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Response of Blackgram (*Vigna mungo* L.) and Soybean (*Glycine max* L.) to Novel Bio Stimulants in North Eastern Dry Zone of Karnataka

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ABSTRACT

Background: The objective of modern agriculture includes environmental sustainability, low production costs and higher productivity. A biostimulant is a plant material or any other organic compound that not only improves the nutritional aspects also enhances the yield of crops. Black gram and soybean crops of immense economic significance. The growth and yield of these crops are limited by supply of nutrients. Biostimulants consists of amino acids and peptides which helps in growth and development of crops.

Methods: The field experiment conducted with randomized complete block design and 4 replications. Effects of different biostimulants at different concentrations as foliar spray and seed treatment for both crops were examined on growth, yield parameters and yield of black gram (TAU-1) and soybean (JS-335) was carried out during *kharif* 2020.

Result: Results showed that foliar application of Quantis biostimulant @ 5 ml L^{-1} recorded higher growth, yield parameters and seed yield (922 kg ha^{-1}), biological yield (1245 kg ha^{-1}) and production efficiency (13.36 kg day^{-1} ha^{-1}) in black gram and seed treatment with Epivio Energy @ 200 ml 100 kg^{-1} fetched higher seed yield (1439 kg ha^{-1}), biological yield (1535 kg ha^{-1}) and production efficiency (2974 kg day^{-1} ha^{-1}) along with higher growth, yield parameters in soybean. It can be concluded that biostimulants will help in achieving higher growth and yield of black gram and soybean.

Key words: Bio stimulants, Black gram, Foliar spray, Growth, Seed treatment, Soybean, Yield.

INTRODUCTION

India is the country where the majority of the people are having vegetarian dietary habit that's why; pulses are chief source of protein in the human diet. By and large, these crops are considered as an important source of proteins, vitamins and minerals contribute significantly to the nutritional security of the country (Singh *et al*., 2015). The recommended dietary allowances (RDA) for protein of an adult male and female are 1 g kg^{-1} body weight day^{-1}. The per capita availability of pulses is 43.8 g per day and only 16 kg $capita^{-1}$ $year^{-1}$ (Anonymous, 2016). As a result of stagnant pulse production and continuous increase in population, the per capita availability of pulses has decreased considerably. Indian contribution is highest at global level in terms of area and production. The per capita per day availability of pulses in 1951 was 60.7 g that dwindled down to level of 35.4 g in the year 2010. The per capita per year availability shows the same decreasing trend from 22.1 kg in 1951 to 12.9 kg in the 2010 (Shukla and Mishra, 2020).

The demand-supply gap for pulses is going to more adverse condition which strongly affects our food and nutritional security. Demand of pluses in 2020 will be 22.92 m t whereas, the pulses supply in that year will be 19.68 m t. But due to poor yield India has a huge gap in demand and supply of pulses. The additional requirement of pulses is fulfilled by importing pulses from other countries. Although it has great potential to produce the pulses, but the negligible attention and poor frame working of policy could be the reason for the lower productivity of pulses. Pulse production in India is very less because of ecological factors (more than 80 per cent of the pulse area is rain fed (only 8% irrigated) and grown under residual soil moisture, sensitivity to excess soil moisture, salinity), poor management practices (like improper sowing time and method, inadequate seed rate, imbalanced nutrition, no seed treatment) and some of the physiological, biochemical and inherent factors associated with the crop (Narayan and Kumar, 2015).

In order to increase the pulse production, it is necessary to use management strategies that enable plants to express their maximum genetic potential. Among them, the use of

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bio stimulants stands out, which are seaweed extracts emerging as commercial formulations for use as plant growth promoting factor and also to improve resistance to salinity, drought and heat stress. These are organic substances that can be applied to leaves, seeds or soil for enhancing plant growth and optimize productivity also in condition of stress-induced limitations. Hence, the experiment was conducted to reduce the losses caused by physiological, biochemical factors and to check the effect of bio stimulants for supporting plant growth and yield enhancement in black gram and soybean.

