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Impact of organic manures on progression of common scab and potato yield

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ABSTRACT

There were five different organic matter (Mustard oil cake, Neem oil cake, Poultry refuse, Annapurna jaibo sar and Cow dung) and their different doses were evaluated over control (only chemical fertilizers) against common scab disease of potato in heavily common scab infested sandy loam soil in Rangpur sadar, Rangpur during 2008-09 and 2009-10 cropping season. The initial pH of that soil was 5.3. Susceptible potato variety (Diamant) was considered in this study. All organic fertilizers except cow dung significantly reduced disease incidence and severity over control treatment (chemical fertilizer) in both cropping seasons. The lowest disease incidence (8.88% and 7.25% in 2008-2009 and 2009-2010, respectively) and severity index i.e., percent disease index (1.97 and 1.65 in 2008-2009 and 2009-2010, respectively) were found in Annapurna Jaibo sar used plots. The significantly highest disease incidence (24.44% and 28.99% in 2008-2009 and 2009-2010, respectively) and severity index (7.23 and 8.30 in 2008-2009 and 2009-2010, respectively) were recorded in cow dung used plots. For tuber yield, organic matters were not significantly different from each other but differed significantly with only chemical fertilizer used treatment. Annapurna jaibo sar yielded the highest in both cropping seasons. The highest yield was 28.82 t ha^{-1} and 27.76 t ha^{-1} in 2008-2009 and 2009-2010 cropping seasons, respectively. A higher dose of each organic amendment was observed to be more effective for managing common scab and increasing yield.

***Key words**: Common scab, Disease incidence, Disease severity, Percent Disease Severity (PDI), Mustard oil cake, Neem oil cake, Poultry refuse, Annapurna jaibo sar and Cow dung*

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I. Introduction

With a total of 9.254 million tons harvested from 0.471 million hectares of land between October and March, potatoes have become one of Bangladesh's most lucrative winter crops. Bangladesh has the

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second-highest total area under potato cultivation and production in the world, behind only China (Anon., 2016). In Bangladesh, potatoes are typically consumed raw. It spreads all over the country but thrives in the north, northwest, and central regions. The disease burden on potatoes is the highest among the major food crops (Agrios, 1997). Fifty different potato diseases have been uncovered; these are the primary cause of significant yield loss in Bangladesh. Potatoes are susceptible to a wide range of diseases, the worst of which are late blight, common scab, bacterial wilt and viral diseases (Hossain et al., 2002 and Anon., 2008). According to Loria et al. (2006) and Wanner (2004), common scab is the fourth most prevalent potato disease in the United States, but it is native to and the most important disease in all of the world's potato-growing areas (Loria et al., 1997). In the United States of America alone, the disease costs millions of dollars every year (Anon., 1988). The common scab disease of potatoes has a significant economic impact in both North America and Europe (Labruyere, 1971 and Loria et al., 1997). The common scab of potato was ranked as the third most worrying disease by Canadian potato farmers in a survey, behind late blight and bacterial ring rot (William, 2012). Most of India's potato fields have fallen victim to the disease, which has become a major obstacle to the country's once-prolific potato crop (Mishra and Srivastava, 2001). One of the most pervasive and devastating potato diseases in Bangladesh is common scab, caused by *Streptomyces scabies* (Thaxt.) Waksman and Henrici (Talukdar, 1974 and Ali and Dey, 1995). Previously, Bangladesh was not a country that could export potatoes, but that is changing. The potato blight poses a significant risk to the country of Bangladesh's potato crop.

Plants and plant products (organic amendments, crop residues and green manures) can have a significant impact on soil microbial communities and are primary drivers of soil microbial dynamics (O'Donnell et al., 2001; Van Elsas et al., 2002 and Garbeva et al., 2004). There is evidence that crop rotation and residue amendments can significantly alter the composition of soil microbes, leading to a decrease in the prevalence of soil-borne diseases (Davis et al., 1996; Abawi and Widmer, 2000; Bailey and Lazarovits, 2003). Multiple potato soil-borne diseases may be mitigated by using brassica rotations and green manures (Larkin and Griffin, 2007). By releasing allelochemicals generated during product storage or subsequent microbial decomposition, the application of organic amendments, manures and composts rich in nitrogen may reduce soil-borne diseases (Bailey and Lazarovits, 2003). For many diseases, such as verticillium wilt and common scab of potato, the mechanisms of disease suppression are made clear. Common scab of potato (*Streptomyces scabies*) can be effectively managed by using an organic amendment (poultry manure@2 MT/ha) with bio-agent Pseudomonas fluorescens or 3% boric acid (Chaudhari et al., 2003). The application of sawdust at 2.0, 2.5 and 3.0 t ha^{-1} 15 days prior to planting significantly reduced the development of common scab and increased tuber yield (Saha et al., 1997). Increasing the amount applied increased both scab control and yield.

However, Rowe (1993) warned that adding animal waste to soil could lead to an increase in the prevalence of common scab. Common scab can become extremely severe after manure application because *S. scabies* is able to survive the journey through the digestive systems of animals and is then spread with manure (Powelson et al. 1993). This led researchers in AEZ-3 with sandy loam soil to investigate the efficacy of various organic amendments in combating common scab of potatoes.

