EFFECT OF MICROBIAL INOCULANTS ON CROP GROWTH, YIELD, BIOCHEMICAL AND PHYIOLOGICAL PARAMETERS OF BLACK GRAM (*Vigna mungo* (L.) Hepper)

ABSTRACT

A field experiment was carried out at the Department of Seed Science and Technology, S.V. Agricultural College, Tirupati during 2022**.** T~~t~~he field experiment was carried out in randomized block design with 10 treatments and 3 replications. The blackgram variety TBG-104 differed for field, biochemical, and physiological parameters in response to different treatments of microbial inoculants. The influence of the treatments in the field was significant with respect to crop growth, phenological and yield parameters, seed quality attributes, biochemical and physiological parameters. In case of crop growth parameters which include field emergence (%), plant height (cm) highest performance was seen in T9(91.67%,27.47cm) over control and other treatments. While all the treatments recorded values that are as~~on~~ par with the highest performed treatment. In case of phenological parameters which include days to first flowering, 50% flowering and maturity, The treatment T9 and T8 were the best performed ~~treatments~~ over the other treatments and control. Similar trend was observed with respect to yield and yield parameters where T9(929.63kg/ha) treatment showed the highest performance. Our results revealed that that the co-inoculation of 4 or 5 microbial inoculants showed better results over individual treatments during the period of storage.

INTRODUCTION

Blackgram is one of the main pulse crops in India. It fixes atmospheric nitrogen into the soil, and improves soil fertility. As a complement to a diet focused on cereal and containing vegetable protein, it is a significant part of the Indian diet. It has a protein content of about 26%, which is about three times that of grains, in addition to other minerals and vitamins. Additionally, it serves as nutritious animal feed for animals.

India is the world's largest producer as well as consumer of blackgram. With an average yield of 501k~~K~~g per hectare in 2020–21, it produces roughly 23.4 lakh ~~tonnes~~tons of blackgram yearly from 46.7 lakh hectares of land (agricoop.nic.in). About 15.7% of India's total pulse acreage and 9.09% of the nation's total pulse production ~~are located in~~are in the Blackgram area. Blackgram was produced in Kharif 2021–22 in an area of 39.43 lakh hectares at a rate of 20.5 lakh ~~tonnes~~tons (first advance estimates; agricoop.nic). In the years 2020–21, Andhra Pradesh produced 3.65 lakh ~~tonnes~~tons of ~~blackgram~~blackgame on a surface area of 3.93 lakh ha (des.ap.gov.in). Blackgram was cultivated on 3.93 lakh hectares with a yield of 3.65 lakh ~~tonnes~~tons and a productivity of 929 kg/ha between 2021 and 2022, according to 2nd advance estimates.

~~The'quantity~~The 'quantity and quality of agricultural output can be increased by using ~~microbial'inoculants~~microbial 'inoculants by reducing the negative impacts of chemical input. The use of microbial inoculants, being ecofriendly provide nutrients in a more dependable manner.' Microbial inoculants ~~can reduce~~can reduce the usage of chemical fertilizers. Fungi, bacteria, and algae can act as microbial inoculants. Given that it allows for the exact application of small amounts of inoculants, seed coating has been suggested as a promising method for ~~immunising~~immunizing various crop seeds. (Rouphael et al., 2018b; Rocha et al., 2019a; Rocha et al., 2019b). Depending on the application goal, the type of seed, or the chosen microorganisms, the three primary types of seed coatings are seed dressing, seed filming, and seed pelleting. Therefore, it is expected in the current study that seed dressing with advantageous inoculants would discover the beneficial effects on

seed quality, storability and yield.

