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Response of Blackgram (*Vigna mungo* L.) to Different Management Practice under North Eastern Transition Zone of Karnataka

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ABSTRACT

Background: With the advancement of green revolution over 3-4 decades, the production and productivity of crop is decreasing with reduction in soil productivity in terms of nutritional disorders,micronutrient deficiencies, poor soil physical condition and livelihood supporting systems. In view of this, natural and organic agriculture systems emerged as an alternative to the chemical oriented agriculture systems. Organic farming and organically produced food products are gaining popularity very rapidly in India and world. To trounce the reliance on chemical fertilizers for crop production and to reduce cost of production experiments were conducted to know the effect of different management practices on blackgram.

Methods: The field experiments were conducted with randomized complete block design with 4 replications. Effects of these different crop management practices were evaluated on growth, yield parameters, yield and nutrient status of blackgram (TAU-1) was carried out during *Kharif* 2019, 2020 and 2021.

Result: Results showed that package of practice recorded significantly higher growth, yield attributes and yields in blackgram followed by organic farming and farmers practice over three years. Based on current investigation it can be concluded that practicing organic farming and natural farming over the years there will be sustainability in food production compared to initial years.

Key words: Black gram, Efficiency, Growth, Returns, Yield.

INTRODUCTION

Feeding a projected population of 9 billion by the mid-century constitutes one of the most fundamental challenges facing humanity (Calicioglu *et al*., 2019). Globally, agricultural production more than tripled between 1960 and 2015. This was initially facilitated, in part by Green Revolution technologies to increase yields and profits compared to traditional techniques (Grigg, 2001). Due to the resultant intensive, high-input agriculture that relies on synthetic chemicals for irrigation, fertilisers and pesticides, there is evidence of environmental degradation and adverse health effects from exposure to these chemicals (Pimentel, 1996; Bhattacharyya *et al*., 2015; Agoramoorthy, 2008). Hence, more environmentally focused solutions have arisen, such as sustainable intensification and agroecology. Such solutions have been promoted as alternative approaches to agricultural production that aligns more closely to the UN Sustainable Development Goals (SDGs). In India, 48% of the land surface was classified as degraded in 2005, driven by processes such as erosion, acidification and salinization. As a result, a number of agricultural systems have been developed that are intended to be more sustainable alternatives to high-input conventional farming systems. By 2015, India will become the most organic producer country among all countries (Willer and Lernoud, 2017). There are around 835,000 organic certified farms across the states of Andhra Pradesh, Gujarat, Himachal Pradesh, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Sikkim and Tamil Nadu, which all have state-level organic farming polices, with Sikkim being declared the first all-organic state in the world (Meek and Anderson, 2020). In principle, organic farming has the potential to address environmental concerns, through reduced use of chemical fertilizers and pesticides compared to conventional techniques. However, conversion of conventional systems to organic agriculture

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can result in a reduction of yield and lower temporal yield stability. This raises the issue of food security and whether organic farming can feed the world without expansion of croplands into natural ecosystems (Kirchmann *et al*., 2008).

In addition, socio-economic impacts associated with conventional farming may not be alleviated by organic farming in India. The involvement of agribusiness companies in controlling the market for organic food, fertilizers and seeds reduces the potential socio-economic benefits of organic farming over conventional systems. Along with becoming codified in regulatory and third-party certification, agribusiness in farming has favored larger farming enterprises, often leaving smallholders disadvantaged due to access or cost. This has resulted in high levels of farmer debt, which has forced farmers to get suicides in India (Mariappan and Zhou, 2019). The subsequent focus on developing sustainable and equitable approaches to agriculture underpin the Zero Budget Natural Farming (ZBNF) approach, which aims to address both environmental and socio-economic concerns within the agricultural sector.

The decline in crop production and productivity over 3-4 decades of green revolution and also reduction in soil productivity in terms of nutritional disorders, micronutrient deficiencies, poor soil physical condition, salinity and alkalinity, poor soil biological activity and the livelihood supporting systems. In view of these, natural and organic agriculture systems emerged as an alternative to the chemical oriented agriculture systems.

'Zero Budget' refers to lower use of purchased inputs and reduced involvement of agribusiness, reducing debt incurred by farmers. 'Natural Farming' refers to the use of homemade amendments from readily available ingredients. These inputs are intended to promote soil health, close nutrient cycling loops and provide greater water retention in soil, alongside integrated pest management and intercropping (Keerthi *et al*., 2018).

The long term studies conducted under All India Network Project on Organic Farming (ICAR), indicated that groundnut, soybean, chickpea, lentil, French bean, peas, cowpea, sorghum, lowland rice, rainfed wheat, maize, cotton and dolichos bean under organic cultivation resulted in higher yields and returns over chemical farming. The studies carried out in UAS, Raichur also showed on par yields of red gram, jowar (R*abi*), sunflower, bengal gram, desi cotton apart from higher monetary returns and improved soil fertility status with organic cultivation when compared with recommended package of practice.

