

Original Research Article

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Evaluation of Efficacy of *Azotobacter* (AZOMAX) and VAM (ECOMAX-G) on Cotton Yield Attributing Characters

N. K. Patke^{1*}, R. S. Wankhade¹, A. A. Choudhary² and Sonal Nage¹

¹Agriculture Research Station, Dr. Panjabrao Deshmukh, Krishi Vidyapeeth,
Achalpur- 444806, Maharashtra, India

²College of Agriculture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Nagpur, India

*Corresponding author

ABSTRACT

A field experiment was carried out to study the efficacy of *Azotobacter* (AZOMAX) and VAM (ECOMAX-G) on Cotton yield and yield attributing characters at Agriculture Research Station, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Achalpur, Maharashtra during *kharif* season of the year 2018-19 and 2019-20. A set of five treatments consist of *Azotobacter* (AZOMAX) as seed treatment @ 10g per acre seed quantity + 100% of recommended "NPK", *Azotobacter* (AZOMAX) as seed treatment @ 10g per acre seed quantity + 100% of recommended "PK" & 75% of recommended "N", VAM (ECOMAX-G) @ 2.0 kg per acre + 100% of recommended "NPK", VAM (ECOMAX-G) @ 2.0 kg per acre + 100% of recommended "NK" & 60% recommended "P" and untreated (100 % of recommended "NPK") were taken under Randomized Block Design with three replication. The experimental results revealed that among the various treatments, application of *Azotobacter* (AZOMAX) or VAM (ECOMAX-G) along with 100% recommended dose of "NPK", produced significantly higher seed cotton yield compared to 100% recommended "NPK" alone. It is also revealed that 25% Nitrogen or 40% Phosphorus fertilizers dose could be saved through use of these biofertilizers without impact on yield and would be more beneficial to the farmers. However, the yield levels under reduced dose of fertilizer along with biofertilizer were at par with 100% recommended dose of "NPK".

Keywords

VAM, AZOMAX,
ECOMAX-G,
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Introduction

Gossypium hirsutum L. (cotton-white gold) is the king of fibers which provides the basic material for the clothing of man. Cotton plays a dominant role in India's agrarian and industrial economy. With the introduction of Bt cotton, this crop grow in fields with marginal and submarginal fertility levels

under dry land farming system in our country. Usually little or no chemical fertilizer is added to this crop and hence characterized by low yield (Koranne, 1996). Hence, there is a need to study the possible ways of improving the yields of this crop.

In this context, *Azotobacter* sp. a well known PGPR (Plant growth-promoting rhizobacteria)

has been observed to improve plant growth by production of IAA and fixation of atmospheric nitrogen (Jackson *et al.* 1964, Barea and Brown 1974, Anjum *et al.*, 2007). Plants inoculated with *Azotobacter* sp. has shown improved seed germination, increase in shoot, root biomass and yield. The beneficial effects have been observed in wheat, rice, maize, millets, mustard, sunflower, cotton and vegetable crops (Malik *et al.*, 2005, Malik *et al.*, 2009, Paul and Paul 2009). The application of Biofertilizer like *Azotobacter* can fix atmospheric nitrogen which is very much essential for plants growth and yield.

Vesicular-Arbuscular mycorrhizal (VAM) fungi commonly occur in the roots of agricultural crops. The positive effect of VAM fungi on plant growth is through improved nutrients and water uptake by root and increased defenses against soil pathogens (Marulanda *et al.*, 2003). Vesicular-Arbuscular Mycorrhizae (VAM) fungi provides significant amount of nutrients to the plants such as copper, zinc, phosphorus and sulphur by making their widely extended hyphal network on the upper or lower side of the soil layer. Favourable response of vesicular-arbuscular mycorrhizae (VAM) have been noticed by many workers (Tilak and Singh, 1994). VAM fungi (Vesicular-Arbuscular Mycorrhizae) is the most important supplement for the increasing high cost of NPK fertilizer input, into cropping system without substantial loss in yield (Vijayakumar *et al.*, 2000; Tripathi *et al.*, 2005). Because VAM fungi reported to be involved in improvement of plant growth and enhancing accumulation of plant nutrients (mainly phosphorus, zinc, copper and sulphur) through greater soil exploration by mycorrhizal hyphae (Kumar *et al.*, 2001). The use of these biofertilizers may open the new vistas of phosphorus nutrition.

