1087 Growth regulators for enhancing seed cotton yield, yield components and fibre quality in american cotton (gossypium hirsutum l.)

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Biovita is an extract from a seaweed *Ascophyllum nodosum*-a marine plant that has been recognized as an excellent natural fertilizer and a rich source of organic matter. It is reported to help in enhancing the bolls retention and thus increased the yield. The objective of the study was to confirm whether the Biovita has any impact on seed cotton yield, yield components and fibre quality in American cotton (*Gossypium hirsutum* L.). The experiment comprising the following ten treatments was conducted at Punjab Agricultural University, Regional Station, Abohar, India during summers of 2005 and 2006: $T_{1:}$ A+B+C+D+E; T_2: A+C+D+E; T_3: A+D+E; T_4: A+E; $T_{5:}$ A; $T_{6:}$ B+C+D+E; $T_{7:}$ C+D+E; $T_{8:}$ D+E; $T_{9:}$ E; $T_{10:}$ Control (No Biovita application, only recommended dose of fertilizers); where A denotes the granules application of Biovita @ 20 kg ha^{-1} at the time of sowing; B indicates the foliar application of liquid Biovita @ 500 ml ha^{-1} at square formation; C is the foliar application of liquid Biovita @ 625 ml/ha at flowering; D is the foliar application of liquid Biovita @ 750 ml ha^{-1} a at boll formation; and E indicates the foliar application of liquid Biovita @ 750 ml ha^{-1} a at boll development stage. The approved cultivar LH1556 was planted in a randomized complete block design with four replicatoions. Each treatment was accommodated in a four rows plot of 6m long. All the recommended crop production and protection practices were followed to raise a good healthy crop. The observations were recorded on number of bolls per plant, boll weight (g), ginning out turn (%), seed index (g), seed cotton yield (kg ha^{-1}) and lint yield (kg ha^{-1}) were recorded on plot basis. The lint samples were analyzed for 2.5% span length (mm), uniformity ratio, micronaire, and fibre strength (g tex^{-1}). On the basis of mean data of two years (2005 & 2006), it was observed that the T_4 treatment was the most effective in increasing the seed cotton yield, lint yield, boll weight and number of bolls per plant in comparison to control where no application of Biovita was given. Regarding the fibre quality, the application of Biovita did not have much significant impact on ginning out turn, fibre length, fibre strength and fineness. However, it improved the uniformity ratio of the fibre from 46 in control to 51 in T_4, T_8 and T_9. The net benefit to the farmers by the use of Biovita is Rs. 5612 ha^{-1}.

Cotton is the most important fibre crop of India grown both under irrigated and rain-fed conditions and has played a vital role in the agriculture based Indian economy. India is the third largest cotton producer in the world, occupying about 9 million hectares with a production of about 24.3 million bales in 2005-06. It accounts for 25 percent of world's total cotton area and 12 percent of global cotton production. However, the productivity of 448 kg ha^{-1} is still far lower than the world average of 718 kg ha^{-1}. The average yields in India are the lowest among the top 10 global cotton producers. There is a need to improve the yield and fibre quality of cotton. Various factors responsible for low productivity are non availability of quality seed of approved cultivars, unbalanced use of fertilizers, and deficiency of certain important micronutrients. Besides, shedding of reproductive parts like squares and young bolls are the common problems in cotton, which results in lower cotton yields. The use of certain growth regulators and micro-nutrients was found to be beneficial in increasing the seed yield and quality in cotton (Anon. 1995).

Apart from major nutrients, the essential micronutrients like Boron and Magnesium play a vital role in certain physiological activities such as respiration, meristematic development, chlorophyll formation, photosynthesis, oil synthesis, gossypol and phenoloic compounds developments in cotton. Foliar applications of micronutrients have been widely studied (Karev, 1980, Khuzhanazarov *et al*. 1983 and Eshanna *et a*l. 2004.

