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USE OF ORGANIC AMENDMENT FOR MANAGEMENT OF FUSARIUM WILT OF GLADIOLUS

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Abstract

The experiment was conducted at Horticulture Research Centre (HRC), Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur during 2009-2011 following RCB design with four replications. Eight soil amendments such as Poultry refuse (5 t ha^{-1}), Mustard oil cake (600 kg ha^{-1}), *Sesbania rostrata* (5 t ha^{-1}), Municipal waste compost (5t ha^{-1}), BARI Trico- compost (2t ha^{-1}), Leachate (200 ml m^{-2}) were evaluated against Fusarium wilt of gladiolus caused by *Fusarium oxysporum* f. sp. g*ladioli* under field condition. Poultry refuse was very effective in inhibiting the disease resulting maximum germination (99.98%), spike length (73.90 cm), rachis length (43.70 cm), florets $spike^{-1}$ (12.63), flower sticks $plot^{-1}$ (38.75) and corm $plot^{-1}$ (60.23) and cormel yield ha^{-1} (2.51 t). Mustard oil cake, BARI Trico-compost and *Sesbania rostrata* compost were also effective in inhibiting the disease and resulting better spike length, rachis length, florets $spike^{-1}$, flower sticks $plot^{-1}$ and corm $plot^{-1}$ and cormel yield.

Keywords: Gladiolus, *Fusarium oxysporum*, Fusarium wilt, Poultry refuse, Mustard oil cake, BARI Trico- compost

Introduction

The flower of gladiolus (*Gladiolus* sp.) is very popular and grown throughout the world in a wide range of climatic conditions. Gladiolus occupies fourth position in the international cut-flower trade (Misra and Singh, 1998). Gladiolus is also one of the most popular commercial flower in Bangladesh. The agro-ecological conditions of the country are very conducive for the survival and culture of gladiolus. But there is no authentic report on the statistics of area under cultivation of this crop. The major production belts of this flower are Jessore sadar, Sharsha, Jhikargacha,

Kushtia, Chuadanga, Satkhira, Khulna, Chittagong, Mymensingh, Dhaka, Savar and Gazipur. It has great economic value as a cut-flower and its cultivation is relatively easy. Income from gladiolus flower production is six times higher than that of rice (Momin, 2006).

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The major obstacle for cultivation of gladiolus in Subtropical and Mediterranean regions is the various diseases caused by fungi, bacteria and viruses of which Fusarium wilt disease caused by *F. oxysporum* f. sp. *gladioli* is a major problem in all over the gladiolus growing areas. Fusarium wilt of gladiolus is considered as a serious and highly devastating disease which can cause 60-70% yield loss (Vlasova and Shitan, 1974) and the damage may reach upto 100% (Pathania and Misra, 2000). Crop loss of 30% in Germany and 60-80% in Russia was estimated due to Fusarium wilt of gladiolus (Bruhn, 1955). It is also a serious problem in India and reduced plant growth and flowering upto 15- 28% in the number of florets/spike (Misra *et al.*, 2003).

The pathogen is both seed and soil borne. It causes curving, blending, arching, stunting, yellowing and drying of leaves associated with root and corm rot in the field as well as in the storage. *F. oxysporum* f. sp. *gladioli* causes three types of rot e.g. vascular corm rot, brown rot and basal rot (Partridge, 2003). Vascular rot is also called yellows and is characterized by a brown discoloration in the centre of the corm and extending into the flesh. The leaf symptoms start at the tip of the leaf blade and gradually spread all over the leaf blade. If the plant is infected at later stage, it produces weak or small florets. When the plant is infected at early stage and infection is severe, whole plant becomes dry and dies within few days (Misra and Singh, 1998).

F. oxysporum f. sp. *gladioli* is a soil borne pathogen. It can survive in soil for many days. Soil amendments with different organic matter play an important role to control the disease as well as to improve soil quality. It prevents environmental pollution associated with the use of chemical fertilizers and pesticides. Soil organic amendments are known to improve soil aeration, structure, drainage, moisture holding capacity, nutrient availability and microbial ecology (Davey, 1996). Organic amendments as poultry manure, bonemeal and soymeal significantly reduced population of soil borne plant pathogens (Lazarovits, 2001). Different plants like *Sesbania rostrata* is used as soil amendment to control corm rot of gladiolus caused by *F. oxysporum* f.sp. *gladioli.* The plant extracts are able to reduce the incidence of the diseases and incorporation of plant extract into the soil enhanced shoot length and biomass (Riaz *et al.*, 2010). The objective of this present work is to find out the effect of soil amendment on Fusarium wilt of gladiolus.

