Enhancing Blackgram Yield through Optimized Irrigation Scheduling and Integrated Nutrient Management: Growth Characteristics and Yield Components

Abstract

A field experiment was carried out at Soil Conservation and Water Management Farm of C S Azad University of Agriculture and Technology, Kanpur during *Zaid seasons* i.e. 2022 to assess the effect of irrigation scheduling and integrated nutrient management on blackgram.The experiment consisted of three irrigation schedules*viz*.I_1:0.4 IW/CPE, I_2:0.6 IW/CPE, I_3:0.8 IW/CPE, along with five integrated nutrient management options *viz*.F_1: 100% RDF, F_2:125% RDF.F_3: 75% RDF + 2.5 ton FYM/ha,F_4: 50 % RDF + 5 ton FYM/ha.F_5: 50% RDF + 2.5 ton FYM/ha + 1 tonvermi-compost. The experiment was conducted in Split Plot Design replicated thrice irrigation scheduling systems in main plots and integrated nutrient managementin sub plots. The result clearly revealed thatsignificantly higher growth attributes *viz*plant height (35.25 cmand 37.56 cm), number of branches plant^{-1}(8.87 and 9.21), number of plant leaves (19.96 and 20.29) at harvest and yield attributes *viz* number of pod per plant (27.80 and 30.10) no of seed per pod (6.62 and 6.91) and also higher seed yield (9.30 q ha^{-1} and 9.90 qha^{-1}), stover yield(23.21 q ha^{-1} and 24.03 q ha^{-1}) were recorded with I_3: 0.8 IW/CPE compared to I_1: 0.4 IW/CPE and I_2: 0.6 IW/CPE. Among the integrated nutrient management significantly higher growth attributes *viz* plant height (36.12 cm and 38.07 cm), number of branches plant^{-1} (9.01 and 9.32), number of plant leaves (20.05 and 20.45) at harvest and yield attributes *viz* number of pod per plant (28.44 and 30.17) no of seed per pod (7.05 and 7.37) and also higher grain yield (9.73 q ha^{-1} and 10.27 qha^{-1}), stover yield(23.55 q ha^{-1} and 24.76 q ha^{-1}) were recorded with F_5:50% RDF + 2.5 ton FYM/ha + 1 ton vermi-compost as compared to other integrated nutrient management protocol.

***Keywords*: IW/CPE, Vermi-compost, FYM, Yield.**

1.INTRODUCTION

Pulses are given second importance after cereals and pulses crop is rich in protein, fibers, vitamins, and minerals such as magnesium, iron, and zinc and low in fat, making them a great addition to any diet that plays a very important role in the diet of humans, especially in Indian people which are not able to supply their body protein due to being vegetarian. By holding atmospheric nitrogen in the root nodules, they keep the soil

fruitful and healthy. India has a ubiquitous position as the leading producer, the foremost consumer, and the largest importer of pulses. Pulses can be grown on a range of soil and climatic conditions and play an important role in crop rotation, mixed and inter-cropping, maintaining soil fertility through nitrogen fixation, releasing soil-bound phosphorus, and thus contributing significantly to the sustainability of the farming system. In the northern part of the country, black gram is grown in *kharif* or *summer* only while in the eastern and southern parts of India it grows in the *rabi* season also and sometimes grows as a green manuring crop.

India is its primary origin and mainly cultivated in Asian countries including Pakistan, Myanmar, and parts of Southern Asia. About 70 percent of the world's black gram production comes from India. India is the world's largest producer as well as consumer of black gram. Our country produces about 24.5 lakh tonnes of Urd bean annually from about 4.6 million hectares of area, with an average productivity of 533 kg per hectare in 2020-21 (Anonymous, 2020) [3]. Black gram area accounts for about 19 percent of India's total pulse acreage which contributes 23 percent of total pulse production. It is mostly grown as rain-fed during *Kharif* and *summer* in Northern India

Irrigation scheduling is one of the factors that influence the agronomic and economic viability of small farms. It is important for both water savings and improved crop yields point of view. Scientific irrigation scheduling should go with an understanding of the soil-water-plant-atmosphere continuum. Irrigation water economy can be aimed through appropriate irrigation schedules and meteorological approaches based on pan evaporation is one of the simplest, most reliable, economical, and least time-consuming methods. The loss of water through evapotranspiration, and leaching, can be minimized by scheduling irrigation. Water is not available in adequate quantities in the summer season, it limits crop production. One scientific method in the area is (IW: CPE Ratios) approach for scheduling of irrigation. Water use in agricultural production as one of the most important environmental factors affecting plant growth and development (Mirzaei *et al*., 2005) [10]. Productivity response to water stress is different for each crop and is expected to vary with the climate (AbdzadGohari, 2013) [1].

