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Study on efficiency of button spent mushroom for managing chick pea wilt incited by *Fusarium oxysporum* f.sp. *ciceris*

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Abstract
Chickpea (*Cicer arietinum* L.), also known as Bengal Gram is one of the major pulse cultivated and consumed in India. Chickpea wilt caused by fungal pathogen *Fusarium oxysporum* f.sp. *ciceris* is one of the serious disease causing huge loss to crop throughout the world. Mushroom growing is an ecofriendly activity as it utilizes the waste from agriculture, horticulture, poultry, brewery etc. for its cultivation. However, piling up of "spent mushroom substrate". The button spent mushroom substrate used as different concentrations with soil to manage aginst *Fusarium oxysporum* f.sp. *ciceris* in chick pea wilt under pot conditions. The observations were recorded for effect of spent mushroom substrate and their combinations on *Fusarium* wilt disease incidence, severity index and phenotypic parameters. All the treatments are significant results over control. The above findings are very useful for the farmers for making decision over the use of organic materials for management of wilt disease which is safe management practice for environment, also increased yield of chickpea.

Keywords: Button spent mushroom substrate (SMS) against *Fusarium oxysporum* f.sp. *ciceris.*

Introduction
Chickpea is a cool season pulse crop and is grown in several countries worldwide as a food source. Chickpea is the third most important food legume crop and India is the largest producer contributing to 65% of world's chickpea production. Chickpea seeds contain on an average 23% protein, 64% total carbohydrates (47% starch, 6% soluble sugar), 5% fat, 6% crude fiber and 3% ash. High mineral content has been reported for phosphorus (340 mg /100 g), calcium (190 mg /100 g), magnesium (140 mg /100 g), iron (7 mg / 100 g) and zinc (3 mg /100 g). Besides these, it also improves the soil fertility due to its nitrogen fixing ability (Maiti 2001) [5]. The major chickpea growing countries are India, Pakistan and Turkey in Asia, Ethiopia in Africa, California and Washington State in the U.S.A. Mexico and Australia.
The major constraint in chickpea cultivation is fusarium wilt, caused by *Fusarium oxysporum* f.sp. *ciceris* is one of the most prevalent disease in India. Different cultivars of chickpea show wilting at different growth stages influencing the yield loss with different degree of severity. Generally wilting at early growth stage causes greater loss than that at later stage. It is typical vascular disease causing xylem browning or blackening. Spent mushroom substrate is the soil-like material remaining after a crop of mushrooms. Spent substrate is high in organic matter making it desirable for use as a soil amendment or soil conditioner. Spent mushroom substrate for disease management used due to the unique chemical constitution and the microflora present in SMS, its application can be more diversified than what is normally predicted. The Management of Spent Mushroom Substrate (SMS) actinomycetes, bacteria and fungi inhabiting the compost, not only play role in its further decomposition but also exert antagonism to the normal pathogens surviving and multiplying in the soil ecosystem.

Material and Methods
The following material and methods were used to "Study on efficiency of Button Spent Mushroom for managing chick pea wilt incited by *Fusarium oxysporum* f.sp. *ciceris*." Experiment and related studies conducted in the (AICRP on Chickpea, Department of plant breeding and genetics) JNKVV, Jabalpur. Seed of crop were used for study: chick pea, variety-JG 62, Pathogen: *Fusarium oxysporum* f.sp. *ciceri.*

Spent mushroom substrate (SMS)
Two year old spent button mushroom substrate (SMS) obtained from mushroom production unit, Department of plant pathology, JNKVV, Jabalpur (M.P.). Sterilized soil and spent mushroom were mixed in four different combination 25%, 50%, 75%, 100% and filled in the sterilized pots.

