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Co-ordinal Impact of Humic Acid, Boron and Zinc Application on Morphological Changes and Chlorophyll in Black gram

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ABSTRACT: An experiment was planned and executed over the field to evaluate the co-ordinal impact of humic acid with foliar applications of Zn and Boron on morphological changesand chlorophyll content in black gram (*Vigna mungo* L.). Out of both the concentrations of humic acid, (HA_1 and HA_2), HA_2 was recorded superiorfor the entire set of parameters as compared to HA_1 which was considered for the present study. Among thesets of foliar application with boron and zinc, T_4 (HA1 + 2% Zn) was recorded consistently better than the rest of the treatments for all the parameters in both concentrations of HA such as plant height (cm), fresh and dry weight g plant^{-1}, the number of leaves and leaf area cm^2 plant^{-1} (107.1, 164.3, 9.20, 45.7, 532 and 114, 178.7, 9.91, 47.5 and 556). The performance of LAI and SPAD reading was noticed well in $HA_1 \times T_4$ at both the time of intervals (60 DAS and at harvest). In the case of HA_2, T_4 performed well only for LAI while for SPAD reading T_2 supersede T_4. The statistical analysis of the data showed that all the parameters recorded significant differences at (P>0.05) except for the dry weight of the plant.The yield of pulse crop is a major challenge that depends directly / indirectly upon the morpho-physiological growth of the plant therefore, the present study was considered to overcome the issue related to morpho-physiological growth of pulse crop.

Keywords: Black gram, boron, chlorophyll, humic acidand Zn.

INTRODUCTION

Black gram (*Vigna mungo*) is one of the highly valuable pulse crops concerning nutrition around the world that is grown in both seasons *Kharif and Rabi*. It is grown on approximately about 3 million hectares and the annual production of this crop is 1.5 to 1.9 million tonnes in India. We can grow this crop throughout the year because it is photo insensitive crop and also a self-pollinated crop. Moreover, it is a short-duration crop, easily suitable in any cropping system and has relative drought tolerance (Cheeran *et al.,* 2017; Gandi *et al.,* 2018). The yield of the black gram crop is adversely affected by the high temperature and drought (Baroowa and Gogoi 2015). It offers nutrition benefits to human beings and provides food security while the additional benefit is given to the soil concerning nitrogen for other crops (Khiangte and Siddique 2021). Humic acid promotes plant growth and yield by increasing nutrient intake and operating on different systems such as cellular respiration, photosynthesis, protein synthesis, and enzyme activities because it is a powerful adsorption and retention complex for inorganic plant nutrients (El-Saadony *et al.,* 2021; Ozfidan-konakci *et al.,* 2018). Zinc and boron both are essential micronutrients that play a wide role in the plant metabolic process in which Zn is the only element that includes in all the classes of an enzyme. Zinc is an element that is required for the biosynthesis of Auxin in the plant system therefore the deficiency of Zinc may show a reduction in auxin content in the plant consequently it alters the growth and development mediated by the interference in carbohydrate and nucleic acid metabolic process (Choudhary*et al.,* 2020; Auld, 2001; Latef *et al.,* 2017). Boron is another micronutrient that interferes in the translocation of sugar from the source to the sink (Farooq *et al.,* 2012; Kihara *et al.,* 2020). Therefore, to enhance the production of black gram, the present piece of work was considered for the research.

MATERIALS AND METHODS

The present piece of research work was planned and executed over the Research Farm of Agronomy, Lovely Professional University, in Kharif seasons of 2021-22. The experiment was laid out in a Randomized Block Design along with the combinations of ten treatments and one control. The treatment combinations were made with two different types of treatment one is concentrations of humic acid @ 10 Kg ha^{-1} (HA_1) and 12 Kg ha^{-1} (HA_2) and the second is the foliar application of Zn and Boron in two different concentrations (1% and 2%) while the single variety of black gram (Mash1008) was used. The humic acid was applied to the soil after dissolvingin the water by the use of a sprinkler in the respective plots before the sowing. The following morphological parameters were used to assess the impact of treatments such asplant height, fresh and dry weight of the plant, number of leaves, leaf area, and LAI while SPAD reading was recorded with a SPAD meter (SPAD-502). The LAI and total chlorophyll content were calculated according to the formula given by (Watson, 1947; Arnon, 1949).

$$\text{Total chlorophyll} = (20.2\ (D\ 645) + 8.02\ (D\ 663) \times \frac{V}{1000 \times W}\ \text{mg g}^{-1}$$

The RBD analysis was carried out through SPSS (Model No-23) while the significance level of the parameters and treatments weretasted at p>0.5%.

