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Influence on vegetative attributes and yield components of blackgram (*Vigna mungo* L.) influenced by plant growth regulators

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Abstract
The use of Plant Growth Regulators (PGRs) has opened up new opportunities for improved productivity of seeds in pulses, in particular, which are often subject to limitations due to both internal and external factors. Therefore, an experiment was carried out inside the net house in cement moulded pots to determine the effect of crop growth regulators viz. Maleic Hydrazide, Gibberellin, Triacontanol, 2,3,5-triiodobenzoic acid and Cycocel, as foliar spray. The result suggested significant differences in vegetation, canopy composition, flower initiation, pod setting, seed per plant, etc. due to plant growth regulators. These changes translated finally to the yield attributes. The findings of the study concluded that productivity and biological yield per plant were the best among all treatments for TIBA 20 ppm, while H.I. It was the largest in CCC 100 ppm. These findings indicate that the use of the plant growth regulator may help us as a means of improving the yield of urad bean. This investigation also suggested that, if a new growth inhibitor were to be identified that could regulate excess vegetative growth without detrimental effects on reproductive production, the yield of seed in urad bean could also likely be increased by combining a growth inhibitor such as TIBA with a growth promoter at a particular developmental level.

Keywords: Cucumber, Boron, Yield, Quality, Konkan

Introduction
Owing to its nutritional content of proteins, vitamins B, minerals, digestibility, and dietary fibres urad bean consists of an indispensable dietary component in regions of the Indian-subcontinent. Blackgram is an extensively grown grain legume and belongs to Fabaceae family and got noticeable significance from the point of food and nutritional security in the world (Thakur *et al*. 2017) [20]. Its intrinsic ability to fix atmospheric nitrogen in the soil makes it a suitable candidate for intercropping and rotational cultivation of cereals and various non-leguminous crops in the soil during *Rabi* (South India), *Kharif* and *Zaid* seasons (Arun *et al* 2019). India is presently the largest producer of black gram accounting for more than 70% of global production. India is followed by Burma and Pakistan. More than 90 per cent of uradbean production comes from 09 states of Madhya Pradesh, Rajasthan, Uttar Pradesh, Andhra Pradesh, Tamil Nadu, Maharashtra, Jharkhand, Gujarat and West Bengal. In U.P., it occupies 7.01 lakh ha area with the contribution 12.20% of the total national production as per third advance estimate of DES, (Ministry of Agri. & 2017-18). Plant regulators can enforce both positive and negative regulations on plants. the last few years, besides the best effort, bean productivity has remained stagnant and the difference between supply and demand has deepened. (Gowda *et al*., 2013) [7]. These stagnation of productivity besides the best-recommended practice is due to natural and physiological constraints such as poor germination, source limitation, slow dry matter accumulation, indeterminate growth habit, C_3 photosynthetic apparatus, decrease in nodule activity, abscission of flowers and pods, higher energy requirement and reduced sink activity (Deol *et al* 2018). Applying an appropriate dose of certain plant growth regulators at a specific stage of growth can overcome these constraints by increasing the limitation factors as reported in various studies. GA plays an important role in the distribution of stored assimilates in the germinating seed to the developing embryo, dramatically improving the germination percentage and ensuring proper plume and radicle growth. TIBA is known to promote photosynthesis due to higher assimilative area production,

which leads to better growth, development and higher yield (Parmar, *et al*., 2012) [16]. TIBA is used to regulate excess vegetative growth and lodging, minimise abscission of flowers and immature pods, and adjust plant canopy to improve crop productivity (Adam and Jahan 2014) [1]. Triacontanol (TRIA) and Cycocel (CCC) have been documented to increase yield by inhibiting floral abscission leading to a higher number of flowers that eventually reflect its yield. TRIA has been reported to have a profound impact on the rise in seed weight Cycocel is considered to have an adequate concentration to mitigate the influence of indigenous ABA and reduce the shedding percentage (Singh *et al*., 2017). Maleic Hydrazide (MH) increased accumulation of dry matter in some legumes. This indicates that these compounds have the ability to overcome physiological shortcomings of pulse and improve their efficiency.

Material and methods

The urad bean variety used in this study was "Shekhar-3" which was procured from the Research cum Seed Production Farm CSAUAT, Kanpur. Experimental was conducted in cemented pots of 25 cm^2 filled with 8 Kg of soil each. The bottom holes were covered with pieces of broken pot well pulverized and air-dried soil was filled in the pots and compacted after filling. The recommended fertilizers, @15 Kg N. 40 Kg P_2O_2/ha were applied as per split doses, half quantity basal and another half as a top dressing. The experiment was laid out in Complete Randomized Design (CRD).

Preparation of solution and spraying

The plant growth regulators were prepared by standard calculations after measuring the necessary amount for the different doses by first dissolving it in few drops of ethyl alcohol stirring well, made a paste and then made up the volume for 1000 ml with distilled water separately. The solutions were stored in a well-stoppered flat bottom flask of capacity 1 litre ready before use. Solutions added with adhesive tween 20 @ 0.1%. Control pots were treated with distilled water along with Tween-20. Foliar applications were carried out at initial flowering and full flowering using an atomizer at a different screened makeshift chamber to avoid unwanted contact.

