}), T_8 (RDN (50%) + FYM (50%N) + S_{20}) (525 kg ha^{-1}) and T_1 (RDN (100%) (522 kg ha^{-1}) which was the lowest of all treatments.

Similar trend of dry matter production of soybean was noticed at 40, 60 DAS and at harvest stage. The treatment T_7 (RDN (75%) + FYM (25%N) + S_{40}) registered the highest dry matter production which was on par with T_4 (RDN (100%) + S_{40}), however these treatments were significantly superior over rest of the treatments. The lowest dry matter production was observed in T_1 (RDN (100%). Dry matter accumulation increased with increasing levels of nitrogen .This could be ascribed to increased cell division and cell enlargement and better root growth which finally reflected into higher drymatter production. These results corroborate with the findings of Hanumanthapa *et al*.[9] and Saxena *et al*[15].

Higher dry matter production with organic and inorganic sources of nitrogen and sulphur levels could be attributed to enhanced assimilatory surface area which helped in the development of efficient photosynthetic system with better availability of nutrients and moisture produced higher dry matter. These findings are in conformity with those of Patel and Puraji[14].

Days to 50% flowering

Data revealed that application of nitrogen (organic and inorganic source) and sulphur to soybean crop was found to be non–significant in influencing the Days 50 % flowering. However, application of RDN (100%) + S_{40} (T_4) was found to be earlier flowering than other treatments.

The abundant supply of fertilizers to the crop will promote vegetative growth for long duration, there by delaying flowering compared to the crop supplied with less or without fertilizers which attains flowering earlier. These findings are in conformity with those of Yagoub *et* [al16].

Seed and stover yield (kg ha^{-1})

Marked differences were noticed among the treatments with regard to seed and stover yield the Soybean crop applied with the treatment T_7 is RDN (75%) + FYM (25%N) + S_{40} recorded maximum seed and stover yield (2290 and 3270 kg ha^{-1}) and it was at par with the application of T_4 (RDN (100%) + S_{40}) (2063 and 3163 kg ha^{-1}) and T_3 (RDN (100%) + S_{30}) (2042 and 3114 kg ha^{-1}), but was significantly higher over rest of the treatments. The treatment next in order to increase seed and stover yield were T_6 (RDN (75%) + FYM (25%N) + S_{30}) (1781 and 2884 kg ha^{-1}), and T_{10} (RDN (50%) + FYM (50%N) + S_{40}) (1779 and 2848kg ha^{-1}) all the treatments were on par with each other but significantly superior over T_9 (RDN (50%) + FYM (50%N) + S_{30}) (1502 and 2644 kg ha^{-1}) T_5 (RDN (75%) + FYM (25%N) + S_{20}) (1457 and 2586 kg ha^{-1}), T_2 (RDN (100%) + S_{20}) (1443 and 2576 kg ha^{-1}), T_8 (RDN (50%) + FYM (50%N) + S_{20}) (1490 and 2496 kg ha^{-1}) and T_1 (RDN (100%) (1418 and 2462 kg ha^{-1}) which was the lowest of all treatments.

Seed and stover yield of soybean increased significantly due to increased sulphur levels from 0 to 40 kg S ha^{-1}. Maximum seed and stover yield of 2290 and 3270 kg ha^{-1} was recorded by applying RDN (75%) + FYM (25%N) + S_{40}, while the lowest seed and stover yield of 1418 and 2462 kg ha^{-1} was recorded with RDN (100%).

Nitrogen influenced the seed yield through source – sink relationship, resulting in higher production of photosynthates and their increased translocation to reproductive parts as nitrogen being the most important essential plant nutrient needed for growth and development of plant and known to increase the yield of soybean (Saxena *et al*., 2001). These findings are in agreement with those of Aruna and Reddy[4].

The application of RDN + FYM recorded higher seed yield ha^{-1}. This might be attributed to rapid mineralization of N from inorganic fertilizers and steady supply of N from FYM, which might have met the N requirement of crop at critical stages. Farm yard manure acts as nutrient reservoir and upon decomposition produces organic acids, there by absorbed ions are released slowly during entire growth period leading to higher seed yield[13].

