Biological Forum – An International Journal **14(1): 1402-1406(2022)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Bio based Natural Resources and their Efficacy on Production of non-GM Organic Cotton in Nimar Valley of Madhya Pradesh

D.K. Shrivastava[1] and Y.K. Shukla[2]
[1]Scientist, AICRP on Cotton, RVSKVV, B. M. College of Agriculture, Khandwa (Madhya Pradesh), India.
[2]Scientist, Krishi Vigyan Kendra, B.M. College of Agriculture, Khandwa (Madhya Pradesh), India.

(Corresponding author: D.K. Shrivastava)*
(Received 27 November 2021, Accepted 07 February, 2022)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: The cost of cultivation of cotton is increasing day by day, the major part of cost of cultivation is covered under cost of fertilizers, hence if some way, the dose of fertilizers was reduced maintaining the stability in yield, the cost may be reduced automatically. The study aimed to estimate the efficacy of different combinations of Vermicompost, Phosphate Rich Organic Manure (PROM), Biofertilizers and identification of the efficient doses of vermicompost, PROM and biofertilizers for higher seed cotton yield to reduce cost of production in organic cultivation.

The study was conducted with nine treatments of different combinations of Vermicompost, PROM and Biofertilizers on cotton variety JK4 in a replicated trial at AICRP on Cotton, Farm B. M. College of Agriculture, Khandwa, Madhya Pradesh during 2019-20. The recommended dose of fertilizers (80: 60: 40 kg ha^{-1} of nitrogen, phosphorus and potash) were applied in 100, 50, 40 and 30% quantity through Vermicompost and Phosphate Rich Organic Manure. The nitrogen fixing (Azotobacter) and phosphate solubilizing bacteria were applied as seed treatment at the time of sowing and as drenching at 20/25 and 40/45 days after sowing. The significant increase in plant height(cm), Bolls/plant, Seed cotton yield (Kg/plot), Seed cotton Yield (Kg/ha) and Lint Yield (Kg/ha) were observed in treatment T2 (3.788 t/ha Vermicompost + 0.364 t/ha PROM + Seed treatment with PSB and Azotobacter + 2l/ha PSB one drenching at 20 DAS + 2l/ha Azotobacter one drenching at 25DAS) against control and other treatments. The uptake of nitrogen, phosphorus and potash was also higher than other treatment in T2 (61.53, 26.73 and 38.64 Kg ha^{-1} respectively). The seed cotton yield of cotton variety JK-4 was highest (1292.44 kg/ha) in T2 than control (T9, 1106.79 kg/ha) and other treatments. The increase in uptake of N, P and K in lower doses of RDF with biofertilizers is clear indication of enhanced availability of N, P and K due to activity of biofertilizers. T2 is more economic with low production cost, high Net returns and highest B:C ratio (1.82). The cost of cultivation of cotton can be reducing up to 50% by the use of PSB and Azotobacter with 50% RDF.

Keywords: Cost of production, estimation of efficiency, recommended dose of fertilizer.

INTRODUCTION

Bio-based input is the basic requirement for organic cultivation of crops. The availability of nutrients required for plant growth are in very less quantity in bio-based input normally used in organic cultivation *viz*, Farm Yard Manure, Vermicompost, NADEP compost etc. The recommended doses of Nitrogen, Phosphorus and potash for non Bt cotton varieties/ hybrids are respectively 100, 60 and 40 kg/ha in Nimar Valley of Madhya Pradesh. The availability of these essential elements in natural sources are very low. The major natural sources for supply of Nitrogen are Farm Yard Manure and Vermicompost but the availability of nitrogen in these sources are ranged from 0.5 % to 1.65% which are meagre in comparison to that of conventional (chemical) sources, that's why these required in a huge quantity. Vermicompost is a rich source of both micro and macro nutrients, vitamins, growth hormones and enzymes (Bhavalkar, 1991). Vermicompost enhances soil biodiversity by promoting the beneficial microbes which intern enhances plant growth directly by production of plant growth-regulating hormones and enzymes and indirectly by controlling plant pathogens, nematodes and other pests, thereby enhancing plant health and minimizing the yield loss (Pathma and Sakthivel 2012).