Detail of treatment

Each of the plant growth regulator were prepared into two concentrations, i.e. ten (10) treatments, one control namely, Maleic Hydrazide (50 ppm and 100 ppm), Gibberellin (20 ppm and 40 ppm), Triacontanol (2 ppm and 4 ppm), Cycocel (50 ppm and 100 ppm), 2,3,5-triiodobenzoic acid (20 and 40 ppm) Control (distilled water) into four replications each treatment were delivered through foliar spray at 30 and 45 days after sowing. The plant parts were separated into leaves, stems and roots.

Leaf area index (LAI)

Since the crop yield is to be assessed per unit ground area instead of per plant, the leaf area existing on unit ground area was proposed by Watson (1952). Leaf area index is the ratio of leaf area to ground area occupied by crop plant. Leaf area index plant^{-1} was calculated by using the following formula.

$$LAI = \frac{\text{Leaf area plant}^{-1}\ (cm^2)}{\text{Ground area plant}^{-1}\ (cm^2)}$$

Harvest Index

$$\text{(2) Harvest Index (\%)} = \frac{\text{Economic Yield}_{\text{(Seeds)}}}{\text{Biological Yield}_{\text{(Total Dry Matter)}}} \times 100$$

Results and Conclusions

Plant height and number of branches

Both GA treatments reached the maximum plant height at 60 DAS and thus both treatments had a comparable impact with respect to plant height. Whereas TIBA treated plants were observed to have a substantial reduction in height from shortened intestines relative to control plants during the levels. The main stem height was significantly reduced and the number of branches per plant and the number of branch nodes increased with TIBA treatment.

Number of leaves and total leaf area

The number of leaves serves as source of photosynthesis, so has a direct effect on the sink's capacity and decides the plant's production. As a result of plant growth regulators the number of leaves per plant attained optimum in TIBA 20 ppm treatment at 50 DAS while at GA 40 ppm effect was expressed in terms of leaves numbers and leaf area as observed by Emongor (2007) [21]. The MH treatment had a negative effect on the number of leaves that appear to rise with an increase in concentration and were slightly smaller than the controls during the development stages. Plant growth regulator affected the leaf expansion and leaf numbers between post flowering initiation and before maturity stages. These results were supported by the observations of Amutha *et al*. (2012) and Marimuthu and Surendran (2015) [2, 15] in blackgram.

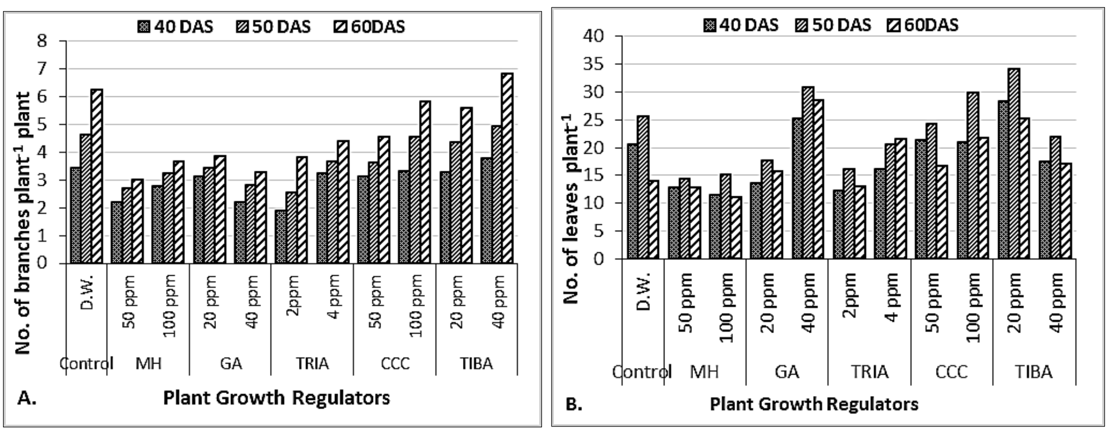

Fig1: Effect of plant growth regulators on A. no. of branches, B. no. of leaves

In CCC 100 ppm plants at 60 DAS stages, the highest leaf area per plant was recorded, followed by TRIA 2 ppm and GA 40 ppm, with higher biological yields projected in the same treatments.

In low ppm treatments in GA, TRIA, TIBA, the effect was less noticeable, while the difference between treatments was significant and conclusive.

Vegetative dry weight

The dry weight accumulation was determined by measuring the dry weight of the leaf and stem which remained in the same trend as that of the total leaf area. Dry matter in trifoliate and stem was found to be highest in CCC 100 ppm treatments followed closely by TRIA throughout the stages. The result of treatment with CCC 50 ppm resulted in a less profound effect than that of CCC 100 ppm. The treatments with MH were the least affected by the treatments.

