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Effect of water soluble fertilizer on growth and growth attributes of soybean [*Glycine max* (L.) Merrill]

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Abstract
A field experiment was conducted during *Kharif* seasons of 2017 at Zonal Agricultural Research Station (ZARS), in Gandhi Krishi Vigyan Kendra (GKVK), University of Agricultural Science (UAS), Bengaluru on red sandy clay loam soil which was medium in available NPK, to evaluate the effect of water soluble fertilizers on growth attributes of soybean crop. The experiment was laid out in a RCBD design with three replications and 10 treatments. Water-soluble fertilizers (WSF) (NPK: 19: 19: 19) was used at different growth stages with 1.5 %, 2% and 2.5% concentration. Significantly higher growth parameters like plant height (69.57 cm), number of branches (6.50), number of leaves plant^{-1} (27.53), leaf area plant^{-1} (1616.7 cm^2), leaf area index (5.39) and dry matter accumulation plant^{-1} (21.30 g) were obtained with the treatment recommended fertilizers dose (RDF) + spraying of water-soluble fertilizer at 2.5 % at flowering + pod formation stage at 60 DAS, compared to other treatments.

Keywords: foliar spray, soybean, water soluble fertilizer, different growth stages

1. Introduction
Soybean [*Glycine max* (L.) Merrill] is the world's most important seed legume, which contributes to 25 per cent of the global edible oil, about two-thirds of the world's protein concentrate for livestock feeding is commercially exploited crop in India. The crop is also termed "Golden Bean" or "Miracle crop" of the 21st century on the reason of its various uses. It has highest protein (40%), oil (20%), rich in lysine and vitamin A, B and D, mineral salts and essential amino acids. Among the grain legume crops it has high potential for combating acute malnutrition. The quality of soya protein is equivalent to that of animal protein and soybean is also a good source of dietary fiber, calcium, magnesium, phosphorous, thiamine, riboflavin, niacin, *etc.* It has been reported to have medicinal properties in combating diabetes, cancer, heart disease *etc*.
Soybean is a major oilseed crop of the world grown in an area of 121.1 m ha (Anon. 2018) [2], with a production of 348.85 mt and productivity of 2.88 t ha^{-1}. In the world, it is cultivated mainly in the USA, Brazil, Argentina, China, and India (Anon, 2018) [2]. In India, it is grown over an area of 11.6 m.ha with a production of 8.57 mt and productivity of 738 kg ha^{-1} (Anon, 2018) [2]. Predominant soybean growing states in India are Madhya Pradesh, Maharashtra, Rajasthan, Andhra Pradesh, Karnataka, and Gujarat. In Karnataka, soybean occupies in an area of 0.32 m ha with a production of 0.25 mt and productivity of 785 kg ha^{-1} (Anon. 2016) [1]. Belgaum, Dharwad, Bidar, Bagalkot, and Haveri are the major soybean growing districts of Karnataka.
Foliar application is considered as a preferred solution when the rapid supply of nutrients is held up or the soil conditions are not favorable for the absorption of nutrients (Salisbury and Ross, 1985) [7]. Foliar spray technique supports the nutrients to reach the place of food synthesis directly, leading no consumption and fast supply of food and thus reduce the requisite of fertilizers. Foliar nutrition can accelerate the growth of a crop quickly. It is also identified that active nodulation of pulse crop stops after 45 to 50 days after cultivation and at that time, the positive effect of supplying legume plants with additional nitrogen was found to have positive effects on increasing growth and enhances seed yield by the rapid supply of nitrogen.

2. Material and Methods
A field experiment was conducted during *Kharif* seasons of 2017 at Zonal Agricultural Research Station (ZARS), in Gandhi Krishi Vigyan Kendra (GKVK), University of Agriculture Science (UAS), Bengaluru, Karnataka. The experimental site was located between 13º 00' and Latitude and 77º 35' E Longitude at an altitude of 930 m above mean sea level (MSL). The soil was red sandy clay loam with organic carbon content of 0.42 per cent. The initial nitrogen, phosphorus and potassium status of the soil were 464.12, 56.2 and 216.24 kg per ha, respectively. The soil pH was 6.23 with an EC of 0.14 dSm^{-1}. The experiment was laid out in a randomized complete block design with ten treatments and three replications.
The land was prepared to a fine tilth before sowing of soybean. Plot size was 3.60 m x 4.00 m, space between plants was 10 cm and between row 30 cm and seed sown with depth of 5 cm. soybean sown variety was MAUS-2 and sowing date was 11/08/2017 and harvested on 23/11/2017. Water-soluble fertilizer (NPK 19: 19: 19) was used at different concentration as per the treatments requirement. Rainfall during these months (August, September, October and November) was 198.5 mm, 275.6 mm, 264.4 mm, and 10 mm respectively. The crop was grown with one life saving irrigation during flowering stage. Weeding and plant protection measures were undertaken as per the need of crop. The observations on growth and growth attributes were recorded at 30, 60 days after sowing and at harvest. Growth and growth parameters like plant height, number of branches,

leaf area, total dry matter accumulation and Chlorophyll contents (SPAD reading) were recorded from five tagged plants in each plot.