The integrated nutrient management ensures higher productivity, minimizes expenditure on costly fertilizer inputs, improves physical properties of soil, efficiency of added nutrients and at the same time ensures good soil health and is also an environment- friendly approach (Singh and Singh, 2017)[16]. It comprises of application of organic manures, green manures, bio-fertilizer and crop rotation with legumes along

with minimum use of chemical fertilizer to produce optimum crop yields without deteriorating the soil health.

2. MATERIALS AND METHODS

The field experiment was carried out at Soil Conservation and Water Management Farm of Chandra Shakher Azad University of Agriculture and Technology, Kanpur. It lies between 25^0 26' and 26^0 58' North latitude and 79^0 31' and 80^0 34'East longitude, during *Zaid seasons* i.e. 2022. The experiment consisted of three irrigation schedules *viz*.I_1: 0.4 IW/CPE, I_2: 0.6 IW/CPE, I_3: 0.8 IW/CPE, along with five integrated nutrient management options *viz.* F_1: 100% RDF, F_2: 125% RDF. F_3: 75% RDF + 2.5 ton FYM/ha, F_4: 50 % RDF + 5 ton FYM/ha. F_5: 50% RDF + 2.5 ton FYM/ha + 1 ton vermi-compost. The experiment was conducted in Split Plot Design replicated thrice, keeping irrigation scheduling in main plots and integrated nutrient management in sub plots. The soil of experimental area was sandy loam having organic carbon (0.33 %), available N (0.03%) available P_2O_5 (17.85kg ha^{-1}) and available K_2O (131.30 kg ha^{-1}). Theblackgram varieties Shekhar-2 was sown in second fortnight of Marchwhile harvested in first fortnight June , respectively during both the consecutive year.

3. RESULT AND DISCUSSION

3.1*Growth characteristics*

The growth attributes of Blackgram as influenced by irrigation scheduling and integrated nutrient management. The data in table 1 showed that growth parameters *viz*., plant height, number of branches $plant^{-1}$ and number of plant leaves were recorded significantly heights by the irrigation scheduling at I_3: 0.8 IW/CPE followed by I_2: 0.6 IW/CPE. Higher plant height (35.25 cm and 37.56 cm) in both year. Might be due to adequate and timely supply of irrigation water at 0.8 IW/CPE which provided better nourishment and enhanced the metabolic process in the plant and promoted the cell division and cell expansion and thereby stem elongation which virtually increased the plant growth in terms of plant heightSimilar result was found by Singh *et al* (2018)[17] and Patel *et al* (2020)[12]. Higher number of branches $plant^{-1}$ (8.87 and 9.21) in both years, might be due to availability of optimum moisture contributed to effective absorption and utilization of nutrients and better proliferation of roots resulting in better branches $plant^{-1}$.These results were in conformity with the findings of Patel *et al* (2020) [12]..Higher number of plant leaves (19.96 and 20.29) each year this is because of the accelerated vegetative growth resulted in an extensive photosynthetic apparatus and relative increase was recorded in plant leaves. Similar results were found by Patel *et al* (2016) [11] and Patel *et al* (2020)

The data in table 1 showed that higher plant height (36.12 cm and 38.07 cm), number of branches $plant^{-1}$ (9.01 and 9.32), number of plant leaves (20.05 and 20.45) in both years recorded highest in F_5: 50% RDF + 2.5 ton FYM/ha + 1 ton vermi-compost as compared to F_1: 100% RDF, F_2: 125% RDF. F_3: 75% RDF + 2.5 ton FYM/ha, and F_4: 50 % RDF + 5 ton

FYM/ha. This was because of availability of nutrients under the treatment receiving organic sources supplemented with vermicompost. These results are also in agreement with the finding Vitnor*et al* (2015)[18]and Singh *et al* (2017) [15]