II. Materials and Methods

The trial was carried out in known common scab infested sandy loam soil in Atiatari village, Rangpur Sadar, Rangpur during the winter seasons of 2008-2009 and 2009-10. The topography of the field is medium highland. Popular but susceptible potato variety Diamant was planted 25 November, 2008 for experimental year 2008-2009 and 27 Nov., 2009 for experimental year 2009-2010. The experiment was comprised of 10 (ten) treatments where, T_1= Mustard oil cake (MOC) 0.5 t ha^{-1}, T_2= MOC 1.0 t ha^{-1}, T_3= Neem Oil cake (NOC) 0.5 t ha^{-1}, T_4= NOC 1.0 t ha^{-1}, T_5= Poultry refuse (PR) 3.0 t ha^{-1}, T_6= PR 4.0 t ha^{-1}, T_7= PR 5.0 t ha^{-1} T_8= Annapurna jaibo sar 1.0 t ha^{-1}, T_9= Cow dung 10 t ha^{-1} and T_{10}= Only chemical fertilizers. Organic manures were applied in the soil and mixed thoroughly with soil in the experimental plots 15 (fifteen) days before seed plantation. Annapurna Jaibo sar (organic fertilizer) mainly made of mustard oil cake, saw dust, poultry refuse, rice and wheat straw, bone meal and pressmud of sugar mill. The experiment was laid out following Randomized Complete Block Design (RCBD) with three replications. Unit plot size was 3 m x 3 m and seed spacing was 60 cm x 25 cm. Each plot received fertilizers like Urea, TSP, MoP, Gypsum, Magnesium sulphate and Zinc sulphate @ 320-200-250-120-100-10 kg ha^{-1} as recommended by Tuber Crops Research Center (TCRC), BARI.

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Considering the requirement of the experiments, three irrigations were applied at the time of 15 DAP, 35 DAP and 55 DAP. While irrigating the potato field, the water level was always maintained below half of the ridge height. Agronomic practices were done properly and plant protection measures were taken against diseases and pest attack except common scab of potato. Haulm pulling was done 90 DAP and tubers were harvested 10 days after haulm pulling. Data on disease incidence and severity or percent disease index (PDI) of common scab on tubers were recorded following standard procedure. The incidence of scab in terms of percent of scabbed tubers was calculated from the tubers of middle eighteen hills in each plot by the following formula:

$$\text{Incidence (\%)} = \frac{\text{Infected tuber}}{\text{Number of tuber counted}} \times 100$$

The severity of the disease and Percent Disease Index (PDI) were recorded. The severity was indexed on a scale of 0-5 (Sharma, 1984) where, 0 = No scabbed area on the surface of potato tuber, 1 = Trace to 10% scabbed area, 2 = > 10-20% scabbed area, 3 = > 20-30% scabbed area, 4 = > 30-50% scabbed area and 5 = above 50 % scabbed area.

Using this index values, PDI was computed as follows:

$$\text{PDI} = \frac{\text{Class frequency}}{\text{Number of tuber counted} \times \text{Maximum value of the scale}} \times 100$$

Data on different parameters were analyzed following statistically computer package MSTAT-C and means were compared using Duncan's Multiple Range Test (DMRT).

III. Results and Discussion

All organic fertilizers except cow dung significantly reduced disease incidence and severity over control treatment (T_{10}) (chemical fertilizer) in both cropping seasons (Table 01). The significantly highest disease incidence (24.44% and 28.99% in 2008-2009 and 2009-2010, respectively) and severity index (7.23 and 8.30 in 2008-2009 and 2009-2010, respectively) were recorded in T_9 (cow dung) treatment. In the year 2008-2009, the lowest disease incidence (8.88%) and severity index (1.97) were observed in T_8 (Annapurna Jaibosar) and it was statistically similar to higher dose of mustard oil cake (1.00 t ha^{-1}) and neem oil cake (1.00 t ha^{-1}) for incidence and statistically similar with only T_2 (MOC 1.00 t ha^{-1}) for PDI. In the year 2009-2010, the lowest incidence (7.25%) and severity (1.65) were also recorded in T_8 which were statistically similar to mustard oil cake used treatments (T_1 and T_2), while T_8 was found only similar with higher dose of mustard oil cake treated plot (T_2) in respect of PDI.

There was no statistical difference among the organic fertilizers on yield under both the crop seasons, but they differed significantly with T_{10} (chemical fertilizer) treatment. Among the treatments, Annapurna jaibo sar (T_8) yielded the highest in both cropping seasons. The highest yield was 28.82 t ha^{-1} and 27.76 t ha^{-1} in 2008-2009 and 2009-2010 cropping seasons, respectively (Table 01). Under this study it was found that disease incidence and severity of common scab significantly managed by mustard oil cake, neem oil cake, poultry refuse and Annapurna Jaibo sar (mainly made of mustard oil cake, saw dust, poultry refuse, rice and wheat straw, bone meal and press mud of sugar mill) and increased yield. This findings are similar with the findings of Faqir et al. (1995); Saha et al. (1997); Lazarovits et al. (2001); Conn et al. (2002); Bailey and Lazarovits (2003); Chaudhari et al. (2003); Mishra and Srivastava (2004) and Hilton et al. (2006).