Vermicomposts have the potential for improving plant growth when added to greenhouse container media or soil. However, there seem to be distinct differences between specific vermicomposts and composts in terms of their nutrient contents, the nature of their microbial communities, and their effects on plant growth (Atiyeh *et al.*, 2000).

The availability of P in soil after application of phosphatic fertilizers is between 10-30% (Gilani *et al.*, 1983). During the process of solubilization of rock phosphate by fungi, the pH of the media was lowered from 7 to 3 (Venkateswarlu *et al*., 1984). The availability of phosphate solubilizing micro-organisms, (PSM) in soil as natural microbial population is not more than 1%, hence it is a common practice in several Russian States, European and Asian countries to inoculate soil with PSM to increase P concentration in the soil solution (Taha *et al.*, 1969).

If the natural sources are being use for supply of the recommended doses of essential elements to plants, a huge quantity of natural sources is required which is very tedious and expensive through use of single source hence a combination of different sources has to be chosen out to get required availability of these essential elements in soil. The need of the day is to work out the proper combinations and doses of natural resources to get best production level of cotton in organic condition which should be equal to or nearby to that of conventional cotton production. The present study has been conducted with the aim to estimate the effect of different combinations of vermicompost, PROM and biofertilizers on Seed Cotton Yield and to identify the best doses of vermicompost, PROM and biofertilizers for high seed cotton yield in organic cultivation.

MATERIALS AND METHODS

Vermicompost and PROM used in the experiment were prepared in Vermicompost and PROM Unit of Centre of Excellence of Organic Cotton, B. M. College of Agriculture, Khandwa. Azotobacter and PSB were purchased from organic certified reputed company. The content of vermicompost and PROM were analyzed for the batch No CEOC/21/Vermi/14 and CEOC/21/PROM/03 which were used in the present study (Table 1). The recommended doses of fertilizers (RDF) for cotton cultivation in Nimar Velley are 80:60:40 (N: P: K) Kg^{-1}ha. The quantities of Vermicompost and PROM were worked out for different doses of RDF. 100% RDF: 7.575 t ha^{-1} Vermicompost + 0.729 t ha^{-1} PROM, 50 % RDF: 3.788 t ha^{-1} Vermicompost + 0.325 t ha^{-1} PROM, 40 % RDF: 3.030 t ha^{-1} Vermicompost + 0.292 t ha^{-1} PROM, 30% RDF: 2.273 t ha^{-1} Vermicompost + 0.195 t ha^{-1} PROM. Azotobacter and PSB were used in liquid form. The doses of bio fertilizers were worked out @ 2 l ha^{-1} for drenching and 50ml Kg^{-1}seeds for seed treatment.

An experiment has been conducted during 2019-20 at AICRP on Cotton in field no 06, Farm B. M. College of Agriculture, Khandwa, Madhya Pradesh, with 9 treatments in three replications on Cotton variety JK-4. The treatments were the combinations of vermicompost, PROM and biofertilizers (Table 2). The cotton variety JK-4 has been planted in 4 rows plots with 90 cm row to row and 60 cm plant to plant distance. The row length was 6m. The sowing was done on 19/06/2019.

Table 1: The availability of essential elements in Vermicompost (batch No CEOC/21/Vermi/14) and PROM (batch no. CEOC/21/PROM/03).

Sr. No.	Sources	Availability of N (%)	Availability of P(%)	Availability of K(%)
1.	Vermicompost	1.32	0.34	0.31
2.	PROM	0.32	8.23	0.38

Table 2: The detail of treatments.

