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Effect of bio stimulant on growth and yield of Bt cotton hybrid and varieties

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Abstract
A field experiment was conducted at Cotton research unit, Dr. PDKV, Akola during *kharif* of 2021-22 and was laid out in Factorial Randomized Block Design (FRBD) design with two main plot treatments and four sub plot treatments.

The soil of experimental plot was vertisol, it was low in available nitrogen (172.35 kg ha^{-1}) and organic carbon (0.37), medium in phosphorus (16.50 kg ha^{-1}), rich in available potassium (335.30 kg ha^{-1}) and slightly alkaline in reaction (7.7). The cotton seed was sown at 90 x 30 cm spacing with 60:30:30 NPK kg/ha. The main plot treatments were two i.e. V_1: PDKV JKAL-116 and V_2: AKH-9-5 (Suvarna shubhra) and sub plot treatments were four i.e. B_1: Bio stimulant (Anacardic acid) @4 mg litre^{-1} at 30, 45 and 60 DAS (20 mg+5 litre of water + 0.5 ml of DMSO), B_2: Bio stimulant (Anacardic acid) @ 4 mg litre^{-1} at 45, 60 and 75 DAS (20 mg+5 litre of water + 0.5 ml of DMSO), B_3: DMSO @ 100 µl litre^{-1} spray at 30, 45, 60 and 75 DAS (0.5 ml of DMSO+ 5 litre of water) and B_4: Control (water spray 30, 45, 60 and 75). Growth characters *viz*., plant height, number of functional leaves, number of monopodial and sympodial branches, dry matter accumulation, leaf area and chlorophyll content was significantly highest with genotype V_1: PDKV JKAL-116 Bt (BG-II) fallowed by V_2: AKH-9-5 (Suvarna shubhra). Yield attributes and seed yield (kg ha^{-1}) *viz*., number of bolls picked plant^{-1}, average boll weight (g), seed cotton yield plant^{-1} (kg ha^{-1}) were recorded maximum in genotype V_1: PDKV JKAL-116 Bt (BG-II). The seed cotton yield was significantly highest in V_1: PDKV JKAL-116 Bt (BG-II) (2275 kg ha^{-1}) followed by V_2: AKH-9-5 (Suvarna shubhra). Same trend was observed in lint yield kg ha^{-1}, stalk yield kg ha^{-1} and harvest index. The seed cotton yield was significantly highest in genotype V_1: PDKV JKAL-116 Bt (BG-II) (2275 kg ha^{-1}) followed by V_2: AKH-9-5 (Suvarna shubhra) (1725 kg ha^{-1}). Total nutrient content *viz*., nitrogen, phosphorous and potassium in seed and stalk were observed maximum by means of genotype V_1: PDKV JKAL-116 Bt (BG-II) followed by V2: AKH-9-5 (Suvarna shubhra). Similar trend was observed in available nitrogen, phosphorous and potassium. The significant difference were observed at to harvest, the growth characters *viz*., plant height, number of functional leaves, monopodial and sympodial branches, and dry matter accumulation content was significantly highest in treatment B_1: Anacardic acid @ 4 mg litre^{-1} at 30, 45 and 60 DAS. However it was at par with B_2: Anacardic acid @ 4 mg litre^{-1} at 45, 60 and 75 DAS. The seed cotton yield was significantly highest in treatment B_1: Anacardic acid @ 4 mg litre^{-1} at 30,45 and 60 DAS (2256 kg ha^{-1}) which was at par with B_2: Anacardic acid @ 4 mg litre^{-1} at 45, 60 and 75 DAS (2068 kg ha^{-1}). Same trend was observed in lint yield kg ha^{-1}, stalk yield kg ha^{-1} and harvest index. Total nutrient content *viz*., nitrogen, phosphorous and potassium in plant and available NPK in soil were observed maximum by means of B_1: Anacardic acid @ 4 mg litre^{-1} at 30, 45 and 60 DAS which was at par with B_2: Anacardic acid @ 4 mg litre^{-1} at 45, 60 and 75 DAS (2068 kg ha^{-1}). Same trend was observed in total nitrogen, total phosphorous and total potassium which were maximum with B_1: Anacardic acid @ 4 mg litre^{-1} at 30, 45 and 60 DAS and superior over B_3: DMSO 100 µl litre^{-1} at 30, 45, 60 and 75 DAS and B_4: Water spray at 30, 45, 60 and 75 DAS. Interaction effect of genotypes and application of different bio stimulant were found to be non-significant in respect of all parameter except yield. Quality parameters *viz*., fibre finess, micronaire value and uniformity index was not significantly influenced by genotype and bio stimulant spray.