Pathogenicity test and mass multiplication of *Fusarium oxysporum sp. ciceris.*
Pathogenicity test was conducted by soil infestation method. The bags containing chickpea straw were autoclaved at 15 psi for 20 min. The pathogen was mass multiplied on sterilized chickpea straw in 500 gm bags. Then the bags were inoculated with 4 discs of 5.0 mm diameter mycelial growth of three days old culture of *Fusarium oxysporum* f.sp. *ciceri* grown on PDA plate. The bags were incubated at 28 ± 2°C for seven days. Then the inoculum was mixed with sterilized soil @ 100 g kg^{-1} soil and filled in the pots (30 cm diameter). The seeds of chickpea were sown simultaneously with pathogen inoculation @ 5 seeds per pot and an un-inoculated control was maintained. The plants were observed for wilt symptoms. Each treatment replicated three times (Nene.1980).

Effect of spent mushroom on growth parameters
Five seeds were sown in sterilized earthen pots filled with sterilized soil. Germination percentage was recorded. Plant height (cm), pod weight (g), seed weight (g) were recorded at maturity. Germination percentage and pre and post emergence mortality were recorded. Per cent mortality will be calculated by using the following formula;

$$\text{Germination (\%)} = \frac{\text{Total number of seed germinated}}{\text{Total number of seed sown}} \times 100$$

$$\text{Disease incidence} = \frac{\text{Number of diseased plants}}{\text{Total number of seedlings}} \times 100$$

Disease severity index
Determination of disease severity index: The disease severity index was calculated as described by Bhattacharya *et al*., (1985) [1]. Disease severity index (D.I.) were calculated as follows:

$$\text{D.I.} = \frac{0\,(Hn) + 1\,(Sn) + 2\,(Hn^*) + 3\,(Dn)}{\text{Total number of plants examined}} \times 100$$

Where -
(Hn) = Number of healthy plants
(Sn) = Number of slightly infected plants
(Hn*) = Number of heavily infected plants
(Dn) = Number of dead plants (Kumar *et al*., 2007) [4]

Results and Discussions
Study on the impact of spent mushroom substrate on seed germination and some morphological parameters
Susceptible varieties of chickpea were selected to study the impact of the SMS alone and in combination on disease incidence, seed germination and some phenotypic parameters. The similar untreated cultivars served as control and all the results are compared.

Table 1: Effect of spent mushroom substrate and their combinations on *Fusarium* wilt disease incidence and phenotypic parameters

Treatments	Germination %	Plant height (cm)	No. of pods/Plant	Pod weight/Plant(gm)	Seed weight/plant (gm)	Disease Incidence (%)
25 % SMS + 75 % soil	92.00	47.00	9.80	19.98	18.00	28.00
50 % SMS + 50 % soil	92.00	50.80	11.20	21.40	19.19	24.00
75 % SMS + 25 % soil	92.00	51.20	18.40	23.04	21.13	16.00
100 % SMS + inoculums	88.00	53.00	20.00	24.86	22.51	12.00
Treated control	72.00	46.60	7.40	15.02	12.64	36.00
Untreated control	92.00	53.20	18.60	25.24	22.73	16.00
SE(m)	4.89	0.97	0.70	0.92	0.97	4.64
C.D.	14.38	2.85	2.06	2.70	2.86	13.80

Mean of 5 replications

Germination percentage
Data presented in Table 1 showed that all the treatments significantly increased the germination percentage as compared to treated control. Among the treatments minimum germination per cent 88.00 % was observed in treatment 100 % SMS + inoculum followed by 92.00 % at 25 % SMS + 75 % soil, 50 % SMS + 50 % soil, 75 % SMS + 25 % soil and by untreated control (92.00 %).

Plant height
Data presented in Table 1 at the time of maturity showed that plant height was significantly increased in all the treatments except treatment 25 % SMS + 75 % soil (47.00 cm). Maximum plant height was recorded in untreated control (53.20 cm) followed by treatment 100 % SMS + inoculum (53.00 cm) and 50 % SMS + 50 % soil (51.20 cm) as compared to treated control (46.60 cm).

Number of pod per plant
Data presented in Table 1 showed that number of pods per plant recorded in all the treatments were significant. Maximum number of pods was recorded in treatment 100 % SMS + inoculum (20.00) followed by untreated control (18.60) and 75 % SMS + 25 % soil (18.40), 50 % SMS + 50 % soil (11.20) and minimum number of pods recorded in treatment 25 % SMS + 75 % soil (9.80) as compared to control (7.40).

