Application Note 013: Study of Lentils Seeds

Introduction:

SeedCount has proven to be an excellent source of physical measurements on different types of seeds. The objective of this study is to test the instrument's suitability to accurately measure physical characteristics, like size and colour, of lentils.

Procedure

A 1 kg bag of lentils was received from the customer. The sample was comprised of red lentils with a minor percentage of yellow, green and dark kernels, as well as some broken seeds.

A new SeedCount module was optimised to measure the size and colour of the lentils.

Ten different sub samples containing between 200 and 600 seeds were randomly taken for analysis. They were placed in a tray with a transparent, non reflective glass in order to leave the seeds flat when the image was taken. Each image was saved for later comparison with the SeedCount results.

For colour, the observation method was purely visual whereas for size, a digital calliper was used in order to determine the accuracy of the instrument. To do so, two samples comprised of 15 seeds each were manually measured with the calliper and compared individually with the instrument's results.

Results:

Table 1 presents some physical features such as length, width and area of each sub sample.

SampleID	# of Seeds	Length Mean	Width Mean	Avg Seed Area	Total Area mm^2
Image1	272	4.01	3.49	10.5	2645
Image2	270	4.07	3.51	10.7	2749
Image3	206	4.07	3.52	10.8	2087
Image4	291	4.07	3.54	10.8	2956
Image5	292	4.06	3.54	10.7	2947
Image6	252	4.16	3.64	11.3	2584
Image7	368	4.08	3.5	10.7	3580
Image8	513	3.99	3.47	10.4	4939
Image9	586	4.06	3.52	10.7	5688
Image10	589	4.03	3.5	10.6	5633

Table 1 – Physical Measurements

Table 2 shows the length results for the 30 individual seeds measured by hand and by the instrument.

Seed #	Manual length	SeedCount length	Seed #	Manual length	SeedCount length
1	4.20	4.20	16	4.25	4.30
2	4.48	4.50	17	3.71	3.60
3	3.71	3.70	18	4.23	4.20
4	4.30	4.20	19	3.56	3.60
5	4.31	4.40	20	4.31	4.40
6	3.13	3.20	21	3.91	3.90
7	4.31	4.40	22	4.13	4.20
8	4.10	4.00	23	3.63	3.70
9	4.24	4.10	24	4.41	4.40
10	3.97	3.90	25	4.94	5.10
11	4.35	4.40	26	4.51	4.60
12	4.37	4.50	27	4.00	4.10
13	3.86	3.90	28	3.10	3.00
14	3.99	4.00	29	4.47	4.40
15	3.83	3.80	30	4.25	4.30
Avg	4.08	4.08	Avg	4.09	4.12

Table 2 – Length of individual seeds

Tables 3 and 4 show colour categories and attributes for all the seeds analysed, whereas table 5 illustrates the manual count for discoloured seeds made on all the samples.

SampleID	Red Count	Green Count	Yellow Count	Dark Count
Image1	262	0	10	0
Image2	259	1	10	0
Image3	176	5	18	7
Image4	267	4	14	6
Image5	268	5	13	6
Image6	240	2	9	1
Image7	364	0	1	3
Image8	506	0	6	1
Image9	572	1	11	2
Image10	575	1	12	1

Table 3 – Colour count

SampleID	Avg CIE L	Avg CIE a	Avg CIE b
Image1	63.9	29.6	44.3
Image2	62.8	30.1	43.8
Image3	63.5	27.4	42.4
Image4	63.7	30	42.8
Image5	63.9	29.8	43.1
Image6	65.9	29.1	43.6
Image7	65.5	29.9	43.5
Image8	64.7	29.4	43.3
Image9	64.4	30.6	44.7
Image10	64.7	30.3	44.2

Table 4 – Average LAB colour

SampleID	Green Manual Count	Yellow Manual Count	Dark Manual Count
Image1	0	9	0
Image2	3	6	0
Image3	7	13	7
Image4	6	10	6
Image5	6	10	6
Image6	2	7	1
Image7	0	0	3
Image8	1	3	1
Image9	1	7	1
Image10	1	8	1

Table 5 – Manual count for discoloured seeds

Discussion:

As all the samples were randomly taken from the same bag, the differences in sizes between them are very subtle, as shown on table 1. However, it is important to note that for all the samples, the length was always higher than the width despite a round appearance of the seeds. This is due to the length algorithm of the SeedCount software which finds the edge of each individual kernel along with the distance of the longest possible straight line inside it; hence the length calculation is independent of the rotation of the seed on the tray.

The results shown on table 2 illustrate the accuracy of the instrument for length measurements on individual seeds. Although SeedCount presents size measurements with one decimal place accuracy, i.e. 0.1 mm, the averages between the instrument and the calliper are very close to each other.

Figure 1 shows the different colours that were found in the bag of lentils. This image is a portion of the sample “Image3” which had the highest amount of discoloured seeds as presented on table 3.

