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Performance analysis of Seed Grader through DOE

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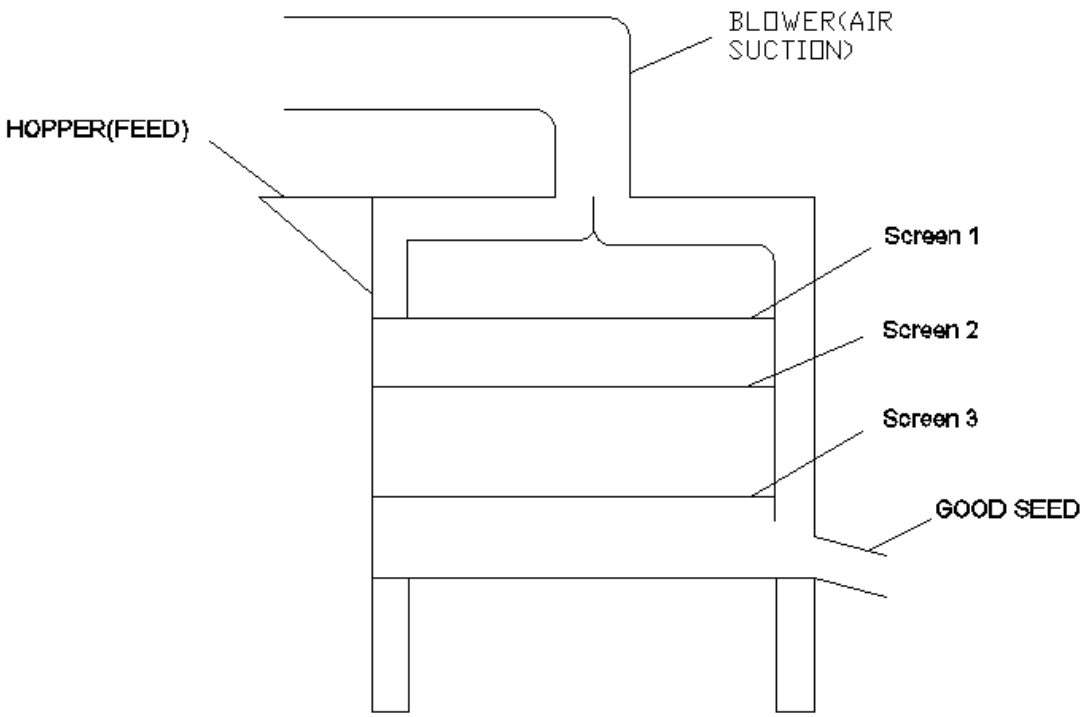
Abstract
The Objective of the experiment was to find the optimum Machine parameter of Grader Machine which will give best Quality of seed or grain cleaned with Maximum Output. This work has been undertaken with the intention to provide optimum setting of grader machine to the operator which will improve performance of Grader machine , in making this setting the operator makes mistake and lot of good seed or grain is wasted (mixes with low grade seed) causing loss to the farmer or Industry . Taguchi approach for Design of Experiment (DOE) was used to solve this problem.
Experiments are conducted following a well planned experimental schedule based on Taguchi's design of experiments(DOE) method and optimum values of process parameters for maximum good seed percent are determined. Process parameter includes Air Suction of Blower(opening), Feed, Speed of blower, Screen Size. Screen size and feed significant control factors predominantly influencing the good seed percentage are identified.
Keywords:Design of experiment, Orthogonal arrays, Taguchi method.

Introduction
Seed Grader is the machine used in Seed Processing Industry for Grading the Seed in different types of grades i.e Good Seed, Low Grade, Foreign Particles (wooden sticks, leaves of soybean plant), mud, Light Weight , Broken Seed and Undersized Seed. Wheat contributes more calories and protein to the world's diet than any other food crop [5]. Seed size and protein content have been shown to be related to seedling vigour[10,6,7]. Weimarck [8] reported that large seeds germinated better than medium and small seeds, and seedlings from large seeds had a higher survival rate than smaller seeds under field conditions. Grader machine sorts good seed from Raw seed and is very important machine in this Industry, Among Total quantity of Low Grade Seed in Seed Processing Plant , Major Low Grade Seed is sorted with this machine i.e this machine separates major Good seed and low grade seed. Grading of Seed or Grains depends upon Setting of different parameters of the Machine , the parameter includes Blower Setting or Blower Suction, Feed rate , Screen Size . Taguchi method was used for optimization of these factors. The Taguchi approach helps in optimization process requiring relative few experiments. The objective of this experiment is to set the machine parameter of Grader Machine and to increase the quality of grading and increase the production rate of Processing. The present setting of machine is done on try and error method based on operator knowledge and experience.

