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Assessment of diseases on rice (*Oriza sativa* L.) in major growing fields of Pawe district, Northwestern Ethiopia

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ABSTRACT

Disease survey was carried out on 37 rice fields in Pawe woreda of Metekel zone to evaluate the prevalence and distribution of different diseases on rice. 0.5m by 0.5m ($0.25m^2$) quadrates was used to assess the type of diseases prevailed in the field. Disease prevalence was calculated as the proportion or percentage of fields showing the disease, out of the total number of fields assessed. Disease incidences were determined as the proportion of plants showing symptoms, expressed as a percentage of the total number of plants assessed. The diseases prevalence, incidence and severity were leaf blast showed the highest prevalence, incidence as well as severity rate 80.08, 75 and 5.2%, respectively at vegetative growth stage as compared to other diseases. From vegetative to heading growth stage leaf blast, panicle blast and bacterial panicle blight were radically increased in prevalence, incidence and severity percentage; leaf blast recorded 80.08, 75, 5.2% at vegetative while 100, 96 and 7.21%, respectively at heading, panicle blast recorded 13.51, 11.15, 1.15 at vegetative while 100, 100 and 10.3% at heading stage and bacterial panicle blight was recorded 9.67, 13.46, 0.9% at vegetative while 21.2, 32.3 and 4.2%, respectively at heading growth stage. In general, the future rice diseases management research direction should be on the diseases with high incidence and severity such as leaf blast, panicle blast and bacterial panicle blight.

***Keywords*:** disease; distribution; incidence; *Oriza sativa*; prevalence; severity

1. INTRODUCTION

Rice (*Oriza sativa* L.) is by far the most economically important food crop in many developing countries, providing two thirds of the calory intake of more than 3 billion people in Asia, and one third of the calory intake of nearly 1.5 billion people in Africa and Latin America (FAO, 1995). Recently, in several developed countries such as North America and European Union, rice consumption has increased due to food diversification and immigration (Faure and Mazaud, 1996). It is the principal food grain consumed by almost half of the world's population (Khush, 2005), making it the most important food crop currently produced (Cottyn *et al*., 2001).

Rice is increasingly becoming a regular staple for the populations of Sub-Saharan Africa (SSA). Its availability and prices impact directly on the welfare of the poorest consumers in the region, many of whom are resource poor farmers depending on rice as both a staple food and a source of income. It is therefore not surprising that rice is a major component of the food security and poverty alleviation strategies of many SSA countries. Against this background, any improvement in rice productivity will contribute significantly to achieving a higher level of regional and household food security, while responding to the needs of the poorest by enhancing their diet both quantitatively and qualitatively and by providing additional income opportunities (Seck *et al*., 2012).

Rice is a recent introduction in Ethiopia; however, its importance is being well recognized in the country as the area coverage of 18,000 ha and total production of 42,000 tons in 2006 has increased in 2009 to 155,000 ha and 496, 000 tons, respectively (MoARD, 2010). Rice production has brought a significant change in the livelihood of farmers and created job opportunities for a number of citizens in different areas of the country. The demand for improved rice technologies is increasing from time to time from different stakeholders. Based on GIS techniques and agro-ecological requirements of rice, the potential rain-fed rice production area in Ethiopia is estimated to be about 30 million hectares. Rice is compatible with various traditional food recipes like bread, soup, "*enjera*", and local beverages like ("*tela*" and "*areki*") (MoARD, 2010).

It is currently challenged by different biotic and abiotic factors. The biotic factors like fungi, bacteria, virus and nematode diseases have been reported on rice crop in the world. Diseases are considered major constraints in rice production and responsible for losses in quantity and quality of harvested produce. Important diseases cause crop damage severe enough to make control measures an economic necessity. Estimated losses can range from 1-100% depending on the nature of the disease, stage of plant growth at infection, resistance of the variety, management and weather conditions. A susceptible host plant, a virulent pathogen and a favorable environment are the three factors composing the plant disease triangle (John and Fielding, 2014).

All three factors are necessary for development of a plant disease; thus, disease can be affected by altering any of these three factors. Diseases cause the alters of the normal physiological activity of a plant; that affects some or all plant functions and may reduce the quality and/or quantity of the harvested product (Mueller *et al*., 2010). But limited research has been conducted in this area and the status of reported on diseases of this crop is not well understood. Thus, this study was proposed: To identify and prioritize major rice diseases in Pawe woreda of Metekel zone and to determine the prevalence and distribution of these diseases in the area.