Keywords: Bio stimulant, growth, yield, Bt cotton hybrid, varieties

Introduction
Cotton (*Gossypium hirsutum* L.) derived from the Arabic word "quotn", belongs to *Gossypium* genus, which was also derived from the Arabic word "goz", meaning a soft substance. It is unique natural fibre producing most common fibre crop in the world. It is also called "white gold". Cotton fibre is the backbone of textile and other industries and plays a prominent role in the rural, national and international economy. It is grown mainly in tropical and subtropical region of more than 80 countries in the world. It is grown mostly for fibre used in the manufacture of cloths for mankind.

Besides fibre, cotton is also valued for its oil (15-20 percent) which are used as vegetable oil and cotton seed cake. Cotton seed cake used as cattle feed and can also be used as manure which contain 6.4, 2.9 and 2.2 percent N, P and K, respectively also it is likely to play a pivotal role in paper, particle board and cardboard industries, With the advanced technology, short fibre or fuzz or lint can now be used to make excellent grade paper like currency paper, linoleum cellophane, rayons, photographic films, dynamic and moulded plastics. Cotton provides livelihood to more than 60 million people in India by way of support in agriculture, processing, and use of cotton in textile.

India is one of the largest producers of cotton in the world accounting for about 26 percent of the world cotton production. The lint yield kg per hectare which is presently 487 kg ha^{-1} is still lower against the world average yield about 768 kg ha^{-1} which is 36.59 percent higher than India average yield (Anonymous, 2020) [2]. Maharashtra is the leading state in respect of area (41.84 lakh hectare) under cotton cultivation, which shares 32.28 percent of total cotton growing area of the country (129.60 lakh hectare) but ranks second in production (86 lakh bales) (which is 17 percent of the production) next to Gujarat (90.50 lakh bales) and 9th in productivity 319 kg ha^{-1} (ICAC, 2021) [10].

Bio stimulant helps to mitigate the impacts of water stress and benefit crops under water scarce condition. They are unique agrochemicals that, they must be absorbed by the plant tissue and transported to a reaction site before the desired response can be achieved (Du Jardin, 2015) [5]. Mostly they are applied as aqueous spray to a variety of plant surfaces. The total surface area and in particular, its surface chemistry and morphology are key factors in determining bio regulator dose that will be retained and hence available for penetration.

Dimethyl sulfoxide (DMSO) is a colourless, mobile, neutral, high boiling liquid that is miscible with water and with most common organic solvents. First synthesized in 1867. It now is commercially produced by utilizing the methyl groups of liquor from the kraft paper manufacturing process. This work showed that DMSO may aid in the absorption and translocation of herbicides following soil, injection, or foliar applications to maple trees. DMSO addition to soils caused a significant depression in soil pH which appears to be strongly linked to the uptake of Mn and P by bean plants (Norris and Freed, 1993) [12].

Bio stimulants are natural or synthetic substances that can be applied to seeds, plants, and soil. These substances cause changes in vital and structural processes in order to influence plant growth through improved tolerance to abiotic stresses and increase seed grain yield and quality. In addition, bio stimulants reduce the need for fertilizers, in small concentrations, these substances are enhancing nutrition efficiency, abiotic stress tolerance, crop quality traits, regardless efficient, of its nutrients content (Du Jardin. 2015) [5].