MATERIAL AND METHODS

The ~~variety~~ blackgram variety TBG-104 was sown and harvested during summer season inaRandomizedBlockDesign(RBD)withthreereplications~~inorderto~~to~~to~~studythecrop growth and yield parameter as per cent of mean. In each replication everytreatment was sown in five rows of 5 m length with aspacing of 30 cm between the rows and 10 cm betweenthe plants within the row. The treatments in the experiment are T1: Rhizobium,T2: Rhizobium + Phosphorous Solubilizing Bacteria (PSB),T3: Rhizobium + Potassium solubilizing Bacteria (KSB), T4: Rhizobium + ~~Phosphorous Solubilizing Bacteria (~~PSB~~)~~ + ~~Potassium solubilizing Bacteria (~~KSB~~)~~, T5: Rhizobium + ~~Phosphorus Solubilizing Bacteria (~~PSB~~)~~ + KSB +Pseudomonas fluorescense, T6: Rhizobium + Trichoderma viride, T7: Rhizobium + PSB + Trichoderma viride, T8: Rhizobium + ~~Potassium solubilizing Bacteria (~~KSB~~)~~ + Trichoderma viride, T9: Rhizobium + PSB + KSB +Trichoderma viride + Pseudomonas fluorescense.T10: Untreated Control.

The data was collected fromfive randomly selected plants of each treatment in eachreplicationfor12charactersviz., Field emergence (%), Plant height(cm), Days to first flowering, Days to 50% flowering, Days to maturity, No of branches/plant, No of pods~~/ per~~ plant., No of seeds/pod, Seed yield~~/ per~~ plant (g), Seed yield/plot (kg/ha), 100 seed weight(g), No of nodules~~/ per~~ plant (effective and ineffective nodules).

RESULTS AND DISCUSSION

The influence of the treatments in the field was significant with respect to crop growth, phenological and yield parameters. In ~~case~~the case of crop growth parameters which include field emergence (%), plant height (cm) highest performance was seen in T9(91.67%,27.47cm) over control and other treatments. While all the ~~treatments recorded~~treatments recorded values that are on par with the highest performed treatment. In case of phenological parameters which include days to first flowering, 50% flowering and maturity, T9(24,31,60.67 days respectively) and T8(26,31.33,62 days respectively) were the best performed treatments over the other treatments and control. Similar trend was observed with respect to yield and yield parameters where T9 treatment showed the highest performance. (No of branches/~~plant(~~plant (10.27), No of pods per plant(14.83), Seed yield~~/ per~~ plant (4.07g), Seed yield/plot (929.63kg/ha), 100 seed weight(5.55g), No of nodules~~/ per~~ plant(26)).

After the crop was harvested, analysis was conducted on seed quality parameters i.e., germination percentage, seedling length(cm), seedling dry weight(g), seed vigour index, and electrical conductivity (µs m-1). During the analysis of seed quality parameters of harvested seed T9 showed better results when compared to control and other treatments T5 was on par with the highest performed~~. treatment.~~

~~"~~In addition to the seed quality parameters, biochemical and physiological parameters were also studied on the harvested seed. Biochemical parameters include nitrogen content (%), protein content (%), total soluble sugars (%), phenol content and chlorophyll content (SCMR Values). T9 recorded the highest mean values when compared to all the treatments except in Total soluble sugars (%) in which T4(3.04%) recorded the highest value. In case of chlorophyll content, at 40 DAS, there is no significant difference was observed among the treatments. ~~Where as~~Whereas at 50 and 60 DAS, ~~highest~~the highest SCMR values were recorded in T9(50.73) and T5(43.1) respectively.

Physiological parameters analysed include the activity of reactive oxygen species (peroxidase activity) and soil enzymes which include enzyme activities of dehydrogenase, acid and alkaline phosphatase, urease. The peroxidase activity was highest in T6(230 U mg-1 protein), dehydrogenase

activity in T5(97.76 µg of TPF g-1 day-1), acid and alkaline phosphatase activity in T4 and T9(87.95, 112.83 µg of p-n-p g-1 hr^{-1} respectively). Significant enzyme activity was recorded in all the treatments which are responsible for various metabolic activities and promote plant health.

