IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)
An International Open Access, Peer-reviewed, Refereed Journal

YIELD AND NUTRIENT UPTAKE OF SOYBEAN AS INFLUENCED BY FERTILIZER LEVELS AND GROWTH REGULATORS SPRAY UNDER DRIP FERTIGATION

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Abstract: Field experiment was conducted at Eastern Block Farm, Tamil Nadu Agricultural University, Coimbatore during *Kharif* 2022 with an objective of influence of drip fertigation and growth regulators in soybean. The treatments composed of 75 % ,100 % and 125 % of RDF through drip fertigation with foliar application of 100 ppm succinic acid and humic acid twice at peak flowering and pod initiation stages. The drip irrigation was scheduled once in five days based on daily pan evaporation as per the treatment schedule and at 0.8 IW/CPE ratio in surface irrigation with 5 cm depth of irrigation and fertigation was scheduled with respect of crop growth stages with the computed quantity of fertilizer as per the treatment. The effect of nutrient application methods drip fertigation and soil application reflected on differential rate of N, P and K uptake by the crop. The nutrient uptake was higher under drip fertigation compared to soil application of nutrients. Among the drip fertigation, the N, P and K uptake was higher at 100 per cent RDF through RDF through drip fertigation with foliar spray of 100 ppm humic acid compared to other treatments. Grain yield was significantly higher under 100 % RDF through drip fertigation with foliar spray of 100 ppm humic acid.

Key words: Soybean, Drip fertigation, Nutrient uptake, humic acid, succinic acid, yield.

I. INTRODUCTION

Soybean (*Glycine max* (L.) Merrill) a grain legume is considered as a wonder crop and “Miracle bean” due to its dual qualities *viz*., high protein (40-43 %) and oil content (20 %), has now become the largest source of protein and oil in the world. It was introduced in India during 1960s and is gaining rapid recognition as a highly desirable pulse and oil seed crop. India stands next only to China in the Asia - Pacific region. In world it is grown in an area of 121.93 m ha with a production of 342.56 m t and productivity 2809 kg ha^{-1} (Anonymous, 2017). In India it is grown in an area of 12.00 m ha with a production of 14.92 m t and productivity of 1239 kg ha^{-1} (Anonymous, 2023). This legume is making straight way in Indian agriculture to meet protein and oil requirement. Drip irrigation is a technique in which water is distributed through the emitters directly into the soil near the plants through a special slow-release device. Adoption of drip irrigation might help in increasing area under irrigation, productivity of crops and increase the water use efficiency (Tarawalie *et al*., 2012). Usually the optimizing nutrient management with drip irrigation would require that attention be paid to soil nutrient dynamics, crop nutrient requirements, as well as soil and plant monitoring techniques. Fertilizers should be applied in a form that becomes available in synchrony with crop demand for maximum utilization of nutrient from fertilizers (Fanish and Muthukrishnan, 2013). Surface irrigation with small furrow is the age old and traditional systems in our country, bears very low irrigation efficiencies, especially the distribution uniformity (Dixit *et al*., 1994). This indicates that there is a wide scope to increase the overall productivity of soybean through improved irrigation techniques and one of the viable options for expanding area under cultivation. Hence drip irrigation, proved to be an efficient method in saving water and increasing water use efficiency as compared to the conventional surface method of irrigation. Micro irrigation systems act as a vehicle not only for carrying and delivering small quantities of water, but also in delivering the nutrients directly to the root zone at frequent intervals. Fertigation helps in minimizing the losses of water and applied nutrients (Bhaskaran and Subrahmanyam, 2012). In the background information the experiment was conducted with an objective of fertilizer level and growth regulators on nutrient uptake and yield of soybean under drip fertigation.