The cost of crop production is increasing year after year due to high production costs of inputs, the volatile market prices of crops, the rising costs of fossil fuel based inputs and private seeds. Debt is a major problem for farmers of all sizes in India. The technical advisory committee of consultative group on international agriculture research also emphasizes on efficient management of natural resources, enhance the quality of environment and conservation of the natural resources in the process to meet our food demand.

In view of all the above facts experiments were carried out to evaluate comparative performance of different management practices on productivity and economics of blackgram.

MATERIALS AND METHODS

Experimental site

Field experiments were conducted during the *kharif*season of 2019, 2020 and 2021 at Agricultural Research Station, Janawada farm, Bidar, University of Agricultural Sciences, Raichur, India. The details of experimental site characteristics are presented in Table 1, physiochemical properties of soil is furnished in Table 2, details of treatment is presented in Table 3 and meteorological data of study area is presented in Table 4.

Experimental design and treatment details

The experiment on black gram comprising of 4 treatments*viz*., T_1: Zero Budget Natural Farming Method, T_2: Organic Farming Practice, T_3: Package of Practice (UASR) and T_4: Farmers Practice was conducted in randomized block design with five replications. Row spacing of 30 cm was adopted for sowing of crop with an intra row spacing of 10 cm and seed rate of 18 kg ha^{-1}. A common fertilizer dose of 25:50:00 (N: P_2O_5:K_2O kg ha^{-1}, respectively) to black gram applied as basal dose to crop at the time of

Table 1: Details of experimental site and meteorological data.

	Site characteristics
Agro climatic zone	North Eastern Transition zone (Zone-I)
State and District	Karnataka and Bidar
Coordinates of the site	77°29′3.32″E longitude, latitude 17°59′3.12″N
Mean annual rainfall	845.75 mm
Major soils	Black clay soil (Vertisols).
Major crops grown	Pigeonpea, Greengram, Sugarcane and Bengalgram
Growing period rainfall (mm)	June (118.4, 168.3 and 161.4) July (156.2, 147.0 and 250.6), August (192.2, 164.6 and 212.8), September (157.7, 415.4 and 372.2) months (Fig 1 and 2)
Dates of sowing	02-07-2019, 13-06-2020 and 12-06-2021

sowing in package of practice treatments. The cultivar of black gram used in the study was TAU-1.

Collection of data on growth, yield and its components of blackgram

The observation on growth parameters like the plant height, number of leaves per plant, number of branches per plant, total dry matter production and yield parameters *viz,*the number of pods per plant, seeds per pod, seed yield, haulm yield and biological yield and production efficiency were recorded at the time of harvest by adopting agronomic standard procedure. Grain and straw yield was calculated based on the yield obtained from each net plot and converted into to kg ha^{-1}. The rain water use efficiency was calculated using formula *i.e.,* amount of yield produced by a crop to amount of rainfall received during the entire growth season.

Production efficiency was calculated by as per the formula given by (Kumawat *et al*., 2012).

$$\text{Production efficiency (kg day}^{-1}\text{ ha}^{-1}) = \frac{\text{Grain yield (kg ha}^{-1})}{\text{Total duration of crop (days)}}$$

$$\text{Rainwater use efficiency (kg ha}^{-1}\text{ mm}^{-1}) = \frac{\text{Grain yield (kg ha}^{-1})}{\text{Total cumulative rainfall during from sowing to harvest (mm)}}$$

Statistical analysis

The data were statistically analyzed one way using SPSS v.18 and graphs were plotted using Origin Pro software v.21.

RESULTS AND DISCUSSION

Effect on growth attributes of black gram

Pooled data presented in Table 5, revealed that package of practice recorded significantly higher growth attributes *viz*., plant height (95.78 cm), number of leaves per plant (59.04), number of branches per plant (7.23) and total dry matter production (5.79 g plant^{-1}) followed by organic farming (87.83 cm, 55.20, 6.48 and 5.40 g plant^{-1}, respectively) and farmers practice (86.94 cm, 49.15, 6.51 and 5.13 g plant^{-1}, respectively). Significantly the lowest growth attributes were recorded in zero budget natural farming treatment (84.51 cm, 45.50, 6.11 and 4.87 g plant^{-1}, respectively) at 60 DAS (Table 5).

The increase in various parameters can be attributed to increased nutrient availability during the early stages of the crop through seed treatment. During later stages because of slower mineralization of nutrients the nutrients were available for longer period of time. The pest and diseases were managed efficiently with chemical methods. Hence there will be higher growth in package of practice treatments. The findings corroborate with those of Ghulam *et al*. (2011), Meena (2013) and Singh and Singh (2017).