The common scab of potato was reduced thanks to the allelochemicals released by nitrogen-rich organic amendments (Bailey and Lazarovits, 2003). Poultry manure at 2 MT ha^{-1} with bio-agent *Pseudomonas fluorescens* or with 3% boric acid was recommended for controlling common scab of potato (*Streptomyces scabies*) by Chaudhari et al. (2003). Soybean green manuring combined with partially decomposed wheat straw was found to be the most effective by Mishra and Srivastava (2004). When applied alone or in combination with urea and ammonium nitrate, organic amendments (dried stems of wheat, rice, maize, cowpea, lucerne and soybean) significantly reduced common scab of potato, as reported by Faqir et al. (1995).

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Table 01. Effect of organic manures on the incidence, severity of common scab and yield of potato variety Diamant

Treatment	Year					
	2008-2009			2009-2010		
	Disease incidence (%)	PDI	Yield (t ha^{-1})	Disease incidence (%)	PDI	Yield (t ha^{-1})
T_1 (MOC 0.50 t ha^{-1})	11.15 de	2.75 e	27.12 a	9.34 e	2.49 ef	25.25 a
T_2 (MOC 1.00 t ha^{-1})	9.35 ef	2.16 f	28.57 a	8.16 e	1.92 fg	27.70 a
T_3 (NOC 0.50 t ha^{-1})	12.48 cd	3.41 cd	26.52 a	15.97 c	4.18 c	24.97 a
T_4 (NOC 1.00 t ha^{-1})	10.75 def	2.79 e	27.40 a	12.15 d	3.05 de	26.69 a
T_5 (PR 3.00 t ha^{-1})	13.69 c	3.83 c	26.84 a	16.22 c	4.36 c	24.89 a
T_6 (PR 4.00 t ha^{-1})	12.28 cd	3.39 cd	27.97 a	14.13 cd	3.49 d	26.04 a
T_7 (PR 5.00 t ha^{-1})	11.35 de	3.01de	28.40 a	13.49 cd	3.43 d	27.47 a
T_8 (An. Jb. 1.00 t ha^{-1})	8.88 f	1.97 f	28.82 a	7.25 e	1.65 g	27.76 a
T_9 (Cowdung 10.00 t ha^{-1})	24.44 a	7.23 a	26.08 a	28.99 a	8.30 a	24.51 a
T_{10} (Chemical fertilizers)	16.25 b	4.62 b	20.79 b	19.98 b	5.74 b	18.62 b
CV (%)	8.25	9.48	5.61	10.34	9.53	7.19
Level of sig.	*	*	*	*	*	*

Means followed by the same letter(s) within a column did not differ significantly at 5% level by DMRT. sig. = significant; MOC = Mustard oil cake, NOC = Neem oil cake, PR = Poultry refuse and An. Jb. = Annapurna Jaibo sar

Higher doses of each organic amendment were found to be more successful in this study at controlling common scab and boosting yield (Saha et al., 1997). The quantity of organic amendments applied directly correlated with the level of scab control and yield. According to Conn et al. (2002), using 10 t ha^{-1} of the organic fertilizer "Nature Safe" (primarily made of chicken feathers) significantly reduced common potato scab and increased marketable yield. Lazarovits et al. (2001) noted that specific organic amendments managed a number of potato soil-borne diseases (including common scab). The production of ammonia and/or nitrous acid after the degradation of the amendments by microorganisms is the mechanism of disease control for high nitrogen-containing amendments. The soil pH, organic matter content, nitrification rate, sand content and buffering capacity all play a role in determining the concentrations of these products that are lethal to pathogens. According to research by Hilton et al. (2006), rapeseed meal use decreased the frequency and severity of common scab in daughter tubers. Rapeseed meal is thought to have some biofumigation properties. Rapeseed meal contains glucosinolates, which upon addition to the soil may decompose to yield the anti-microbial compounds isothiocyanates. The results of the current investigation showed that using cow dung as organic manure increased disease incidence and severity. Numerous researchers agreed with this observation (Christ 1998; Loria 1991; Rowe 1993 and Sturz and Clark 2007). Following the application of manure, common scab is frequently severe and *S. scabies* is spread with manure after surviving passage through an animal's digestive tract. For the purpose of reducing common potato scab, Chirst (1998) advised against using animal manure in potato fields. Avoid applying animal manure to potato fields, especially if the animals were fed scabby potatoes, according to Sturz and Clark (2007). According to Loria (1991), spreading manure on potato fields may increase scab infections.

IV. Conclusion

It might be concluded that among other organic fertilizers, 'Annapurna Jaibo sar' perform best to minimize disease severity and incidence of common scab and produce the highest marketable tuber yield of potato.

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