Materials and method

The experiment was conducted at the Floriculture Field, Horticulture Research Centre (HRC) of Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur during the period of 2009-2011. The experiment was set up in previously *Fusarium oxysporum* infested soil. It was laid out in the Randomized

Complete Block Design (RCBD) with four replications. Treatments were T_1 = Poultry refuse (PR) @ 5t ha^{-1} , T_2 = Mustard oil cake (MOC) @ 600kg ha^{-1} , T_3 = Saw dust @ 5t ha^{-}1, T4 = *Sesbania rostrata* compost @ 5t ha^{-1}, T_5 = Municipal waste compost @ 5t ha^{-1}, T_6 = BARI Tricho-Compost @ 2t ha^{-1}, T_7 =Tricho-Leachate 200ml m^{-2} and T_8 = Control. The organic amendment viz., Poultry refuse (PR), Mustard oil cake (MOC), *Sesbania rostrata* compost, Municipal waste compost were incoporated in soil 25 days before and BARI Tricho-Compost, Leachate, Sawdust burning were incorporated in soil before 5 days of seed sowing. The materials were mixed well with 12-15cm top soil of the field.

The recommended dose of fertilizers cowdung @ 10t/ha, TSP @ 225kg/ha and MoP 190kg/ha were applied to the soil during land preparation and thoroughly mixed with the soil. Urea @ 200kg/ha was top dressed in two equal splits, one at the four leaf stage and another at spike initiation stage (Woltz, 1976).

The unit plot size was 1.25m × 1.6m. Spacing was maintained at 25cm between the rows and 20cm between the plants. Depth of planting of the corms was 6cm. Two adjacent unit plots were separated by 50cm space, and there was 75cm space between the blocks. Germination (%), Plant height (cm) , Spike length (cm), Rachis length (cm), Florets $spike^{-1}$, Flower stick weight (g), Flower sticks $plot^{-1}$, Flower sticks ha^{-1}, Pre-germination-corm rot (%), Wilted plant (%), Disease incidence (%), Percent disease index (PDI), Corms $hill^{-1}$, Corm yield, Cormels $hill^{-1}$ and Cormels yield (g) were rcorded. The disease incidence, disease index and wilted plant were calculated using following formula:

$$\text{Disease incidence (\%)} = \frac{\text{Number of infected plants plot}^{-1}}{\text{Number of total plants plot}^{-1}} \times 100$$

$$\text{Percent disease index (\%)} = \frac{\text{Class frequency}}{\text{Total number of sample x Maximum grade of scale}} \times 100$$

$$\text{Wilted plant (\%)} = \frac{\text{Number of wilted plants plot}^{-1}}{\text{Total number of plants plot}^{-1}} \times 100$$

Data were analysed through MSTAT-C Software. Mean separation was done by DMRT at 5% probability level.

Results and Discussion

All the parameters of vegetative growth of gladiolus due to different types of soil amendments showed significant variations (Table 1). The maximum germination (99.98%) was found in poultry refuse and BARI Trico compost amended plots and minimum corms (93%) were germinated in control.

Table 1. Effect of soil amendments on germination and vegetative growth of gladiolus

Treatments	Germination (%)	Days to 50% germination	Plant height (cm)
Poultry refuse (PR)	99.98 a (10.0)	17 b	39.11 a
Mustard oil cake (MOC)	99 ab (9.97)	20 a	38.57 ab
Saw dust burning (SD)	96 d (9.8)	20 a	37.72 bcd
Sesbania rostrata compost (SRC)	97 cd (9.8)	17 b	38.28 abcd
Municipal waste compost (MWC)	97 cd (9.8)	18 b	37.42 d
BARI Trico-compost (BTC)	99.98 a (10.0)	18 b	37.49 cd
Leachate	98 bc (9.12)	17 b	38.40 abc
Control	93 e (9.62)	20 a	37.39 d
CV%	0.41	3.98	1.56

Means followed by the same letters in a column did not differ significantly by DMRT at the 5% level of probability.