Treatment No.	RDF (%)	Quantity of Natural sources
T1	50% RDF	3.788 t ha^{-1} Vermicompost + 0.364 t ha^{-1} PROM + Seed treatment with PSB and Azotobacter
T2	50% RDF	3.788 t/ha Vermicompost + 0.364 t ha^{-1} PROM + Seed treatment with PSB and Azotobacter + 2l ha^{-1} PSB one drenching at 20 DAS + 2l ha^{-1} Azotobacter one drenching at 25DAS
T3	40 % RDF	3.030 t ha^{-1} Vermicompost + 0.292 t ha^{-1} PROM + Seed treatment with PSB and Azotobacter
T4	40 % RDF	3.030 t ha^{-1} Vermicompost + 0.292 t ha^{-1} PROM + Seed treatment with PSB and Azotobacter + 2l ha^{-1} PSB one drenching at 20 DAS + 2l/ha Azotobacter one drenching at 25DAS
T5	40 % RDF	3.030 t ha^{-1} Vermicompost + 0.292 t ha^{-1} PROM+ Seed treatment with PSB and Azotobacter+ 2l ha^{-1} PSB two drenching at 20 & 40 DAS + 2l ha^{-1} Azotobacter two drenching at 25 & 45DAS
T6	30 % RDF	2.273 t ha^{-1} Vermicompost + 0.219 t ha^{-1} PROM+ Seed treatment with PSB and Azotobacter
T7	30 % RDF	2.273 t ha^{-1} Vermicompost + 0.219 t ha^{-1} PROM+ Seed treatment with PSB and Azotobacter + 2l t ha^{-1} PSB one drenching at 20 DAS + 2l t ha^{-1} Azotobacter one drenching at 25DAS
T8	30 % RDF	2.273 t ha^{-1} Vermicompost + 0.219 t ha^{-1} PROM+ Seed treatment with PSB and Azotobacter + 2l t ha^{-1} PSB two drenching at 20 & 40 DAS + 2l t ha^{-1} Azotobacter two drenching at 25 & 45 DAS
T9	100% RDF	Control (7.575 t ha^{-1} Vermicompost + 0.729 t ha^{-1} PROM)

The worked-out quantities of vermicompost and PROM as per the percentage of RDF were weighed, the half dose of Vermicompost and full dose PROM was placed in rows before sowing and remaining half dose of vermicompost was given by ring- column method at 40 DAS. Seed treatment and biofertilizers were applied as per the treatment. Two irrigations were provided in October and November month. The observations were recorded on five randomly selected plants on Plant Height(cm), Number of Monopodia, Number of Sympodia, Number of Bolls/plants, Total number of Bolls/plot, Boll weight(g), Seed Cotton Yield (kg ha^{-1}), Seed Index(g), Ginning %, Lint Index and Lint Yield (kg ha^{-1}) for each treatment and the data were analyzed. The standard procedure was adopted to work out the cost of cultivation (Rs. ha^{-1}), gross returns (Rs. ha^{-1}), net returns (Rs. ha^{-1}) and B:C ratio based on the local prevailing price.