RESULT AND DISCUSSION

The co-ordinal impact of humic acid, boron, and zinc application as soil and foliar application on plant height (cm), fresh and dry weight (g plant^{-1}), the number of leaves, and leaf area (cm^2 plant^{-1}) were assessedin black gram. It was observed from the data presented in (Table 1) showed that out of both the concentrations of humic acid (HA_1 and HA_2), HA_2 recorded consistently better as compared to HA_1 for all the parameters such as plant height, fresh and dry weight, number of leaves and leaf area. The performance of the treatments among the foliar applications of Zn and Boron with HA_1 showed that T_4(HA_1 + 2% Zn) was found maximum value with highly significantfor all the parameters which were followed by T_2 and T_5 as compared to the control set whilein case of HA_2 in combination with Zn and boron, a similar trend was found for all the parameters except to dry weight of the plant. The data presented in parenthesis (Table 1) showed about the % increase/decrease over the control indicated the same trend concerning gain of growth. Data presented in (Table 2) reveals the impact of treatments on LAI (leaf area index) and SPAD readings at the intervals of 50DAS and at harvest.The performance of the treatments among the foliar applications of Zn and Boron with HA_1 showed that T_4 (HA_1 + 2% Zn) was found to the maximum value with highly significantfor both the parameters which were followed by T_2 and T_5 as compared to control set while in case of HA_2 in combination with Zn and boron, the trends was recorded same for LAI while T_2 was recorded best for SPAD reading at both the intervals. It was observed from the data presented in (Table 2) showed that out of both the concentrations of humic acid (HA_1 and HA_2), HA_2 recorded consistently better as compared to HA_1 for both the parameters such as LAI and SPAD reading except for SPAD reading at harvest. The data relating to % increase/decrease over control justified the performance of treatments (Table 2). Total chlorophyllcontent (mg g^{-1}) was measured from the leaf of black gram and recorded highest in HA_2 as compared to HA_1 however, within the $HA_{1,}$ T_4 was recorded significantly better as compared to the rest of the treatments while T_2 was in HA_2 at both the time of intervals showed that HA_2 (Fig. 1). However, astrong positive correlation was observed between the SPAD reading and total chlorophyll content (Fig. 2). Humic acid is an important compound that helps in many ways to boost plant growth and development in which one of which is enhancing the capacity to release nutrients in soil followed by the uptake of nutrients. The importance of Zn and boron is already well known,especially in the synthesis of Auxin, the production of carbohydrates, and its translocation from the place of the source to the place of the sink (Pandey and Gupta, 2013; Pandey *et al.,* 2006). The co-ordinal impact of the treatments showed that HA_1 and HA_2 both were doing well incombination with T_4 most of the time except fora few parameters such as SPAD reading and total chlorophyll content T_2 was recorded better. The results of the present study areper the findings of (Ibrahim and Ramadan, 2015) who reported that the combined application of humic acid and FA of Zinc benefited the crop up to the yield by manipulating morphological characters such as vegetative and reproductive growth mediated by the enhancing the nutrient release followed by the uptake of the plant (Pandey *et al.,* 2013; Ahmed *et al.,* 2010; Fawzy *et al.,* 2010).

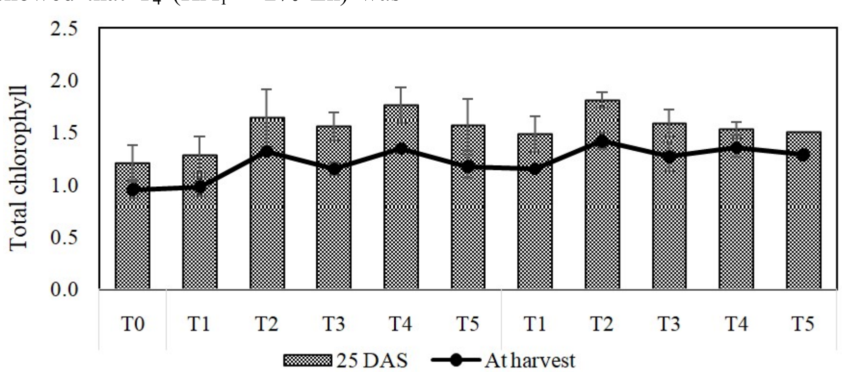

Fig. 1. Efficiency of humic acid and foliar application of boron and zinc on Total chlorophyll content [mg g^{-1}] in black gram.