MATERIALS AND METHODS

Both field experiments were conducted during the *kharif* season of 2020 at Main Agricultural Research Station, University of Agricultural Sciences, Raichur and details of study area is furnished in Table 1. The experiment on black gram and soybean comprising of 8 and 7 treatments, respectively and was conducted in randomized block design with four replications. For black gram, the treatment details were given in Table 2. All these treatments were applied as foliar spray during pre-flowering stage of black gram. For soybean seed treatment details were presented in Table 2. The crops were sown on 25thJune and 17th June, 2020 for black gram and soybean, respectively. Row spacing of 30 cm was adopted for sowing of both the crops with a intra row spacing of 10 cm and seed rate of 18 and 62 kg ha^{-1} was followed in black gram and soybean, respectively. A common fertilizer dose of 25:50:00 (N: P_2O_5:K_2O kg ha^{-1}) to black gram and 40:80:25 (N: P_2O_5:K_2O kg ha^{-1}) to soybean were applied as basal dose to both the crops at the time of sowing. The cultivars used in the study were TAU-1 (black gram) and JS-335 (soybean).

Observations on growth parameters *viz*., plant height, number of branches per plant, leaf area per plant, total dry matter production at 60 DAS and yield parameters *viz,* number of pods per plant, pod weight per plant, Seed yield, haulm yield and biological yield were recorded for both the crops at the time of harvest whereas, in case of soybean the data on germination percentage, number of seedlings per meter and number of root nodules per plant were recorded. The crop growth rate (CGR) and relative growth rate (RGR) were calculated using standard formula, given by Watson (1947) and Williams (1946).

$$CGR= W_2 - W_1 / t_2 - t_1$$

$$RGR= (Log_{10} W_2 - Log_{10} W_1) / (t_2 - t_1)$$

Where,

W_2 and W_1 are plant dry weight per plant at time period (t_2) and (t_1) respectively.

With respect to yield data firstly all the border plants were cut close to ground level and kept separately and then plants from net plot area were cut at the base close to ground level. The data obtained from various characters under study were analysed one way using SPSS v.18. The graphs were plotted using Origin Pro software.

RESULTS AND DISCUSSION

Effect on growth attributes of black gram

Data presented in Table 3, reveals that foliar application of quantis @ 5.00 ml L^{-1} at 60 DAS recorded significantly higher plant height (38.15 cm), number of branches per plant (7.07), leaf area (9.43 dm^2 plant^{-1}) and total dry matter production (18.91 g plant^{-1}) and statistically at par with the treatments *viz.,* Pulse magic (10 ml L^{-1}), Quantis @ 3.75 ml L^{-1} and Ambition @ 2.5 L ha^{-1} at 60 DAS. Significantly lower growth attributes were recorded with the Untreated check (34.86 cm, 6.37, 8.49 dm^2 plant^{-1} and 18.91 g plant^{-1} respectively). Crop growth rate (CGR) and relative growth rate (RGR) were not significantly different due to foliar application of various biostimulants. The increased growth characters might be due to higher accessibility of nitrogen which improved the plant growth as nitrogen after absorption by the plant is transformed in to amino acids, building blocks of protein which might have escalated rate of meristematic activity resulting in better growth characters. These results are in conformity with the results of Choudhari *et al.,* (2001).

Foliar application of Quantis as a source of amino acids and peptides at pre flowering stage of the crop enhanced the plant vigour and improve the growth attributes by promoting cell elongation, shoot development with better photosynthetic activity and also increases the plant capacity for building metabolites which intern helps in production of more number of reproductive branches. Subramani *et al.* (2002), Chandrasekhar and Bangarusamy (2003) and Ganapathy *et al.* (2008) have reported similar results of importance of foliar nutrition with amino acid based

Table 1: Characteristics of the study area.