2. MATERIALS AND METHODS

2. 1. Description of the study area

The survey was conducted during 2015/16 cropping season of one major rice growing woreda of Metekel zone *i.e.* Pawe. The site was located Northwest Ethiopia in Benishangul-gumuz regional state. The altitude, annual rainfall and average minimum and maximum temperature of Pawe woreda is 1100 masl, 1586.31 ml, 16.9 °C and 32.5 °C, respectively.

2. 2. Survey of rice diseases

Surveys were conducted during August and September 2015 to determine the incidence and distribution of rice diseases in Pawe woreda of Metekel zone.

2. 3. Disease assessment

0.5 m by 0.5 m quadrates were used to assess the type of diseases prevailed in the field. This was conducted at 5 km intervals right and left of the main road, four farmers field at each stoppage and five samples from each field was taken. A total of 37 farmer's field and 185 quadrates were surveyed in the woreda. Type of diseases, number of plants infected and severity of each disease was recorded in each quadrates. GPS reading of each field, previous crop, variety of the crop and soil type were also recorded. Disease prevalence was calculated as the proportion or percentage of fields showing the disease, out of the total number of fields assessed (Mounde *et al*., 2009).

$$\text{Disease Prevalence} = \frac{\text{Number of fields with the disease x100}}{\text{Total number of fields assessed}}$$

Disease incidence also was determined as the proportion of plants showing symptoms, expressed as a percentage of the total number of plants assessed. Disease incidence was calculated using the following formula (Teng and James, 2002).

$$\text{Disease incidence (DI)} = \frac{\text{Number of infected plant units x100}}{\text{Total number of units assessed}}$$

During assessment, the disease severity was recorded as percentage of infection directly from the field.

2. 4. Growth stage and disease identifications

The scouting was carried out at the vegetative and heading growth stage. Disease identification was done based on information on related symptoms on the internet and using rice diseases identification field guides (Hodgson *et al.*, 2011).

3. RESULT AND DISCUSSION

3. 1. Survey of rice diseases

3. 1. 1. Panicle blast

Lesions typically are spindle-to diamond-shaped. Single or several florets on a panicle branch turn light brown to straw colored; floret stem with brown lesion; grain stops developing and florets turns gray. In the early of infection spots were small and brown; and gradually increased into irregular-shaped and dark brown (Fig. 1). The occurrence of the blast disease is favored by extended periods of free moisture on plant surfaces and temperatures at night between 63-73^{o}F with little or no wind and high relative humidity (RH). Conidia are produced and released under high RH with no spore production below 89% RH. Leaf wetness or free moisture from dew or other sources is required for infection to occur. Optimum temperature for germination, infection, lesion formation and sporulation are 77-82^{o}F (Fakorede and Yoboué, 2001).

3. 1. 2. Leaf blast

The lesions due to this disease appear on leaves. The tips of leaf lesions are typically spindle-shaped to diamond-shaped spots, wide in the center and pointed at the ends (Fig. 2). Lesion size varies from small to large with the most commonly observed field lesions having a reddish brown border and off-white to tan center. Blast spores need free moisture on the plant to cause infection, the disease is favored by long dew periods (9 plus hrs), increased by fog, shade or frequent light rain and become worse when temperature is slightly cooler (Liu *et al*., 2007).

3. 1. 3. Bacterial panicle blight

The disease is first detected as a light to medium brown discoloration of the lower third to half of hulls shortly after emergence. The stem below the infected grain remains green. Pollination occurs, but the grain aborts sometime after grain filling begins (Fig.3). Over time, diseased grains become gray to black or pink because of growth of secondary fungi.

Figure 1. Symptoms of panicle blast on the panicle of rice.

Figure 2. Leaf blast on the upper leaf surface and field of rice.

Figure 3. Bacterial panicle blight on the leaves and panicle of rice.