The sulphur fertilization played a vital role in improving the three major aspects of yield determination i.e. formation of vegetative structure there by photosynthesis strong sink strength through development of reproductive structure and production of assimilates to fill economically important sink. Thus cumulative influence of S application maintained balance source – sink relationship and ultimately resulted in increased seed yield. The results are in close conformity with the findings of Ganeshmurthy[8], Jat[11] and Hussain *et al*[10].

Table 1: Plant height (cm) of soybean as influenced by different treatments at various crop growth stages during *kharif* 2013

Treatments	20 DAS	40 DAS	60 DAS	At Harvest
T_1 : RDN (100%)	15.03	26.30	36.80	39.80
T_2 : RDN (100%) + S_{20}	15.33	28.17	40.20	42.87
T_3 : RDN (100%) + S_{30}	16.87	32.17	44.00	49.0
T_4 : RDN (100%) + S_{40}	18.27	36.30	50.13	55.13
T_5 : RDN (75%) + FYM (25%N) + S_{20}	15.20	30.07	37.23	46.80
T_6 : RDN (75%) + FYM (25%N) + S_{30}	17.43	31.96	45.19	50.19
T_7 : RDN (75%) + FYM (25%N) + S_{40}	18.83	37.60	52.13	57.13
T_8 : RDN (50%) + FYM (50%N) + S_{20}	15.17	27.77	38.33	42.33
T_9 : RDN (50%) + FYM (50%N) + S_{30}	15.20	31.93	40.00	47.0
T_{10} : RDN (50%) + FYM (50%N) + S_{40}	16.00	32.00	45.20	50.20
S.Em±	0.84	1.10	1.24	1.31
CD at 5%	2.49	3.28	3.71	3.89

Table 2: Dry matter production (kg ha^{-1}) at different crop growth stages of soybean as influenced by various treatments during *kharif* 2013

Treatments	20 DAS	40 DAS	60 DAS	At harvest
T_1 : RDN (100%)	522	2499	4704	5695
T_2 : RDN (100%) + S_{20}	537	2746	5009	6070
T_3 : RDN (100%) + S_{30}	630	3419	5845	7220
T_4 : RDN (100%) + S_{40}	715	3946	6320	7883
T_5 : RDN (75%) + FYM (25%N) + S_{20}	529	2703	5064	6147
T_6 : RDN (75%) + FYM (25%N) + S_{30}	628	3317	5659	6892
T_7 : RDN (75%) + FYM (25%N) + S_{40}	759	4048	6637	7942
T_8 : RDN (50%) + FYM (50%N) + S_{20}	525	2576	4988	5778
T_9 : RDN (50%) + FYM (50%N) + S_{30}	561	2792	5130	6209
T_{10} : RDN (50%) + FYM (50%N) + S_{40}	621	3325	5622	6770
S.Em±	15.7	175.5	146.3	173.9
CD at 5%	46.4	521.5	434.7	516.7

Table 3: Leaf area plant^{-1}(cm^2), Days to 50 % flowering and Days to maturity and Yield and yield attributes at different crop growth stages of soybean as influenced by various treatments during *kharif* 2013

Treatments	20 DAS	40 DAS	60 DAS	Days to 50 % flowering	Days to maturity	Seed yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Harvest index (%)
T_1 : RDN (100%)	53	304	388	43	85	1418	2462	37
T_2 : RDN (100%) + S_{20}	60	335	447	4	84	1443	2576	36
T_3 : RDN (100%) + S_{30}	69	383	515	42	84	2042	3114	40
T_4 : RDN (100%) + S_{40}	74	427	570	40	83	2063	3163	39
T_5 : RDN (75%) + FYM (25%N) + S_{20}	62	337	458	42	86	1457	2586	36
T_6 : RDN (75%) + FYM (25%N) + S_{30}	68	384	507	41	84	1781	2884	38
T_7 : RDN (75%) + FYM (25%N) + S_{40}	76	458	596	41	84	2290	3270	41
T_8 : RDN (50%) + FYM (50%N) + S_{20}	59	327	414	43	83	1490	2496	37
T_9 : RDN (50%) + FYM (50%N) + S_{30}	63	342	457	43	83	1502	2644	36
T_{10} : RDN (50%) + FYM (50%N) + S_{40}	67	382	518	43	81	1779	2848	38
S.Em±	1.22	13.83	14.43	1	1.76	82	61	1.2
CD at 5%	3.63	41.09	42.88	NS	NS	255	182	NS

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