RESULT AND DISCUSSION

Significant differences were observed for all the traits recorded among different treatments except Monopodia/plant, Sympodia/Plant, Boll Weight (g) and Ginning percentage. The significant response of 3.788 t ha^{-1} Vermicompost + 0.364 t ha^{-1} PROM + Seed treatment with PSB and Azotobacter + 2l ha^{-1} PSB one drenching at 20 DAS + 2 l ha^{-1} Azotobacter one drenching at 25DAS (T2), has been clearly reflected from the data recorded on Plant height (cm), Bolls/plant. Seed cotton yield (Kg $plot^{-1}$), Seed cotton Yield (kg ha^{-1}) and Lint Yield (kg ha^{-1}). The major yield contributing traits *i.e.* plant height (cm), Bolls/plant. Seed cotton yield (Kg $plot^{-1}$), Seed cotton Yield (kg ha^{-1}) and Lint Yield (kg ha^{-1}) were significantly higher than treatment T9 (control) followed by treatment T1. The estimates for Monopodia/ plant, Sympodia/plant, Boll weight(g) and Ginning percentage for treatment T2, were not differed significantly against treatment T9(Control) but these were higher than that of all other treatments. The cost of production was very height (Rs. 0.56 lakhs/ha, T9) with net returns of Rs. 0.16 lakh/ha and 1.28 B:C ratio, when the 100% RDF were provided through vermicompost and PROM. But it was observed that 50% RDF through vermicompost and PROM and use of PSB and Azotobacter as seed treatment and/ or drenching was more cost effective (Rs 0.43-0.46 lakh ha^{-1}, T1 & T2) with better net returns (Rs. 0.22 lakh ha^{-1}, T1 and Rs 0.38 lakh ha^{-1}, T2) and B:C ratio (1.52, T1 and 1.82, T2). The reduced levels of RDF *i.e*. 40% and 30% with the same applications of biofertilizers (T3 to T8) were not found effective as the yield levels with other yield contributing traits were reduced and the cost of production, net returns and B:C ratio were also at low levels (Table 4). The uptake of N, P and K was varied significantly among different treatments. The uptake of N, P and K were highest in T2 suggesting the positive roll of Azotobacter and PSB in increasing the availability of these elements in soil during the growth period of cotton (Table 3). The results of Thimmareddy *et al.* (2013) and Kumar *et al.* (2017) are in support of these findings. Kundu and Gaur (1984) reported that the phosphate solubilizing microorganisms improved phosphorus uptake over control with and without chemical fertilizers. Tomar *et al*. (1998) suggested that different combinations of *Azotobacter* with PSB increase yield in wheat Blaise *et al.* (2004) observed that a better soil moisture and improved nutrient availability in the organic system enabled cotton to produce more lint along with good fiber quality. Egamberdiyeva *et al.* (2004) also observed that P-solubilizer increased the available P in soil at different growth stages. Aftab Afzal *et al.* (2005) concluded that Phosphate Solubilizing Microorganism alone or along with other combinations produced profound effect on grain and biological yield, tillers per m^2 and seed phosphorus content in wheat. PSB enhance the rhizosphere colonization, better nutrient availability and biosynthesis of hormones (Patten and Glick, 2002; Rai, 2006; Idris *et al.* 2007). Increase in Seed cotton yield in inoculated treatment with PSB was also recorded by Qureshi *et al.* (2012). Narasimha (2013) suggested that the **s**upplementation of organic and microbial amendments had improved physicochemical and biological parameters in soil. Higher water holding capacity, moisture content, and electrical conductivity, organic carbon content and bacterial and fungal populations are observed in test soil than control. Machala Santos Kumar *et al.* (2017) revealed that, use of bulky organic manure *i.e.* FYM, vermicompost and conc. organic manure i.e. castor cake full fill the nutritional requirement of rainfed cotton crop. Muthukrishnan (2017) concluded that integration of 100 per cent inorganic fertilizers along with FYM @12.5 tonnes ha^{-1} not only increases the seed cotton yield and economic parameters.

Table 3: Nutrient uptake.

Treatment	N Uptake (kg ha^{-1})	P Uptake (kg ha^{-1})	K Uptake (kg ha^{-1})
T1	49.43	21.12	29.28
T2	61.53	26.73	38.64
T3	53.32	23.52	34.25
T4	41.44	19.36	31.21
T5	42.33	20.16	33.42
T6	45.38	22.54	34.24
T7	37.71	16.25	26.41
T8	38.22	18.39	28.62
T9	58.22	24.52	35.23
SEM	1.43	1.32	1.76
CD at 5%	2.13	1.86	2.02.

Table 4: Effect of different doses of Vermicompost, PROM and biofertilizers on yield and yield contributing traits of cotton.

Treatments	Plant Height (cm)	Monopodia/ Plant	Sympodia/ Plant	Bolls/ Plant	Boll Weight (g)	Seed Cotton Yield (Kg/plot)	Seed Cotton Yield (Kg/ha)	GP (%)	Lint Yield (Kg/ha)	Cost of Production/ha (Rs in lakh)	Gross Return/ha (Rs in lakh)	Net Return/ha (Rs in lakh)	B : C Ratio
T1	151.00	1.56	24.00	15.33	3.30	2163.67	1001.70	34.90	350.12	0.43	0.65	0.22	1.52
T2	165.93	2.33	27.67	19.00	3.63	2791.67	1292.44	36.43	471.33	0.46	0.84	0.38	1.82
T3	143.13	1.33	21.67	9.67	2.93	1781.00	824.54	33.40	274.80	0.40	0.54	0.13	1.33
T4	144.13	1.44	22.67	12.33	3.10	1847.33	855.25	33.47	286.43	0.44	0.56	0.12	1.27
T5	149.30	2.00	23.00	14.00	3.57	2106.33	975.15	34.53	336.33	0.46	0.63	0.17	1.38
T6	138.23	1.00	18.33	8.00	2.80	1695.00	784.72	32.63	255.96	0.38	0.51	0.13	1.36
T7	140.57	1.11	19.67	10.67	2.93	1758.00	813.89	32.67	265.16	0.41	0.53	0.12	1.29
T8	142.67	1.22	22.00	13.00	3.13	1921.00	889.35	34.33	305.32	0.43	0.58	0.14	1.33
T9	157.17	2.11	26.00	16.33	3.53	2390.67	1106.79	35.80	396.49	0.56	0.72	0.16	1.28
SEM	4.089	0.724	1.666	1.265	0.191	164.578	164.58	0.896	64.404				
CD (5%)	8.264	1.464	3.368	2.557	0.385	332.613	153.98	1.811	60.260				
CV	3.817	21.197	10.150	13.544	8.199	11.137	11.137	3.615	12.683				