2.MATERIALS AND METHODS

Field experiment was carried out in Field No.75 at Eastern Block farm, Deportment of Farm Management, Tamil Nadu Agricultural University, Coimbatore. The experimental site is geographically situated in the Western agro-climatic zone of Tamil Nadu at 11º North latitude and 77º East longitude at an altitude of 427 m above MSL. The soil of the experimental field was well drained sandy clay loam in texture belonging to Typic Ustropept, which was low in available nitrogen (202 Kg/ha), medium in available phosphorus (15 Kg/ha) and high in available potassium (396.0 Kg/ha). The soil was texturally classified as sandy clay loam having 26.52 per cent field capacity, 13.53 per cent permanent wilting point with 1.33 Mg m^{-3} bulk density. Soil pH was 7.94 with an organic carbon content of 0.30 per cent and EC of 0.77 dSm^{-1}.

The experiment was laid out in randomized block design with three replications. The treatments consisted of fertigation levels in combination with two foliar sprays of growth regulators. The treatments were T_1-75 % RDF through drip fertigation,T_2 -75 % RDF through drip fertigation + Foliar spray of 100 ppm succinic acid,T_3-75 % RDF through drip fertigation + Foliar spray of 100 ppm humic acid,T_4 - 100 % RDF through drip Fertigation,T_5 - 100 % RDF through drip fertigation + Foliar spray of 100 ppm succinic acid ,T_6 - 100 % RDF through drip fertigation + Foliar spray of100 ppm humic acid ,T_7– 125 % RDF through drip Fertigation ,T_8-125 % RDF through drip fertigation + Foliar spray of 100 ppm succinic acid , T_9 -125 % RDF through drip fertigation + Foliar spray of 100 ppm humic acid ,T_{10} - Surface irrigation + RDF.

Recommended dose of fertilizers *viz.*, 20:80:40:30 NPKS kg ha^{-1} was applied to the crop. For conventional plot half dose of N and full dose of P and K were applied basally in the form of urea, super phosphate and muriate of potash, the remaining N was top dressed at 45 DAS. For drip irrigation using conventional fertilizer of N and K fertilizers were given according to fertigation schedule in the form of urea and muriate of potash and whole P was given as basal in the form of SSP.

The drip irrigation was scheduled once in five days based on daily pan evaporation as per the treatment schedule and at 0.8 IW/CPE ratio in surface irrigation with 5 cm depth of irrigation and fertigation was scheduled with respect of crop growth stages with the computed quantity of fertilizer as per the treatment. The quantity of water applied through drip fertigation was computed based on the following formula:

WRc = CPE x Kc x Kp x Wp x A

Where,

WRc	=	Computed water requirement of the crop (l plant -1)
CPE	=	Cumulative pan evaporation for two days (mm)
Kc	=	Crop factor
		Initial stage (0 – 20 days) = 0.35
		Crop development stage (20-40 days) = 0.75
		Late stage (40 -55 days) = 1.15
		Maturity stage (55-100 days) = 0.75
Kp	=	Pan co-efficient (0.80)
Wp	=	Wetted percentage (80)
A	=	Area per plot (m^2)

3.RESULTS AND DISCUSSION

Nitrogen

The nitrogen uptake was increased with advancement of crop growing stage. Drip fertigation with foliar application of growth regulators at vegetative stage was recorded not significant but later stage it was influenced on N uptake at flowering and harvest stage Among the treatments 100 % RDF through drip fertigation with foliar spray of 100 ppm humic acid (T_6) recorded 31.69 kg ha^{-1} and 43.46 kg ha^{-1} at flowering and harvest, respectively. It was followed by the treatments T_9, T_8, and T_7 which was on par with each other. Surface irrigation with soil application of RDF recorded lower nitrogen uptake of 22.93 kg ha^{-1} and 31.96 kg ha^{-1} at flowering and harvest stage, respectively. (Table.1)This results was in accordance with Sampathkumar and Pandian, 2011 reported that due to excess irrigation in surface irrigation methods, fertilizer nutrients might have been leached beyond the root zone of maize. More uptakes of plant nutrients in drip fertigation mainly due to continuous availability of higher soil moisture and plant nutrient near the root zone. In surface irrigation with RDF, nutrients were applied to the top soil layer. This layer was subjected to alternate drying and wetting cycles due to longer irrigation intervals. Low soil-water content as well as higher fixation with soil colloids and lesser mobility had reduced the availability of nutrients. Similar absorption pattern with varying irrigation methods was narrated by Escobar (1995).