The disease tends to develop in circular patterns with the most severely affected panicles in the center remaining upright because of grain not filling (Gonzalez *et al*., 2007). As the disease appears at early stages, there is often a large, reddish-brown lesion on the flag leaf sheath that may result in the death of the flag leaf and also panicle branch below grain remains green; single to all florets turn brown on lower part of grain, grains stops developing and florets turns gray. During grain fill, depending on diseases severity, cluster of panicles do not fill out and turn over because they are blanked. Color of the blanked grain is uniformly tan at first, but it later turns a grayish color as other microorganisms invade (Gnanamanickam *et al*., 1999).

The disease is associated with hot, dry weather. Losses include reduced yields and poor milling with loss estimates ranging from a trace to 70%. The bacteria are seed-borne and have caused seedling blights in many countries. The bacteria appear to survive on the plant as an epiphytic population on the prevalence, incidence and severity of rice diseases leaf and leaf sheath and follow the canopy up. This population infects the grain at flowering and causes grain abortion and rotting during grain filling (Gnanamanickam *et al*., 1999).

3. 2. Prevalence, incidence and severity of rice diseases

At the time of survey panicle blast, leaf blast, brown spot, sheath blight, bacterial panicle blight, sheath spot and bacterial leaf strike on rice crop were identified. Disease identifications were conducted based on the books of field guide of rice diseases (Hodgson *et al*., 2011) and literatures of rice diseases on the internet.

The disease leaf blast showed the highest prevalence, incidence as well as severity rate of 80.08, 75 and 5.2%, respectively at vegetative growth stage compared to other diseases (Table 1). However, at head setting growth stage the disease panicle blast recorded the highest severity percentage (10.3%).

Table 1. The prevalence, incidence and severity of rice diseases at vegetative growth stage.

No.	Type	Prevalence (%)	Incidence (%)	Severity (%)
1	Panicle blast	13.51	11.15	1.10
2	Leaf blast	80.08	75.00	5.20
3	Brown spot	32.43	46.15	1.40
4	Sheath blight	56.75	69.23	2.70
5	Bacterial panicle blight	9.67	13.46	0.90
6	Sheath spot	21.62	25.00	1.60
7	Bacterial leaf strike	32.64	21.15	0.80

Table 2. The prevalence, incidence and severity of rice diseases at heading growth stage.

No.	Type	Prevalence (%)	Incidence (%)	Severity (%)
1	Panicle blast	100.00	100.00	10.30
2	Leaf blast	100.00	96.00	7.21
3	Brown spot	47.83	74.00	1.90
4	Sheath blight	62.16	42.30	2.90
5	Bacterial panicle blight	21.20	32.30	4.20
6	Sheath spot	16.21	28.84	1.71
7	Bacterial leaf strike	35.13	46.15	1.10

Table 3. Type of diseases and the percentage of their severity and incidence on rice.

No.	Diseases		Growth stage			
	Type	Causal agent	Vegetative		Heading	
			DI (%)	DS (%)	DI (%)	DS (%)
1	Panicle blast	*Pyricularia oryzae*	11.15	1.10	100.00	10.30
2	Leaf blast	*Pyricularia oryzae*	75.00	5.20	96.00	7.21
3	Brown spot	*Cochliobolus miyabeanus*	46.15	1.40	74.00	1.90
4	Sheath blight	*Rhizoctonia solani*	69.23	2.70	42.30	2.90
5	Bacterial panicle blight	*Burkholderia glumae*	13.46	0.90	32.30	4.20
6	Sheath spot	*Rhizoctonia oryzae*	25.00	1.60	28.84	1.71
7	Bacterial leaf strike	*Xanthomonas oryzae* pv. *oryzicola*	21.15	0.80	46.15	1.10

** DI and DS = disease incidence and severity, respectively

at heading stage followed by leaf blast, recorded 7.21%. Blast diseases become worse when temperature is slightly cooler and humidity becomes high.

During periods of wet spring weather spores (conidium) produced on crop residues, infected rice and seed are splashed or blown to leaves and panicles on rice plants where they cause infection (AfricaRice, 2010). In both growth stages the lowest disease severity was recorded on the disease bacterial leaf strike 0.8 and 1.1% (Table 1).