	a. Site characteristics	
Agro climatic zone	North Eastern dry zone (Zone-II)	
State and District	Karnataka and Raichur	
Coordinates of the site	15°14' N 77° 07' E longitude with an altitude of 389 meters	
Mean annual rainfall	650.75 mm	
Major soils	Black clay soil (*Vertisols*).	
Major crops grown	Cotton, pigeonpea, paddy, sunflower	
Growing period rainfall (mm)	July (113.1), August (126.6), September(160.6) and October (105.7) months (Fig 1)	
Rainy days during experimentation (Days)	July (13.0), August (12.0), September (11.0) and October (6.0)	
	b. Soil characteristics	
Particulars	Values	Category
Texture	-	Sandy clay
pH	8.10	Alkaline
EC (dsm^{-1})	0.32	-
Organic carbon (%)	0.53	Medium
Available nitrogen (kg ha^{-1})	216.48	Low
Available phosphorus (kg ha^{-1})	24.04	Medium
Available potassium (kg ha^{-1})	234.26	Medium

biostimulant in black gram. Similar results in line with findings of Venkata Reddy *et al.* (2009) in soybean. Leaf area (LA) is one of the photosynthetic determinants in determining the dry matter production of a crop and subsequently the yield. The significant improvement in the accumulation of dry matter in plant due to use of amino total as a source of amino acids may play an important role in plant metabolism and protein assimilation which is necessary for cell formation and consequently increase in dry matter (Yadav *et al.*,2008 and Verma *et al.,* 2009).

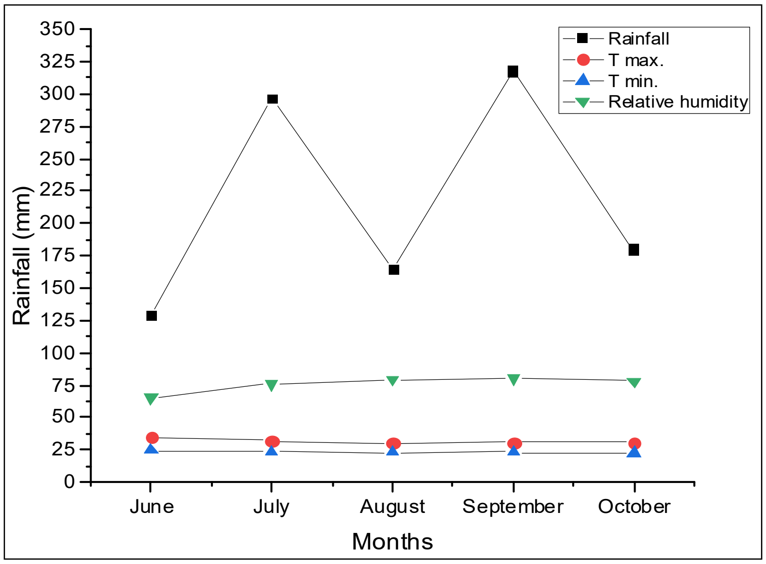

Fig 1: Meteorological data of experimental site during crop season.

Table 2: Treatment details of both the experiments.

A. Treatment details for black gram			B. Seed treatment details for soybean		
Tr, no.	Treatment details	Dose	Tr, no.	Treatment details	Dose
1	Untreated check	-	1	Untreated check	-
2	Quantis	2.5 ml L^{-1}	2	Epivio energy	0.50 ml kg^{-1} of seed
3	Quantis	3.75 ml L^{-1}	3	Epivio energy	1.00 ml kg^{-1} of seed
4	Quantis	5.00 ml L^{-1}	4	Epivio energy	2.00 ml kg^{-1} of seed
5	Biozyme crop +	2 ml L^{-1}	5	Biozyme seed plus	4.00 ml kg^{-1} of seed
6	Ambition	2.5 ml L^{-1}	6	Humesol	2.5 litre ha^{-1}
7	Biovita liquid	2 ml L^{-1}	7	Rhizobium + PSB seed treatment	1.25 kg ha^{-1}
8	Pulse magic	10 ml L^{-1}			
Note: Time and method of application: Foliar spray at pre flowering stage			Note: Time and method of application: Soybean seeds were treated with slurry method at the time of sowing		

Table 3: Growth attributes and growth indices of blackgram as influenced by foliar application of biostimulants.