About 17 days were required by the treatment of poultry refuse, *Sesbania rostrata* compost and leachate to 50% corm germination while maximum (20) days needed in the treatment saw dust burning, mustard oil cake and control.

The plant height was 39.11cm in poultry refuse which was identical to mustard oil cake, *Sesbania rostrata* and Leachate. The plants were comperatively short in control, municipal waste, BARI Trico-compost and sawdust.

Sharp variation was recorded on the pre-germination corm rot, severity (PDI) and wilted plant among different types of soil amendments (Table 2). The highest pre-germination corm rot (8.0%) was recorded in control and minimum corm rot (0.50%) was observed in the plot where poultry refuse and BARI Trico-compost (T_6) were used. The pre-germination corm rot ranged from 1.13% to 4.25% in other treatments.

Table 2. Effect of different types of soil amendment on corm rot and Fusarium wilt of gladiolus

Treatments	Pre-germination corm rot (%)	Disease severity (PDI)	Wilted plants (%)
PR	0.50 d	26.25 d	1.75e
	(0.71)	(29.73)	(1.22)
MOC	1.13 d	27.5 c	3.02d
	(0.97)	(30.50)	(1.74)
SD	4.25 b	30.63 b	6.98ab
	(2.04)	(32.40)	(2.63)
SRC	3.63 bc	28.13 c	4.36cd
	(1.89)	(30.88)	(2.07)
MWC	3.63 bc	30.63 b	6.30bc
	(1.89)	(32.40)	(2.50)
BTC	0.50 d	27.5 c	3.63d
	(0.71)	(30.50)	(1.89)
Leachate	2.38 c	28.13 c	6.22bc
	(1.48)	(30.88)	(2.49)
Control	8.00 a	33.13 a	9.71a
	(283)	(33.89)	(3.11)
CV%	17.10	1.35	15.03

Means followed by the same letters in a column did not differ significantly by DMRT at the 5% level of probability.

Percent disease index (PDI) was maximum (33.13%) in control plot and minimum (26.25%) in soil amended by poultry refuse. Other treatments showed similar performance. The wilted plants were 9.71% in control plot, 1.75% in Poultry refuse and 3.02% to 6.98% in other plots.

Eighty eight days required for 50% spike initiation in Poultry refuse, *Sesbania rostrata* and Leachate . The effect of Municipal waste, Mustard oil cake and BARI Trico compost were similar. The maximum days (90) required for the control treatment to reach 50% spike initiation (Table 3). The poultry refuse produced the longest spike (73.90cm) and the control plot gave the shortest spike (66.68cm).

Poultry refuse and BARI Trico compost produced 12.63 florets spike^{-1}. The number of florets spike^{-1} was 11.50 in sawdust followed by control. The weight of flower stick was 67.75g in poultry refuse and 61.45g in control. The range of stick weight of other treatments was 62.0g to 66.90g. The higher number of flower sticks plot^{-1} was 38.75 in poultry refuse and lower number was 33.75 in control plot.