Biovita is an extract from a seaweed *Ascophyllum nodosum*-a marine plant that has been recognized as an excellent natural fertilizer and a rich source of organic matter. The manufacturer of Biovita M/S *PI Industries Ltd.,* Udaipur claims that the application of Biovita enables plants to receive direct benefits from the naturally balanced nutrients and plant growth substances available in this seaweed extract. It is one of the most preferred products in its class as non-polluting, non-toxic natural bio-product. It provides over 60 naturally occurring major and minor nutrients and plant development substances comprising of enzymes, proteins, cytokinins, amioacids, vitamins, gibberlins, auxins, betains *etc*. in organic form. It contributes to greater microbial activity when applied to soil thus increasing nutrient availability. It is an ideal organic product for better growth and productivity. Moreover, it is compatible with insecticides, fungicides, and fertilizers, which can be used in combination, without additional cost of application. It is non corrosive and can be applied with any standard equipment. It has longer shelf life under normal room storage conditions. It can be applied at all stages of the plant growth from seeding to fruiting. The repeated use of Biovita contributes towards better root system, excellent appearance of plants and greater yield potential. It enhances resistance of the plants to pests and diseases and environmental and moisture stress conditions. Keeping in view the above said properties of Biovita, attempts were made in the present investigation to study the effect of Biovita on growth, seed cotton yield, yield components, and fibre quality in American cotton (*G. hirsutum* L.).

MATERIALS AND METHODS

The study was conducted at Punjab Agricultural University, Regional Station, Abohar in the summers of 2005 and 2006. The local approved open pollinated cultivar LH 1556 was selected for this study. The variety LH1556 is a short duration, early maturing variety of upland cotton having a semi-sympodial growth habit, medium sized green leaves, round bolls with good fluffy opening. It has a 2.5% span length of about 27.7 mm and is suitable for spinning at 40 counts with a ginning per cent of about 34. The sowing was done on May 12 in 2005 and May 14 in 2006 in a randomized complete block design using four replications. The experiment comprised of the following ten treatments: $T_{1:}$ A+B+C+D+E; T2: A+C+D+E; T3: A+D+E; T4: A+E; $T_{5:}$ A; $T_{6:}$ B+C+D+E; $T_{7:}$ C+D+E; $T_{8:}$ D+E; $T_{9:}$ E; $T_{10:}$ Control (No Biovita application, only recommended dose of fertilizers); where A denotes the granules application of Biovita @ 20 kg ha^{-1} at the time of sowing; B indicates the foliar application of liquid Biovita @ 500 ml ha^{-1} at square formation; C is the foliar application of liquid Biovita @ 625 ml/ha at flowering; D is the foliar application of liquid Biovita @ 750 ml ha^{-1} at boll formation; and E indicates the foliar application of liquid Biovita @ 750 ml ha^{-1} at boll development stage. Each treatment was accommodated in a four rows plot of 6 m. Rows were kept apart at 67.5 cm while plant to plant distance was maintained at 60 cm. All recommended crop production and protection practices were followed to raise a good healthy crop. The fertilizers @ 75 kg Nitrogen and 30 kg P_2O_5 were applied to the crop. Five competitive plants were taken at random from each treatment and replication for recording observations on number of bolls per plant, boll weight (g), ginning out turn (%), and seed index (g). Seed cotton yield (kg ha^{-1}) and lint yield (kg ha^{-1}) were recorded on plot basis.

The lint samples were analyzed for fibre properties such as 2.5% span length (mm), fibre strength (g tex^{-1}), uniformity ratio and micronaire. Means of five plants over replications were used for estimating various statistical parameters.

RESULTS AND DISCUSSION

Modifying cotton growth has become an essential component of cotton production, whether by making adjustments in fertility, water management or use of harvest aids. The key to modifying plant growth is knowing what the plant needs at each stage of development to reach the final goal of higher yield and quality. The next step is to do everything possible to provide for these needs. Applying plant growth regulators to modify early and mid-season growth is similar to other management practices. Plant growth regulators have the potential to promote crop earliness, square and boll retention, higher nutrient uptake, and keeping vegetative and reproductive growth in harmony to improve lint yield and quality (Robertson and Cothren. 1993 and Oosterhuis and Zhao 1993)

Effect on seed cotton and lint yield: In our 2005 experiment, the application of Biovita results in significantly higher seed cotton yield (2097 kg ha^{-1}) in treatment T_4, which involves granular application of Biovita @ 20 kg ha^{-1} at the time of sowing accompanied by foliar application of liquid Biovita @ 750 ml ha^{-1} at boll development stage, in comparison to control (1823 kg ha^{-1}) where no Biovita treatment was given (Table 1). The treatment T_2 (granular application of Biovita @ 20 kg ha^{-1} at the time of sowing and foliar application of liquid Biovita @ 625 ml ha^{-1} at flowering; @ 750 ml ha^{-1} at boll formation; and @ 750 ml ha^{-1} at boll development stage) also significantly enhanced the seed cotton yield (2017 kg ha^{-1}) as compared to control (T_{10}). Significantly higher seed cotton yield (2023 kg ha^{-1}) as compared to control T10 (1823 kg ha^{-1}) was also obtained in T_8, where only foliar applications of liquid biovia were given @ 625 ml ha^{-1} at flowering; @ 750 ml ha^{-1} at boll formation; and @ 750 ml ha^{-1} at boll development stage. The lint yield (926 kg ha^{-1}) and seed index were also higher in T_8 as compared to control T_{10}. The treatments T_1 and T_5 also had significantly higher seed cotton yield than the control (Table 1). Similar trend was observed for lint yield (Table 1).