Yield attributes and yields of blackgram

Significantly the highest yield attributes *viz*., number of seeds per pod (6.61), number of pods per plant (50.43) and grain, stover and biological yield (1364, 1704 and 3068 kg ha^{-1}) were recorded in package of practice treatment followed by organic farming and farmers practice. While the lowest yield attributes (5.94 and 41.52, respectively) and yields (1084, 1404 and 2488 kg ha^{-1}, respectively) on pooled basis (Table 6).

It is stated that the poor production potential of black gram attributed to poor photosynthetic efficiency, lack of partitioning of photosynthates to pods and seed setting (Dixit and Elamathi, 2007). Pests and diseases were controlled at economic threshold level hence crop growth was favoured. This improved the synthesis of carbohydrates and protein and their transportation to the site of seed formation.

Further decreased flower drop and senescence and increased pod set, which increased the yield attributes and yield of blackgram. This can also be attributed to slow release pattern of nutrients and precautionary application of organic plant protection chemicals.

The improved rate of photosynthesis, which also contributed to larger assimilate supply to the pods and subsequently increased seed weight, is primarily responsible for the higher yield features in the practise treatment package (Table 4 and 5). The results were in accordance to the results obtained by Yakadri and Thatikunta Ramesh (2002), Meena (2005), Kumawat *et al*. (2013) and (Dhaka *et al*. 2016).

Efficiency and economics of blackgram production

Production efficiency

The maximum production efficiency (15.68 kg day^{-1} ha^{-1}) was recorded in T_3 which was significantly higher compared to all other treatments. On the other hand. The minimum production efficiency (12.46 Kg day^{-1} ha^{-1}) was recorded in treatment T_1 (Table 5) on pooled basis. This might be because of increase in grain yield under T_3 which also enhanced production efficiency per day. These results are in conformity with the results of Choudhari *et al*. (2001) and Subramani and Solaimalai (2000).

Rainwater use efficiency

Practice package reported maximum rainwater use efficiency (8.31 kg ha^{-1} mm^{-1}) compared to the other treatments and the natural farming treatment had the lowest efficiency (6.60 kg ha^{-1} mm^{-1}) Table 6. This may be caused by increased rainfall during the growing season and increased yield in the practise treatment package. These

Table 2: Details of physiochemical properties of soil and management practices with treatments.

Particulars	Values	Category
Texture	-	Sandy clay
pH	7.75	Alkaline
EC (dsm^{-1})	0.32	-
Organic carbon (%)	0.53	Medium
Available nitrogen (kg ha^{-1})	198.02	Low
Available phosphorus (kg ha^{-1})	38.10	Medium
Available potassium (kg ha^{-1})	479.47	Medium

Table 3: Details of nutrient, pest, and disease management in blackgram.

	Nutrient management
Treatment details	Blackgram
T_1: Zero Budget Natural farming method (ZBNF)	Beejamrutha: Seed treatment Ghanajeevamrutha: 400 kg/acre Jeevamrutha: 200 litre/acre Mulching @ 2 tonn/acre
T_2: Organic farming practice (OF)	Seed treatment (acre): Rhizobium (200 gm) + PSB (200 gm)N eq. vermicompost: 660 kg/acre Mulching @ 2 tonn/acre
T_3: Package of practice (POP)	Seed treatment (acre): Rhizobium (500 gm) +PSB (500 gm) 10:20:0 kg N:P:K/acre FYM: 2.00 tonnes/acre
T_4: Farmers practice (FP)	6.61 kg Nitrogen/acre 16.88 kg Phosphorus/acre FYM: 1.28 tonnes/acre
	Pest management
T_1: Zero Budget Natural farming method (ZBNF)	Leafeating caterpillar: Agniastra @ 30 ml/liter Pod borers: Brahmastra @ 30 ml/liter
T_2: Organic farming practice (OF)	Leafeating caterpillar and Pod borers: Neem oil (10000 ppm) @ 5%
T_3: Package of practice (POP)	Sucking pests: Seed treatment with Imidacloprid 60 FS @ 10 ml/kg of seeds Leafeating caterpillar and Pod borers: Emamectin benzoate 5 SG @ 0.3 g/liter
T_4: Farmers practice (FP)	Leafeating caterpillar and Pod borers: Lambdacyhalothrin 5 EC @ 0.5 ml/liter
	Disease management
T_1: Zero Budget Natural farming method (ZBNF)	➢ Seed treatment with Beejamrutha ➢ Spray of butter milk immediate after notice of the disease incidence
T_2: Organic farming practice (OF)	➢ Seed treatment with *Trichoderma* @ 4 gm/kg ➢ Spray of *Pseudomonas fluorescens* @ 10 g/l immediate after the notice of disease incidence
T_3: Package of practice (POP)	➢ Seed treatment with *Trichoderma* @ 5 g/kg ➢ Spray of Hexaconazole 5% SC ➢ 1 ml/l immediate after notice of the disease incidence
T_4: Farmers practice (FP)	➢ No seed treatment ➢ Spray of Carbendazim 50 WP @ 1 g/l immediate after notice of the disease incidence

Table 4: Mean monthly meteorological data of experimental site (2019, 2020 and 2021).