3. Results and Discussion

Plant height, number of branches, number of leaves, total dry matter accumulation, leaf area and chlorophyll contents are important growth attributes which directly and indirectly influences the yield components. Plant height as a measure of crop growth was recorded at three stages like 30 DAS, 60 DAS and at maturity. The data is presented in table 1 and 2.

The plant height at all growth stages was not affected significantly due to the treatments. This is due to the imposition of foliar application treatments at glowering stage and onward. However, application of RDF+ WSF 2.5 % spray at flowering stage + pod formation stage recorded higher plant height of 66.50 cm and 69.57 cm at 60 DAS and at harvest stages respectively than other treatments. The increased plant height might be due to spraying of higher concentration of water-soluble fertilizers and also could be attributed due to involvement of nutrients in synthesis of plant cell, cell wall, and translocation of plant nutrients to growing point and thereby increased photosynthetic efficiency by delaying the leaf senescence. Similar results were obtained by Senthil Kumar *et al*. (2008) [9].

Significantly higher number of branches at 60 DAS, were obtained with application of RDF + foliar application of WSF @ 2.5 % at flowering + pod filling stage (6.50) over other treatments and it was on par with application of RDF + foliar application of WSF @ 2 % at flowering stage + pod filling stage (6.40) and also on par with RDF + foliar application of WSF @ 2 % at flowering stage + pod formation stage (6.30) and with RDF + pod formation stage (6.27). Significantly lower number of branches was noticed with recommended dose of fertilizer (control) at 60 DAS (5.60) over other treatments. The increased number of branches might be due to the foliar spray which might have helped in sustaining greenness of leaves for longer period, which in turn helps in further improving productivity due to better photosynthesis. Foliar application of NPK spray also improves storage of N compounds like amino acids and protein in plants. Thus directly affects N metabolism under stress condition. The marked superiority of growth parameters like more number of branches observed due to potassium which enhances plant vigor and strengthens the stalk, further it has synergistic effect with nitrogen and phosphorus which might have resulted in better plant growth and more number of branches per plant. Similar results were obtained by Hiwale (2015) [3].

Significantly higher number of leaves per plant was recorded with application of RDF + foliar application of WSF @ 2.5 % at flowering + pod filling stage at 60 DAS, (27.53) and it was statistically on par with RDF + foliar application of WSF @ 2.5 % at pod filling stage (26.50) and also on par with RDF + foliar application of WSF @ 2 % at flowering + pod filling stages (26.33). Lower numbers of leaves per plant were recorded with control (23.83). The higher number of leaves was due to improved growth characters like plant height and number of branches per plant which led to more number of leaves with additional nitrogen from foliar nutrients application which might have influenced vegetative growth in plant and reduced fertilizer losses and resulted in higher number of leaves per plant. This is in corroborating with the study of Hugar and Kurdikeri (2000) [4].

Significantly higher leaf area was recorded at 60 DAS with RDF + foliar application of WSF @ 2.5 % at flowering + pod filling stage (1616.67 cm^2) and it was statistically on par with the treatments RDF + Spraying of 2% water-soluble fertilizer at pod formation stages (1440.56 cm^2), and also on par with the application of RDF + Spraying of 2 % water-soluble fertilizer at flowering stage + pod formation stage (1399.33), RDF + Spraying of 2.5 % water-soluble fertilizer at flowering stage (1419.00 cm^2), and RDF + Spraying of 2.5 % water-soluble fertilizer at pod formation stage (1492.67 cm^2). Significantly lower leaf area was recorded with control (1135.36 cm^2). The leaf area index followed the same trend as that of leaf area. Significantly higher leaf area index at 60 DAS was recorded with RDF + foliar application of WSF @ 2.5 % at flowering + pod filling stage (5.39) and it was statistically on par with treatments like, application of RDF + Spraying of 2 % water-soluble fertilizer at pod formation stage (4.80), RDF + Spraying of 2 % water-soluble fertilizer at flowering stage + pod formation stage (4.66), RDF + Spraying of 2.5 % water-soluble fertilizer at flowering stage (4.73), and RDF + Spraying of 2.5 % water-soluble fertilizer at pod formation stage (4.98). Significantly lower leaf area index was recorded with control (3.79). The higher leaf area index was directly attributed to the higher leaf area. The formation of optimum photosynthetic surface area for longer period was essential for increasing yield which was met through the foliar nutrients applied to the soybean crop. On the other side, improved photosynthetic capacity as influenced by the foliar fertilization of major nutrients *viz.*, N, P and K (Watson, 1952). The synergistic effect of macro nutrients might have helped in rapid growth and development of plants as they help in photosynthesis and various biochemical processes which responds towards growth (Jasim Iqbal, *et. al.*, 2016) [5].

