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Influence of Foliar Nutrition for Maximising the Growth and Yield of Black Gram (*Vigna mungo* L.) under Irrigated Condition

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ABSTRACT

Background: A field experiment was conducted at the Central farm of Imayam Institute of Agriculture and Technology, Thuraiyur, during *Thaipattam* (Jan.- Feb.) 2019 to study the influence of foliar nutrients for maximizing the yield of blackgram (*Vigna mungo* L.) under irrigated condition.

Methods: The experiment was laid out in a randomized block design and replicated thrice. The treatments comprised six different foliar nutrients *viz*.,T_1 - Control (RDF alone - 25:50:25 kg NPK ha^{-1}), T_2 - RDF + foliar spray of 1% TNAU Pulse wonder, T_3 - RDF + foliar spray of 1% (19:19:19), T_4 - RDF + foliar spray of 1% KCl, T_5 - RDF + foliar spray of 2% DAP, T_6 - RDF + foliar spray of Salicylic acid 100 ppm, T_7 - RDF+ foliar spray of PPFM @ 500 ml ha^{-1}. The variety used VBN(Bg) 5. The foliar nutrients were sprayed on 30 and 45 DAS.

Result: The results revealed that among the different foliar nutrients, foliar application of 1% pulse wonder resulted in higher LAI and DMP, closely followed by 2% DAP spray. Similar to the yield parameters, foliar application of 1% TNAU pulse wonder produced more pod clusters $plant^{-1}$, number of pods $plant^{-1}$ and number of seeds pod^{-1} and it, however, was on par with 2% DAP spray. Foliar spray of 1% TNAU pulse wonder produced a higher grain yield of 918 kg ha^{-1}, comparable with a grain yield of 2% DAP (896 kg ha^{-1}). The highest gross return (₹ 50,490 ha^{-1}), net return (₹ 26,000 ha^{-1}) and BCR (2.03) were obtained with foliar spray of 1% pulse wonder followed by 2% DAP spray, Hence, it is concluded that raising blackgram with foliar spray of pulse wonder spray @ 1% twice at 30 and 45 DAS is the viable package for getting higher yield and higher income.

Key words: Foliar Nutrition, KCL, PPFM, Pulse wonder, Salicylic acid.

INTRODUCTION

Pulses play an important role in the Indian diet and in the country's farm economy. India is the largest producer, consumer and importer of pulses. The major pulses-producing states are Madhya Pradesh (25%), Uttar Pradesh (13%), Maharashtra (12%), Rajasthan (11%) andhra Pradesh (9%) and other states together (30%). Chickpeas, pigeon peas, lentils, blackgram, green gram and field pea are major pulses grown and consumed in India. Among the pulses, chickpea contributes 48%, pigeonpea 17%, blackgram 10%, greengram 7% and other pulses 18% towards total pulses production. In India pulse production of pulses during 2017-2018 was 1900 thousand tonnes. India produces about a quarter of the world's pulses. However, the production is not sufficient to meet the domestic demand of the population. The per capita availability of pulses has declined to 43 grams per day, which is lower than ICMR recommendation of 65 grams per day. The mismatch between production and consumption of pulses is increasing, which has resulted in larger imports of pulses. In 2018 the pulses production in India is about 25.23 MT. Blackgram (*Vigna mungo* L.) is one of the major pulse crops cultivated in about 4.02 million hectares with average productivity of 547 kg ha^{-1}. The major blackgram producing states are Andhra Pradesh, Maharashtra,

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Madhya Pradesh, Tamil Nadu and Uttar Pradesh. Tamil Nadu accounts for an area of 4.16 lakh hectares under blackgram cultivation, producing 2.8 lakh tonnes with the productivity of 673 kg ha^{-1} which is much lower than Andhra Pradesh (901), Bihar (895), Jharkhand (760) and West Bengal (727). One of the possible ways to increase pulse production is cultivating the crop in non-traditional areas and season (Prakash *et al*., 2023). In recent years, due to recurrent monsoon failure and non-availability of canal water, the farmers are suggested to cultivate blackgram as an alternate crop to paddy, under irrigated conditions by utilizing bore wells. The yield potential of blackgram is very low because of the fact that the crop is mainly grown in rainfed conditions with poor management practices and also due to various physiological, biochemical as well as inherent factors associated with the crop. Apart from the genetic makeup, the physiological factors *viz*., insufficient portioning of assimilates, poor pod setting due to the flower abscission and lack of nutrients during critical stages of crop growth, coupled with a number of diseases and pests (Mahala *et al*., 2001) were the reasons for the poor yield. Pulses normally produce a large number of flowers but only a few are retained and developed into pods. Supply of nutrients through foliar application during critical stage ensured positive source-sink gradient of photosynthates translocation and balanced growth habit (Maheswari *et al*., 2017). This attributed to reduced flower shedding and increase in pod setting, grain filling and ultimately the yield.