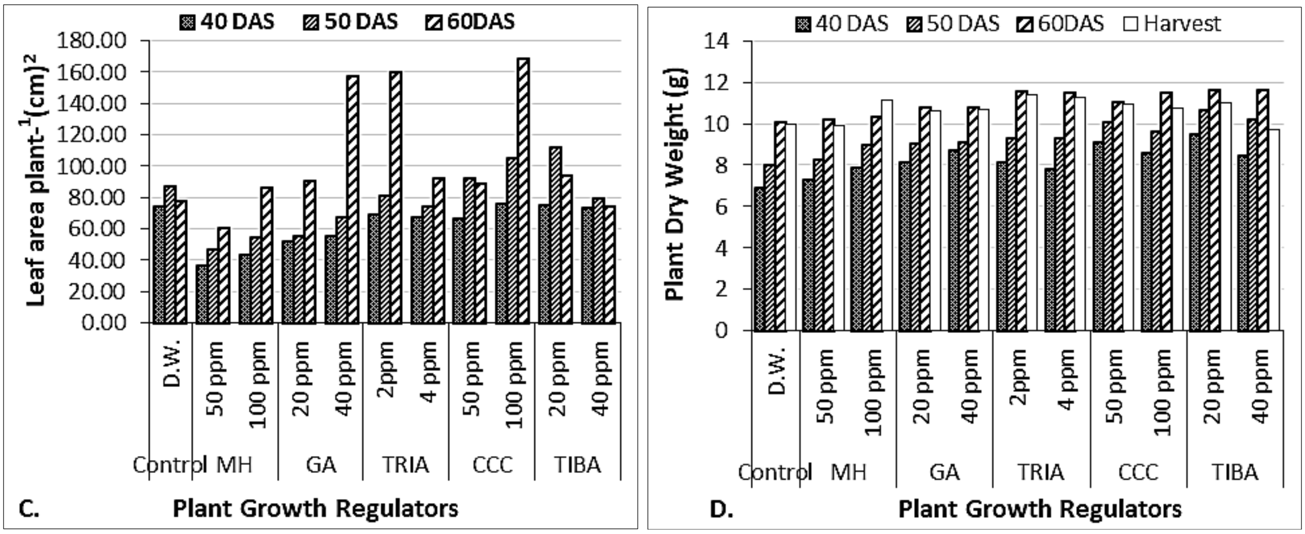

Fig2: Effect of plant growth regulators on C. Leaf area, D. Plant dry weight

Leaf area index (LAI)

LAI steadily increased even after flowering and were highest at around 60 DAS then it gradually declined. LAI were recorded similar in trend to the leaf area, with CCC 100 ppm being the highest of all treatment followed by TRIA 4 ppm and GA 40 ppm. Increased LAI can be attributed to the increased leaf area upon plant growth regulators application and these findings were in close conformity with the results of Marimuthu and Surendran (2015) [15]. TIBA, both the treatment showed a relatively higher LAI then the control and MH treatments. This is due to reduction abscission of floral buds and leaf, which will translate finally to the yield and photosynthetic source by modification of the canopy structure that optimizes productivity (Adam and Jahan 2014) [1]

Seed yield per pod and Seed yield per plant

A critical examination of seed yield data displayed in the (Table 1) revealed that spraying of growth regulators on urad bean plant produced significantly more seed yield over control plants. Maximum seed yield per plant was recorded by the treatment of TIBA 40ppm followed by TIBA-20ppm, closely followed by CCC 50 ppm and CCC 100 ppm. TIBA treatments are found to improve pod setting and seed filling similar to the results of Jahan (2014) [1].

Table 1: Effects of plant growth regulators on LAI, seed yield plant, biological yield plant, H.I., Productivity Harvest Index

Treatment in ppm		LAI at 60 DAS	Seed yield plant^{-1} in (g.)	Biological yield plant^{-1} (g.)	H.I. (%)	Productivity g^{-1}day^{-1} plant^{-1}
MH	50 ppm	1.7	5.4	36.1	14.96	0.092
	100 ppm	1.4	6.9	36.6	18.85	0.113
GA	20 ppm	1.9	6.8	36.9	18.43	0.112
	40 ppm	3.5	6.9	34.6	19.94	0.115
TRIA	2ppm	3.5	6.5	37.1	17.52	0.113
	4 ppm	2.6	6.7	38.7	17.31	0.112
CCC	50 ppm	3.4	6.7	37.6	17.82	0.112
	100 ppm	3.8	7.9	37.7	20.95	0.130
TIBA	20 ppm	3.1	8.2	40.1	20.45	0.132
	40 ppm	3.0	7.6	39.4	19.29	0.123
Control	Water	1.7	7.5	22.6	33.19	0.122
S.Ed (±)		1.7	0.34	0.78	43.59	0.005
C.D. (5%)		3.5	0.65	2.00	32.50	0.011

Based on the data presented in (Table No.1), the maximum harvest index was recorded with CCC 100 ppm, followed closely by TIBA 20 ppm and CCC 50 ppm, whereas MH 100 ppm gave the least position in this regard.

Productivity

For the TIBA treatment, the maximum productivity was found to be 40 ppm closely followed by 20 ppm. TIBA was at the same level as CCC's efficiency. The productivity of MH 50 ppm was negligible to the control's productivity. GA was important for regulation but was at the same productivity as MH 100 ppm, TRIA 2ppm, TRIA 4 ppm.

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