Significantly higher chlorophyll content (SPAD reading) at 60 DAS, was recorded with application of RDF + foliar application of WSF @ 2.5 % at flowering + pod formation stage (46.37) and it was statically on par with the treatments RDF + Spraying of 2.5% water-soluble fertilizer at pod formation stage (45.30) and RDF + Spraying of 2% water-soluble fertilizer at flowering stages + pod formation stage (45.27). Significantly lower chlorophyll content was recorded in control (41.77). The higher chlorophyll content (SPAD) of the leaf might be due to steady supply and better utilization of nitrogen applied through soil and foliar spray. Foliar application of nitrogen at flowering and pod filling stages along with RDF resulted in maximum photosynthesis due to more availability of nitrogen, in turn enhancing the photosynthetic activity of leaf. This result is in line with the work carried out by Senthil Kumar *et al.* (2008) [9].

Significantly higher total dry matter per plant was recorded at 60 DAS with application of RDF + foliar application of WSF @ 2.5 % at flowering + pod formation stages (21.30 g) and it was statistically on par with treatments RDF + Spraying of 2% water-soluble fertilizer at flowering stage + pod formation stages (19.50 g) RDF + Spraying of 2% water-soluble fertilizer at pod formation stage (19.32 g) RDF + Spraying of 2.5% water-soluble fertilizer at flowering stage (18.11 g), and RDF + Spraying of 2.5% water-soluble fertilizer at pod formation stages (20.77 g). Significantly lower total dry matter per plant was with control (14.36 g).

Table 1: Plant height, number of branches and number of leaves plant^{-1} of soybean as influenced by water-soluble fertilizers

Treatments		Plant height (cm)			Number of branches plant^{-1}		Number leaves plant^{-1}	
		30 DAS	60 DAS	Harvest	30 DAS	60 DAS	30 DAS	60 DAS
T_1	RDF + Spraying of 1.5% water-soluble fertilizer at flowering stage	26.80	61.97	64.50	3.00	5.83	9.27	24.27
T_2	RDF + Spraying of 1.5% water-soluble fertilizer at pod formation stage	25.60	63.87	65.00	2.60	6.00	8.73	25.27
T_3	RDF + Spraying of 1.5% water-soluble fertilizer at flowering stage + pod formation stage	25.00	64.20	65.30	1.93	6.30	7.53	25.60
T_4	RDF + Spraying of 2% water-soluble fertilizer at flowering stage	24.60	62.33	64.70	2.67	5.90	7.87	24.40
T_5	RDF + Spraying of 2% water-soluble fertilizer at pod formation stage	26.47	64.00	65.87	2.60	6.03	8.00	25.93
T_6	RDF + Spraying of 2% water-soluble fertilizer at flowering stage + pod formation stage	26.60	64.80	66.53	2.80	6.40	8.87	26.33
T_7	RDF + Spraying of 2.5% water-soluble fertilizer at flowering stage	25.80	63.13	64.73	2.73	6.03	8.27	24.60
T_8	RDF + Spraying of 2.5% water-soluble fertilizer at pod formation stage	26.00	64.47	65.97	2.87	6.27	9.60	26.50
T_9	RDF + Spraying of 2.5% water-soluble fertilizer at flowering stage + pod formation stage	26.13	66.50	69.57	2.93	6.50	8.73	27.53
T_{10}	RDF only (Control)	26.27	61.13	63.40	2.53	5.60	7.80	23.83
	S. Em ±	1.04	2.10	2.14	0.25	0.15	0.63	0.42
	CD (5%)	NS	NS	NS	NS	0.43	NS	1.26

