Introduction
Paddy Bunt of rice also known as Kernel smut is caused by Tilletia aurea (syn. Neotrypsia aurea, N. horrida) is prevalent in all the major rice growing countries (CMI, 1976; Ou, 1985; Santosh et al., 1996). In India, the disease was reported for the first time by Butler in 1913. Since then, it has spread to all the rice growing states of the country (Sharma, 2001). During harvesting, the smutted grains besides carrying the inoculum to the soil, also release banut spores which impart grey colour to the milled rice and rice flour. This adversely affects the market value of such rice.

Objective
Elimination of bunted grains/seed through mechanical processing with maximum recovery per unit of time.

Symptoms
Disease symptoms can be seen in the field at the time of crop maturity resulting in qualitative and quantitative losses. Only a few grains in a panicle are infected. Normally only a part of the grain is affected but many a times the entire grain may be replaced by a black powder mass of spores. The symptoms appear first as minute black streaks bursting through the glumes at the time of ripening. The telosporae of the fungus are the primary source of infection. Infected grain shows no symptoms until near maturity. Even then, the disease is difficult to detect in the field. The seed must be threshed and examined. Bunt pathogen is seed, soil and air borne.

Materials and Methods
10000Kg seed of paddy cultivar ‘Pusa 44’ grown at ICAR-Indian Agricultural Research Institute, Regional Station, Karnal during kharif 2014 was used for the study. Seed was processed by Nippon Sharyo (Japan) make processing plant of one ton per hour capacity comprising of seed pre-cleaner, screen grader, indented cylinder grader in bypassed mode and specific gravity separator. Top and bottom screens of air screen machines were 3.2mm (silt) and 2.1mm (silt), respectively. The inclination of deck, feeding and output of specific gravity separator were adjusted for better separation of low density and diseased seeds from the lot. Total 18 combinations, comprising of three slopes (S1 - 2.5°, S2 - 2.0°, S3 - 1.5°), three feedings (F1 - 9kg, F2 - 12kg, F3 - 15kg per minute) and two output settings (O1 - 30cm, O2 - 40cm deck width) were studied. Ten samples, recovery efficiency of paddy bunt (PB) free seed was computed using the following equation:

\[
\text{Recovery efficiency} (\%) = \frac{\text{Final output (100 - PB infection)} \times \text{Feeding (100 - PB infection)}}{X \times 100}
\]

Data were subjected to analysis of variance using completely randomized design (Gomez and Gomez, 1984).

Results
• Mechanical processing reduced bunt infection by more than 66%, depending on the intensity of infection. Significant improvement in the quality parameter of seed lot was observed through processing (Fig. 1).
• Mechanical processing increased seed quality i.e. seed germination improved by 4.31% and physical purity by 2.83 %.
• Seed weight reduced by 4.16% and 16.26% in full and partial infections, respectively (Plate 2).
• Pre-cleaner and screen grader removed 44.9 and 35.1% of the total bunt infected seeds present in the seed lot and reduced bunt infection from 1.32 to 0.75% (Table 2).
• Specific gravity separation removed 36.98% of paddy bunt infected seed (Fig. 2).
• Maximum seed recovery (13.27%/minute) and bunt infection in final product (0.85%) with 89.1% recovery efficiency (Fig. 2) has been obtained by the treatment S3F3O2 (slope of deck 1.5°, feeding 15 Kg/minute, output deck width 40cm).
• With increase in slope of the deck, recovery efficiency decreased significantly (Fig. 3).
• Increased feeding led to significant increase in final output per minute and decrease in recovery but bunt infection in final output was at par in all the feedings (Fig. 3).
• Output treatments were at par for bunt infection in the final output but recovery efficiency decreased significantly with reduction in output collection deck width (Fig. 3).

Conclusions
• All the three operations are necessary in processing of paddy seed for efficient removal of Bunt infected seed.
• Mechanical processing reduced paddy bunt infection by more than 66% depending on the intensity of infection and improved seed germination by 4.31% and physical purity by 2.83 %.
• With increase in disease intensity there was a gradual decrease in seed weight and seed germination.
• Treatment S3F3O2 (slope of deck 1.5°, feeding 15 Kg/minute, output deck width 40cm) was found to be the best as it gave 0.65% bunt infection in final product with maximum bunt free seed recovery per minute (13.27Kg) with 89.68% recovery efficiency.

Significance
The economic importance of the disease has been highlighted by various workers from many countries where the losses have been reported to be ranging from 2-63 % (Sharma, 2001). In paddy, this is the only disease for which seed standards are available. In the past two decades, the disease has assumed serious proportion in the Haryana and Punjab states resulting in large scale rejection of quality seed for not meeting the minimum tolerance standards of 0.5 and 0.1% for certified and foundation seeds, respectively (Sharma et al., 2010).

Acknowledgements
The authors are thankful to ICAR-Indian Agricultural Research Institute, New Delhi for providing the facilities to conduct this experiment. The authors also appreciate the guidance from Dr. B.S. Modi, Resd. Principal Scientist (Seed Processing), ICAR-IARI, Reg. Sta., Karnal.

Literature cited