Bio stimulants offer a potentially novel approach for the regulation and/or modification of physiological processes in plants to stimulate growth, to mitigate stress induced limitations, and to increase yield. Bio stimulants based on humic substances have been studied in terms of stress protection against salinity due to their bio stimulatory activity (Aydin *et al.* 2012) [3].

The effects of bio stimulants are still not clear. They can act on plant productivity as a direct response of plants or soils to the bio stimulant application or an indirect response of the bio stimulant on the soil and plant micro-biome with subsequent effects on plant productivity (Kumar *et al.* 1976) [11]. Several researches have been developed in order to evaluate the use of bio stimulants in improving plant growth subjected to abiotic stresses. Furthermore, various raw materials have been used in bio stimulant compositions, such as humic acids, hormones, algae extracts, and plant growth-promoting bacteria.

Material and Methods

The present study was conceptualized and executed with the prime objective to study the effect of bio stimulant such as anacardic acid and dimethyl sulfoxide on growth and yield of cotton. The investigation was conducted during *kharif* season of 2021 at Cotton Research Unit, Dr. Panjabrao Deshmukh Krishi Vidhyapeeth, Akola. Number of various biostimulant like anacardic acid and dimethyl sulfoxide are being used on different crops at various concentrations and at different stages of development. The soil of experimental plot was vertisol black cotton soil it was clay (clay 55.12 percent) in texture. Soil was slightly alkaline in reaction. As regard to fertility status, the soil was medium in available Nitrogen, low in available Phosphorus, fairly high in available Potassium, and moderate in organic carbon. Akola is situated in sub-tropical zone about 307.4 m above the mean sea level at the latitude of 22.42 degree North and the longitude of 77.02 degree East. The climate of the area is semi-arid characterized by three distinct seasons *viz*., summer, rainy, winter. The normal mean monthly maximum temperature is 42.6 °C during the hottest month (May) while the normal mean monthly minimum temperature is 10.3 °C in the coldest month (December). The mean daily evaporation reaches as high as 17.3 mm in the month of May and as low as 4.2 mm in the month of August. The mean wind velocity varies from 4.1 km hr^{-1} during October to 16.2 km hr^{-1} during June. Relative humidity attains the maximum value of 88% during the August season and the minimum 30% during May month. The amount of rainfall received during the cropping season was 1085 mm in 54 rainy days. During the crop season, the actual mean bright sunshine hours recorded were 5.3 hr which is 1 hr lesser than the normal mean of 6.3 hr. The highest BSH recorded with 8.9 hr during 43th MW (normal BSH of 8.2 hr during 43th MW) and the lowest with 1.4 hr during the 31st MW (normal BSH of 3.3 hr during 31st MW). The lower BSH facilitated improved the moisture use efficiency by the plant. The mean actual relative humidity during both day and night time was found higher than the mean normal relative humidity.

Treatment details

Factor A: Variety

V_1: PDKV JKAL -116 (BG II)

V_2: AKH 9-5 (Suvarna Shubhra)

Factor B: Biostimulant

B_1: Bio stimulant (Anacardic acid) @ 4 mg $litre^{-1}$ at 30, 45 and 60 DAS (20 mg+5 litre of water + 0.5 ml of DMSO).

B_2: Bio stimulant (Anacardic acid) @ 4 mg $litre^{-1}$ at 45, 60 and 75 DAS (20 mg+5 litre of water + 0.5 ml of DMSO).

B_3: DMSO µl $litre^{-1}$ spray at 30, 45, 60 and 75 DAS (0.5 ml of DMSO + 5 litre of water)

B_4: Control (water spray 30, 45, 60 and 75).

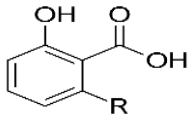
The cotton crop was fertilized with the recommended dose of 60:30:30 NPK kg ha^{-1}. The source of nutrient used was by Urea, Single Super Phosphate (SSP) and Murate of Potash (MOP). Cotton was sprayed with different bio stimulants *viz*., Anacardic acid and Dimethyl sulfoxide using their specific concentrations at different days after sowing to study their effect on growth and productivity of cotton.