Treatments	60 DAS					
	Plant height (cm)	Number of branches per plant	Leaf area (dm^2 $plant^{-1}$)	Total dry matter production (g $plant^{-1}$)	CGR (30-60 DAS)	RGR (30-60 DAS)
T_1	34.86	6.37	8.49	17.02	0.0149	0.0301
T_2	36.97	6.75	9.00	18.04	0.0158	0.0301
T_3	38.32	7.00	9.33	18.70	0.0164	0.0301
T_4	38.74	7.07	9.43	18.91	0.0166	0.0301
T_5	36.51	6.67	8.89	17.82	0.0156	0.0301
T_6	38.15	6.96	9.29	18.62	0.0163	0.0301
T_7	35.83	6.54	8.72	17.49	0.0153	0.0301
T_8	38.48	7.03	9.37	18.78	0.0164	0.0301
S.Em.±	0.19	0.04	0.05	0.23	0.0002	0.0001
C.D. (P=0.05)	0.59	0.12	0.15	0.72	NS	NS

Growth attributes of soybean

Improvement in growth characters is considered to be prerequisite to increase yield of any crop. Treating soybean seeds with different biostimulants at the time of sowing had significant positive effect on growth characters as compared to Untreated check (Table 5).

Biostimulant Epivio Energy as seed treatment @ 2.00 ml kg^{-1} of seed recorded higher germination and number of Seedlings/m row at 20 DAS (86.5% and 8.64, respectively) and found on par with Rhizobium + PSB seed treatment @ 1.25 kg ha^{-1} (86.1% and 8.59, respectively), Epivio Energy @ 1.00 ml kg^{-1}of seed (85.8% and 8.57, respectively) and Biozyme Seed Plus @ 4.00 ml kg^{-1}of seed (84.8 and 8.45, respectively). Significantly lower germination and number of Seedlings/m row at 20 DAS (80.8% and 7.98, respectively) was recorded with the untreated check (Table 5).

Germination and seedling establishment are critical stages which affected both quality and quantity of crop yields. The increase in seed germination percentage and seedling root length was considered typical biostumlant responses. They mimic the effect of exogenous GA_3 application. Initially, inoculated plants showed higher emergence which might be due to the production of phytohormone as phytohormone influences seed germination (Solaimalai *et al*., 2001).

Seed treatment of soybean with different biostimulants showed significant effect on all the growth attributes along with root length. Significantly higher plant height (26.04 cm), root length (11.52), number of branches per plant (4.55) and total dry matter production (39.79 g plant^{-1}) was noticed in the plot which received seed treatment of Epivio Energy @ 2.00 ml kg^{-1} of seed, which was remained statistically at par with Rhizobium + PSB seed treatment @ 1.25 kg ha^{-1}, Epivio Energy @ 1.00 ml kg^{-1}of seed and Biozyme Seed Plus @ 4.00 ml kg^{-1}of seed. Significantly lower growth attributes were recorded with the Untreated check (22.65 cm, 9.98, 4.03 and 35.26 g plant^{-1}, respectively) (Table 5). Crop growth rate (CGR) and relative growth rate (RGR) were not significantly different due to foliar application of various biostimulants.

Higher growth attributes like plant height and root length are due to seed treatment with Epivio energy which helps to increase the soil microbial activity in the soil which in turn helps in better stand establishment and higher root length. The microbial load around the root zone helps in production of phytoharmones such as gibberellins, auxins which helps in cell multiplication, elongation and metabolic pathways of protein synthesis. Similar results are obtained by Funguetto *et al*. (2010) and Verma *et al.,* 2009.

Table 4: Yield parameters, yield and production efficiency of blackgram as influenced by foliar application of biostimulants.