In 2006 experiment also, the application of Biovita significantly increased the seed cotton yield (2691 kg ha^{-1}) in T3 (granular application @ 20 kg ha^{-1} at the time of sowing followed by foliar application of liquid Biovita @ 750 ml ha^{-1} at boll formation and boll development stage) and T_4 (2649 kg ha^{-1}) which involved the granular application @ 20 kg ha^{-1} at the time of sowing followed by foliar application of liquid Biovita @ 750 ml ha^{-1} at boll development stage only as compared to control (2263 kg ha^{-1}). The differences among T_3 and T_4 for seed cotton yield were not significant. Similar trend was observed for lint yield (Table 1).

Yield components: In 2005**,** number of bolls per plant were significantly higher in treatment T_2 (40) as compared to control (34). The treatments T_3 and T_4 also had considerably higher number of bolls (38) than control. The application of Biovita did not have any significant impact on boll weight and seed index in 2005. Similarly, in 2006, number of bolls per plant and boll weight improved significantly in treatment T_4 (Table 1). Number of bolls and boll weight were also high in T_3. The effect of Biovita on seed index was non-significant in 2006 also.

Fibre quality: With regards to the fibre quality, the application of Biovita did not have much significant impact on ginning out turn, fibre length, fibre strength and fineness. However, it improved the uniformity ratio of the fibre from 45.5 in control to 50 in T_4 and T7 (Table 2).

On the basis of mean data of two years (2005 & 2006), it was observed that the T4 treatment was most effective in increasing the seed cotton yield (2373 kg ha^{-1}), lint yield (939 kg ha^{-1}), boll weight (3.51 g) and number of bolls per plant (41.08) in comparison to control where no application of Biovita was given (Table 1). Mondino *et al.* (2004) reported that due to an increase in the boll weight and boll number per plant, the yield of Cycocel 75 treated plots increased by an average of 35% in comparison with the control in American cotton. Regarding fibre quality, application of Biovita did not have much impact on ginning out turn, fibre length, strength, and micronaire. It improved the uniformity ratio of the fibre (Table 2). Contrarily, Mondino *et al*. 2004 reported that Cycocel 75 improved the fibre strength significantly, although other parameters of fibre quality, such as length, uniformity, elongation, and micronaire index were not affected.

Cost-benefit ratio: Before suggesting any extra growth regulators or bio-fertlizers to the cotton growers, it is important to calculate its advantages (economic benefits) in relation to its cost. According to the manufacturer, *PI Industries Ltd*., the granules of Biovita costs Rs. 25 kg^{-1}, while the liquid Biovita costs Rs. 330 $litre^{-1}$. Therefore, one granular application @ 20 kg ha^{-1} and one foliar application @ 750 ml ha^{-1} at boll development stage costs Rs.748. If the costs of spraying (Rs 100 per spray ha^{-1}) is also included, the total costs for T_4 treatment is Rs. 948 ha^{-1}. The gain in seed cotton is 330 kg ha^{-1}. Thus, the benefit from the seed cotton yield @ Rs. 2000 qtl^{-1} is Rs. 6660. Therefore, the net benefit to the farmers by the use of Biovita is Rs. 5612 (Table 3).

CONCLUSIONS

The results of our study suggest that the application of granular Biovita @ 20 kg ha^{-1} followed by foliar application of liquid Biovita @ 750 ml ha^{-1} at boll development stage only are effective for enhancing seed cotton yield, boll number and boll weight. However, the application of Biovita did not have any impact on fibre quality parameters.

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Table 1. Effect of Biovita on seed cotton yield and yield components in cotton during summer of 2005 and 2006.