Table 2: Leaf area, leaf area index, SPAD and total dry mater accumulation plant^{-1} is influenced by water-soluble fertilizers

Treatments		Leaf area plant^{-1} (cm^2)		Leaf area index (LAI)		SPAD		Dry matter plant^{-1} (g)	
		30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS
T_1	RDF + Spraying of 1.5% water-soluble fertilizer at flowering stage	727.00	1311	2.24	4.37	33.20	43.73	3.44	14.78
T_2	RDF + Spraying of 1.5% water-soluble fertilizer at pod formation stage	766.00	1210	2.17	4.04	32.53	44.67	3.44	15.69
T_3	RDF + Spraying of 1.5% water-soluble fertilizer at flowering stage + pod formation stage	736.00	1148	2.22	3.83	33.23	45.00	3.01	16.11
T_4	RDF + Spraying of 2% water-soluble fertilizer at flowering stage	566.00	1303	2.25	4.34	32.90	43.80	2.96	13.47
T_5	RDF + Spraying of 2% water-soluble fertilizer at pod formation stage	368.33	1440	2.05	4.80	34.33	44.77	2.63	19.32
T_6	RDF + Spraying of 2% water-soluble fertilizer at flowering stage + pod formation stage	687.67	1399	2.24	4.66	40.10	45.27	3.58	19.50
T_7	RDF + Spraying of 2.5% water-soluble fertilizer at flowering stage	416.67	1419	2.07	4.73	31.17	44.47	3.42	18.11
T_8	RDF + Spraying of 2.5% water-soluble fertilizer at pod formation stage	550.00	1492	2.06	4.98	33.27	45.30	4.58	20.77
T_9	RDF + Spraying of 2.5% water-soluble fertilizer at flowering stage + pod formation stage	930.00	1616	2.38	5.39	32.83	46.37	3.72	21.30
T_{10}	RDF only (Control)	696.00	1135	2.31	3.79	30.87	41.77	3.42	14.36
	S. Em ±	104.95	74.77	0.08	0.25	2.03	0.53	0.62	1.36
	CD (5%)	NS	222.15	NS	0.74	NS	1.58	NS	4.05

The significant increase in dry matter per plant was due to the nitrogen which might have helped in maintaining higher auxin level and might have resulted in better plant height, leaf area and presumably chlorophyll content of the leaves. This might have resulted into better interception, absorption and utilization of radian energy, leading to higher photosynthetic rate and finally more accumulation of dry matter by the plants. Similar results were reported by Mohan and Rao (1989) [6] and Sarkar *et al*. (1999) [8].

References

1. Anonymous, 2016, www.SOPA.org.
2. Anonymous, 2018, Biannual report on global food markets, FAO.
3. Hiwale R. Effect of foliar application of potassium nitrate on yield, growth and quality of soybean (*Glycine max* (L.) *Merrill.* M.Sc. (Agri.) Thesis, Vasantrao Naik Marathwada *Agril. Univ.*, Parbhani, Int.J. of Agriculture Sci. 2015; 7(5):516-519. India.
4. Hugar AB, Kurdikeri MB. Effect of application methods and levels of zinc and molybdenum on field performance and seed yield in soybean. Karnataka J. Agric. Sci. 2000; 13(2):439-441.
5. Jasim Iqbal, Rayyan Khan, Abdul Wahid, Kamil Sardar, Nangial Khan, Murad Ali, *et al*. Effect of nitrogen and zinc on maize (*Zea mays* L.) yield components and plant concentration. Adv. Envi. Biol. 2016; 10(10):203-208.
6. Mohan CYK, Rao GR. Influence of foliar application of calcium on growth performance, chlorophyll and protein contents in groundnut under water stress. Narendra Dev J. Of Agril. Research. 1989; 4(1):7-11.
7. Salisbury FB, Ross CW. Plant physiology. Wadsworth Publishing Co., Belmont, Calfornia, 1985, 540.
8. Sarkar RK, Chandraborthy A, Anitha Saha. Effect of foliar application of potassium nitrate and calcium nitrate on groundnut (*Arachis hypogaea*. L.). Indian J. Agronomy. 1999; 44(4):809-812.
9. Senthil Kumar G, Muthukrishnan P, Ramasamy S, Chandaragiri KK. Effect of organic and inorganic foliar spray on growth and yield of blackgram (*Vigna mungo* L.). Madras Agric. J. 2008; 95(1-6):57-60.
10. Watson DJ. The physiological basis for variation in yield. Adv. Agron. 1952; 4:101-145.