Study the Effect of Few Parameters on the Performance of Air Screen Seed Cleaner Machine

S.K.Patil[1], S.V.Bansod[2], S.D.Gawande[3]
[1]*Associate Professor, College of Engineering and Technology, Akola (M.S.)INDIA*
[2]*Professor, PRMIT, Badnera (M.S.)INDIA*
[3]*Assistant Professor, College of Engineering and Technology, Akola (M.S.) INDIA*

***Abstract*---Seed size offers yield and agronomic advantages over using un-graded planting seed materials .There was clear increase of seed weight when seed size increased. Seed weight has positive influenceon germination percentage, vigor and yield. Air Screen Seed Cleaner Machine plays prominent role in gradation of seed by its size in seed processing Industry. Segregation of seeds on Air Screen Seed Cleaner Machine deck for various levels of frequency of vibration, slope of deck and air fluidization was studied. In the experiment, the effects of frequency of vibration slope of deck and air speed on effective separation of wheat seeds as per size was investigated. A quality of seed grade was defined by gradation of seed on the basis of size of seed. It was found that eccentricity was most influential parameter in achieving effective gradation of seed.**

Keywords – Air Speed, Eccentricity, Germination, Gradation, Seed

I. INTRODUCTION

Quality seeds are the basic requirement for sustainable agriculture. Annual report of directorate of seed research [2007] reveal that quality seed alone can enhance 15 to 20 percent of productivity .It is estimated that quality seed under optimum management may contribute to the tune of 45% of total crop production. Worldwide seed processing industry is multibillion-dollar business, where billion tons of seeds have been processed every year. Quality seeds with higher germination and vigor fetches 30% to 50% more price in market & also help to improve brand image of company in the market.

India owns prominently an agrarian economy. Agriculture contribute lifeline for 65% population and contribute more than 22% GDP. Quality seed denotes the seed of improved variety having high physical and genetic purity, high germination rate, and great vigor, free from seed borne disease pests, need based value addition and long shelf life and high storability. To cope up with the increasing demand of quality seed there is need to do scientific analysis of grading machines and study the parameters responsible for effective grading of seed. To get quality seed, seed processing machinery set up has great importance in seed industry. The term seed processing plant refers to sequential set up of Seed cleaners, graders, Gravity separators, seed theaters and packing machine

Annual report on Agriculture (2009-10) Hannaford Australia, heavy weighted seeds have more germination power than lighter seeds. That's because seeds is the bridge between one generation of plant & the next. So seed grading is to maintain this quality from one season to next by removing all destructive elements such as other crop seeds, weed seeds, straw, soil dust, immature, shriveled, damaged, cracked, undersize and oversized seeds. The cost of cultivating, fertilizing and controlling weeds in a paddock are high we cannot afford to permit faulty, foreign or diseased seeds to occupy our carefully prepared land

Seed type	Germination %	Emergence %
Large	95	85
Pinched	99	73
Small	91	72
Broken	21	3

Seeds grading has the smallest cost input in crop management but the highest return (see chart)

Both expert official's tests & practical results have proved that proper seed grading gives a dramatic increase in yield (up to 45% better from large grain compared to small grain). Seed with less than 80% emergence is not considered satisfactory and will require higher sowing rates to obtained optimum plant density. As per research done by Colorado State University in 2008 on crop production, seeds are one of the least expensive but most important factors influencing crop yield potential. Seed quality is determined by many factors principally seed purity and germination. However many other factors, such as the verity, presence of seed-born disease, vigor of seed, and seed size are important when considering seed purchasing. The percentage by weight of crop seeds compared to other components. The best quality seeds are nearly 100% pure. To meet certified seeds standard for small grains, seeds must be more than 98% pure. Research in Kansas and other states shows significant increase in yield when a large seeds were compared to small seeds from the same lot.