The importance of foliar nutrition it can be applied directly to site of metabolism. It increases yield upto 15 to 25%. More than 90% of the fertilizer is used by the plant. Deficiencies can be corrected within short period. Foliar applied fertilizers are more effective than soil applied fertilizers. Thus foliar application of macro and micronutrients and growth regulators is considered to be an efficient and economic method of supplementing part of the nutrient requirements at critical stages. Foliar application of nutrient formulations, growth regulators and biological formulations in pulses are being tried by many researchers. DAP application induce flower initiation and pod formation. Foliar application of KCl increases the pod filling and creates the drought tolerance capacity in plants. Pink-pigmented facultative methylotrophic bacteria (PPFMs) increase chlorophyll content there by increasing the photosynthetic efficiency and makes drought tolerance ability of plants (Ashraf *et al*., 2020). Salicylic acid is an endogenous growth regulator of phenolic nature, which participates in the regulation of physiological processes like water balance in order to mitigating the stress, acts as a chelate for phosphorous uptake, increases pod setting, flowering and grain yield (Ashraf and Ragavan, 2019). TNAU pulse wonder is the combination of nutrients and growth regulators which is exclusively developed in the laboratory of Crop Physiology of Tamil Nadu Agricultural University. Pulse Wonder decreases flower shedding, increases yield upto 20% and offers moisture stress tolerance. All19 increases the grain yield of the crop. Keeping above points in view, an experiment entitled “Foliar nutrient management studies in irrigated blackgram” has been planned.

MATERIALS AND METHODS

A field experiment was conducted at Central farm of Imayam institute of Agriculture and Technology, Thuraiyur during *Thaipattam* (Jan - Feb) 2019 in Imayam Institute of Agriculture and Technology Farm at Thuraiyur, to study the influence of foliar nutrition for maximizing the yield of black gram under irrigated condition. The field experiment was conducted in A block, in field of Imayam Institute of Agriculture and Technology, Thuraiyur during 2019. The location of the farm is in North western Agro-climatic Zone of Tamil Nadu at 11°N latitude and 70°E longitude with an altitude of 135 above MSL. The texture of the surface soil (0-15 cm) of the experimental field was loamy. The soil of the experimental fields was medium deep, well drained with clay loam texture and grouped under taxonomical classification of *Govinthapuram* series. The nutrient status of the field was very low in available nitrogen, medium in available phosphorus and medium in available potassium. Blackgram variety VBN(Bg) 5 was used for the study and characteristic features of the variety are presented in Table 1.

The experiment was laid out in randomized block design and replicated thrice. The treatments comprised of six foliar nutrients. T_1 - Control (RDF alone - 25:50:25 kg NPK ha^{-1}), T_2 - RDF + foliar spray of 1% TNAU Pulse wonder at 30 and 45 DAS, T_3 - RDF + foliar spray of 1% (19:19:19) at 30 and 45 DAS, T_4 - RDF + foliar spray of 1% KCl at 30 and 45 DAS, T_5 - RDF + foliar spray of 2% DAP at 30 and 45 DAS, T_6 - RDF + foliar spray of Salicylic acid 100 ppm at 30 and 45 DAS and T_7 -RDF+ foliar spray of PPFM (Pink-pigmented Facultative Methylotrophic Bacteria) @ 500 ml ha^{-1} at 30 and 45 DAS. The experimental field was prepared by ploughing once followed by two harrowing. The land configuration of the experimental field was flat bed with specific dimensions and by providing irrigation channels. Good quality seeds of blackgram variety VBN (Bg) 5 were sown at the rate of 20 kg ha^{-1}. The required quantity of seeds were treated with Imidacloprid (70% WS) @ 5 ml kg^{-1} of seed on the day before sowing followed by inoculation with biocontrol agent *Pseudomonas fluorescens* at 10 g kg^{-1} of seed and *Rhizobium* @ 600 g ha^{-1}, shade dried and dibbled at 10 cm plant to plant spacing with row to row distance of 30 cm. The recommended dose of nutrients *viz*., 25:50:25 kg NPK ha^{-1} were applied basally in the form of urea, single super phosphate and MOP. All package of practices were carried out as per recommendation of CPG (2020). The fertilizers were applied uniformly for all treatments. Foliar application of nutrients *viz*., DAP, PPFM, KCl, All 19:19:19 NPK fertilizer, 1% Salicylic acid and TNAU Pulse wonder was done at 30 and 45 DAS using knapsack sprayer with spray volume of 500 liters ha^{-1} (Table 2). The growth parameters *viz*., plant height, root length, number of branches $plant^{-1}$, root nodules $plant^{-1}$, LAI, CGR, DMP,

