Research Article

Effect of Fertility Levels and Foliar Nutrition on Blackgram (*Vigna Mungo* L.) Under Drip Fertigation

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Abstract

Field experiments were conducted during summer 2012 and 2013 to study the effect of different fertility levels with and without foliar spray such as drip fertigation of RDF of NPK at 50%, 75% and 100% with foliar spray of 2% DAP and 1% urea phosphate at flowering and then 15 days thereafter. These practices were compared with surface irrigation with application of recommended dose of fertilizer alone. Drip fertigation with 100% RDF of NPK and foliar spray of 1% urea phosphate recorded the higher grain yield of 926 and 991 kg ha^{-1} during summer 2012 and 2013, respectively which was significantly superior over the rest of the treatments. Surface irrigation with 100% RDF recorded the lowest grain yield of 469 and 495 kg ha^{-1} during summer 2012 and 2013, respectively.

Keywords: Blackgram, DAP, Drip fertigation, Foliar spray, Grain yield and Urea phosphate

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Introduction

Blackgram (*Vigna mungo* L. Hepper.) is one among highly prized vegetarian diets in India. It can be boiled or eaten whole and they are ground into flour and used to make porridge or baked into bread and biscuits. The green pods are also edible. Dried blackgram contains about 9.7% water, 23.4% protein, 1.0% fat, 57.3% carbohydrate and 3.8% fibre along with 154 mg calcium, 9.1 mg iron, 0.37 g riboflavin and 0.42 g thiamin in each gram of blackgram [1]. In South India, the most popular food preparations *viz*., *idly* and *dosa* are prepared by mixing rice and blackgram flour. Being leguminous crop, it has beneficial effect on improving soil fertility through fixation of atmospheric nitrogen. India is the largest producer and consumer of pulses accounting for 33.6% of the world area and 24% of the world production of pulses [2].

In Tamil Nadu, blackgram covers an area of about 3.41 lakh hectares with the production of 1.21 lakh tonnes and productivity of 355 kg ha^{-1} [3]. Tamil Nadu is not self sufficient in pulses requirement. There is therefore, an urgent need to increase the production of blackgram, the major pulse crop of the state. The low productivity of blackgram is due to the cultivation of this crop in marginal and sub-marginal lands with poor management practices. Use of improved crop management packages can invariably increase the productivity by 50-100 %. In addition to other management practices such as irrigation and plant protection, blackgram respond markedly to précised application of plant nutrients in combination with foliar nutrition especially when applied in balanced amount and at appropriate time.

The soil applied nutrients undergo several changes and losses which occur through leaching and volatilization. Besides adverse soil conditions like acidity, alkalinity, water logging and lack of adequate moisture would also result in non availability of nutrients. In order to avoid or minimize severity of such condition foliar application of nutrients is imperative. Though foliar spray is not a substitute to soil application but it is certainly considered as a supplement to soil application [4]. As per the research findings under All India Co-ordinated Pulses Improvement Project (1983) [5] foliar application of DAP at the rate of 25-50 kg ha^{-1} was as good as 100 kg DAP ha^{-1} through soil application. Foliar application of nutrients has been suggested as the means for increasing the fertilizer use efficiency. It provides more rapid utilization of nutrients and permits the correction of observed deficiencies in less time than would be required by soil treatments.

Materials and Methods

Field experiments were conducted at Agricultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore, India during winter seasons of 2011-12 and 2012-13. Experimental soil was sandy clay loam with 1.33 g cc^{-1}, 26.5 and 13.5% bulk density, field capacity and permanent wilting point, respectively. Soil fertility

was low (210 kgha^{-1}), medium (17 kg ha^{-1}) and high (420 kg ha^{-1}) for available nitrogen, phosphorus and potassium, respectively.