From vegetative to heading stage diseases leaf blast, panicle blast and bacterial panicle blight were radically increased in prevalence, incidence and severity percentage; leaf blast recorded 80.08, 75, 5.2% at vegetative growth stage while 100, 96 and 7.21%, respectively at heading stage, panicle blast recorded 13.51, 11.15, 1.1% at vegetative while 100, 100 and 10.3%, respectively at heading and bacterial panicle blast was recorded 9.67, 13.46, 0.9% at vegetative while 21.2, 32.3 and 4.2%, respectively at heading stage (Table 1,2). In vegetative to heading stage the temperature was become cooler and blast is favored by relatively cooler temperature and wet weather condition. Spores are spread to and infect rice during periods of high humidity or moisture and relatively cool temperatures (ASARECA, 2011).

3. 3. Disease severity and growth stage

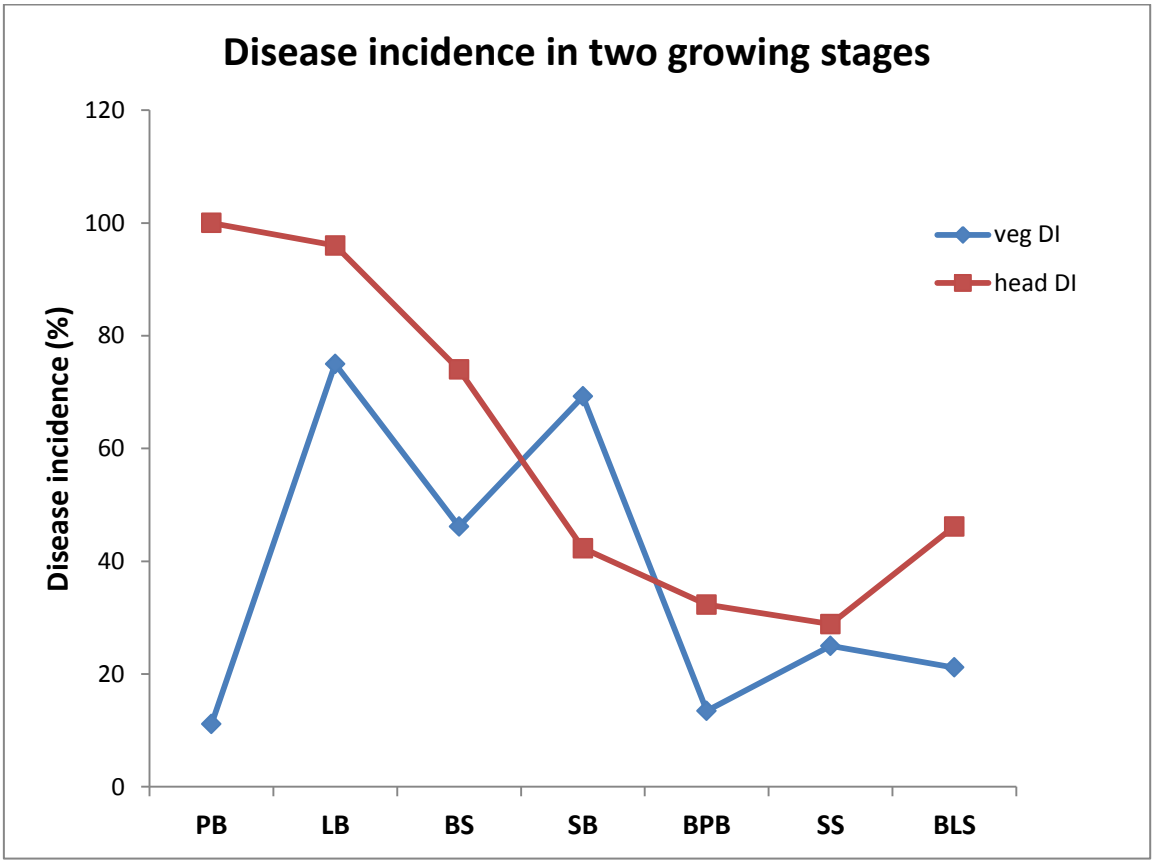
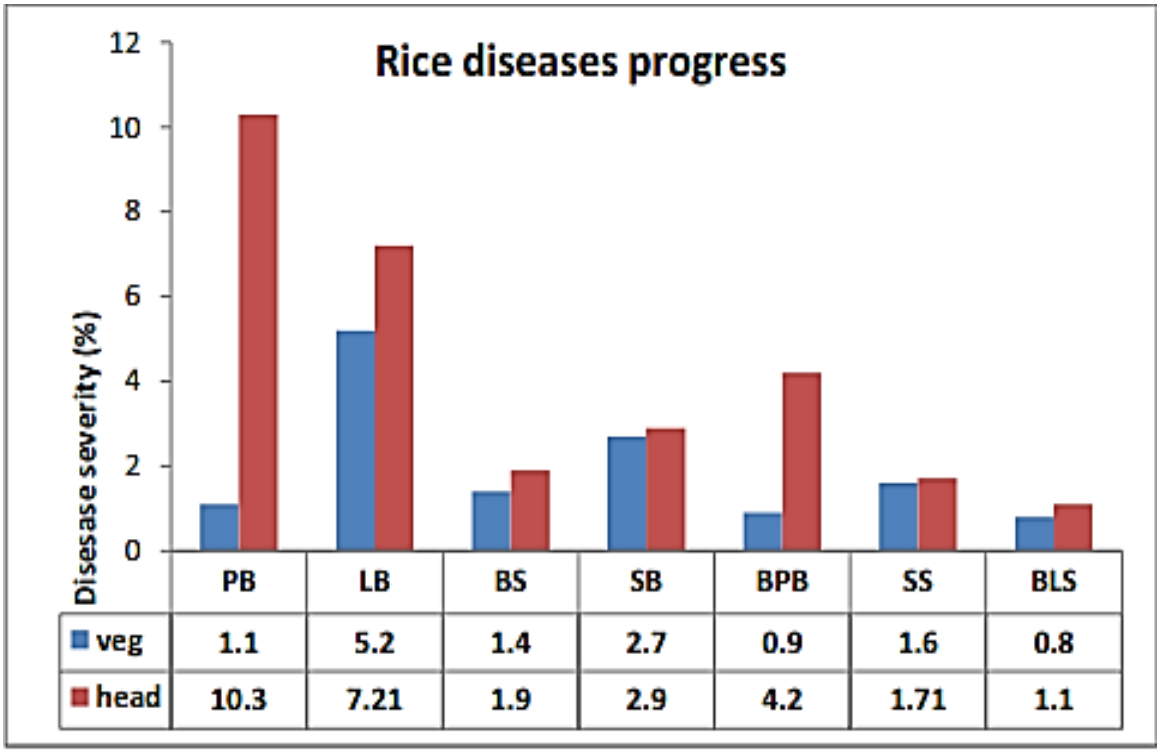