number of pod clusters plant^{-1}, number of pods plant^{-1} and number of seeds pod^{-1}.

RESULTS AND DISCUSSION

Growth parameters

Among the different foliar nutrients evaluated, the effect on plant height was significant only at harvest stage. Higher values of plant height were noted with the application of 1% TNAU pulse wonder spray (though it was on par with PPFM @ 500 ml ha^{-1} and 2% DAP spray). The number of branches per plant did not differ significantly among the different foliar nutrients studied. Though numerically more number of branches per plant was observed with the application of 1% pulse wonder spray (5.2) and it was on par with PPFM @ 500 ml ha^{-1} (4.9) and 2% DAP spray (5.0). From the results it is inferred that foliar application of nutrients did not exhibit significant difference in plant height at early stages of crop (30 DAS). However, foliar spray of 1% pulse wonder continued to satisfy the nutrient demand which resulted in significantly higher plant height at harvest and it was closely followed by PPFM @ 500 ml ha^{-1} and 2% DAP spray. The presence of macro and micro nutrients and growth promoters in pulse wonder could able to increase the plant height through better growth and development of pulse crop only numerically as compared to urea which supplies only N and DAP (N and P). The significant increase in plant height might be due to the internodes elongation and the vigorous root growth. These results are very similar to the reports of Kumar *et al*. (2018), which indicated that though the values of plant height was highest with 1% pulse wonder, the values were comparable with application of 2% DAP in blackgram. Branching is an important character of crop, which bears the pods and ultimately enhanced the yield of crop. The number of branches per plant however did not differ among the different foliar nutrients tried. Though TNAU pulse wonder would have accelerated various metabolic processes by means of macro and micronutrients, no significant variation was observed. The presence of nitrogen and phosphorus in DAP, MAP and All 19:19:19 fertilizer would have also increased the number of branches through its vital role in cell division and hence non-significant would have occurred. Kumar *et al.* (2018) observed no significant difference for number branches between TNAU Pulse wonder and 2% DAP. The results from the leaf area index computed revealed that differences in LAI of blackgram among the different foliar application were at all the stages of observation. Among the different foliar nutrients applied, LAI was higher with foliar spray of 1% pulse wonder at 45 and 60 DAS. However these values were on par with PPFM @ 500 ml ha^{-1} spray and 2% DAP spray (Table 2, 3 and 4).

The mean data on dry matter production (kg ha^{-1}) recorded at, 45, 60 DAS and at harvest are presented in Table 5, 6 and 7. Foliar nutrients had greater influence on influence on dry matter production at all the stages of observation except 30 DAS as the treatment was imposed only on 30 DAS. Irrespective of the treatments, dry matter accumulation showed a linear increase from 30 DAS to harvest of the crop. Foliar application of 1% pulse wonderspray produced numerically higher dry matter production at all the stages of observation though it was on par with

Table 1: Varietal characteristics of black gram VBN(Bg) 5.

Particulars	Description
Year of release	2007
Released by	Tamil Nadu Agricultural University, Coimbatore.
Parentage	Vamban 1 × UK 17
Maturity duration	65-70 days
Plant height	34 cm
Days to 50% flowering	32 days
Hairiness of pods	Hairy
Colour of grain	Black
100 seed weight	4.0 g
Yield (irrigated)	820 kg ha^{-1}
Special features	Double blooming character; After 65 DAS second setting of flowering starts. Moderately resistant to yellow mosaic.