The experiment was laid out in randomized block design and replicated thrice. Drip fertigation with three levels of fertilizer and two foliar sprays were included in the study. The treatments were T_1 - Surface irrigation and soil application of 100% RDF; T_2 - T_1 + foliar spray of 2% DAP ; T_3 - T_1 + foliar spray of 1% urea phosphate; T_4 - Drip irrigation and soil application of 100% RDF; T_5 - T_4 + foliar spray of 2% DAP ; T_6 - T_4 + foliar spray of 1% urea phosphate; T_7 - Drip fertigation at 100% RDF; T_8 - T_7 + foliar spray of 2% DAP ; T_9 - T_7 + foliar spray of 1% urea phosphate; T_{10} - Drip fertigation at 75% RDF; T_{11} - T_{10} + foliar spray of 2% DAP ; T_{12} - T_{10} + foliar spray of 1% urea phosphate; T_{13}- Drip fertigation at 50% RDF; T_{14} - T_{13} + foliar spray of 2% DAP ; T_{15} - T_{13} + foliar spray of 1% urea phosphate.

The experimental field was thoroughly ploughed using tractor drawn disc plough and cultivator and then properly levelled. After levelling the field ridges and furrows were formed at 90 cm apart to accommodate furrow irrigated crop under surface irrigation. For drip irrigated plots raised beds were formed in the dimension of 150 cm width and 15 cm height. Buffer channels were formed to control the lateral seepage of water from one plot to another. The plot size was 8.2 x 5.4 m (44.28 m^2). Laterals were placed 1.8 m apart as one per two rows of crop. Emitters were inline, placed 60 cm apart with the discharge rate of 4 lph. Healthy and viable blackgram seeds of CO 6 were hand dibbled at the rate of one per hole with 60 cm spacing within the row. Paired row spacing of 120/30 x 10 cm was followed. Sowing irrigation was uniformly given to all the treatments. Irrigation scheduling was done at 0.60 IW/CPE ratio with 5 cm depth for surface irrigation treatments. Irrigation under drip was scheduled once in three days with 100% CPE and water requirement was worked out using the formula

$$WRc = CPE \times Kp \times Kc \times Wp \times A$$

where, WRc - Computed water requirement (litre plant^{-1}), CPE - Cumulative pan evaporation for three days (mm), Kp - Pan factor (0.75), Kc - Crop factor (values for each crop given in table), Wp - Wetting percentage (80), A - Area plant^{-1}.

Time of operation of drip system to deliver the required volume of water plot^{-1} was computed based on the formula

$$\text{Time of operation} = \frac{\text{Volume of water required}}{\text{Emitter discharge x No. of emitters}}$$

Kc values for different growth periods of blackgram

Stage	Duration (days)	Kc value
Initial	10	0.40
Crop development	20	1.15
Mid season	20	1.15
Late season	15	0.35

Fertigation was done through venturi injector to individual plots. Fertilizer solution was prepared and kept in plastic container and connected with suction device of venturi. Fertigation was given as per the schedule devised for blackgram. The recommended dose of fertilizer (RDF) 25:50:25 of NPK kg per hectare was applied. Nitrogen, phosphorus and potassium were applied in the form of urea, urea phosphate and muriate of potash, respectively.

Fertigation schedule for blackgram

Crop stage (DAS)	Quantity (%)		
	N	P	K
Sowing to crop establishment (6 - 10)	10	60	10
Flower initiation to flowering (11 - 30)	35	30	20
Flowering to pod formation (31 - 45)	35	10	35
Pod formation to picking (46 - 55)	20	-	35
Total	100	100	100

For surface irrigation treatments, the recommended doses of NPK fertilizers were applied as per crop production guide. Fertilizer sources used for supplying NPK were urea (46% N), single super phosphate (16% P_2O_5) and muriate of potash (60% K_2O) respectively. The same schedule was followed for the treatments involving drip irrigation and soil application of 100% RDF. Healthy crop stand was ensured by adopting need based plant protection and following the recommended package of practices for irrigated blackgram. Five plants were selected at random and tagged. These plants were used for recording plant height, leaf area index (LAI) and dry matter production (DMP) at 20 days intervals. Yield attributes *viz*., number of clusters plant^{-1}, number of pods plant^{-1}, number of seeds pod^{-1} and finally grain yield were recorded. The data pertaining to the experiment were subjected to statistical analysis as suggested by Gomez and Gomez (1984) [6].