Anacardic acid

Anacardic acid is yellow liquid. It is partially miscible with ethanol and ether, but nearly immiscible with water it is found in the shell of cashew nut (*Anacardium occidentale*). Chemically, anacardic acid is a mixture of several closely related organic compounds. Each consists of a salicylic acid substituted with an alkyl chain that has 15 or 17 carbon atom and alkyl group may be saturated or unsaturated. (Rosen 1994).

Chemical Formula: $C_{22}H_{36}O_3$
Molecular Weight: 348.52 g mol^{-1}
Melting Point: 90 °C
Boiling Point: 474 °C

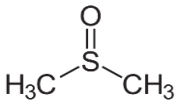
Structural Formula:



Dimethyl sulfoxide

Dimethyl sulfoxide (DMSO) is an organosulfur compound with the formula $(CH_3)_2SO$. This colorless liquid is an important polar aprotic solvent that dissolves both the polar and nonpolar compounds and is miscible in a wide range of organic solvents as well as water. It has a relatively high boiling point. (Thomas 1966) [16].

IUPAC name: (Methanesulfinyl) methane
Chemical Formula: C_2H_6OS
Molar mass: 78.13 g mol^{-1}
Melting Point: 19 °C
Boiling Point: 189 °C
Structural Formula:



Statistically data was analyzed with Factorial Randomized Block Design programmed on computer by adopting standard statistical technique of analysis of variance (Gomez and Gomez, 1984) [8].

Results and Discussion

The plant height, functional leaves, monopodial and sympodial branches, and dry matter $plant^{-1}$ were presented in Table 1.

Effect of Variety

Plant height, functional leaves, monopodial and sympodial branches, and dry matter $plant^{-1}$ was significantly influenced due to different variety at, harvest. However, monopodial branches were found non–significant.

Variety V_1 *i.e* PDKV JKAL – 116 recorded significantly highest plant height, functional leaves, sympodial branches, and dry matter $plant^{-1}plant^{-1}$ *i.e* 143.52,113.13,27.78 and 205.25 at harvest than variety V_2 *i.e* AKH 9-5 (Suvarna Shubhra). Similarly highest monopodial branches 2.53. These may be due the genetic potential of Bt hybrids to develope more number of sympodial branches as compare to improved variety.

Table 1: Plant height, functional leaves, monopodial and sympodial branches and dry matter $plant^{-1}$ (cm) of cotton at harvest as influenced by different treatments

Treatment	Plant height (cm)	Functional leaves $plant^{-1}$	Monopodial Branches $plant^{-1}$	Sympodial Branches $plant^{-1}$	Dry matter (g)
Factor A – (Variety)					
V_1 : PDKV JKAL- 116 (BG-II)	143.52	113.13	2.53	27.78	208.25
V_2 : AKH 9-5 (Suvarna Shubhra)	136.97	108.16	2.49	24.79	200.10
SE(m) ±	1.58	1.14	0.06	0.67	1.97
CD at 5%	4.79	3.47	NS	2.05	5.96
Factor B – (Application of bio stimulant)					
B_1 : Anacardic acid @ 4 mg $litre^{-1}$ at 30,45 and 60 DAS	145.42	118.15	2.64	27.97	211.27
B_2 : Anacardic acid @ 4 mg $litre^{-1}$ 1 at 45, 60 and 75 DAS	143.08	111.10	2.57	26.90	205.25
B_3 : DMSO 100 µl $litre^{-1}$ at 30, 45, 60 and 75 DAS	137.32	109.68	2.47	25.08	203.53
B_4 : Water spray at 30, 45, 60 and 75 DAS	135.15	103.63	2.39	23.97	196.65
SE (m) ±	2.23	1.62	0.08	0.95	2.78
CD 5%	6.77	4.90	NS	2.89	8.43
Interaction (A X B)					
SE (m) ±	3.16	2.29	0.12	1.35	3.93
CD 5%	NS	NS	NS	NS	NS
GM	140.24	110.64	2.51	25.85	204.18