Table 2: The details of foliar spray solution applied.

Name of the chemical	Nutrient content	Concentration	Required quantity spray^{-1}
DAP	18% N, 48% P_2O_5	20 g litre^{-1} of water	10 kg ha^{-1}
Salicylic acid	-	10 g litre^{-1} of water	5 kg ha^{-1}
KCL	12% N, 61% P_2O_5	10 g litre^{-1} of water	5 kg ha^{-1}
19:19:19 NPK	19% N, 19% P_2O_5, 19% K_2O	10 g litre^{-1} of water	5 kg ha^{-1}
TNAU Pulse Wonder	-	10 g litre^{-1} of water	5 kg ha^{-1}
PPFM	-	2 ml litre^{-1} of water	1 lit ha^{-1}

Table 3: Effect of foliar nutrition on plant height (cm) of irrigated blackgram.

Treatment	45 DAS	60 DAS	Harvest
T_1- Control (RDF alone - 25:50:25 kg NPK ha^{-1})	25.1	35.7	41.1
T_2- RDF + foliar spray of 1% TNAU Pulse wonder	28.2	39.9	46.2
T_3- RDF + foliar spray of 1% (19:19:19)	25.8	36.6	42.8
T_4- RDF + foliar spray of 1% Kcl	26.4	37.2	42.9
T_5- RDF + foliar spray of 2% DAP	28.2	38.1	45.0
T_6- RDF + foliar spray of Salicylic acid 100 ppm	25.7	36.2	42.8
T_7- RDF+ foliar spray of PPFM @ 500 ml ha^{-1}	28.1	37.5	44.4
Mean	26.8	37.3	43.6
SEd	1.72	2.37	2.79
CD (0.05)	3.73	5.17	6.08

Table 4: Effect of foliar nutrition on number of branches $plant^{-1}$ and root length (cm) of irrigated blackgram.

Treatment	Number of branches $plant^{-1}$	Root length (cm)
T_1- Control (RDF alone - 25:50:25 kg NPK ha^{-1})	4.0	16.3
T_2- RDF + foliar spray of 1% TNAU Pulse wonder	5.2	18.0
T_3- RDF + foliar spray of 1% (19:19:19)	4.4	17.0
T_4- RDF + foliar spray of 1% Kcl	4.6	14.9
T_5- RDF + foliar spray of 2% DAP	5.0	17.4
T_6- RDF + foliar spray of Salicylic acid 100 ppm	4.3	16.3
T_7- RDF+ foliar spray of PPFM @ 500 ml ha^{-1}	4.9	17.4
Mean	4.6	17.0
SEd	0.28	1.07
CD (0.05)	0.62	2.34

Table 5: Effect of foliar nutrition on leaf area index (LAI) of irrigated blackgram.

Treatment	45 DAS	60 DAS	Harvest
T_1- Control (RDF alone - 25:50:25 kg NPK ha^{-1})	0.46	0.83	0.46
T_2- RDF + foliar spray of 1% TNAU Pulse wonder	1.06	1.55	1.06
T_3- RDF + foliar spray of 1% (19:19:19)	0.71	1.10	0.71
T_4- RDF + foliar spray of 1% Kcl	0.75	1.20	0.75
T_5- RDF + foliar spray of 2% DAP	0.89	1.35	0.82
T_6- RDF + foliar spray of salicylic acid 100 ppm	0.68	0.96	0.68
T_7- RDF+ foliar spray of PPFM @ 500 ml ha^{-1}	0.98	1.44	0.95
Mean	0.76	1.19	0.76
SEd	0.07	0.07	0.05
CD (0.05)	0.17	0.17	0.11

Table 6: Effect of foliar nutrition on dry matter production (DMP) (kg/ha) of irrigated blackgram.