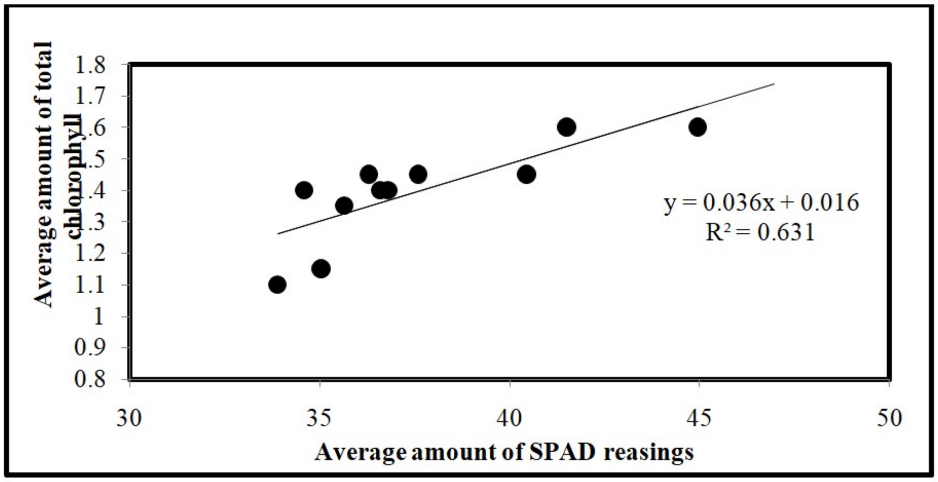

Fig. 2. Correlation between SPAD reading VS total chlorophyll.

Table 1: Effect of humic acid and foliar application of zinc and boron on plant height (cm), fresh weight and dry weight (g plant^{-1}), number of leaves, leaf area (cm^2 plant^{-1}) at harvest.

Treatments		Plant height	Fresh weight	Dry weight	Number of leaves	Leaf area
HA$_1$	**T$_0$**	97.0 ± 2.72^{a}	140.0 ± 0.58^{a}	8.11 ± 0.55^{a}	32.7 ± 1.34^{a}	441.2 ± 1.81^{a}
	T$_1$	100.2 ± 4.94^{ab} [3.19]	145.3 ± 2.03^{abc} [3.67]	8.40 ± 1.04^{a} [4.13]	34.7 ± 2.67^{ab} [5.77]	462.9 ± 15.22^{ab} [4.69]
	T$_2$	104.6 ± 2.55^{abc} [7.24]	158.7 ± 1.67^{def} [11.76]	8.64 ± 0.39^{a} [6.75]	40.0 ± 2.31^{bcd} [18.33]	495.7 ± 4.53^{c} [11.00]
	T$_3$	98.7 ± 3.65^{a} [1.76]	149.7 ± 5.49^{bcd} [6.46]	8.29 ± 0.54^{a} [2.82]	37.7 ± 0.89^{ab} [13.27]	469.5 ± 0.47^{b} [6.02]
	T$_4$	107.1 ± 1.22^{abc} [9.46]	164.3 ± 2.41^{ef} [14.81]	9.20 ± 1.18^{a} [12.42]	45.7 ± 1.77^{cde} [28.47]	532.4 ± 6.28^{d} [17.12]
	T$_5$	104.6 ± 3.20^{abc} [7.30]	154.3 ± 1.46^{cd} [9.29]	8.05 ± 0.20^{a} [0.67]	39.0 ± 2.09^{abc} [16.24]	471.6 ± 4.63^{b} [6.45]
Mean		**103.04**	**154.46**	**8.516**	**39.42**	**486.42**
HA$_2$	**T$_1$**	101.8 ± 2.76^{ab} [4.68]	144.0 ± 2.09^{ab} [2.78]	9.00 ± 0.82^{a} [10.55]	36.7 ± 2.34^{ab} [10.91]	467.2 ± 13.90^{b} [5.57]
	T$_2$	110.4 ± 2.66^{bc} [12.14]	166.3 ± 1.86^{f} [15.83]	10.01 ± 0.55^{a} [19.53]	46.0 ± 1.53^{de} [28.99]	543.3 ± 0.42^{de} [18.79]
	T$_3$	105.8 ± 3.11^{abc} [8.32]	156.7 ± 3.53^{de} [10.64]	9.36 ± 0.87^{a} [13.97]	40.5 ± 1.51^{bcde} [19.34]	476.9 ± 6.13^{bc} [7.48]
	T$_4$	114.0 ± 5.44^{c} [14.94]	178.7 ± 4.81^{g} [21.64]	9.91 ± 1.13^{a} [18.71]	47.0 ± 3.79^{e} [30.50]	556.8 ± 7.84^{e} [20.77]
	T$_5$	104.0 ± 1.83^{abc} [6.70]	157.0 ± 2.89^{def} [10.83]	9.42 ± 0.86^{a} [14.46]	41.3 ± 0.89^{bcde} [20.97]	481.9 ± 3.38^{bc} [8.44]
Mean		**107.2**	**160.54**	**9.54**	**42.3**	**505.22**
C.D.		9.406	9.220	NS	6.221	22.302
C.V.		5.254	3.448	16.057	9.044	2.649