Treatment	Seed cotton yield (kg ha^{-1})			Lint yield (kg ha^{-1})			Ginning out turn (%)			Seed index (g)			Boll weight (g)			Number of bolls per plant		
	2005	**2006**	**Mean**	**2005**	**2006**	**Mean**	**2005**	**2006**	**Mean**	**2005**	**2006**	**Mean**	**2005**	**2006**	**Mean**	**2005**	**2006**	**Mean**
T_1	1920	2454	2187	878	833	856	35.83	34.03	34.93	7.25	9.12	8.19	3.35	3.46	3.41	38.0	41.90	39.95
T_2	2017	2503	2261	922	892	907	35.60	35.64	35.62	7.25	8.57	7.91	3.49	3.44	3.47	40.2	34.95	37.58
T_3	1846	2691	2269	844	948	896	34.95	35.23	35.09	7.25	9.19	8.22	3.34	3.65	3.50	38.2	39.10	38.65
T_4	2097	2648	2373	959	918	939	34.23	34.70	34.47	7.75	8.71	8.23	3.54	3.48	3.51	38.4	43.75	41.08
T_5	1983	2471	2227	906	834	871	35.85	33.70	34.78	7.25	8.86	8.06	3.46	3.50	3.48	36.4	35.75	36.08
T_6	1874	2378	2127	857	863	860	34.85	34.62	34.74	8.00	9.02	8.51	3.44	3.46	3.45	36.4	32.85	34.63
T_7	1851	2314	2083	846	791	819	36.25	34.20	35.23	7.75	8.79	8.27	3.54	3.38	3.46	31.0	30.80	30.90
T_8	2023	2322	2173	925	811	868	34.58	34.98	34.78	8.00	9.01	8.51	3.37	3.50	3.44	37.4	33.85	35.63
T_9	1874	2061	1968	857	733	795	35.85	35.59	35.72	7.50	8.66	8.08	3.46	3.31	3.39	33.6	31.70	32.65
T_{10}	1823	2263	2043	833	829	831	35.45	35.33	35.39	7.50	8.44	7.97	3.33	3.32	3.33	34.4	36.10	35.25
CD 5%	**96.3**	**299.6**	-	**44.0**	**127.6**	-	**0.99**	**2.19**	-	**NS**	**NS**	-	**NS**	**0.17**	-	**3.22**	**4.75**	-
CV %	**3.44**	**8.68**	-	**4.05**	**10.4**	-	**1.95**	**4.34**	-	**5.92**	**4.85**	-	**5.45**	**3.40**	-	**7.85**	**9.07**	-

Table 2. Effect of Biovita on fibre quality in cotton during summer of 2005 and 2006

Treatment	2.5% span length (mm)			Uniformity ratio			Micro-naire			Fibre strength 3.2 mm (g/tex)		
	2005	2006	Mean	2005	2006	Mean	2005	2006	Mean	2005	2006	Mean
T_1	26.8	29.1	27.9	48	47	47.5	4.2	4.4	4.3	22.0	23.7	22.8
T_2	26.1	27.9	27.0	48	46	47.0	4.4	4.0	4.2	21.2	23.4	22.3
T_3	27.0	29.3	28.1	50	48	49.0	4.3	4.1	4.2	22.0	22.7	22.3
T_4	26.5	29.0	27.7	51	49	50.0	4.4	4.4	4.4	22.1	22.7	22.4
T_5	26.7	28.3	27.5	49	48	48.5	4.4	4.2	4.3	22.5	24.1	23.3
T_6	26.9	30.0	28.4	49	49	49.0	4.3	4.1	4.2	22.9	21.5	22.2
T_7	27.0	29.2	28.1	50	51	50.5	4.5	4.1	4.3	21.0	22.8	21.9
T_8	27.3	28.9	28.1	51	47	49.0	4.3	4.0	4.1	21.4	23.6	22.5
T_9	27.0	28.6	27.8	51	48	49.5	4.4	4.0	4.2	22.2	23.9	23.0
T_{10}	27.4	30.0	28.7	46	45	45.5	4.3	4.1	4.2	23.4	22.0	22.7

Table 3. Estimate of cost benefit ratio with regards to application of Biovita in cotton

Cost of granular application @ 20 kg ha^{-1}	Rs. 500.00
Cost of liquid Biovita @ 750 ml h^{-1}	Rs. 248.00
Cost of spraying/ha (including labour, diesel etc.)	Rs. 200.00
Total cost	Rs. 948.00
Increase in seed cotton yield	333 kg
Income from enhanced seed cotton @ Rs 2000 $qtl.^{-1}$	Rs. 6600/
Net benefit ha^{-1}	Rs. 5612