Treatment	45 DAS	60 DAS	Harvest
T_1- Control (RDF alone - 25:50:25 kg NPK ha^{-1})	756	1044	1299
T_2- RDF + foliar spray of 1% TNAU pulse wonder	1222	1543	1978
T_3- RDF + foliar spray of 1% (19:19:19)	843	1077	1566
T_4- RDF + foliar spray of 1% Kcl	856	1122	1644
T_5- RDF + foliar spray of 2% DAP	1188	1266	1777
T_6- RDF + foliar spray of Salicylic acid 100 ppm	789	1066	1555
T_7- RDF+ foliar spray of PPFM @ 500 ml ha^{-1}	1099	1166	1766
Mean	1046	1126	1655
SEd	62.66	76.26	107.03
CD (0.05)	136.53	166.17	233.21

2% DAP spray. The LAI was significantly increased by foliar application of pulse wonder and the values are comparable with PPFM @ 500 ml ha^{-1}spray and 2% DAP spray. The dry matter production was accelerated after foliar application of nutrients. Foliar supplement of nutrients could have enhanced the level of available nutrients resulting in better plant growth and development.

Foliar application of nutrients had significant influence on nodule count. The nodule count was found to be significantly higher with one per cent pulse wonder at 45 DAS. The nodulation and nitrogen fixation was peak at 30 DAS (flowering and early pod-filling stage) and thereafter reduced drastically to meet demand for nitrogen for developing seed. The reduction in nodulation and nitrogen fixation may be due to preferential mobilization of assimilates for seed development which resulted in lower availability of photosynthates for nodule formation, growth, maintenance and development. This might be due to better absorption of nutrients applied through foliage, leading to better activity of functional root nodules (Solaiappan *et al*., 2002). Foliar spray of pulse wonder could have supplemented the micro and macronutrients requirement for seed development and reduced the translocation of nitrogen from nodules.

Growth parameters clearly indicated the highest growth was observed with 1% pulse wonder spray though it was on par with 2% DAP. Dry matter production in above ground parts is contributed by stem, branches, leaves, pods and grains inside the pods. The significant increase of dry weight/plant with 1% pulse wonder application might be due to the fact that nitrogen helps in maintaining higher auxin level that would have resulted in better leaf area and presumably chlorophyll content of the leaves. This might have resulted into better light interception, absorption and utilization of radian energy, leading to higher photosynthetic rate and finally more accumulation of dry matter by the plants.

Yield attributes

The foliar nutrients showed significant effect on the number of pod clusters per plant. Among the foliar nutrients, though foliar application of 1% pulse wonder (6.63) significantly produced more number of pod clusters per plant, it was comparable with foliar spray of 2% DAP spray (6.10) and PPFM 500 ml/ha (5.85).

The length of the pods did not differ significant among the different foliar nutrients. The numerically higher pod length was observed with 1% pulse wonder spray (4.91 cm) which was it was comparable with foliar spray of 2% DAP spray (4.44) and PPFM @ 500 ml ha^{-1} (4.0). The data on number of pods per plant as influenced by foliar nutrients are presented in Table 8. The results revealed that the influence of foliar nutrients on the number of matured pods per plant was significant. Among the different nutrients sprayed, foliar application of 1% pulse wonder produced more number of pods per plant (6.63). However the values

Table 7: Effect of foliar nutrition on number of pod clusters $plant^{-1}$ and pod length (cm) of irrigated blackgram.

Treatment	Number of pod clusters $plant^{-1}$	Pod length (cm)
T_1- Control (RDF alone - 25:50:25 kg NPK ha^{-1})	5.00	4.23
T_2- RDF + foliar spray of 1% TNAU pulse wonder	6.63	4.91
T_3- RDF + foliar spray of 1% (19:19:19)	5.45	3.63
T_4- RDF + foliar spray of 1% Kcl	5.27	3.84
T_5- RDF + foliar spray of 2% DAP	6.10	4.44
T_6- RDF + foliar spray of Salicylic acid 100 ppm	5.33	3.46
T_7- RDF+ foliar spray of PPFM @ 500 ml ha^{-1}	5.85	4.0
Mean	5.66	4.0
SEd	0.35	0.56
CD (0.05)	0.77	0.26

Table 8: Effect of foliar nutrition on pods $plant^{-1}$, number of seeds pod^{-1} and 100 seed weight (g) of irrigated blackgram.