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Table 1. Effect of microbial inoculants on crop growth parameters

S.No	Treatments	Field emergence (%)	Plant height(cm)
1	T1	84.33 (66.68)	27.70
2	T2	84.67 (66.94)	27.88
3	T3	85.00 (67.21)	28.00
4	T4	85.67 (67.75)	28.26
5	T5	90.33 (71.88)	29.04
6	T6	82.67 (65.39)	24.44
7	T7	85.33 (67.48)	25.76
8	T8	90.33 (71.88)	27.47
9	T9	91.67 (73.22)	29.40
10	T10	71.00 (57.42)	20.11
	Mean	85.10 (67.29)	26.81
	SEM±	2.653	1.39
	CD (5%)	7.94	4.16
	CV (1%)	5.39	8.98

*Values in the parenthesis indicate arc-sine transformed values.

Table 2. Effect of microbial inoculants on phenological parameters

S.No	Treatments	Days to first flowering	Days to 50% flowering	Days to maturity
1	T1	28.33	36.67	71.33
2	T2	26.33	35.00	71.33

3	T3	26.33	35.00	70.67
4	T4	26.67	34.00	70.67
5	T5	26.00	31.00	60.67
6	T6	28.33	36.00	71.33
7	T7	26.67	35.00	70.67
8	T8	26.00	31.33	62.00
9	T9	24.00	31.00	60.67
10	T10	32.00	39.00	77.33
	Mean	2.56	1.86	2.47
	SEM~~m~~±	0.86	0.62	0.83
	CD (5%)	0.86	0.62	0.82
	CV (%)	5.47	3.13	2.08

Table 3. Effect of microbial inoculants on yield and yield parameters

S.No	Treatments	No of branches/ plant	No of pods per plant	No of seeds /pod	Seed yield /Plant(g)	Seed yield (Kg/ha)	Test weight(g)	No of nodules /plant

1	T1	7.13	10.03	5.71	2.04	737.78	5.29	24.00
2	T2	7.73	10.93	5.25	3.29	745.19	5.22	22.33
3	T3	8.07	11.27	5.40	3.39	774.07	5.05	24.00
4	T4	8.27	13.23	5.43	3.66	890.37	5.29	23.67
5	T5	8.80	14.07	5.75	3.82	906.67	5.49	23.67
6	T6	7.67	9.60	5.60	3.00	691.11	5.09	23.67
7	T7	8.13	11.23	5.37	3.11	785.19	5.09	20.33
8	T8	8.20	12.13	5.43	3.61	905.19	5.47	21.00
9	T9	10.27	14.83	5.67	4.07	929.63	5.55	26.00
10	T10	6.80	7.67	5.09	2.62	503.45	4.6	13.33
	Mean	8.11	11.50	5.47	3.26	786.86	5.21	22.20
	SEM~~m~~±	0.46	0.84	0.21	0.04	29.84	0.16	1.02
	CD (5%)	1.39	2.50	NS	0.12	89.34	0.48	3.07
	CV (%)	9.97	12.58	6.59	2.18	6.59	5.38	7.98

Table 4. Effect of microbial inoculants on seed quality parameters

S. No	Treatments	Germination (%)	Seedling length(cm)	Seedling dry weight(g)	Seedling vigour index I	Seedling vigour index II	Electrical conductivity (dsm^{-1})
1	T1	82.33 (65.14)	30.42	4.07	2504.82	554.20	233.33

2	T2	86.67 (68.58)	32.10	5.20	2782.62	551.01	203.33
3	T3	87.33 (69.14)	32.74	5.53	2858.92	519.43	196.67
4	T4	90.33 (71.88)	33.98	6.33	3069.51	486.87	193.33
5	T5	91.00 (72.54)	34.65	6.73	3152.98	352.59	180.00
6	T6	84.67 (66.94)	30.85	4.24	2611.81	469.92	216.67
7	T7	87.00 68.86)	32.96	4.60	2867.36	418.58	196.67
8	T8	88.00 (69.73)	33.88	5.67	2981.44	358.29	183.33
9	T9	91.67 (73.22)	34.67	7.30	3178.09	637.54	173.33
10	T10	75.37 (60.22)	27.87	3.00	2099.64	225.99	270.00
	Mean	86.43 (68.38)	32.41	5.27	2810.72	554.20	204.67
	SEM±	1.13	0.36	0.07	35.89	24.20	2.26
	CD (5%)	3.38	1.08	0.20	107.47	8.08	6.76
	CV (%)	2.26	1.93	2.29	2.22	3.06	1.91