Effect of Bio stimulant

Significantly highest plant height, functional leaves, sympodial branches and dry matter $plant^{-1}$ was recorded in treatment B_1 *i.e* Anacardic acid @ 4 mg $litre^{-1}$ at harvest which was remain at par with treatment B_2 *i.e* Anacardic acid @ 4 mg $litre^{-1}$. Plant growth regulators are known to enhance source-sink relationship and stimulate translocation of photoassimilates. The significant increase in the plant height, functional leaves, sympodial branches and dry matter $plant^{-1}$ was due to spraying of anacardic acid @ 4 mg $litre^{-1}$ might be because of its involvement in seed germination, seedling establishment, This is in agreement with Patel (1993) [13] who

reported that application of NAA (10 ppm) increased plant height in cotton and Gadakh *et al.* (1992) [6]. However, monopodial branches were found non–significant. This might be attributed to increased plant height, which provides site for more number of nodes and internodes from where sympodial branches emerge similarly increased number of sympodial branches were noticed in cotton by several scientist Pothiraj *et al.* (1995) [15] and Gadakh *et al.* (1992) [6]. Higher dry matter accumulation plant^{-1} was recorded in bio stimulant spray B_1 *i.e* Anacardic acid @ 4 mg litre^{-1} at 211.27 at harvest respectively. However it was at par with treatment B_2 *i.e* Anacardic acid @ 4 mg litre^{-1} at 45, 60 and 75 DAS with respect to 120 DAS and at harvest. Treatment B_3 also remain at par with treatment B_1 and B_2 with respect to at harvest and lowest dry matter accumulation plant^{1} was recorded in treatment B_4 *i.e* Water spray.

The plant growth regulators are known to enhance the crop growth by cell division in meristematic region through cell enlargement and cell division and thereby increase in plant height, number of branches and number of functional leaves might have contributed to more amount of photosynthetates to be assimilated which were further stored in plant body resulted in higher dry matter accumulation plant^{-1}. Similar findings were also reported by Govindan *et al.* (2000) [9] and Ahmed *et al.* (2013) [1]. The interaction effect was found to be nonsignificant for all parameters.

Table 2: Seed cotton yield, lint yield, cotton stalk yield, biological yield and harvesting index influenced by various treatments

Treatment	Seed cotton yield (kg ha^{-1})	Lint yield (kg ha^{-1})	Cotton stalk yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest index (%)
Factor A – (Variety)					
V1 : PDKV JKAL- 116 (BG-II)	2275	809	4459	6734	33.78
V2 : AKH 9-5 (Suvarna Shubhra)	1725	612	4259	5945	29.01
SE(m) ±	50	11	109	2400	0.12
CD at 5%	152	33	NS	NS	NS
Factor B – (Application of bio stimulants)					
B1 : Anacardic acid @ 4 mg litre^{-1} at 30,45 and 60 DAS	2256	809	4658	6914	32.62
B2 : Anacardic acid @ 4 mg litre^{-1} at 45, 60 and 75 DAS	2068	729	4434	6502	31.80
B3 : DMSO 100 µl litre^{-1} at 30, 45, 60 and 75 DAS	1962	699	4307	6269	31.29
B4 : Water spray at 30, 45, 60 and 75 DAS	1714	607	3958	5672	30.21
SE (m) ±	71	16	154	3393	0.17
CD 5%	215	48	468	NS	NS
Interaction (A X B)					
SE (m) ±	102	21	218	4799.13	0.23
CD 5%	300	66	NS	NS	NS
GM	2000	711	4339	6339	31

Fect of variety

Post-harvest observations

The data pertaining to seed cotton, lint, cotton stalk, biological yield (kg ha^{-1}) and harvest index as influenced by various treatments.