Results and Discussion

Plant growth

The plant height of blackgram showed an increasing trend at different stages of observation **Table 1**, which was due different levels of fertigation and foliar nutrition during both the years. Among the treatments, drip fertigation with 100% RDF of NPK and foliar spray of 1% urea phosphate at flowering and at 15 days thereafter registered significantly higher plant height of 11.1, 36.1 and 44.4 cm during summer 2012 and 12.1, 37.4 and 48.3 cm during summer 2013 at 20, 40 and 60 DAS, respectively which was on par with drip fertigation at 75% RDF of NPK with foliar spray twice of 1% urea phosphate. Lesser plant height was recorded under surface irrigation and soil application of 100% RDF of NPK (T_1) during both the years. Drip fertigation with 100% and 75 % RDF of NPK with foliar spray of 1% urea phosphate recorded maximum plant height as given by Khetre Mayur Lahurao (2010) [7] in tomato and Selvarani (2009) [8] in maize-bhendi cropping sequence. This could be due to the fact that nutrients applied through foliage would be easily available and translocated in the plants without any loss, hence the plants could put forth better growth. This was in agreement with the findings of Srinivasan and Ramasamy (1992) [9] in cowpea. The increased fertilization favoured more growth possibly due to the availability of major nutrients. Pasricha *et* al. (1995) [10], Subramani and Solaimalai (2000) [11] and Pandian *et al*. (2001) [12] reported positive response of pulses to balanced fertilization.

Dry matter production

Drip fertigation with 100% RDF of NPK with foliar spray of 1% urea phosphate at flowering stage and 15 days thereafter registered higher dry matter production (DMP) of 276, 1397 and 2989 kg ha^{-1} during summer 2012 and 284, 1502 and 3336 kg ha^{-1} during summer 2013 at 20, 40 and 60 DAS, respectively **(Table 1)**. This might be drip fertigation combined with foliar nutrition of 1% urea phosphate might have facilitated more availability in the absorption of nutrients. This paves way for the production of more biomass leading to higher DMP. With regard to foliar nutrition, urea phosphate 1% gave higher DMP than 2% DAP. This increased DMP with urea phosphate might be attributed to easy availability and better mobilization of nutrients to plants leading to taller plant, higher LAI, DMP and more number of pods plant^{-1} in blackgram. The values of yield parameters were higher due to application of urea phosphate which is an adduct of urea and phosphoric acid with high soluble nitrogen (17%) and phosphorus (44%) which facilitated in better absorption of nutrients. Similar results were obtained by Suganthi (2011) [13] in greengram wherein foliar application of 2% urea phosphate produced maximum quantity of DMP. In the same way, application of 100% RDF of NPK with water soluble fertilizer through drip fertigation coupled with foliar fertilization of either urea phosphate or DAP resulted in the higher dry matter production in tomato [7].

Yield components

The yield parameters like number of cluster plant^{-1}, number of pods plant^{-1}and number of seeds pod^{-1} were higher of 18.2, 34.5 and 7.9 during summer 2012 and 18.9, 36.3 and 8.2 during summer 2013 at 20, 40 and 60 DAS, respectively in blackgram receiving drip fertigation with 100% RDF of NPK and foliar spray of 1% urea phosphate twice at flowering stage and 15 days thereafter **Table 2**. Micronutrients are available to the crop in the acidic nature, the direct and indirect acidification of urea phosphate reduced the soil pH which led to higher availability of micronutrients particularly Zn and Fe that facilitates uptake of phosphorus and that ultimately resulted in increased yield components. Application of 100% RDF of NPK as water soluble fertilizer through drip fertigation combined with foliar fertilization of either urea phosphate or DAP resulted in higher yield components in tomato as noticed by Khetre Mayur Lahurao (2010) [7]. The present findings are in line with the reports of Papadopoulos and Leena Ristimaki (2010) [14] in egg plant, Kawther latiti *et al.* (2011) [15] in tomato and Suganthi (2011) [13] in greengram.