According to International Seed Testing Association, seed quality depends upon seed size, color, diseased free seeds which directly relate to germination power of seeds

II. EXPERIMENTAL DESIGN

Machine involves a number of process variables, which contribute in a large way to the quality and quantity of good graded seed. During grading operation, various operating parameters are determined mostly based on past experience. It therefore does not provide the optimal set of parameters for a particular objective. In order to obtain the best result with regard to any specific grading characteristic, accurate identification of significant control parameters is essential. For this purpose, a statistical technique called The

Orthogonal Array Testing Strategy (OATS) for Experimental Design based on Taguchi method is used. Factors are identified according to their influence on the seed grading

A. The Orthogonal Array Testing Strategy (OATS) for Experimental Design.

The present work is based on Taguchi method of OATS Technique's concept of mixed-level orthogonal array, which is applied to the air screen seed cleaner machine for identifying the significant process variables influencing quality of grading. The levels of these factors are also found out so that the process variables can be optimized within the test range.

Experiments are carried out to investigate the influence of the five selected control parameters. The code and levels of control parameters are shown in table. This table shows that the experimental plan has four levels of five parameters. A Taguchi experimental plan with notation L'16 OATS Technique concept of mixed-level orthogonal arrays is chosen as outlined in table. In this method, experimental results are transformed into a signal-to-noise (S/N) ratio. It uses the S/N ratio as a measure of quality characteristics deviating from or nearing to the desired values. There are three categories of quality characteristics in the analysis of the S/N ratio, i.e. the lower-the-better, the higher-the-better, and the nominal-the-better. To obtain optimal sp. Gravity of good seed as well as quantity in kilograms of good graded seed, the higher-the-better quality characteristic is taken into consideration

B. Selection of independent variables

We have selected these five parameters for the purpose of experimentation-

i. Oscillation speed
ii. Air flow
iii. Screen slope
iv. Eccentricity
v. Feed rate

C. Selection of number of level settings for each independent variable

For the selection of levels of each independent variable/ parameter we examine the machine output by changing each parameter from its basic setting. There are some limitations of each machine parameters after which quality of grading decreases & increase in the vibrations of the machine. We are selecting levels of each parameter within safe zone from which we have selected four levels of each parameter.

Parameters	Level1	Level2	Level3	Level4
Oscillation speed (rpm)	350	370	400	420
Airflow (ft/min)	840	1540	1900	2200
Screen-slope (degree)	6	7	8	9
Eccentricity (degree)	6	7	8	9
Feed-rate (tons/hr)	6	7	8	9

D. Selection of orthogonal Array –

We have five variables (parameters) in our case with four levels,

Hence, Degree of freedom= 1+5(4-1) =16

So, minimum 16 experiments are to be conducted. In this case array that can be used is L'16 orthogonal array. The naming of this array means that there are 16 runs for 5 factors, contain 4 levels. Our problem happens to fit inside of this array.

TABLE 1 L'16 Mixed-level orthogonal Array for 5 parameters of 4 levels

Experiments	Parameters				
	P1	P2	P3	P4	P5
1	1	1	1	1	1
2	1	2	2	2	2
3	1	3	3	3	3
4	1	4	4	4	4
5	2	1	2	3	4
6	2	2	1	4	3
7	2	3	4	1	2
8	2	4	3	2	1
9	3	1	3	4	2
10	3	2	4	3	1
11	3	3	1	2	4
12	3	4	2	1	3
13	4	1	4	2	3
14	4	2	3	1	4
15	4	3	2	4	1
16	4	4	1	3	2

Parameter 1-oscillation speed
Parameter 2-air flow
Parameter 3-flow rate
Parameter 4-slope of screen
Parameter 5-eccentricity

E. Signal to noise ratio-

To determine the effect each variable has on the output, the signal-to-noise ratio, or the SN number, needs to be calculated for each experiment conducted. The calculation of the SN for the first experiment in the array above is shown below-

$$SN = 10 \log \left\{ \frac{(1/N) * (Sm\,1 - Ve\,1)}{Ve\,1} \right\} - \quad \text{------ (1)}$$