Effect of Variety

The seed cotton and lint yield (kg ha^{-1}) was significantly highest in genotype V_1 *i.e* PDKV JKAL – 116 (2275 and 809 kg ha^{-1}) fallowed by genotype V_2 *i.e* AKH 9-5 (Suavarna Shubhra) (1725 and 612 kg ha^{-1}). This might be due the more yield potential of Bt cotton hybrids over non Bt variety. The cotton stalk and biological yield and harvest index (%) of cotton did not significantly influenced by different genotypes.

Effect of Bio stimulants

The seed cotton, lint and cotton stalk yield (kg ha^{-1}) was significantly highest *i.e* 2256, 809 and 4658 kg ha^{-1} respectively in treatment B_1 *i.e* Anacardic acid @ 4 mg litre^{-1} at 30, 45 and 60 DAS which was found significantly superior over B_3 *i.e* DMSO 100 µl litre^{-1} at 30, 45, 60 and 75 DAS (1962 kg ha^{-1}) and B_4 *i.e* Water spray at 30, 45, 60 and 75 DAS (1714 kg ha^{-1}). However B_1 *i.e* Anacardic acid @ 4 mg litre^{-1} at 30, 45 and 60 DAS was found at par with B_2 *i.e* Anacardic acid @ 4 mg litre^{-1} at 45, 60 and 75 DAS (2068 kg ha^{-1}). This may be ascribed to the beneficial effect of Anacardic acid and DMSO as a growth regulator on physiology, growth of cotton which is ultimately reflected into increased seed cotton yield as reported by Patel (1992) [14]. It was conclude that with the low concentration of hormone and with more number of spray and vice versa was beneficial all the fibre parameters resulting in higher cotton yield this results were accordance with Yakhin *et al.* (2016) [17]. Spraying of different bio stimulant at different growth stages of crop did not significantly influenced the harvest index of cotton. However highest harvest index (%) was recorded in treatment B_1.

Interaction effect

The data related to interaction effect between genotypes and different bio stimulants on seed cotton yield (kg ha-^{1}) of cotton as influenced by different treatments are presented in Table 3.

Table 3: Interaction effect of different genotypes and bio stimulants on seed cotton yield (kg ha-^{1})

Factor	V1	V2	Mean	Anova	SE (m)±	CD 5%
B1	2627	1885	2256	Genotype	50	152
B2	2376	1761	2068	Bio stimulant	71	215
B3	2182	1741	1962	V x B	102	300
B4	1914	1541	1714			
Mean	2275	1725				

V_1 *i.e* PDKV JKAL – 116 genotype with B_1 *i.e* Anacardic acid @ 4 mg litre^{-1} at 30, 45 and 60 DAS combination recorded maximum seed cotton yield *i.e* 2627 kg ha^{-1} which was remain at par with treatment combination B_2 with V_1. Treatment B_1 *i.e* Anacardic acid @ 4 mg litr litre^{-1} at 30, 45 and 60 DAS registered 24.02% yield increase as compare to control B_4 *i.e* Water spray at 30, 45, 60 and 75 DAS.

In cotton, the seed cotton yield depends on the accumulation of photo assimilates and partitioning of these in different parts of the plant. The seed cotton yield was strongly influenced by the application of different growth regulators indicating the role of these chemicals in increasing the seed cotton yield though their effect on various morpho-physiological and biochemical traits. Similar findings were also reported by Ahmed *et al.* (2013) [1]. V_1 *i.e* PDKV JKAL – 116 genotype with B_1 *i.e* Anacardic acid @ 4 mg litre^{-1} at 30, 45 and 60 DAS combination recorded maximum lint yield *i.e* 945 kg ha^{-1} which was found significantly superior over other genotypes and bio stimulants spray. Cotton stalk and biological yield (kg ha^{-1}) was not significantly influenced due to interaction between genotypes and different bio stimulant spray at all the stages of crop growth.

Effect of variety

Micronaire value (µg in^{-1}) and fibre uniformity (%) of cotton did not significantly influenced by different genotypes as the micronaire value is genetic character. However, the fibre length was significantly more in genotype V_1 i.e PDKV JKAL – 116 *i.e* 30.33 mm than genotype V_2 *i.e* AKH 9-5 (Suavarna Shubhra) *i.e* 27.75 mm this is may be due to the varietal characters.