Table 3. Effect of soil amendments on flower characters of gladiolus

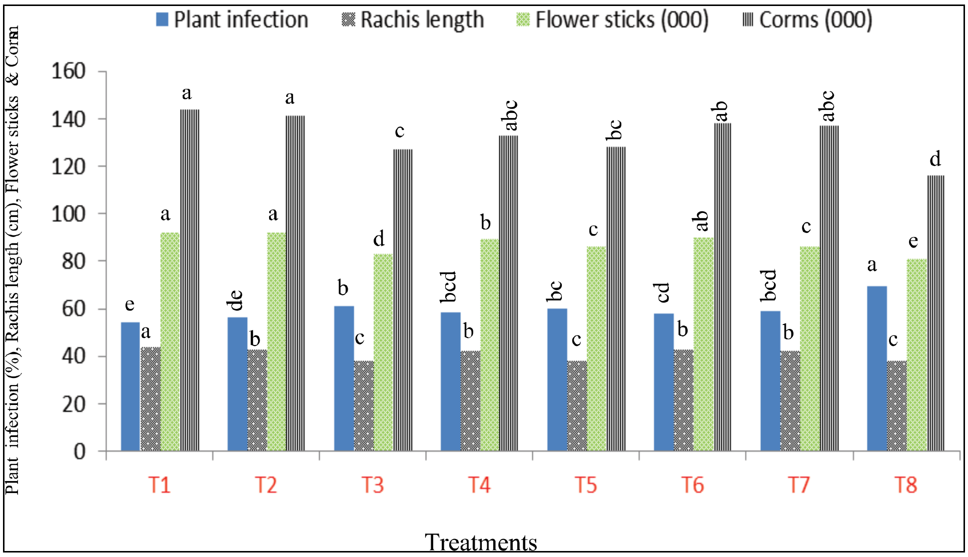
Treatments	Days to 50% spike initiation	Spike length(cm)	Florets spike^{-1}	Flower stick weight (g)	Flower sticks plot^{-1}
PR	88 bc	73.90 a	12.63 a	67.75 a	38.75 a
MOC	89 abc	72.58 b	12.38 ab	66.90 b	38.50 ab
SD	90 a	67.54 f	11.50 c	62.00 e	34.75 e
SRC	88 c	71.63 c	12.38 ab	66.38 b	37.50 c
MWC	89 abc	68.50 e	11.82 bc	62.75 d	36.00 d
BTC	89 abc	72.00 c	12.63 a	66.63 b	38.00 bc
Leachate	88 bc	69.50 d	11.83 bc	65.50 c	36.25 d
Control	90 a	66.68 g	11.53 c	61.45 e	33.75 f
CV%	1.11	0.55	3.34	0.71	1.28

Means followed by the same letters in a column did not differ significantly by DMRT at the 5% level of probability.

The highest incidence of plant infection (69.25%) was observed in control which produced the shortest rachis (37.63cm) (Fig. 1). The lowest infection was recorded in soil amended by Poultry refuse (54.50%) where longest rachis 43.70cm, number of flower sticks 92000 and corms 144,000 ha^{-1} was produced. Mustard oil cake also showed better performance as a soil amendment regarding disease incidence where rachis length was 42.50cm, number of flower sticks 91500 and corms 141,000 ha^{-1}.

Number of flower sticks, corms ha^{-1} and rachis length was minimum (116,000) in control plots where plant infection was high.

Number of corms hill^{-1} was insignificant among the treatments of soil amendment. Weight of individual corm varied significantly among the treatments where the weight (17.75 g) was maximum in Poultry refuse and minimum (14.83 g) in control. Diameter of individual corm was comperatively large (3.87cm) in Poultry refuse which was statistically similar to other treatments. Lowest diameter was 3.48cm in control. Number of corm plot^{-1} ranged from 53 – 60 among the amended plots though control plot gave only 49 corms plot^{-1}.



T_1= Poultry refuse (5t ha^{-1})
T_2= Mustard oil cake (600kg ha^{-1})
T_3= Saw dust burning (5t ha^{-1})
T_4= *Sesbania rostrata* compost (5t ha^{-1})
T_5= Municipal waste compost (5t ha^{-1})
T_6= BARI Trico-compost (2t ha^{-1})
T_7= Leachate (200ml m^{-2})
T_8= Control

Fig. 1. Effect of different types of soil amendment on the plant infection (%), rachis length (cm), flower and corm (ha^{-1}) of gladiolus.

Table 4. Effect of different types of soil amendments on corm production of gladiolus

Treatments	Corms hill^{-1}	Corm weight (g)	Corm diameter (cm)	Corms plot^{-1}
PR	1.53	17.75 a	3.87 a	60 a
MOC	1.53	17.00 a	3.78 ab	59 a
SD	1.48	15.25 cd	3.58 bc	53 c
SRC	1.50	16.63 abc	3.76 ab	56 abc
MWC	1.48	15.45 bcd	3.60 bc	54 bc
BTC	1.50	16.75 ab	3.75 ab	58 ab
Leachate	1.50	16.75 ab	3.64 abc	57 abc
Control	1.45	14.83 d	3.48 c	49 d
CV%	5.34	5.51	4.40	4.99

Means followed by the same letters in a column did not differ significantly by DMRT at the 5% level of probability.