Note: T$_0$= Control, T$_1$=HA$_1$, T$_2$= HA$_1$ + 1% Zn, T$_3$= HA$_1$ + 1% Bo, T$_4$= HA$_1$ + 2% Zn, T$_5$= HA$_1$ + 2% Bo, T$_1$=HA$_2$, T$_2$= HA$_2$ + 1% Zn, T$_3$= HA$_2$ + 1% Bo, T$_4$= HA$_2$ + 2% Zn, T$_5$= HA$_2$ + 2% Bo

Table 2: Effect of humic acid and foliar application of zinc and boron on different parameters *i.e*. LAI and SPAD readings at 50 DAS and at harvest.

Treatments		LAI		SPAD readings	
		50 DAS	At harvest	50 DAS	At harvest
HA_1	T_0	1.77±0.02^{a}	1.47±0.01^{a}	41.9±0.77^{a}	25.9±0.99^{a}
	T_1	1.78±0.02^{a} [0.39]	1.54±0.05^{ab} [4.69]	43.0±1.71^{a} [2.64]	27.1±1.22^{ab} [4.43]
	T_2	2.12±0.02^{c} [16.56]	1.65±0.02^{c} [11.00]	48.3±0.84^{bc} [13.26]	32.6±0.44^{cd} [20.55]
	T_3	1.80±0.02^{ab} [1.63]	1.56±0.01^{b} [6.02]	44.1±2.46^{a} [5.06]	29.1±2.46^{abc} [11.00]
	T_4	2.18±0.05^{c} [18.83]	1.77±0.03^{d} [17.12]	49.3±0.92^{c} [15.14]	33.7±1.57^{de} [23.07]
	T_5	1.83±0.02^{ab} [3.35]	1.57±0.02^{b} [6.45]	44.3±0.99^{a} [5.42]	29.3±0.99^{abc} [11.50]
Mean		**1.942**	**1.618**	**45.8**	**30.36**
HA_2	T_1	1.80±0.02^{ab} [1.61]	1.56±0.05^{b} [5.57]	44.0±0.45^{a} [4.78]	27.3±0.91^{ab} [5.13]
	T_2	2.26±0.03^{d} [21.67]	1.81±0.01^{de} [18.79]	53.2±1.16^{d} [21.35]	36.7±1.18^{e} [29.36]
	T_3	1.85±0.03^{b} [4.47]	1.59±0.03^{bc} [7.48]	43.8±0.58^{a} [4.49]	28.8±0.58^{abc} [10.17]
	T_4	2.36±0.03^{e} [24.86]	1.86±0.03^{e} [25.77]	44.8±1.69^{ab} [6.48]	30.4±1.38^{bcd} [14.90]
	T_5	1.86±0.02^{b} [4.74]	1.61±0.02^{bc} [8.44]	42.3±0.01^{a} [1.02]	26.9±0.70^{ab} [3.84]
Mean		**2.026**	**1.686**	**45.62**	**30.02**
C.D.		0.060	0.075	3.843	3.734
C.V.		1.772	2.674	4.940	7.305

Note: T_0= Control, T_1=HA_1, T_2= HA_1 + 1% Zn, T_3= HA_1 + 1% Bo, T_4= HA_1 + 2% Zn, T_5= HA_1 + 2% Bo, T_1=HA_2, T_2= HA_2 + 1% Zn, T_3= HA_2 + 1% Bo, T_4= HA_2 + 2% Zn, T_5= HA_2 + 2% Bo

It is also reported that humic acid along with Zinc confers supports respiration, photosynthesis, water uptake and protein synthesis (Zhang and Ervin 2004; Sheikha and Al-Malki 2011 and Abu-Muriefah, 2013) while its ultimate impact is reflected in the yield of crop via improving the morphological growth and chlorophyll content.

CONCLUSION

Soil application of humic acid followed by foliar application of Zinc and Boron showed their co-ordinal impact on morphological growth and total chlorophyll content. Out of the entire set of treatments, HA_1 and HA_2 both were found most effective along with T_4 (Zn 2%) for most of the parameters studied. The applied treatments can help in many ways like nutritional support from the soil, translocation of nutrients within the plant, and additional support in the synthesis of chlorophyll content. On the behalf of these results, we can expect that yield of this crop would be better as compared to normal cultivation practices.

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Conflict of Interest. None.

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