3.2*yield components*

The yield attributes of blackgram as influenced by irrigation scheduling and integrated nutrient management. The data in table 2 showed that yield parameter *viz* number of pod per plant (27.80 and 30.10) number of seed per pod (6.62 and 6.91) were significantly highest by the irrigation scheduling at I_3: 0.8 IW/CPE followed by I_2: 0.6 IW/CPE.This might be due to maintenance of optimum soil moisture condition which affected the root nodulation as well as availability of different nutrients, further adequate availability of moisture at all stages of crop growth and development leading to high water potential, stomatal conductance, higher photosynthesis, partitioning of photosynthates to sink consequently increasing pods per plant and number of seed per pod. This is in conformity with the result of Yadav and Singh (2014) [19], Shirgapur and fatima(2018) [14] and Patel *et al* (2022) [13].

The data in the table 2 showed that higher number of pod per plant (28.44 and 30.17) and number of seed per pod (7.05 and 7.37) in both years were recorded significantly highest in F_5: 50% RDF + 2.5 ton FYM/ha + 1 ton vermi-compost as compared to F_1: 100% RDF, F_2: 125% RDF. F_3: 75% RDF + 2.5 ton FYM/ha, and F_4: 50 % RDF + 5 ton FYM/ha. This was because of availability of nutrients under the treatment receiving organic sources supplemented with Vermicompost. Similar results were found by De *et al* (2011) [6] and Meena *et al* (2019) [8].

3.3*Yield*

The yield parameters of blackgram as influenced by irrigation scheduling and integrated nutrient management. The data in table 3 showed that yield parameter viz., grain yield (9.73 q ha^{-1} and 10.27 qha^{-1}), and stover yield(23.55 q ha^{-1} and 24.76 q ha^{-1}) were significantly highest by the irrigation scheduling at I_3: 0.8 IW/CPE followed by I_2: 0.6 IW/CPE.This might be due to maintenance of optimum soil moisture condition which affected the root nodulation as well as availability of different nutrients, further adequate availability of moisture at all stages of crop growth, higher vegetative growth and development leading to high water potential, stomatal conductance, higher photosynthesis, partitioning of photosynthates to sink consequently increasing grain yield and stover yield. This result also confirms the finding Chavan *et al* (2014) [4], Kumar *et al* (2015) [7] and Shirgapur and fatima (2018)[14]

The data in table 3 showed that higher grain yield (9.73 q ha^{-1} and 10.27 qha^{-1}), and stoveryield (23.55 q ha^{-1} and 24.76 q ha^{-1}) in both years recorded highest in F_5: 50% RDF + 2.5 ton FYM/ha + 1 ton vermi-compost as compared to F_1: 100% RDF, F_2: 125% RDF. F_3: 75% RDF + 2.5 ton FYM/ha, and F_4: 50 % RDF + 5 ton FYM/ha. This was because of availability of nutrients under the treatment receiving organic sources supplemented with vermicompost. This is in conformity with the result ofAbhilasha*et al* (2022) [2],Danga*et al (*2022) [5] and Meera *et al* (2022) [9].

Table 1The effect of irrigation scheduling and integrated nutrient management on growth of Urd bean.

Treatments	Plant height (cm)			No. of branches per plant			No. of Plant leaves		
	At Maturity			At Maturity			At Maturity		
	2022	**2022**	**2022**	**2022**	**2023**	**Pooled**	**2022**	**2023**	**Pooled**
Irrigation Scheduling-									
I_1 - 0.4 IW/CPE.	31.51	32.44	31.975	5.88	6.43	6.155	17.17	17.38	17.275
I_2 - 0.6 IW/CPE.	34.54	36.18	35.36	8.42	8.83	8.625	18.98	19.25	19.115
I_3 -0.8 IW/CPE.	35.25	37.56	36.40	8.87	9.21	9.04	19.96	20.29	20.125
Se(d)	0.55	0.43	0.49	0.11	0.12	0.115	0.24	0.26	0.25
CD at 5 %	1.58	1.25	1.415	0.33	0.36	0.345	0.68	0.75	0.715
Integrated nutrient management									
F_1 - 100% RDF.	31.49	32.76	32.125	6.83	7.04	6.935	17.90	17.95	17.925
F_2 - 125% RDF.	32.84	33.92	33.38	7.00	7.31	7.155	18.09	18.12	18.105
F_3 -75% RDF + 2.5 t FYM/ha.	33.81	35.46	34.635	7.48	8.29	7.885	18.47	18.92	18.695
F_4 - 50% RDF + 5.0 t FYM/ ha.	34.57	36.77	35.67	8.30	8.82	8.56	19.01	19.44	19.225
F_5 -50% RDF + 2.5 t FYM/ha + 1 t Vermicompost.	36.12	38.07	37.095	9.01	9.32	9.165	20.05	20.45	20.25
Se(d)	0.76	0.49	0.625	0.18	0.20	0.19	0.43	0.43	0.43
CD at 5%	1.59	1.03	1.31	0.37	0.42	0.395	0.89	0.91	0.9