Treatments	No. of pods per plant	Pod weight (g plant^{-1})	Seed yield (kg ha^{-1})	Haulm yield (kg ha^{-1})	Biological yield (q ha^{-1})	Production efficiency (kg day^{-1} ha^{-1})
T_1	39.84	16.60	830	229	1059	12.03
T_2	45.13	17.60	880	279	1159	12.75
T_3	46.68	18.25	912	311	1223	13.22
T_4	49.38	18.45	922	323	1245	13.36
T_5	44.31	17.38	869	268	1137	12.59
T_6	46.14	18.17	908	307	1215	13.16
T_7	41.92	17.06	853	252	1105	12.36
T_8	47.42	18.33	916	314	1230	13.28
S.Em.±	1.08	0.05	0.05	0.05	10	0.07
C.D. (P=0.05)	3.24	0.29	0.14	0.16	30	0.21

Table 5: Growth attributes and growth indices of soybean as influenced by seed treatment of different biostimulants.

Treatments	60 DAS							
	Germination (%)	Seedlings/ m row At 20 DAS	Plant height (cm)	Root length (cm)	Number of branches per plant	Total dry matter production (g plant^{-1})	CGR30 -60 DAS	RGR30 -60 DAS
T_1	80.8	7.98	22.65	9.98	4.03	35.26	0.0302	0.0281
T_2	83.0	8.28	24.64	10.63	4.27	37.33	0.0320	0.0281
T_3	85.8	8.57	25.41	11.41	4.51	39.46	0.0338	0.0281
T_4	86.5	8.64	26.04	11.52	4.55	39.79	0.0341	0.0281
T_5	84.8	8.45	25.34	11.33	4.49	39.26	0.0337	0.0281
T_6	83.5	8.32	23.75	10.42	4.25	37.19	0.0319	0.0281
T_7	86.1	8.59	25.81	11.50	4.52	39.57	0.0339	0.0281
S.Em.±	0.56	0.05	0.23	0.07	0.02	0.16	0.0001	0.0001
C.D.(P=0.05)	1.71	0.19	0.71	0.20	0.06	0.52	NS	NS

Table 6: Yield parameters, yield and production efficiency of soybean as influenced seed treatment of different biostimulants.

Treatments	No. of nodules per plant	Number of pods per plant	Pod weight (g plant^{-1})	Number of seeds pod^{-1}	Seed yield (kg ha^{-1})	Haulm yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Production efficiency (kg day^{-1} ha^{-1})
T_1	30.00	45.33	25.18	4.23	1275	1360	2635	14.66
T_2	31.20	47.99	26.66	4.28	1350	1440	2790	15.52
T_3	33.08	50.73	28.18	4.62	1427	1522	2949	16.40
T_4	33.60	51.16	28.42	4.80	1439	1535	2974	16.54
T_5	30.80	50.48	28.05	4.41	1420	1514	2934	16.32
T_6	32.00	47.82	26.56	4.33	1345	1434	2779	15.46
T_7	30.40	50.87	28.26	4.74	1431	1526	2957	16.45
S.Em.±	0.20	0.23	0.12	0.13	0.06	0.07	8	0.35
C.D. (P=0.05)	0.52	0.69	0.38	0.39	0.19	0.22	25	1.08

Yield attributes and yields of black gram

Foliar application of different biostimulants to blackgram crop resulted in significant increase in yield and its attributes *viz*., number of pods per plant, pod weight per plant, seed yield, haulm yield and biological yield per hectare.

The data pertaining to yield and its attributes presented in Table 4 revealed that foliar application of quantis @5.00 ml L^{-1} at pre flowering stage reordered significantly higher number of pods per plant (49.38), pod weight per plant (18.45 g plant^{-1}), seed yield (922 kg ha^{-1}), haulm yield (323 kg ha^{-1}) and biological yield (1245 kg ha^{-1}). The aforesaid treatment also followed the treatments in order *Viz.,* Pulse magic @ 10 ml L^{-1},Quantis@3.75 ml L^{-1} and Ambition @ 2.5 litre ha^{-1}. Significantly lower yield attributes and yield was noticed with Untreated check (39.84, 16.60 g plant^{-1}, 830 kg ha^{-1}, 229 kg ha^{-1} and 1059 kg ha^{-1}, respectively) (Table 4).