Hence, an experiment was conducted to study the efficacy of *Azotobacter* (AZOMAX-Atmospheric nitrogen fixing bacteria) and VAM (ECOMAX-G) biofertilizer on cotton yield and yield attributing characters.

Materials and Methods

An agronomic experiment was carried out at Agriculture Research Station, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Achalpur, Maharashtra during *kharif* season of the year 2018-19 and 2019-20. The cotton crop (var. PKV Hy II BG 2) was sown at 90 x 45 cm spacing in a gross plot size of 5.4 x 5.4 m with a seed rate of 2 to 2.5 kg ha⁻¹. The crop was raised using RDF @ 120:60:60 kg N:P:K ha⁻¹. The treatments were allotted in field follow the random methods. A set of five treatments consist of *Azotobacter* (AZOMAX) as seed treatment @ 10g per acre seed quantity + 100% of recommended "NPK", *Azotobacter* (AZOMAX) as seed treatment @ 10g per acre seed quantity + 100% of recommended "PK"& 75% of recommended "N", VAM (ECOMAX-G) @ 2.0 kg per acre + 100% of recommended "NPK", VAM (ECOMAX-G) @ 2.0 kg per acre + 100% of recommended "NK"& 60% recommended "P" and untreated (100 % of recommended "NPK") were taken under Randomized Block Design with three replication. The biofertilizer *Azotobacter* (AZOMAX) was applied as seed treatment before sowing@10g acre⁻¹ seed quantity whereas VAM (ECOMAX-G) was applied as soil application before sowing and mixed thoroughly in the soil @ 2.0 kg acre⁻¹. Observation on germination percentage, plant height, number of monopodial branches plant⁻¹, number of sympodial branches plant⁻¹, number of bolls plant⁻¹ and seed cotton yield were recorded treatment wise. After boll busting, cotton was picked in two pickings from each net plot and converted into ha⁻¹ yield. The impact on seed germination was

accessed by actually counting the number of seeds germinated from each net plot, impact on fertilizer and yield was analyzed by comparing the seed cotton yields obtained under different treatments. Data obtained during the course of investigation were subjected to statistical analysis by statistical method as suggested by Panse and Sukhatme (1954) in RBD and pooled analysis over two years data were calculated and conclusions were drawn.

Results and Discussion

Impact on germination

Data on seed germination are presented in Table 1. Various biofertilizers, in combination with different fertilizer levels did not influence the germination of cotton crop in both the years.

Impact on growth attributes

Pooled means over two years revealed that application of *Azotobacter* (AZOMAX) as seed treatment + 100% recommended “NPK” recorded the significantly higher plant height (127.27 cm) in cotton. However, it remained at par with other biofertilizer treatment and proved significantly superior over untreated control.

Soil application of VAM (ECOMAX-G) at sowing + 100% “NPK” recorded the highest number of monopodia plant⁻¹ (3.35) and proved significantly superior over other treatments in pooled means over two years.

Pooled Means over two years resulted that soil application of VAM (ECOMAX-G) at sowing + 100% “NPK” recorded the highest number of sympodia plant⁻¹ (21.60), however, it remained at par with seed treatment with *Azotobacter* (AZOMAX) + 100% “NPK” and proved significantly superior over other treatments.

No. of bolls plant⁻¹ (32.87) were also recorded significantly higher with soil application of VAM (ECOMAX-G) at sowing + 100% “NPK”, however, it remained at par with seed treatment with *Azotobacter* (AZOMAX) + 100% “NPK” and proved significantly superior over other treatments in pooled means.

Such improvement in plant growth of fibre crops due to *Azotobacter* sp. inoculation in cotton has been reported earlier also (Anjum *et al.*, 2007). *Azotobacter* is known to improve growth of plant through production of IAA and biologically fixed nitrogen (Hafeez *et al.*, 2004).

Sridevi and Ramakrishnan, 2010 reported similar result in cotton growth attributes like plant height under increased 100 per cent NPK with VAM fungi inoculated plants.

There was significant improvement in plant height, number of flowers and bolls formed, boll weight and seed cotton yield in most of the treatments as compared to uninoculated control reported by Sangeeta Paul *et al.*, 2011 in cotton.