Figure 4. The disease incidence in two growing stages of rice at Pawe.



	PB	LB	BS	SB	BPB	SS	BLS
veg	1.1	5.2	1.4	2.7	0.9	1.6	0.8
head	10.3	7.21	1.9	2.9	4.2	1.71	1.1

Figure 5. The disease severity level in vegetative and heading growth stages of rice at Pawe.

Where: veg = vegetative growth stage, head = head setting growth stage, PB = panicle blast, LB = leaf blast, BS = brown spot, SB = sheath blight, BPB = bacterial panicle blight, SS = sheath spot and BLS = bacterial leaf strike.

Where PB panicle blast, LB leaf blast, BS brown spot, SB sheath blight, BPB bacterial panicle blight, SS sheath spot, BLS bacterial leaf strike and veg DI, head DI means incidence on vegetative and incidence on heading growth stage.

The disease incidence of sheath blight was decreased from 69.23% in vegetative to 42.3% in heading growth stage while the remaining diseases were increased with the increase of growth stage that is from vegetative to heading including leaf blast 75% to 96% (Table 1, Fig. 4 and 5). Here is clearly observed that when the growth stage increases, the host loses its potential against the pathogen and the pathogen becomes virulent against the host; consequently the symptoms of the pathogen were observed evidently.

4. CONCLUSION AND RECOMMENDATION

Panicle blast, leaf blast, brown spot, sheath blight, bacterial panicle blight, sheath spot and bacterial leaf strike diseases were assessed in the major rice growing fields of Pawe woreda of Metekel zone. These diseases occurred in low levels and do not show high levels of severity. However, under favorable conditions for disease development, losses can be serious. In general, these diseases were observed in different levels of incidence and severity. Therefore, according to the diseases pressure or severity the management options should be taken on time. Moreover, the future research direction should be against diseases with high

incidence and severity (*i.e* leaf blast, panicle blast and bacterial panicle blight). Research on this regard should be considered to increase the quantity and quality of rice production.

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