Significant variation was observed in cormel production of gladiolus by different types of soil amendments (Table 5). The number of cormels hill^{-1} was higher (22.13) in the Poultry refuse and lower (16.75) in control. Weight of cormels hill^{-1} was 21.25g in control plot which was enhanced in amended plots. The cormel yield plot^{-1} was 1053g and yield ha^{-1} was 2.51t in Poultry refuse. BARI Trico compost produced cormel of 1008g plot^{-1} and 2.40t ha^{-1}, respectively. The other amended plots produced lower yield of cormel. Cormel yield plot^{-1} and ha^{-1} was 711g and 1.70t, respectively in control plots.

Table 5. Effect of different types of soil amendments on cormel production of gladiolus

Treatments	Cormels hill^{-1}	Cormel weight hill^{-1} (g)	Cormel yield plot^{-1} (g)	Cormel yield ha^{-1} (t)
PR	22.13 a	26.00 a	1053 a	2.51 a
MOC	21.25 a	25.63 ab	994 a	2.37 a
SD	18.00 bc	23.88 b	860 c	2.05 c
SRC	20.00 ab	26.10 a	972 ab	2.32 ab
MWC	19.50 ab	24.13 ab	881 bc	2.10 bc
BTC	21.50 a	26.00 a	1008 a	2.40 a
Leachate	19.75 ab	25.13 ab	855 c	2.04 c
Control	16.75 c	21.25 c	711 d	1.70 d
CV%	8.90	4.89	7.79	7.75

Means followed by the same letters in a column did not differ significantly by DMRT at the 5% level of probability.

Eight soil amendments such as Poultry refuse (5 t ha^{-1}), Mustard oil cake (600 kg ha^{-1}), *Sesbania rostrata* (5 t ha^{-1}), Municipal waste compost (5t ha^{-1}), BARI Trico- compost (2t ha^{-1}), Leachate (200 ml m^{-2}) were tested for controlling Fusarium wilt of gladiolus. Poultry refuse was very effective in inhibiting the disease resulting maximum germination (99.98%), spike length (73.90 cm), rachis length (43.70 cm), florets spike^{-1} (12.63), flower sticks plot^{-1} (38.75) and corm plot^{-1} (60.23) and comel yield ha^{-1} (2.51 t). Lazarovits (2001) found that poultry manure, meat and bone meal and soymeal significantly reduced population of soil-borne plant pathogen. Mustard oil cake and BARI Trico compost were also effective in inhibiting the disease and resulting better spike length, rachis length, florets spike^{-1}, flower sticks plot^{-1} and corm plot^{-1} and comel yield. Sultana and Ghaffar (2010) reported that *F. solani* infested seeds of bottle gourd, cucumber and biter gourd reduced seedling mortality and root infection when sown in mustard and neem cake amended soil. Raj and Kapoor (1996) also reported that groundnut and mustard oil cake at 2% concentration of soil (w/w) were most effective in reducing pathogen population (>70%) and disease incidence of Fusarium wilt of tomato. Mishra *et al.* (2004) reported that an isolate of *Trichoderma virens* significantly reduced the pathogen of corm rot and wilt of gladiolus. Walid *et al.* (2010) proved that *T. harzianum* was more efficient to control *F. oxysporum* f. sp. *gladioli* corm rot of gladiolus and enhanced plant growth, increased flower production and quality. *Sesbania rostrata* compost was also effective in inhibiting the disease. Riaz *et al.* (2010) reported the incorporation of leaves of some plant species significantly reduced the disease incidence and number of lesions on corms and enhanced shoot length and biomass.

Conclusion

Poultry refuse (5 t ha^{-1}) was highly effective to combate Fusarium wilt of gladiolus resulting maximum germination, spike length, rachis length, florets $spike^{-1}$, flower sticks $plot^{-1}$ and corm $plot^{-1}$ and comel yield. Mustard oil cake and BARI Trico compost were also effective in inhibiting the disease and resulting quality flower of gladiolus.

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