Table 2The effect of irrigation scheduling and integrated nutrient management on the Yield attributing character of Urd bean.

Treatments	Yield attributing character					
	Number of pods per plant			Number of seeds per plant		
	2022	2023	Pooled	2022	2023	Pooled
Irrigation Scheduling-						
I_1 - 0.4 IW/CPE.	21.70	23.11	22.405	4.81	5.23	5.02
I_2 - 0.6 IW/CPE.	26.33	28.30	27.315	6.10	6.41	6.255
I_3 - 0.8 IW/CPE.	27.80	30.10	28.95	6.62	6.91	6.765
Se(d)	0.36	0.40	0.38	0.08	0.09	0.085
CD at 5 %	1.04	1.14	1.09	0.24	0.27	0.255
Integrated nutrient management						
F_1 - 100% RDF.	22.75	24.20	23.475	4.99	5.22	5.105
F_2 - 125% RDF.	23.68	25.19	24.435	5.22	5.37	5.295
F_3 -75% RDF + 2.5 t FYM/ha.	24.77	27.47	26.12	5.62	5.92	5.77
F_4 - 50% RDF + 5.0 t FYM/ ha.	26.76	28.81	27.785	6.34	7.04	6.69
F_5 -50% RDF + 2.5 t FYM/ha + 1 t Vermicompost.	28.44	30.17	29.305	7.05	7.37	7.21
Se(d)	0.59	0.63	0.61	0.13	0.14	0.135
CD at 5%	1.22	1.31	1.265	0.28	0.30	0.29

Table 3The effect of irrigation scheduling and integrated nutrient management on yield of Urd bean.

Treatments	YIELD					
	Seed yield(q/ha)			Stover yield		
	2022	2023	Pooled	2022	2023	Pooled
IRRIGATION SCHEDULIN-						
I_1 - 0.4 IW/CPE.	6.83	7.00	6.915	20.25	21.00	20.625
I_2 - 0.6 IW/CPE.	8.59	9.17	8.88	22.79	23.54	23.165
I_3 -0.8 IW/CPE.	9.30	9.90	9.6	23.21	24.03	23.62
Se(d)	0.30	0.29	0.295	0.57	0.48	0.525
CD at 5 %	0.87	0.83	0.85	1.62	1.37	1.495
Integrated nutrient management						
F_1 - 100% RDF.	7.18	7.40	7.29	20.14	21.01	20.575
F_2 - 125% RDF.	7.49	7.74	7.615	21.21	21.72	21.465
F_3 -75% RDF + 2.5 t FYM/ha.	7.98	8.57	8.275	22.54	22.94	22.74
F_4 - 50% RDF + 5.0 t FYM/ ha.	8.82	9.47	9.145	22.97	23.86	23.415
F_5 -50% RDF + 2.5 t FYM/ha + 1 t Vermicompost.	9.73	10.27	10	23.55	24.76	24.155
Se(d)	0.36	0.37	0.365	0.60	0.62	0.61
CD at 5%	0.75	0.77	0.76	1.24	1.29	1.265

4. CONCLUSION

Based on results obtained during the experimentation, it can be concluded that amongst different irrigation scheduling I_3: 0.8 IW/CPE, with F_5: 50% RDF + 2.5 ton FYM/ha + 1 ton vermi-compost recorded highest Growth characteristics, yield components and also yield of Blackgram as compared to other irrigation scheduling and integrated nutrient management

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