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Research Paper

Effect of Nitrogen and Phosphorous on *in vitro* Decomposition of Wheat Crop Residues By *Stachybotrys atra* Corda

Botany

KEYWORDS : Stachybotrys atra, Decomposition of fungi, wheat internodes, wheat leaves, wheat chaff, wheat straw, nitrogen and phosphorous.

Raj Singh	Dept. of Biotechnology, Faculty of Science, S.V. Subharti University, Meerut (U.P.), India
Amit Kumar	Dept. of Biotechnology, Faculty of Science, S.V. Subharti University, Meerut (U.P.), India
Gyanika Shukla	Dept. of Biotechnology, Faculty of Science, S.V. Subharti University, Meerut (U.P.), India
Anju Rani	Dept. of Botany, Faculty of Science, S.V. Subharti University, Meerut (U.P.), India
Vineet Girdharwal	Dept. of Zoology, Faculty of Science, S.V. Subharti University, Meerut (U.P.), India

ABSTRACT

Effects of treatment with nitrogen or phosphorous or their combination on decomposition of wheat internodes, wheat leaves, wheat chaff and straw by Stachybotrys atra Corda was investigated in vitro for 30 days. Wheat leaves showed maximum decomposition followed by mixed, chaff, and wheat in ternodes in control as well as all three replicates. Treatment with nitrogen as well as phosphorous increased the rate of decomposition but it was higher in the case of nitrogen-treated residues. However, treatment with combination of nitrogen and phosphorous resulted in much more increase in the rate of decomposition as compared to that with nitrogen or phosphorous alone. As far as separate parts are concerned, wheat internodes exhibited very good response to nitrogen and phosphorous treatment followed by mixed straw and chaff. In case of wheat leaves decomposition is synergistic with nitrogen followed by phosphorous alone whereas internode shows moderate decomposition as compared to other substrates.

I. INTRODUCTION

About 678 million tons of wheat straw were estimated be available in 2011 throughout the world [1]. There is increasing emphasis on the proper management of the straw for which various strategies have been proposed from time to time; a number of these strategies involved its decomposition by microorganisms [2,3,4]. Like many other agricultural wastes, wheat straw also largely consists of lignified cell wall material–cellulose, hemicellulose and lignin being the three primary structural components. Lignin, together with hemicellulose, encrusts the cellulose chains forming a barrier which prevents wetting and access of microbial enzymes [5]. Therefore, it would be worthwhile using selected micro-organisms for loosening the lignocellulosis bond [6]. The addition of phosphorus and nitrogen have been reported to enhance the rate of decomposition [7,8,9,10,11,12]. Therefore, it would be worthwhile to study the effect of addition of phosphorus and nitrogen containing compounds singly and in combination on the decomposition of straw and its components by *Stachybotrys atra* isolated from these substrates decomposing naturally in the field in our laboratory.

II. MATERIALS AND METHODS

To find out the effect of urea (nitrogen) and Single Super Phosphate (SSP) on the ability of the selected fungus *S. atra* to decompose different compounds of wheat crop residues *in vitro,* the previously defined method was followed [13,14]. The wheat internodes, leaves, chaff as well as straw were cut in to small pieces and were air-dried. About 2 gm of wheat internodes were placed in 15 conical flasks each (250mL capacity). Same procedure was done with wheat leaves, straw and chaff. Thus, total 60 flasks were used. The flasks were plugged and autoclaved at 15 lbs/square inch pressure for 30 minutes and then again after 24 hours for 30 minutes. Each set of 15 flasks was treated as –

a. 10 mL of sterilized water were added to each of the three flasks.
b. 10 mL of sterilized water + inoculum of *S. atra* were added to each of set of 3 flasks.
c. 10 mL of urea solution (0.21%) + inoculum of *S. atra* were added to each of a set of 3 flasks.
d. 10 mL single super phosphate solution (1%) + inoculum of *S. atra* were added to each of a set of 3 flasks.
e. 10 mL of urea solution (0.21%) + single super phosphate solution (1%) + inoculum of *S. atra* were added to each of a set of 3 flasks.

III. RESULTS AND DISCUSSION

Observation of presented in table 1 reveals that the treatment with 0.21% urea(N) or 1% single super phosphate (P) or their combination exhibited highly significant variations with regard to their effect on the decomposition of the different component of wheat crop residues by *S. atra in vitro*. Not only this, different substrate exhibited significant differences in their responses to different treatments.

Table 1: Percentage loss (after 30 days) in the dry wt. of unamended wheat crop residues as well as those amended with 0.21% Urea(N) and 1% Single Super phosphate (SSP)—singly and in combination—and inoculated with S. atra

Crop Residues	Water + *S. atra* (control)	Urea(N) + *S. atra*	SSP(P) + *S. atra*	SSP(P) + Urea(N) + *S. atra*
Internodes	10.75±1.18	12.85±0.89	11.2±1.06	19.25±1.18
Leaves	21.70±1.14	25.20±2.14	24.95±2.33	26.75±1.34
Chaff	12.80±1.13	12.95±1.07	16.435±1.41	20.30±1.81
Mixed	18.90±1.94	22.25±1.86	19.95±1.92	22.35±1.14

The application of urea and SSP show positive effect on the decomposition of all component of wheat residue. The effect of the single super phosphate was less marked then that of urea. The combined effect of urea and single super phosphate was more than that of urea and single super phosphate separately. However, the combined effect of urea and SSP in case of internodes inoculated with *S. atra* appeared to be synergistic rather than additive. Similar results were obtained in case of leaves and straw. In case of the chaff however, the observations were slightly different. In case of the chaff inoculated with *S. atra,* addition of SSP had more pronounced positive effect than that of urea which had a very meager effect; also the combined effect of urea and SSP was synergistic. The rate of decomposition of different components was in the order of leaves > straw > chaff > internodes.Decomposition of given substrate by a given microorganism depends up to a number of factors. These includes C : N

levels [15], C : N ratio of internodes is 109.3 while that of leave is 39.0 [16]. Nitrogen is a key nutrient substance for the growth of microorganism and its sufficient supply is absolutely necessary for the decomposition of the residues. Microbial cells contain 5-15 parts of carbon to one part of nitrogen [17]. The straw contains 0.5% nitrogen and 40% carbon. When it is attacked by decomposers, specially fungi, it has only 0.5 units of nitrogen to satisfy the active biological agents which generally require 1.2 to 1.6 units of nitrogen [17]. Thakur and Gupta [18] as well as Newton [19] also reported that the application of urea increased microbial decomposition of cellulose.

The addition of phosphorus led to an increase in the rate of decomposition [20,21]. During organic matter decomposition, assimilation of phosphorus into the cytosol of microorganisms takes places [22]. The best results were obtained when nitrogen and phosphorus (both) were applied as compared to nitrogen and phosphorus alone [23].

S. atra is known to posses good cellulolytic as well as lignolytic activities and good hemicellulolytic ability [24,25] *in vitro*. Further analysis of biochemical changes in the crop residues as a result of *in vitro* decomposition in the fungus would reveal the reason behind the differences in the rate of decomposition of different substrate by fungal species.

0.21% solution of urea was used because *S. atra* can grow at very low nitrogen level; and such fungi were earlier shown to exhibit significant increase in the rate of decomposition of paddy straw amended with 0.21% urea solution [24].

IV. CONCLUSION

Microorganisms require nutrients for their growth and development and its sufficient supply is absolutely necessary for the decomposition of organic residues. Nitrogen and phosphorus play a significant role in metabolism and growth, so that microorganisms actively secrete lignocellulosic wastes for safe and clean environment.

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