Effect of Bio stimulant

Spraying of different bio stimulant at different growth stages of crop did not significantly influenced the micronaire value (µg inch^{-1}), fibre length (mm) fibre uniformity (%) and of cotton however highest value recorded with treatment B_1. Interaction effect between genotype and different bio stimulant spray were not significant.

Table 4: Micronaire value (µg/inch), fibre length (mm) and uniformity index (%) of cotton as influenced by different treatments

Treatment	Micronaire value (µg/inch)	Fibre length (mm)	Uniformity index (%)
Factor A – (Variety)			
V_1 : PDKV JKAL- 116 (BG-II)	4.01	30.33	82.58
V_2 : AKH 9-5 (Suvarna Shubhra)	4.19	27.75	82.75
SE(m) ±	0.07	0.17	0.30
CD at 5%	NS	0.52	NS
Factor B – (Application of bio stimulants)			
B_1 : Anacardic acid @ 4 mg litre^{-1} at 30, 45 and 60 DAS	4.18	29.32	83.00
B_2 : Anacardic acid @ 4 mg litre^{-1} at 45, 60 and 75 DAS	4.02	28.63	82.50
B_3 : DMSO 100 µl litre^{-1} at 30, 45, 60 and 75 DAS	4.18	28.98	82.50
B_4 : Water spray at 30, 45, 60 and 75 DAS	4.03	29.22	82.67
SE (m) ±	0.10	0.24	0.42
CD 5%	NS	NS	NS
Interaction (A X B)			
SE (m) ±	0.14	0.34	0.60
CD 5%	NS	NS	NS
GM	4.10	29.04	82.67

Chemical studies

Nutrient Uptake by crop

The data regarding uptake of Nitrogen, phosphorous and potassium by cotton plant influence due to various treatment of genotypes and bio stimulant are presented in table 5 total were 68.23, 16.01 and 50.43 kg ha^{-1} respectively.

Table 5: NPK (kg ha^{-1}) uptake by cotton crop as influenced by different treatment

Treatment	Toal uptake by cotton crop (kg ha^{-1})		
	N	P	K
Factor A – (Variety)			
V_1 : PDKV JKAL- 116 (BG-II)	76.45	18.24	53.17
V_2 : AKH 9-5 (Suvarna Shubhra)	60.02	13.82	47.69
SE(m) ±	1.85	0.36	1.09
CD at 5%	5.61	1.08	3.29
Factor B – (Application of bio stimulants)			
B_1 : Anacardic acid @ 4 mg litre^{-1} at 30,45 and 60 DAS	78.86	18.77	56.26
B_2 : Anacardic acid @ 4 mg litre^{-1} at 45, 60 and 75 DAS	71.11	16.48	52.42
B_3 : DMSO 100 µl/ litre^{-1} at 30, 45, 60 and 75 DAS	65.85	15.48	49.08
B_4 : Water spray at 30, 45, 60 and 75 DAS	57.11	13.39	43.97
SE (m) ±	2.62	0.50	1.53
CD 5%	7.93	1.53	4.66
Interaction (A X B)			
SE (m) ±	3.70	0.71	2.17
CD 5%	NS	NS	NS
GM	68.23	16.01	50.43

Effect of variety

Uptake of nitrogen, phosphorous and potassium by seed and stalk of cotton crop significantly influenced by different genotypes. Maximum uptake was found with genotype V1 *i.e* PDKV JKAL – 116 in both seed and stalk as compared to genotype V2 *i.e* AKH 9-5 (Suavarna Shubhra).