Table 5. Effect of microbial inoculants on biochemical parameters

S.No	Treatments	Nitrogen content (%)	Protein content (%)	Total Soluble Sugars (%)	Phenol content (mg g^{-1})
1	T1	3.62	22.64	2.68	0.25
2	T2	3.67	22.94	2.99	0.26
3	T3	3.79	23.67	2.20	0.28
4	T4	3.84	24.01	3.04	0.29
5	T5	3.85	24.04	2.28	0.35
6	T6	3.64	22.77	2.81	0.25
7	T7	3.74	23.36	2.74	0.28
8	T8	3.82	23.86	2.45	0.29
9	T9	3.87	24.17	2.85	0.41
10	T10	3.66	22.89	2.45	0.24
	Mean	3.75	23.44	2.65	0.29
	SEM±	0.05	0.30	0.04	0.04
	CD (5%)	0.14	0.90	0.11	0.01
	CV (%)	2.21	2.21	2.33	2.45

Table 6. Effect of microbial inoculants on chlorophyll content (SCMR Values)

S.No	Treatments	40 DAS	50 DAS	60 DAS
1	T1	41.31	42.60	38.27
2	T2	46.29	42.97	38.50

3	T3	45.02	44.67	41.13
4	T4	44.34	44.93	42.50
5	T5	46.29	47.13	42.60
6	T6	44.45	43.57	38.77
7	T7	43.86	44.23	40.30
8	T8	42.87	45.10	41.83
9	T9	43.10	50.73	43.10
10	T10	41.60	38.90	35.57
	Mean	43.91	44.48	40.26
	SEM±	1.99	1.30	0.53
	CD (5%)	NS	3.90	1.59
	CV (%)	7.84	5.08	2.28

Table 7. Effect of microbial inoculants on peroxidase activity in harvested black gram seed (U mg^{-1} protein)

S.No	Treatments	Peroxidase (U mg^{-1} protein)
1	T1	212.47
2	T2	213.73
3	T3	220.31
4	T4	214.22
5	T5	222.51
6	T6	218.47
7	T7	214.51
8	T8	218.30
9	T9	230.96
10	T10	205.72
	Mean	217.13
	SEM±	1.29
	CD (5%)	3.85
	CV (%)	1.02

Table 8. Effect of microbial inoculants on enzyme activity in soil

S.No	Treatments	Dehydrogenase (µg of TPF g^{-}	Acid phosphatase	Alkaline phosphatase	Urease (µg of NH_4-N g^{-}

		^{1}day^{-1})	(µg of *p-n-p* g^{-1} hr^{-1})	(µg of *p-n-p* g^{-1} hr^{-1})	^{1} 2 hr^{-1})
1	T1	85.69	76.37	96.37	70.97
2	T2	85.17	87.01	96.30	74.62
3	T3	81.50	80.83	111.2	75.84
4	T4	82.59	87.95	92.15	84.15
5	T5	97.76	87.66	102.28	86.93
6	T6	87.36	82.59	107.31	90.11
7	T7	83.52	79.30	97.77	91.5
8	T8	80.77	75.97	102.76	82.64
9	T9	68.77	85.69	112.83	70.57
10	T10	70.75	76.92	99.90	86.02
	Mean	82.39	82.03	101.89	81.34
	SEMm±	1.17	1.43	2.58	5.15
	CD (5%)	3.51	4.29	7.71	NS
	CV (%)	6.46	7.57	4.38	10.97

CONCLUSION

Further from this study, the treatment T9(Rhizobium + PSB + KSB +Trichoderma viride + Pseudomonas fluorescens) ~~has'emerged~~has 'emerged as an ideal treatment with superior morphological, physiological, biochemical and yield parameters. Hence T9(Rhizobium + PSB + KSB +Trichoderma viride + Pseudomonas fluorescens) can be recommended for enhanced seed quality, seed yields and productivity. Our results revealed that that the co-inoculation of 4 or 5 consortiums microbial inoculants showed better results over individual treatments during the period of storage.

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