Impact on yield

Pooled means over two years showed that highest seed cotton yield (2212 kg ha⁻¹) was recorded with soil application of VAM (ECOMAX-G) at sowing + 100% “NPK” (T₃), followed by *Azotobacter* (AZOMAX) as seed treatment + 100% of “NPK” (2104 kg ha⁻¹, T₁) and soil application of VAM (ECOMAX-G) at sowing + 100% “NK” & 60% “P” (2016 kg ha⁻¹, T₄).

However, all these yield levels were statistically at par with each other. Untreated control (100% recommended “NPK” only, T₅) recorded the significantly lowest seed cotton yield (1740 kg ha⁻¹).

Table.1 Evaluation of Efficacy of *Azotobacter* (AZOMAX) and VAM (ECOMAX-G) biofertilizer on growth and seed yield of Cotton

TrNo	Treatments	Germination percentage			Plant Height (cm)			No. of Monopodia plant ⁻¹			No. of Sympodia Plant ⁻¹			No. of bolls Plant ⁻¹			Seed Cotton Yield (kg/ha)		
		2018-19	2019-20	Pooled	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled
T ₁	<i>Azotobacter</i> (AZOMAX) as seed treatment @ 10g per acre seed quantity+ 100% of recommended “NPK”.	96.0	95.43	95.73	128	126.67	127.27	3.13	3.20	3.17	21.6	18.33	19.97	32.8	28.00	30.40	2140	2067	2104
T ₂	<i>Azotobacter</i> (AZOMAX) as seed treatment @ 10g per acre seed quantity + 100% of recommended “PK”& 75% of recommended “N”	95.5	96.59	96.03	122	115.00	118.37	3.20	2.53	2.87	19.5	14.33	16.93	29.5	24.67	27.10	1928	1906	1917
T ₃	VAM (ECOMAX-G) @ 2.0 kg per acre + 100% of recommended “NPK”	94.4	94.25	94.35	125	125.33	125.33	3.33	3.37	3.35	23.5	19.67	21.60	35.4	30.33	32.87	2236	2189	2212
T ₄	VAM (ECOMAX-G) @ 2.0 kg per acre + 100% of recommended “NK”& 60% recommended “P”	97.6	94.23	95.91	117	117.33	117.20	3.47	2.73	3.10	19.9	17.00	18.47	31.2	26.00	28.60	2061	1970	2016
T ₅	Untreated (100 % of recommended “NPK”)	93.4	95.45	94.43	111	105.00	107.77	2.93	2.60	2.77	16.7	14.00	15.33	24.4	22.33	23.37	1778	1700	1740
	SE(m) +/-	1.5	2.07	1.78	3.93	4.11	3.60	0.13	0.16	0.07	0.44	1.23	1.01	1.7	1.30	1.60	91	88	84
	CD at 5%	N. S.	N. S.	N. S.	15.41	12.47	10.93	0.51	0.49	0.21	1.74	3.73	3.06	0.51	3.93	4.86	356	268	254

It is further revealed from the data that soil application of VAM (ECOMAX-G) + full “NK” & 60% “P” (T₄) or seed treatment with *Azotobacter* (AZOMAX) + full “PK” & 75% “N” (T₂) produced comparable seed cotton yield with that of 100% recommended “NPK” applied with these biofertilizers (T₁ & T₃), indicating 40% dose of “P” or 25% dose of “N” can be saved by using these biofertilizers without impact on yield and would be more profitable to the farmers.

Such improvement increase in the yield of fiber crops due to *Azotobacter* sp. inoculation in cotton has been reported earlier also (Anjum *et al.*, 2007).

Sridevi and Ramakrishnan, 2010 reported similar result in cotton yield attributes, like number of sympodial branches, bolls etc., under increased 100 per cent NPK with VAM fungi inoculated plants.

Improvement in bolls formed and increase in boll weight and yield by *Azotobacter* treatment reported by Sangeeta Paul *et al.*, 2011 in cotton.

The results of present investigation suggests that, among the various treatments, application of *Azotobacter* (AZOMAX) or VAM (ECOMAX-G) along with 100% recommended dose of “NPK”, produced significantly higher seed cotton yield compared to 100% recommended “NPK” alone. It is also revealed that 25% Nitrogen or 40% Phosphorus fertilizers dose could be saved through use of these biofertilizers without impact on yield and would be more beneficial to the farmers.

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