Table 1 Effect of drip fertigation levels and foliar spray on plant height (cm) and dry matter production ($kgha^{-1}$) of blackgram

Treatments	Summer 2012						Summer 2013					
	Plant height (cm)			DMP ($kgha^{-1}$)			Plant height (cm)			DMP ($kgha^{-1}$)		
	20 DAS	40 DAS	60 DAS	20 DAS	40 DAS	60 DAS	20 DAS	40 DAS	60 DAS	20 DAS	40 DAS	60 DAS
T_1 - SI & soil application of 100% RDF	8.9	25.3	28.9	178	731	1378	9.5	26.5	29.8	189	784	1524
T_2 - T_1 + Foliar spray of 2% DAP	9.3	26.1	29.4	191	803	1553	10.1	27.2	30.6	197	833	1720
T_3 - T_1 + Foliar spray of 1% $UreaPO_4$	9.7	26.2	31.0	198	831	1629	10.4	27.6	31.9	200	867	1829
T_4 - DI & soil application of 100% RDF	9.0	25.6	29.0	184	767	1491	9.5	27.1	30.2	196	838	1655
T_5 - T_4 + Foliar spray of 2% DAP	9.2	26.0	30.2	203	875	1724	9.8	28.0	32.4	206	948	1884
T_6 - T_4 + Foliar spray of 1% $UreaPO_4$	9.7	26.9	32.7	206	929	1858	10.0	28.6	33.8	210	982	2035
T_7 - DF at 100% RDF with $UreaPO_4$ & MOP	10.4	29.8	36.9	225	1120	2335	10.9	30.2	37.5	232	1160	2574
T_8 - T_7 + Foliar spray of 2% DAP	10.4	32.9	40.6	249	1272	2684	11.4	33.9	42.4	258	1351	2981
T_9 - T_7 + Foliar spray of 1% $UreaPO_4$	11.1	36.1	44.4	276	1397	2989	12.1	37.4	48.3	284	1502	3336
T_{10} - DF at 75% RDF with $UreaPO_4$ & MOP	9.6	27.9	35.0	220	1021	2079	10.2	29.2	36.2	225	1091	2346
T_{11} - T_{10} + Foliar spray of 2% DAP	10.2	31.0	38.7	247	1204	2468	10.9	32.7	40.5	251	1269	2732
T_{12} - T_{10} + Foliar spray of 1% $UreaPO_4$	10.6	34.3	42.3	274	1359	2807	11.0	36.6	45.1	276	1455	3144
T_{13} - DF at 50% RDF with $UreaPO_4$ & MOP	9.2	27.2	33.0	214	981	1986	9.6	28.6	34.6	217	1035	2202
T_{14} - T_{13} + Foliar spray of 2% DAP	9.7	30.3	36.8	233	1119	2280	10.1	32.0	39.0	242	1205	2539
T_{15} - T_{13} + Foliar spray of 1% $UreaPO_4$	10.0	33.5	40.4	260	1247	2566	10.5	35.5	43.4	269	1382	2855
SEm+	0.5	1.4	1.7	9	52	105	0.6	1.6	2.1	12	58	148
CD at 5%	0.9	2.9	3.5	18	106	215	1.1	3.3	4.2	24	119	241

SI - Surface Irrigation; DI - Drip Irrigation; DF - Drip Fertigation; Foliar spray of two stages at flowering and 15 days thereafter

Table 2 Effect of drip fertigation levels and foliar spray on yield components and grain yield of blackgram