Where, $Sm1 = \frac{(T_{1,1} + T_{1,2} + \cdots\ldots)^2}{N}$

$$ST1 = T_{1,1}^{\ 2} + T_{1,2}^{\ 2} + \cdots \ldots \ldots$$

$$Ve1 = \frac{Se1}{N-1}$$

$$Se1 = ST1 - Sm1$$

TABLE 2 Assigning The Independent Variables To Each Column

Experiments	Parameters				
	Oscillation Speed(rpm)	Air Flow (ft/min)	Feed Rate (tons/hr)	Slope of Screen (degree)	Eccentricity (mm)
1	350	840	1.5	6	6
2	350	1540	1.8	7	7
3	350	1900	3	8	8
4	350	2200	6	9	9
5	370	840	1.8	8	9
6	370	1540	1.5	9	8
7	370	1900	6	6	7
8	370	2200	3	7	6
9	400	840	3	9	7
10	400	1540	6	8	6
11	400	1900	1.5	7	9
12	400	2200	1.8	6	8
13	420	840	6	7	8
14	420	1540	3	6	9
15	420	1900	1.8	9	6
16	420	2200	1.5	8	7

TABLE 3 Orthogonal Array For Quality Of Good Seed Trial 1

Experiment no	Quality parameters Trial 1			
	% of Under size seed in good seed.	% of Insect ridden seed in good seed.	% wt of Good seed	Wt. in grams of sample collected in cup of volume 39.13 cu.cm.
1	1.85	0.53	97.60	37.20
2	2.95	0.38	96.67	36.99
3	2.78	0.45	96.76	39.92
4	3.28	0.59	96.11	38.63
5	1.06	0.46	98.49	34.64
6	4.87	1.14	93.71	33.23
7	2.66	0	97.34	35.76
8	1.85	0.64	96.76	37.15
9	7.14	0.51	94.95	39.63
10	3.63	0.58	96.45	34.42
11	10.79	0.48	87.08	37.16
12	3.14	0.82	96.03	39.84
13	6.52	0	93.70	35.87
14	3.97	0.48	95.54	37.22
15	3.47	0.72	90.55	34.52
16	0	1.8	98.20	34.40

TABLE 4 Orthogonal Array For Quality Of Good Seed Trial 2

Experiment no Expt. No	Quality parameters Trial 2			
	% of Under size seed in good seed.	% of Insect ridden seed in good seed.	% wt of Good seed	Wt. in grams of sample collected in cup of volume 39.13 cu.cm.
1	4.10	0.28	95.63	36.15
2	0.42	0.34	99.24	35.61
3	1.40	0.70	97.89	31.37
4	6.58	0.82	92.59	36.61
5	3.74	1.13	95.13	37.16
6	2.92	1.63	95.45	35.61
7	3.07	0.13	96.79	36.46
8	0.88	1.10	98.01	36.28
9	3.38	1.71	94.84	36.04
10	2.82	1.02	96.16	36.19
11	1.06	0.22	98.72	35.88
12	3.49	0.36	96.14	36.30
13	2.38	0	97.62	34.43
14	1.06	0.22	98.71	35.68
15	1.09	1.09	97.81	33.88
16	0.53	0.68	98.78	32.04

TABLE 5 Conducting & Recording Experimental Results-

Expt. No.	Trial T1 In wt % of seed	Trial T2 In wt % of seed	SN ratio
1	97.60	95.63	36.83
2	96.67	99.24	34.63
3	96.76	97.89	41.70
4	96.11	92.59	31.57
5	98.49	95.13	32.21
6	93.71	95.45	37.71
7	97.34	96.79	47.98
8	96.76	98.01	40.85
9	94.95	94.84	60.46
10	96.45	96.16	53.63
11	87.08	98.72	21.24
12	96.03	96.14	59.44
13	93.70	97.62	30.93
14	95.54	98.71	32.73
15	90.55	97.81	25.27
16	98.20	98.78	47.60

TABLE 6 For calculating SN ratio the higher-the-better quality characteristic is taken into consideration