Treatment	No of pods $plant^{-1}$	No of seeds pod^{-1}	100 seed weight (g)
T_1- Control (RDF alone - 25:50:25 kg NPK ha^{-1})	10.33	3.43	4.8
T_2- RDF + foliar spray of 1% TNAU Pulse wonder	14.2	3.72	5.6
T_3- RDF + foliar spray of 1% (19:19:19)	12.5	3.55	5
T_4- RDF + foliar spray of 1% Kcl	13	3.32	4.9
T_5- RDF + foliar spray of 2% DAP	13.9	3.21	5.4
T_6- RDF + foliar spray of Salicylic acid 100 ppm	12	3.11	4.9
T_7- RDF+ foliar spray of PPFM @ 500 ml ha^{-1}	13.4	3.68	5.2
Mean	10.7	2.92	5.11
SEd	0.81	0.24	0.23
CD (0.05)	1.77	0.52	0.51

were comparable with 2% DAP (6.10) and PPFM @ 500 ml ha^{-1} spray (5.85). The recorded data on mean number of seeds per pod are presented in Table 9. Foliar application of nutrients did not exert significant influence on number of seeds pod^{-1}. The mean data on 100 seed weight (g) are presented in Table 8. The foliar application of nutrients caused significant variation in 100 seed weight. Foliar application 1% pulse wonder registered highest 100 seed weight of 4.09 g and it was on par with 1% urea (4.02 g) and 2% DAP (3.95 g) spray.

Yield characters

Foliar nutrients exerted a significant influence on the grain yield. Foliar nutrients exerted a significant influence on the grain yield. A remarkable increase in the grain yield was achieved when different foliar spray was studied. Among the different treatments, foliar application of 1% pulse wonder registered significantly higher pod yield of 918 kg ha^{-1}. However the yield obtained with 1% pulse wonder spray was on par with the yield of 2% DAP and PPFM @ 500 ml ha^{-1} spray. The perusal of mean data on haulm yield (Table 7, 8 and 9). Foliar application of 1% pulse wonder resulted in higher haulm yield of 1548 kg ha^{-1}, followed by 2% DAP spray (1418 kg ha^{-1}) and PPFM @ 500 ml ha^{-1} (1399 kg ha^{-1}). The treatments 1% pulse wonder, 2% DAP and PPFM @ 500 ml ha^{-1} were on par with each other for haulm yield. The yield attributes were significantly influenced by foliar nutrition with more number of pods $plant^{-1}$ being obtained by foliar application of 1% pulse wonder and it was on par with 2% DAP and PPFM @ 500 ml ha^{-1}. Timely supply of nutrients through foliar spray during peak nutrient demand might have reduced shedding of flowers and fruits resulting in higher number of pods. Foliar application of nutrients was significant in grain filling as the 100 seed weight varied among different source of nutrients (Ashraf *et al*., 2023). The grain filling was highest with foliar application of 1% pulse wonder, closely followed by 2% DAP and PPFM @ 500 ml ha^{-1} spray. This may be due to increase in photosynthates production and effective translocation of assimilates from source to sink. Further yield might be also due to increased uptake of nutrients by blackgram through effective translocation of nutrients from sink to reproductive area of crop (Fig 1).

Effective partitioning of photosynthetic assimilates from leaves to pods might be the reason for attaining higher harvest index through foliar application of 1% pulse wonder and 2% DAP solution. The foliar nutrients might have supplemented the nutrient demand of the crop at the critical stage, resulting in better growth and development of the crop and ultimately the yield attributing characters and enhanced positive source-sink gradient of photosynthates translocation guaranteeing seed formation and better grain-filling (Manivannan *et al*., 2002). These positive impacts on yield attributes by foliar application of 1% pulse wonder and 1% DAP resulted in higher grain yield. Das and Jana (2015) also reported that significantly higher seed yield of pulses

Table 9: Effect of foliar nutrition on grain yield (kg ha^{-1}), haulm yield (kg ha^{-1}) and harvest index of irrigated blackgram.