Treatments	Summer 2012				Summer 2013			
	No. of clusters $plant^{-1}$	No. of pods $plant^{-1}$	No. of seeds $pods^{-1}$	Grain yield ($kg\ ha^{-1}$)	No. of clusters $plant^{-1}$	No. of pods $plant^{-1}$	No. of seeds $pods^{-1}$	Grain yield ($kg\ ha^{-1}$)
T_1 - SI & soil application of 100% RDF	9.7	19.3	6.1	469	10.3	21.2	6.4	495
T_2 - T_1 + Foliar spray of 2% DAP	12.0	21.5	6.5	497	12.5	23.7	6.6	514
T_3 - T_1 + Foliar spray of 1% $UreaPO_4$	10.8	22.9	6.6	510	12.9	24.1	6.7	532
T_4 - DI & soil application of 100% RDF	10.8	20.7	6.3	485	11.2	22.3	6.5	506
T_5 - T_4 + Foliar spray of 2% DAP	12.5	23.2	6.7	520	13.3	24.5	6.8	540
T_6 - T_4 + Foliar spray of 1% $UreaPO_4$	12.9	23.5	6.7	545	13.5	24.7	6.9	577
T_7 - DF at 100% RDF with $UreaPO_4$ & MOP	14.7	28.9	7.3	710	16.0	29.8	7.5	773
T_8 - T_7 + Foliar spray of 2% DAP	16.4	31.6	7.8	815	17.5	33.1	7.9	874
T_9 - T_7 + Foliar spray of 1% $UreaPO_4$	18.2	34.5	7.9	926	18.9	36.3	8.2	991
T_{10} - DF at 75% RDF with $UreaPO_4$ & MOP	13.6	27.0	7.2	630	15.1	27.5	7.4	666
T_{11} - T_{10} + Foliar spray of 2% DAP	14.4	29.4	7.7	728	16.2	30.6	7.8	783
T_{12} - T_{10} + Foliar spray of 1% $UreaPO_4$	16.5	32.1	7.8	823	17.6	33.4	8.0	889
T_{13} - DF at 50% RDF with $UreaPO_4$ & MOP	12.8	23.8	7.2	569	13.6	24.9	7.3	606
T_{14} - T_{13} + Foliar spray of 2% DAP	13.9	26.3	7.5	651	14.8	27.7	7.6	699
T_{15} - T_{13} + Foliar spray of 1% $UreaPO_4$	14.8	28.7	7.6	743	16.3	30.5	7.7	790
SEm+	0.4	1.1	0.4	37	0.5	1.3	0.5	43
CD at 5%	0.9	2.2	0.8	77	1.1	2.7	1.1	89

SI - Surface Irrigation; DI - Drip Irrigation; DF - Drip Fertigation; Foliar spray of two stages at flowering and 15 days thereafter

Grain yield

The maximum grain yield of 926 and 991 kg ha^{-1} during summer 2012 and 2013, respectively was recorded under drip fertigation with 100% RDF of NPK and foliar spray of 1% urea phosphate followed by drip fertigation with 75% RDF of NPK with foliar spray of 1% urea phosphate (823 and 889 kg ha^{-1} during summer 2012 and 2013, respectively) (**Table 2**). The percentage yield increase was to the tune of 49.4 and 50.1 during summer 2012 and 2013, respectively over surface irrigation with soil application of recommended dose of NPK. Drip fertigation with 75% RDF of NPK and foliar spray of 1% urea phosphate registered 43.0% and 44.3% yield increase during summer 2012 and 2013, respectively as compared to surface irrigation with soil application of RDF of NPK. 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 Khetre Mayur Lahurao (2010) [7] in tomato. Ramasamy and Ramiah (1980) [16] and Geetha (2003) [17] also reported such beneficial effects in blackgram.

With regard to foliar nutrition, the grain yield was significantly higher with the foliar application of 1% urea phosphate when compared to foliar spray of 2% DAP at all the levels of fertigation. Foliar application of urea phosphate one at flowering and another at 15 days thereafter enhanced the grain yield. The increased yield components led to increased grain yield in blackgram. The present findings are in consonance with the reports of Papadopoulos and Leena Ristimaki (2010) [14] in egg plant and Kawther latiti *et al.* (2011) [15] in tomato and Mady (2009) [18] in winter squash and Suganthi (2011) [13] in greengram.

Conclusion

On the basis of results obtained in present investigation, it may be concluded that scheduling of drip fertigation with 100 % RDF of NPK applied once in three days in combination with foliar application of 1% urea phosphate at flowering and then 15 days thereafter could be the optimal management practice for getting higher yield in blackgram crop in sandy clay loam soils with moderate fertility.

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