Levels	**Parameter**				
	Oscillation speed	Air flow	Flow rate	Slope of screen	eccentricity
1	36.18	40.10	35.84	44.24	39.14
2	39.68	39.67	37.88	31.91	47.66
3	48.69	34.04	43.93	43.78	42.44
4	34.13	44.86	41.02	38.75	29.43
Range	**14.56**	**10.82**	**8.09**	**12.33**	**18.23**
Rank	**2**	**4**	**5**	**3**	**1**

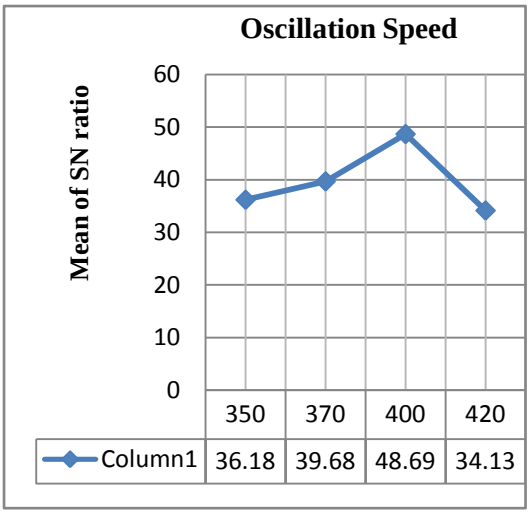

Figure 1Mean of SN ratio vs Oscillation speed

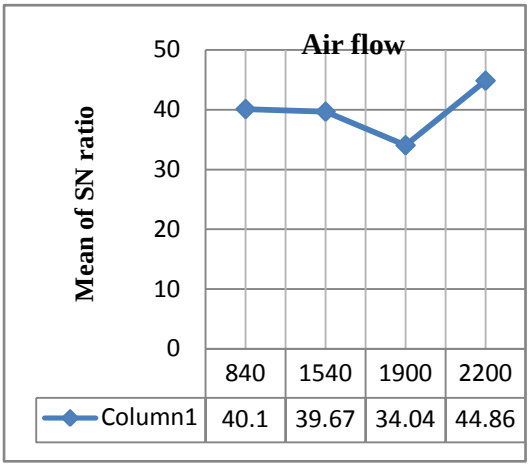

Figure 2Mean of SN ratio vs Air-flow

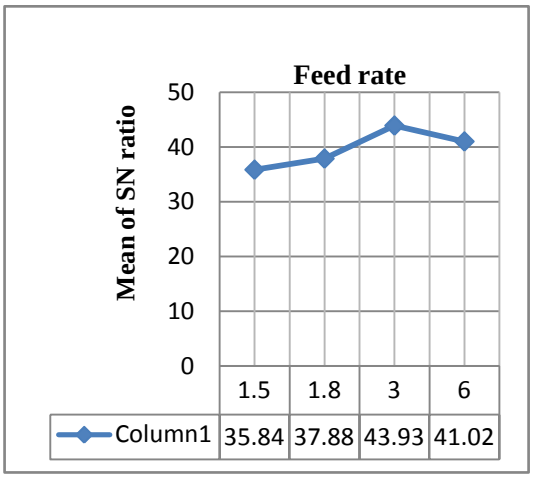

Figure 3Mean of SN ratio vs Feed rate

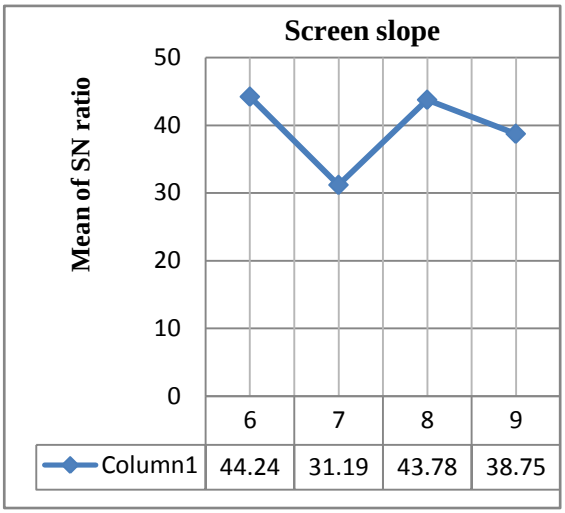

Figure 4Mean of SN ratio vs Screen Slope

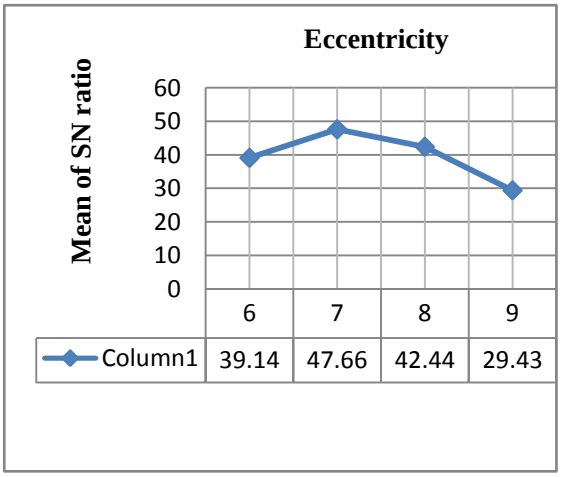

Figure 5Mean of SN ratio vs Eccentricity

III. RESULT AND DISCUSSION

After conducting experiments, we lead to following results.

- As level of parameters increases grading is good qualitatively but reduces quantitatively.
- As level of parameter increases some quantity of good seed is collected as a secondary aspiration material & some quantity is separated as an oversize material.
- From graphs, we can find that both quality and quantity wise grading is somewhat near to basic setting i.e.

Oscillation speed = 370 rpm
Air flow =1540 ft/min
Screen slope = 7°
Eccentricity = 7 mm
Feed rate = 1.8 tons/hr

CONCLUSION

This experimental investigation on the grading parameters has led to the following specific conclusions for qualitatively & quantitatively grading of seeds.

1. From above experimental analysis, Eccentricity is found to be most influencing parameter followed by oscillation speed, screen slope, air flow, and feed rate.