Effect of bio stimulant

Spray of different bio stimulant significantly influenced uptake of nitrogen, phosphorous and potassium by cotton crop. Significantly higher uptake of nitrogen, phosphorous and potassium by seed, stalk was found highest with treatment B_1 *i.e* Anacardic acid @ 4 mg litre^{-1} at 30, 45 and 60 DAS which was at par with B_2 *i.e* Anacardic acid @ 4 mg litre^{-1} at 45, 60 and 75 DAS and lowest uptake was found with control treatment B_4 *i.e* Water spray at 30, 45, 60 and 75 DAS. Total uptake nitrogen, phosphorous and potassium was also found in highest (61.70, 18.77 and 56.26 kg ha^{-1}) in treatment B_1 i.e Anacardic acid @ 4 mg litre^{-1} at 30, 45 and 60 DAS over all other treatment.

Uptake of nutrients, although a function of soil moisture condition, spraying of various plant growth regulator helps in augmenting the auxin supply from the leaves and consequently developing better system inside the plant for nutrient uptake Goldsworthy and Fisher (1984) suggested that the ability of crop to take up and store nitrogen in early stages of crop growth and subsequently to remobilize it for boll growth may be as important as photosynthesis in determining carrying capacity of crop. The interaction effect between the genotypes and different bio stimulant remained to be non-significant NPK uptake in plant.

Available N, P, K.

The data regarding Available N, P, K. of soil influence due to various treatments of genotypes and bio stimulant are presented in table 6

Effect of variety

The soil available nitrogen, phosphorous and potassium was influenced significantly due to different genotypes among the two genotypes V_1 *i.e* PDKV JKAL – 116) (184.53 kg ha$^{-1)}$ recorded higher available N (184.53 kg ha^{-1}) P (22.91 kg ha$^{-1)}$ and K (345.75) than V_2 *i.e* AKH 9-5 (Suavarna Shubhra) N (182.09 kg ha^{-1}) P (20.46 kg ha$^{-1)}$ and K (340.84). Application of recommended dose of nutrients fulfil the nutritional requirement of crop and excess nutrients were contributed in increase the soil available nutrients.

Effect of bio stimulant

Soil available nitrogen, phosphorus and potassium after harvest of crop were influenced significantly due to spray of different bio stimulant. Significantly more N (185.60 kg ha^{-1}) P (23.13) and K (347.14) remained in soil recorded in B_1 *i.e* Anacardic acid @ 4 mg litre^{-1} at 30, 45 and 60 DAS. However, the lowest available N (174.71kg ha^{-1}), P (18.67 kg ha^{-1}) and K (338.90 kg ha^{-1}) was recorded in B_4 *i.e* Water spray at 30, 45, 60 and 75 DAS. This might be due to the beneficial effect of plant growth regulator spray towards physiological crop growth of plant which ultimately increase nutrient requirement and capacity for uptake of NPK and decrease the left over NPK in soil. Similar results were also reported by Basole *et al*. (2003) [4]. The interaction effect between the genotypes and different bio stimulant with respect to Available N, P, K was found to be non-significant.

Table 6: Available N (kg ha^{-1}), P (kg ha^{-1}) and K (kg ha^{-1}) at harvest influenced by different treatment

Treatment	Nutrient status of soil (kg ha^{-1})		
	Available N	Available p	Available K
Factor A – (Variety)			
V_1 : PDKV JKAL- 116 (BG-II)	184.53	22.91	345.75
V_2 : AKH 9-5 (Suvarna Shubhra)	182.09	20.46	340.84
SE(m) ±	0.58	0.27	1.32
CD at 5%	1.76	0.84	4.02
Factor B – (Application of bio stimulants)			
B_1 : Anacardic acid @ 4 mg litre^{-1} at 30,45 and 60 DAS	185.60	23.13	347.14
B_2 : Anacardic acid @ 4 mg litre^{-1} at 45, 60 and 75 DAS	181.99	21.89	344.29
B_3 : DMSO 100 µl litre^{-1} at 30, 45, 60 and 75 DAS	178.95	19.05	343.85
B_4 : Water spray at 30, 45, 60 and 75 DAS	174.71	18.67	338.90
SE (m) ±	0.82	0.38	1.87
CD 5%	2.49	1.02	5.68
Interaction (A X B)			
SE (m) ±	1.16	0.54	2.65
CD 5%	NS	NS	NS
GM	181.31	21.01	343.46

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