Phosphorus

Phosphors uptake at the vegetative stage was non-significant, but significantly higher P uptake of 15.88 kg ha^{-1} and 21.78 kg ha^{-1} was registered in 100% RDF through drip fertigation with foliar spray of 100 ppm humic acid (T_6) at flowering and harvest stage, respectively. It was followed by the treatment T_9, T_8, T_7 andT_5 which were on par with each other at flowering and harvest stage. Phosphorous uptake was lower under surface irrigation with soil application of RDF (T_{10}) (11.05 kg $ha^{-1}$and 16.76 kg ha^{-1}, respectively) at flowering and harvest stages (Table.2)

Potassium

Similar trend of results recorded as that of nitrogen and phosphorus uptake and the highest values was recorded at 100 % RDF through drip fertigation with foliar spray of 100 ppm humic acid (T_6) (43.23 and 58.76 kg ha^{-1}) at flowering and harvest stage respectively (Table.3). It was followed by the treatment T_9, T_8, T_7 and T_5. It was on par with each other at flowering and harvest stage. Potassium uptake at the vegetative stage is non-significant. Surface irrigation with RDF (T_{10}) had recorded lower potassium uptake of 26.76 and 43.41 kg ha^{-1} at flowering and harvest stage, respectively. Similar observations were made by Ayyadurai (2013) in black gram.

4.Grain yield of soybean

In the present study, soybean responded significantly in terms of grain yield to drip fertigation with foliar spray of growth regulators compared to surface irrigation with RDF. Soybean grain yield was significantly higher in 100 % RDF through drip fertigation with foliar spray of 100 ppm humic acid twice (1804 kg ha^{-1}). Increase of soybean grain yield was 37.8 % in drip system over surface irrigation. This finding was in accordance with -Habbasha et al., 2015 in groundnut. The reason being increased nutrient availability and subsequent absorption by the crop under optimum moisture condition coupled with frequent nutrient delivery through fertigation and consequent better formation and translocation of assimilates from source to sink might have increased the yield. Similar observations were made by Ayyadurai (2013) in black gram (Table.4)

With regard to growth regulators, the grain yield was higher with the foliar spraying of 100 ppm humic acid twice when compared to foliar spray of 100 ppm succinic acid with three levels of fertigation. These results are in agreement with that of Lingaraju and Hunshal, (2015) in soybean. Under surface irrigation with RDF had inadequate soil moisture availability leading to inadequate supply of nutrient to the crop has resulted in lower grain yield of soybean.

5.Haulm yield

Haulm yield was recorded in 100 % RDF through drip fertigation with foliar spray of 100 ppm humic acid twice (4650 kg ha^{-1}) over surface irrigation with RDF (3516 kg ha^{-1}). This result was confirmed by Fred *et al.*, (2017). The increased haulm yield was mainly due to the higher production of dry matter, leaf area and all the yield attributing components of the crop and better availability of soil moisture and nutrients which facilitated easy uptake of the required plant nutrients and thereby increased the performance of the crop with increase in photosynthetic rate.

6.Harvest index (HI)

Harvest index was not significantly influenced by drip fertigation and foliar spray of growth regulators on treatments during cropping period. Similar observations were made by Saravanan (2009). Higher harvest index in 100 % RDF through drip fertigation with foliar spray of 100 ppm humic acid as compared to surface irrigation with soil application of recommended dose of fertilizer. The slight increase in HI might be due to the increased mobilization of metabolites to reproductive sinks.

7.Conclusions

From the above study, it can be concluded among different combination of the fertilizer levels and growth regulators on the soybean. Higher nutrient uptake of Nitrogen, Phosphors and Potassium with 100 % RDF through drip fertigation with foliar spray of 100 ppm humic acid was found good.