Material and Methods
WORKING PRINCIPLE OF SEED GRADER
Working principle of Seed grader is to grade different type of seed or grains depending upon size and shape and separates good seed from Low grade seed.
Design Of Experiment (DOE) was carried out at: Anupam Agro Industries MIDC Akola.
Line diagram of Seed grader is shown below



Raw seed or grains is feed to the hoper of Seed grader from where this seed is uniformly feed to first screen of Seed Grader , Generally this screen has round Holes and its Size is generally very large then the Size of seed Usually for Red Gram and Soybean the size of Screen is 20/64 to 21/64 inch, the main purpose of the first screen is to separate Mud of large size, metal pieces from the Raw seed, Now the seed or grains free from mud or stone falls on second screen which is greater than the size seed feed to grader(Generally for soyabeen seed size of middle screen is 13/64 or 12/64, main purpose of this screen is to separate oversize seed from the normal seed). Now the remaining seed passes through Second Screen fall on the third Screen or Bottom Screen which is a Slotted Screen of size close to the seed or grain feed to the grader, generally for Soybean and red gram it is 9/64 or 10/64 or 11/64 depending upon the requirement of the customer, Now the seed which flows over this screen is said to be good seed and the seed which passes down through the screen is treated as Low grade seed. Low grade seed or grains consist of Immature, shrived, broken seed this seed because of its under size falls down from the bottom screen and is collected in the Low grade section. Now the good seed moves forward and passes through blower suction, if the good seed is having any sticks ,steam, leaves or light seed is picked away by the blower section, the suction of blower can be varied depending upon the raw seed, there are two suction from blower ,one is at the entry of raw seed and one is at the exit of good seed.

Design Of Experiments (DOE)

A set of experiments were conducted on Seed Grader machine on Red Gram seed to determine effect of machining parameters namely Air Suction(%opening of blower), feed rate (Tons/hr), Blower speed (rpm), Screen Size (1/64) on Good Seed percentage. Three levels and four factors L9 Orthogonal array used to design the orthogonal array by using design of experiments (DOE) and relevant ranges of parameters as shown in Table 1.

Table –1: Parameter and level

Symbol	Factor	Unit	Level		
			1	2	3
A	Air Suction	(% opening)	33	66	100
B	Feed	Tons/hour	0.5	1	2
C	Blower Speed	RPM	750	850	1000
D	Screen Size	1/64	9/64	10/64	11/64

The experiment using Taguchi method was considered Table 1 shows four factors and three levels used in the experiment. If three levels were assigned to each of these factors and a factorial experimental design was employed using each of these values, number of permutations would be 3^4. The fractional factorial design reduced the number of experiments to nine. The orthogonal array of L9 type was used and is represented in Table 2. This design requires nine experiments with four parameters at three levels of each. The good seed percent was maximized [6, 12-15].

TABLE 2 : TAGUCHI L9 (3^4) ORTHOGOANAL ARRAY

Experiment	P1	P2	P3	P4
1	1	1	1	1
2	1	2	2	2
3	1	3	3	3
4	2	1	2	3
5	2	2	3	1
6	2	3	1	2
7	3	1	3	2
8	3	2	1	3
9	3	3	2	1

Assigning the independent variable to each column

The order in which independent variables are assigned to the vertical column is very essential. In case of mixed level variables and interaction between variables, the variables are to be assigned at right column as stipulated by orthogonal array as shown in Table 3.

TABLE 3

Experiment	Air Suction (% opening)	Feed Tons/hour	Blower Speed RPM	Screen Size 1/64
1	33	1	1000	9/64
2	33	1.5	800	10/64
3	33	2	750	11/64
4	66	1	800	11/64
5	66	1.5	750	9/64
6	66	2	1000	10/64
7	100	1	750	10/64
8	100	1.5	1000	11/64
9	100	2	800	9/64

Conducting the Experiment

Once the experiment design has been determined and the trials have been carried out, the measured performance characteristic from each trial can be used to analyze the relative effect of the different parameters shown in Table 4. To demonstrate the data analysis procedure, the following L9 array will be used .

TABLE 4

EXPERIMENT	GOOD SEED PERCENTAGE			
	T1	T2	T3	T4
1	84	82	83	84
2	81	82	83	82
3	76	74	76	75
4	73	72	74	71
5	80	83	82	80
6	80	81	78	80
7	82	80	81	81
8	72	72	73	71
9	77	76	77	78

Result and Discussion

TABLE 5 :SIGNAL TO NOISE RATIO (SN)

Experiment	Air Suction (% opening)	Feed Tons/hour	Blower Speed RPM	Screen Size 1/64	S/N
1	33	1	1000	9/64	4.44
2	33	1.5	800	10/64	4.43
3	33	2	750	11/64	4.36
4	66	1	800	11/64	4.32
5	66	1.5	750	9/64	4.42
6	66	2	1000	10/64	4.41
7	100	1	750	10/64	4.42
8	100	1.5	1000	11/64	4.32
9	100	2	800	9/64	4.38