2. Taguchi experimentation predicts best setting for best quality grading i.e.

   i. Oscillation speed =400 rpm
   ii. Air flow =2200 ft/min
   iii. Screen slope = 6º
   iv. Eccentricity = 7 mm
   v. Feed rate = 3 ton/hr

REFERENCES

[1] Annual report 06-07 of directorate of seed research.

[2] Brenchley, W. E. (1923), Effect Of Weight Of Seed Upon The Resulting Crop. Rothamsted Experimental Station, Publication History--Issue published online: 26 Feb 2008 ,Article first published online: 26 FEB 2008 ,Received December 6th, 1922. Annals of Applied Biology, 10: 223–240. doi: 10.1111/j.1744-7348.1923.tb05671.

[3] B. Tuba Biçer ,The effect of seed size on yield and yield components of chickpea and lentil,Department of Field Crops, Faculty of Agriculture, University of Dicle, Diyarbakir.21280-Turkey. 24 December, 2008.

[4] A Ferit Ficici*, Murat Kapsiz and Mesut Durat, Applications of taguchi design method to study wear behaviour of boronized AISI 1040 steel Faculty of Technical Education, Sakarya University, Sakarya, Turkey. International Journal of the Physical Sciences Vol. 6(2), 237-243, 18 January, 2011 ,ISSN 1992 - 1950 ©2011 Academic Journals Available online at http://www.academicjournals.org/IJPS

[5] G. Belay*, A. Zemede, K. Assefa, G. Metaferia and H. Tefera Seed size effect on grain weight and agronomic performance of tef [Eragrostis tef (Zucc.) Trotter] Ethiopian Institute of Agricultural Research, Debre Zeit Center, P.O. Box 32, Debre Zeit, Ethiopia. Accepted 1 August, 2009