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Table 1. Nitrogen uptake of soybean as influenced by drip fertigation and growth regulators (kg ha $^{-1}$)

Treatment		Vegetative (Kg ha $^{-1}$)	Flowering (Kg ha $^{-1}$)	Harvest (Kg ha $^{-1}$)
T1	75 % RDF through drip fertigation	9.26	23.26	32.41
T2	75 % RDF through drip fertigation + Foliar spray of 100 ppm succinic acid twice	9.33	23.94	33.01
T3	75 % RDF through drip fertigation + Foliar spray of 100 ppm humic acid twice	9.47	25.32	35.28
T4	100 % RDF through drip fertigation	9.59	25.62	35.67
T5	100 % RDF through drip fertigation + Foliar spray of 100 ppm succinic acid twice	9.73	26.00	36.21
T6	100 % RDF through drip fertigation + Foliar spray of 100 ppm humic acid twice	10.60	31.69	43.46
T7	125 % RDF through drip fertigation	9.97	28.23	38.99
T8	125 % RDF through drip fertigation + Foliar spray of 100 ppm succinic acid twice	10.04	28.62	39.53
T9	125 % RDF through drip fertigation + Foliar spray of 100 ppm humic acid twice	10.10	29.13	39.88
T10	Surface irrigation + RDF	9.052	22.93	31.96
	SEd	**0.49**	**1.18**	**1.59**
	CD (P = 0.05)	**NS**	**2.49**	**3.34**

Table 2. Phosphorus uptake of soybean as influenced by drip fertigation and growth regulators (kg ha $^{-1}$)

Treatment		Vegetative (Kg ha $^{-1}$)	Flowering (Kg ha $^{-1}$)	Harvest (Kg ha $^{-1}$)
T1	75 % RDF through drip fertigation	3.28	12.19	16.76
T2	75 % RDF through drip fertigation + Foliar spray of 100 ppm succinic acid twice	3.29	12.38	17.03
T3	75 % RDF through drip fertigation + Foliar spray of 100 ppm humic acid twice	3.32	13.09	18.06
T4	100 % RDF through drip fertigation	3.34	13.22	18.24
T5	100 % RDF through drip fertigation + Foliar spray of 100 ppm succinic acid twice	3.36	14.23	18.49
T6	100 % RDF through drip fertigation + Foliar spray of 100 ppm humic acid twice	3.48	15.88	21.78
T7	125 % RDF through drip fertigation	3.39	14.37	19.75
T8	125 % RDF through drip fertigation + Foliar spray of 100 ppm succinic acid twice	3.40	14.54	20.00
T9	125 % RDF through drip fertigation + Foliar spray of 100 ppm humic acid twice	3.41	14.76	20.16
T10	Surface irrigation + RDF	3.26	11.05	16.76
	SEd	**0.35**	**0.71**	**0.94**
	CD (P = 0.05)	**NS**	**0.57**	**1.74**

Table 3.Potassium uptake of soybean as influenced by drip fertigation and growth regulators (kg ha $^{-1}$)

Treatment		**Vegetative (Kg ha $^{-1}$)**	**Flowering (Kg ha $^{-1}$)**	**Harvest (Kg ha $^{-1}$)**
T1	75 % RDF through drip fertigation	3.14	29.48	45.00
T2	75 % RDF through drip fertigation + Foliar spray of 100 ppm succinic acid twice	3.17	30.36	46.72
T3	75 % RDF through drip fertigation + Foliar spray of 100 ppm humic acid twice	3.25	32.80	51.03
T4	100 % RDF through drip fertigation	3.29	33.19	51.59
T5	100 % RDF through drip fertigation + Foliar spray of 100 ppm succinic acid twice	3.58	36.16	52.08
T6	100 % RDF through drip fertigation + Foliar spray of 100 ppm humic acid twice	3.96	43.23	58.76
T7	125 % RDF through drip fertigation	3.59	38.54	52.38
T8	125 % RDF through drip fertigation + Foliar spray of 100 ppm succinic acid twice	3.59	39.05	52.59
T9	125 % RDF through drip fertigation + Foliar spray of 100 ppm humic acid twice	3.59	39.40	53.70
T10	Surface irrigation + RDF	3.10	26.76	43.41
	SEd	**0.28**	**1.62**	**2.30**
	CD (P = 0.05)	**NS**	**3.40**	**4.20**