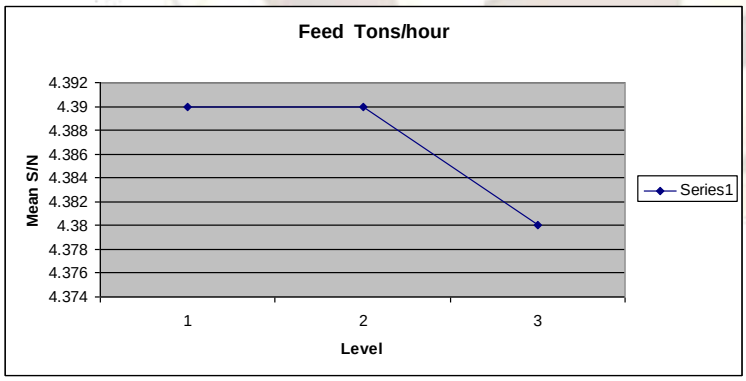
Once these ratio values are calculated for each factor and level, they are tabulated as shown above and the range R(R=high SN- low SN) of the SN for each parameter is calculated and entered into table. The larger the R value for a parameter, the larger the effect the variable has on the process. This is because the same change is signal causes a larger effect on the output variable being measured as shown in table 6.

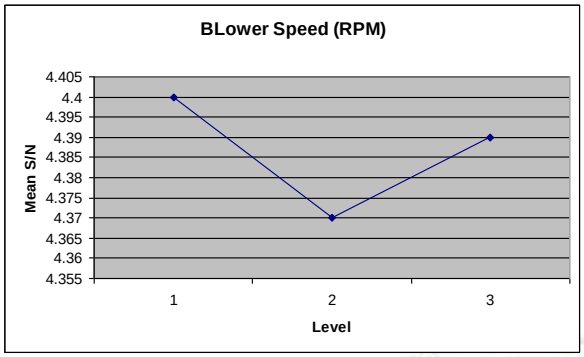
Table 6 : Response Table of the average SN value for each factor

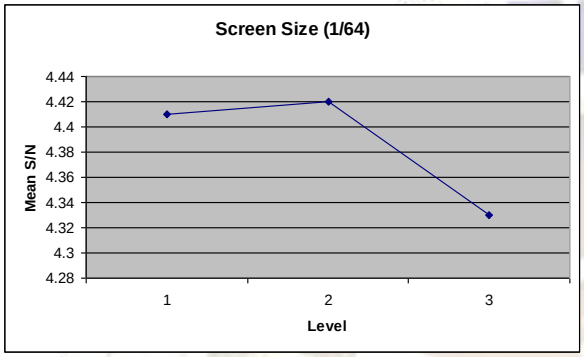
Level	Air Suction (% opening)	Feed Tons/hour	Blower Speed RPM	Screen Size 1/64
1	4.41	4.39	4.4	4.41
2	4.38	4.39	4.37	4.42
3	4.37	4.38	4.39	4.33
Δ	0.04	0.01	0.03	0.09
RANK	**2**	**4**	**3**	**1**
Contibution %	**23.5**	**5.9**	**17.6**	**53**

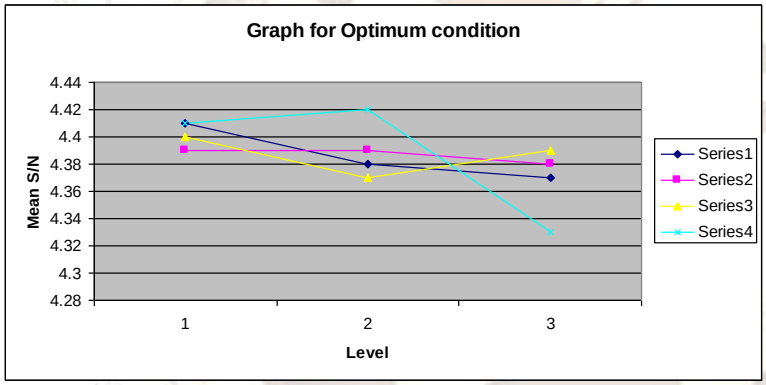
Δ= Max- Min

Graph









Series1- Air suction (A) Series 2- Feed(B) Series3 – Blower RPM(C)
Series 4-Screen Size (D)
Overall optimum Condition A1B2C1D3

7. CONCLUSION

Optimization of Seed Grader using Taguchi Analyis was studied in this Thesis

- Seed grader is a machine having many number of factor affecting grading of seed
- But for current study main factors considered are Air Suction, Feed , Blower Speed and Screen size.
- The effect of these factors on the good seed percent was studied
- For Optimiztion Taguchi method was used
- Optimum parameter setting obtained from S/N ratio plot are Air Suction=33% open, Feed =1 Ton/hour, Blower Speed =750 RPM, Screen Size=11/64
- Screen Size is the most Significant factor followed by Air Suction Opening, Blower Speed and then feed.
- Confirmatory experiment has been performed and found a good agreement between predicted and experimental value.

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