	Tmax			Tmin			Rainfall (mm)			Rainy days (days)			Relative humidity		
	2019	2020	2021	2019	2020	2021	2019	2020	2021	2019	2020	2021	2019	2020	2021
Jan	28.8	29.0	29.4	11.8	14.0	13.4	5	0.0	2.4	1	0	0	76	88	82
Feb	32.4	30.8	30.2	16.3	15.0	11.6	0	0.0	0.0	0	0	0	66	84	70
Mar	36.3	34.1	35.2	19.3	18.0	16.0	0	12.6	1.0	0	2	0	57	71	55
Apr	39	36.9	36.8	23	20.6	19.4	2	73.5	15.0	0	5	2	58	61	55
May	40.3	38.8	35.9	24.9	22.8	20.8	4	47.9	87.2	1	6	6	43	62	67
Jun	36.3	32.6	31.7	22.4	20.4	19.3	100	168.3	161.4	7	11	9	82	87	88
july	30.7	30.0	29.6	20.5	19.5	19.0	117.1	147.0	250.6	6	11	14	87	93	89
Aug	29.2	28.2	29.5	19.8	19.1	18.7	155.9	164.6	212.8	12	17	12	90	91	88
Sept	29	30.1	28.9	19.5	19.2	18.3	175.4	415.4	372.2	12	13	11	92	86	89
Oct	29.6	29.8	30.4	18.6	18.0	16.9	137.6	221.4	13.4	12	5	1	90	80	76
Nov	29.2	29.0	29.1	15.9	13.4	17.8	33	0.0	4.2	3	0	1	87	74	79
Dec	27.5	28.4	28.2	14.3	10.6	14.6	0	0.0	0.0	0	0	0	91	73	76

Table 5: Effect of different management practices on growth and yield attributes of blackgram (Data pooled over 3 years).

Treatments	At 60 DAS				At harvest		
	Plant height (cm)	No. of leaves per plant	Number of branches per plant	Total dry matter production (g plant^{-1})	No. of seeds pod^{-1}	No. of pods plant^{-1}	Test weight (g)
T_1: ZBNF	84.51	45.50	6.11	4.87	5.94	41.52	47.42
T_2: OF	87.83	55.20	6.48	5.40	6.12	45.82	47.78
T_3: POP	95.78	59.04	7.23	5.79	6.61	50.43	49.24
T_4: FP	86.94	49.15	6.51	5.13	5.99	42.20	47.91
S.Em.±	2.19	1.08	0.25	0.10	0.14	1.49	0.87
CD @ 5%	6.84	3.72	0.73	0.37	0.47	4.52	2.98

Table 6: Effect of different management practices on yield, economics and indices of blackgram (Data pooled over 3 years).

Treatments	Yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Production efficiency (kg day^{-1} ha^{-1})	Rainwater use efficiency (kg ha^{-1} mm^{-1})	Gross returns (Rs. ha^{-1})	Net returns (Rs. ha^{-1})	B:C ratio
T_1: ZBNF	1084	1404	2488	12.46	6.60	72463	34076	1.91
T_2: OF	1237	1528	2765	14.22	7.53	83411	38134	1.89
T_3: POP	1364	1704	3068	15.68	8.31	85102	41357	1.97
T_4: FP	1131	1479	2610	13.00	6.89	70510	28524	1.70
S.Em.±	39	49	69	0.41	0.22	101	88	0.02
CD @ 5%	121	154	210	1.42	0.69	314	273	0.06

results are in line with findings of Meena (2009) in clusterbean and sesamum pigeonpea.

Economics

Higher gross, net returns and B: C ratio Rs.85,102, 41,1357 ha^{-1} and 1.97, respectively)was found in package of practice treatment (on pooled basis (Table 5). However, B: C ratio was found on par with natural farming (1.91) due to its lower cost of inputs and less cost of cultivation. The higher returns in package were directly related to the yields. These observations were supported with the findings of Quddus *et al*. (2012) and also by Choudhary *et al*. (2018).

CONCLUSION

From the results of experiments (3 years data) it can be inferred that package of practice performed the best results with respect to growth, yields and economics and natural farming was next best in terms of benefit cost ratio over the years. Thus it can be concluded that, for achieving higher productivity and profitability package of practice followed by natural farming can be adopted over the years in North Eastern Transition Zone of Karnataka.

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