Treatment	Grain yield (kg ha^{-1})	Haulm yield (kg ha^{-1})	Harvest index (%)
T_1- Control (RDF alone - 25:50:25 kg NPK ha^{-1})	583	1048	35.2
T_2- RDF + foliar spray of 1% TNAU Pulse wonder	918	1548	37.8
T_3- RDF + foliar spray of 1% (19:19:19)	823	1444	35.7
T_4- RDF + foliar spray of 1% Kcl	844	1429	35.6
T_5- RDF + foliar spray of 2% DAP	896	1418	37.4
T_6- RDF + foliar spray of Salicylic acid 100 ppm	714	1345	36.4
T_7- RDF+ foliar spray of PPFM @ 500 ml ha^{-1}	882	1399	35.
Mean	808	1376	36.2
SEd	52.19	88.35	2.30
CD (0.05)	113.72	192.51	5.02

Fig 1: Best performance of black gram under RDF + foliar spray of 1% TNAU Pulse wonder on 30 and 45 DAS (T_2).

Table 10: Effect of foliar nutrition on economics of irrigated blackgram.

Treatment	Cost of cultivation (₹ ha^{-1})	Gross return (₹ ha^{-1})	Net return (₹ ha^{-1})	Benefit cost ratio
T_1- Control (RDF alone - 25:50:25 kg NPK ha^{-1})	24,000	32,065	8,065	1.34
T_2- RDF + foliar spray of 1% TNAU Pulse wonder	24,900	50,490	26,000	2.03
T_3- RDF + foliar spray of 1% (19:19:19)	24,700	45,265	25,700	1.83
T_4- RDF + foliar spray of 1% Kcl	24,607	46,420	25,607	1.89
T_5- RDF + foliar spray of 2% DAP	24,750	49,280	25,750	1.99
T_6- RDF + foliar spray of Salicylic acid 100 ppm	24,897	39,270	25,897	1.58
T_7- RDF+ foliar spray of PPFM @ 500 ml ha^{-1}	24,798	48,510	25,798	1.96
Mean	24,665	44471	23260	2.01

Data not statistically analysed.

with application of 2% DAP spray. However Kumar *et al.* (2018) reported that foliar application of 2% DAP twice at flower initiation (flowering stage) and pod formation stage (15 days later of flowering) produced significantly higher seed yield, which was comparable with 19:19:19 (NPK) 2% spray and TNAU pulse wonder spray.

Economics

Among the foliar nutrients, higher gross return (₹ 50,490/- ha^{-1}), net return (₹ 26,000/- ha^{-1}) and BCR (2.03) were obtained with foliar spray of 1% pulse wonder. Economic analysis of the data indicated that adoption of foliar application of nutrients increased the monetary returns (Table 10). The cost of cultivation did not differ much among the cultivation practices adopted. Among the foliar nutrients, higher gross return (₹ 50,490/- ha^{-1}), net return (₹ 26,000/- ha^{-1}) and BCR (2.03) were obtained with foliar spray of 1% pulse wonder. The increase in gross and net return was mainly due to increase in grain yield.

CONCLUSION

The results revealed that among the various foliar nutrients, foliar application of 1% pulse wonder spray resulted in higher growth parameters *viz*., plant height, root length, LAI, CGR and DMP which was closely followed by 2% DAP spray. Similar to the growth parameters, foliar application of 1% pulse wonder spray produced more number of pod clusters plant^{-1}, number of pods plant^{-1} and number of seeds pod^{-1} and it however was on par with 2% DAP spray. Foliar spray of 1% pulse wonder spray produced higher grain yield of 918 kg ha^{-1}, comparable with grain yield of 2% DAP spray (896 kg ha^{-1}).Among the foliar nutrients, higher gross return (₹ 50,490/- ha^{-1}), net return (₹ 26,000 ha^{-1}) and BCR (2.03) was obtained with foliar spray of 1% pulse wonder followed by 2% DAP spray.

From the above summary, the following conclusions are drawn:

1. Foliar spray of 1% pulse wonder spray had better crop establishment and the growth of blackgram under irrigated condition.
2. Foliar application of 1% pulse wonder spray enhanced yield attributing characters and yield of blackgram.
3. Higher gross and net return was associated with foliar spray of 1% pulse wonder spray. Foliar nutrition of 2% DAP performed the next best gross and net return of irrigated blackgram.

Hence, it is concluded that during *Thaipattam* (Jan. - Feb.) season, raising blackgram with foliar spray of pulse wonder spray @ 1% twice at 30 and 45 DAS is the viable package for getting higher yield and higher income. This technology is economically viable and could be introduced in the Trichy tracts during all the seasons to have a successful crop for farmers.

Conflict of interest

All authors declared that there is no conflict of interest.

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