Pod weight
Data presented in Table 1 showed that pod weight among the treatments varied from 19.98 to 25.24 gm/plant as compared to treated control (15.02 gm/plant). All treatments showed significantly increased pods weight, maximum pod weight was recorded in untreated control (25.24 gm) followed by treatments 100 % SMS + inoculum (24.86 gm), 75 % SMS +

25 % soil (23.04 gm), 50 % SMS + 50 % soil (21.40 gm), least significant increased pod weight was recorded 19.98 gm at 25 % SMS + 75 % soil.

Seed weight

Data presented for seed weight indicated that untreated control (22.73 gm) was highly significant as compared to treated control (12.64 gm), followed by treatments 100 % SMS inoculum (22.51 gm), 75 % SMS + 25 % soil (19.19 gm), 50 % SMS + 50 % soil (19.19 gm) and minimum seed weight were recorded 12.64 gm in treatment 25 % SMS + 75 % soil as compared to control.

Disease incidence

Disease incidence caused by *Fusarium oxysporum* f.sp. *ciceris* in the susceptible variety JG - 62 of chickpea was highly significant in treatment 100 % SMS + soil (12.00 %) as compared to treated control, followed by treatment 75 % SMS + 25 % soil (16.00 %) and untreated control (16.00 %). The disease incidence showed by treatment 50 % SMS + 50 % soil was 24% and maximum disease incidence 28.00 % showed by treatment 25 % SMS + 75 % soil as compared to treated control.

Table 2: Disease severity index of *Fusarium oxysporum* f.sp. *cicero*

Treatments	*Fusarium oxysporum* f.sp. *ciceris*
25 % SMS + 75 % soil	64.00
50 % SMS + 50 % soil	44.00
75 % SMS + 25 % soil	32.00
100 % SMS + inoculums	24.00
Treated control	92.00
Untreated control	32.00
SE(m)	9.30
C.D.	27.33

Fusarium oxysporum* f.sp. *ciceris

Fusarium wilt disease (24.00%) was least in treatment 100 % SMS + inoculum as compared to treated control (92.00 %), followed by treatment 75 % SMS + 25 % soil (32.00 %) and by untreated control (32.00 %), maximum disease severity 64.00 % was observed in treatment 25 % SMS + 75 % soil followed by treatment 50 % SMS + 50 % soil (44.00 %) as compared to treated control (92.00 %).

Table 3: Analogy of assessment of various factors against *Fusarium oxysporum* f.sp. *cicero*

Treatments	Control factor	Efficiency	Relationship factor
25 % SMS + 75 % soil	0.60	0.10	0.59
50 % SMS + 50 % soil	0.80	0.20	0.79
75 % SMS + 25 % soil	0.30	0.30	0.29
100 % SMS + inoculum	0.40	0.70	0.39
Treated control	1.00	1.00	0.99
Untreated control	0.40	0.60	0.39
SE(m)	0.10	0.15	0.10
C.D.	0.29	0.44	0.29

Impact of spent mushroom treatments was studied with respect to seed germination, morphological traits and disease incidence to *Fusarium oxysporum* f.sp. *ciceri,* the discussion pertaining has been furnished under the following heads.

SMS play role in its further de-composition but also exert antagonism to the normal pathogens surviving and multiplying in the soil ecosystem, restricts the root knot infections of tomato plant, presence of Pseudomonas and Bacillus present in the SMS exert antagonism to a number of soil pathogens (Mohapatra and Behera 2011) [6]. SMS treated plant showed high growth rate with maximum shoot and root length as compared to control in tomato plant (Jonathan *et al*. 2011) [3]. SMS for the control of *Fusarium* wilt in tomato and also showed that spent mushroom compost was a soil amendment Harender Raj and Kapoor I.J. (1997) [2]. SMS play role in its further de-composition but also exert antagonism to the normal pathogens surviving and multiplying in the soil ecosystem, restricts the root knot infections of tomato plant, presence of Pseudomonas and Bacillus present in the SMS exert antagonism to a number of soil pathogens (Mohapatra and Behera 2011) [6].

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