The findings of Singh *et al.* (1999), Omar (1998), Saad and Hammad (1998), Kumar *et al.* (1999), Chabot and Antoun (1996) and Kundu *et al*. (1984) are also supported the result, who also reported increase in biological yield of cotton, wheat, sorghum, maize and rice respectively.

CONCLUSION

The study suggested that 50% RDF through vermicompost and PROM assisted with Seed treatment with PSB and Azotobacter and one drenching of PSB and Azotobacter are most economical in a view to reduce the cost of cultivation of cotton crop with increase in Seed cotton yield and net return (Rs. 0.38 lakh/ha) with the highest B: C ratio (1.82) rather than applying only 100% RDF through vermicompost and PROM. The increase activity of N fixing bacteria (Azotobacter) and phosphate solubilizing bacteria improve the availability of N, P and K in soil.

FUTURE SCOPE

(i) Bioinputs viz VAM, Jeevamurit, Beejamurit etc may be studied for their efficacy on availability of N, P and K in soil

(ii) The effect of bio inputs on Physical, chemical and biological properties of soil and quality parameters of crops may be included in future studies.

Acknowledgments. I acknowledge my sincere thanks to Dean College of Agriculture Khandwa, Scientist of AICRP on cotton for their support in conduction of experiment.

Conflict of Interest: None

REFERENCES

Afzal Aftab, Ashraf, M., Saeed Asad, A. and Farooq, M. (2005). Effect of Phosphate Solubilizing Microorganisms on Phosphorus Uptake, Yield and Yield Traits of Wheat (*Triticum aestivum* L.) in Rainfed Area *Int. J. Agri. Biol*., *7*(2): 207–209.

Atiyeh, R. M, Subler, S, Edwards, C. A., Bachman, G., Metzger, J. D. and Shuster, W. (2000). Effects of vermicomposts and composts on plant growth in horticulture container media and soil. *Pedobiologia, 4*: 579–590.

Bhavalakar, U. (1991). Vermiculture biotechnology for LEISA -Seminar on low external input sustainable agriculture. Amsterdam, Netherlands, pp: 16.

Blaise, D., Rupa, T. R. and Bonde, A. N. (2004). Effect of organic and modern method of cotton cultivation on soil nutrient status. Comm. *Soil Sci. Plant Anal*., *35*(9&10): 1247-61.

Chabot, R. and Antoun, H. (1996). Growth promotion of maize and lettuce by phosphate solubilizing *Rhizobium leguminosarum. Pl. Soil*, *184*: 311–21.

Egamberdiyeva, D., Juraeva, D., Pobeerejskaya, S., Myachina, O., Teryuhova, P., Seydalieva, L. and Aliev, A. (2004). Improvement of wheat and Cotton growth and nutrient uptake by phosphate solubilizing bacteria. P.58-66. *In*: D. Jordon and D. Caldwell (eds) 26th Southern Conservation Tillage Conference for Sustainable Agriculture, June 8-9, 2004. Raleigh, North Carolina, North Carolina Agricultural Research Service.

Kumar, M. S., Bhoyar, S., Deshmukh, P., Sathyanarayana, E., & Karangami, L. D. (2017). Evaluation of nutrients uptake under rainfed organic cotton in vertisol. *Trends in Biosciences*, *10*(12), 2280-2283.