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). Foliar application of biostimulant to crop increases the photosynthetic activity, enhances the synthesis of carbohydrates and protein and their transport to the site of seed formation, reduce the senescence and flower drop percentage and increase the pod set by resulting in increased the growth and yield of black gram. Increased yield due to seaweed sap application were also reported for *Phaseolus radiata* (Pramanick *et al*.,2013); *Vigna sinensis* (Sivasankari *et al*., 2006). The increase in seed yield of pulses with foliar application of nutrients could be attributed to reduced flower drop and increased fruit set percentage. These results corroborate the findings of Kocira (2018) and Subramani and Solaimalai (2000).

Production efficiency (kg day^{-1} ha^{-1})

The maximum production efficiency (13.36 kg day^{-1} ha^{-1}) was recorded in T_4 which was significantly higher compared to all other treatments. Minimum production efficiency (12.03 kg day^{-1} ha^{-1}) was recorded in treatment T_1 (Table 4). This might be because of increase in grain yield under T_4 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).

Nodulation, yields attributes and yield of soybean

Effect on nodulation

Number of root nodules per plant was observed to be significantly superior in treatment received Epivio Energy as seed treatment @ 2.00 ml kg^{-1} of seed (13.60 nos.) as compared to rest of the treatments (Table 5). Increased nodulation might be due to supply of the required nutrients easily and rapidly to soybean plants which helps in spreading of root system and gives more site for rhizobia infection and increase their proliferation in rhizosphere, helps in forming more effective nodules. Results are in conformity with Meena *et al*., 2017.

Effect on yield and its attributes

Seed treatment of soybean with different biostimulants showed significant effect on all the yield attributes and yield of soybean.Higher yield parameters *viz*., number of pods per plant (51.16), pod weight (28.42 g plant^{-1}), number of seeds per pod (2.80), seed yield (1439 kg ha^{-1}), haulm yield (1535 kg ha^{-1}) and biological yield (2974 kg ha^{-1}) were recorded in treatment receiving Epivio Energy seed treatment @ 2.00 ml kg^{-1} and at par with Rhizobium + PSB seed treatment @ 1.25 kg ha^{-1}, Epivio Energy @ 1.00 ml kg^{-1}of seed and Biozyme Seed Plus @ 4.00 ml kg^{-1}of seed. Significantly lower yield attributes and yield was recorded with treatment T_1 (Table 6). Increased yield attributes and yield in the current study might be the collective response of vigorous growth and net assimilation, resulting in a higher number of branches and pods. Furthermore, earlier crop establishment with vigorous growth minimizes weed competition, which facilitates increased water and nutrient absorption, resulting in a higher number of branches and yield. (Gunes *et al*., 2005) opined that seed treatment with Epivio Energy which helps to increase soil microbial population around rhizosphere which helps to increase nodule formation and in turn helps in fixation of nitrogen. Since nitrogen helps in better growth and development of plants which ultimately improves yield and yield attributes in soybean (Mintah *et al*., 2020; Rafique *et al*., 2020).

In current study, the maximum production efficiency (16.54 kg day^{-1} ha^{-1}) was recorded in T_4 which was significantly higher compared to all other treatments. Minimum production efficiency (14.66 Kg day^{-1} ha^{-1}) was recorded in treatment T_1 (Table 6). This might be because of increase in grain yield under T_4 which also enhanced production efficiency per day. Similar results are in line with findings of Choudhari *et al.,* (2001).

CONCLUSION

Biostimulants are environmentally benign and safe for the health of animals and human being can be considered as a potential organic farm input to be used. From the results of experiments it can be inferred that foliar application quantis @5.00 ml L^{-1} in black gram improves growth and yield, yield attributes. Seed treatment effect of Epivio Energy @ 2.00 ml kg^{-1} increases all morpho-physiological parameters of soybean from initial establishment to final yield was affected by seed treatment with Epivio Energy biostimulant.

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