Narasimha, G. (2013). Comparative studies on physico-chemical, biological and enzymatic properties of soil amended with organic manure, vermicompost and indigenous microorganisms (IMOs). *BTAIJ*, *7*(8), 313-319.

Gilani, R. H., Mian, M. A., Muhammad, S. and Ghani, A. (1983). The fertilizer phosphate utilization efficiency in wheat Production. *Pakistan J. Soil Sci.*, *1*: 7–9.

Idris, E. E., Iglesias, E.J., Talon, M. and Borriss, R. (2007). Trytophan dependent production of indole-3-acetic acid (IAA) affects level of plant growth promotion by *Bacillus amyloliquefaciens* FZB42. *Molecular plant-mMicrobe Interaction*, *20*: 619-626.

Pathma, J., & Sakthivel, N. (2012). Microbial diversity of vermicompost bacteria that exhibit useful agricultural traits and waste management potential. *SpringerPlus*, *1*(1), 1-19.

Kumar, V., Punia S. S., Lakshminarayana, K. and Narula, N. (1999). Effect of phosphate solubilizing analogue resistant mutants of *Azotobacter chroococcum* on sorghum. *Indian J. Agric. Sci*., *69*: 198–200.

Kundu, B. S. and Gaur A. C. (1980). Establishment of nitrogen fixing and phosphate dissolving bacteria in rhizosphere and their effect on yield and nutrient uptake of wheat crop. *Pl. Soil*, *57*: 223–230.

Qureshi M. A., Ahmad, Z. A., Akhatar N., Iqbal A., Muzeeb F. and Shakir M. A. (2012). Role of Phosphate Solubilizing Bacteria (PSB) in Enhancing P Availability and Promoting Cotton Growth. *The J. Anim. Plant Sci*., *22*(1): 204-210.

Muthukrishnan, P., Thavaprakaash, N. and Srinivasan, K. (2017). Effect of organic nutrient management practices in comparison with conventional method on performance of cotton in Tamil Nadu. *Madras Agric. J.*, *104*(1-3): 15-22.

Patten, C. L. and Glick, B. R. (2002). Role of *Psudomonas putida* indoleacetic acid in development of host plant root system *Appl. Environ. Microbiol., 68*: 3795-3801

Rai, M. K (2006). Hand book of microbial biofertilzers. Food product press, an imprint of The Harworth Press, Inc, Binghamton, New York.

Saad, O. A. O. and Hammad A. M. (1998). Fertilizing wheat plants with rock phosphate combined with phosphate dissolving bacteria and V.A– mycorrhizae as alternate for ca–superphosphate. *Annals Agric. Sci. Cairo*, *43*: 445–60

Singh, J., Taneja, K. D., Agarwal, S. K. and Nehra, D. S. (1999). Comparative efficiency of different nitrogenous and phosphatic fertilizer for cotton. *J. Cotton. Res. Dev.*, *13*(2): 120-122.

Taha, S. M., Mahmood, S. A. Z., EL–Damaty, A. A. and Abd –El–Hafez, A. M. (1969). Activity of phosphate dissolving bacteria in Egyptian Soil. *Pl. Soil*, *31*: 149–60.

Thimmareddy, K., Desai B. K. and Vinodakumar S. N. (2013). Seed Cotton Yield, Uptake of NPK and Economics of Bt Cotton (*Gossypium hirsutum* L.) as Influenced by Different Bio Fertilizers In-situ G M under Irrigation trends in *Bio Sci.*, *6*(6): 838-841.

Tomar, U.S., Tomar, I.S. and Badaya, A. K. (1998). Response of chemical and biofertilizer on some matric traits in wheat. *Crop Res.* Hissar. New Delhi. *16*: 408–410.

Venkateswarlu, B., Rao, A.V. and Raina, O. (1984). Evaluation of phosphorus solubilization by microorganisms isolated form arid soils. *J. Indian Soc. Soil Sci*., *32*: 273–7.

How to cite this article: D.K. Shrivastava and Y.K. Shukla (2022). Bio based Natural Resources and their Efficacy on Production of non-GM Organic Cotton in Nimar Valley of Madhya Pradesh. *Biological Forum – An International Journal*, *14*(1): 1402-1406.