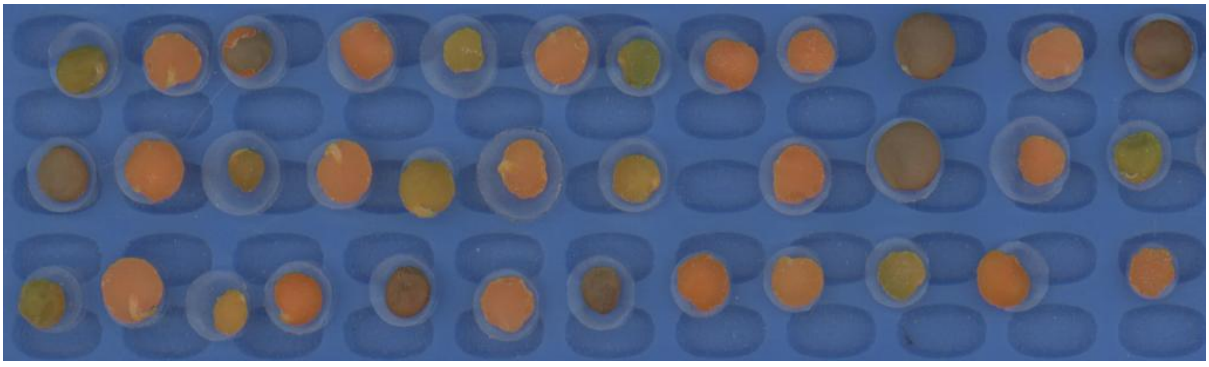

Figure 1 – Different colour seeds

Since the sample didn’t have any quantitative data, i.e., percentage of discoloured seeds or size measurements, nor a description of the physical characteristics that the customer may be interested in finding, the results were based only on visual recognition for colour. It can be seen on figures 2 and 3 that there were slight differences in the recognition of green and yellow seeds whereas for dark seeds, the manual count and the instrument were very precise as depicted on figure 4.

The disparity between green and yellow recognition is mostly due to human error since 2 untrained people can categorise the same seed with a different colour. On the other hand, SeedCount measures and quantifies the colour of the sample and thus the results are more accurate. The colour recognition algorithm can be finely tuned with the customer’s expertise and feedback.

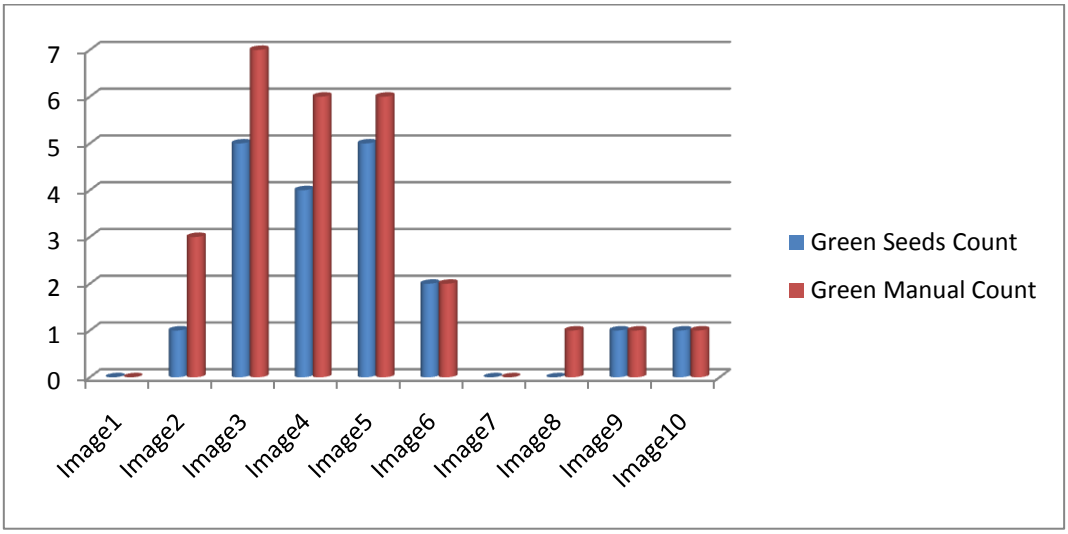

Figure 2 – Comparison between manual count and SeedCount for green seeds

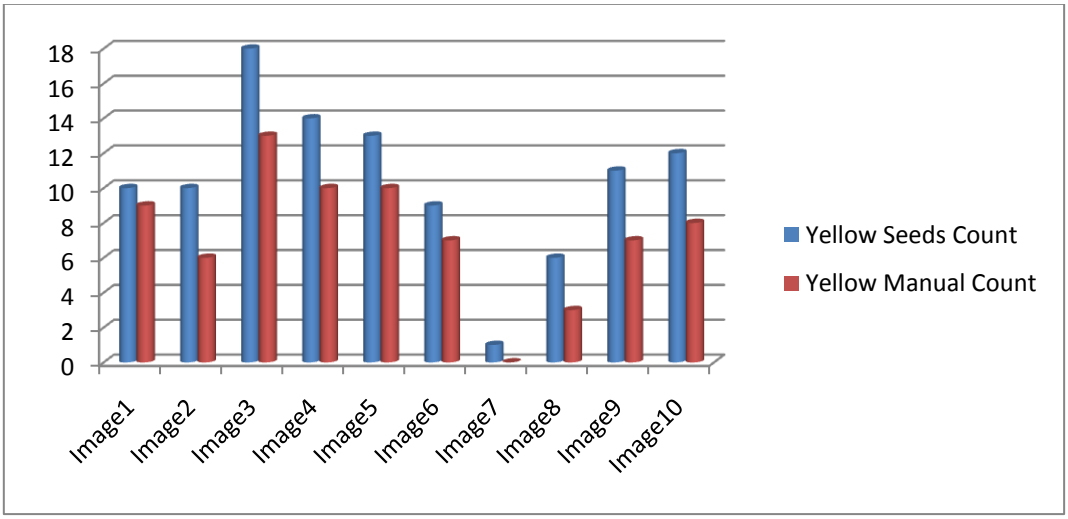

Figure 3 – Comparison between manual count and SeedCount for yellow seeds

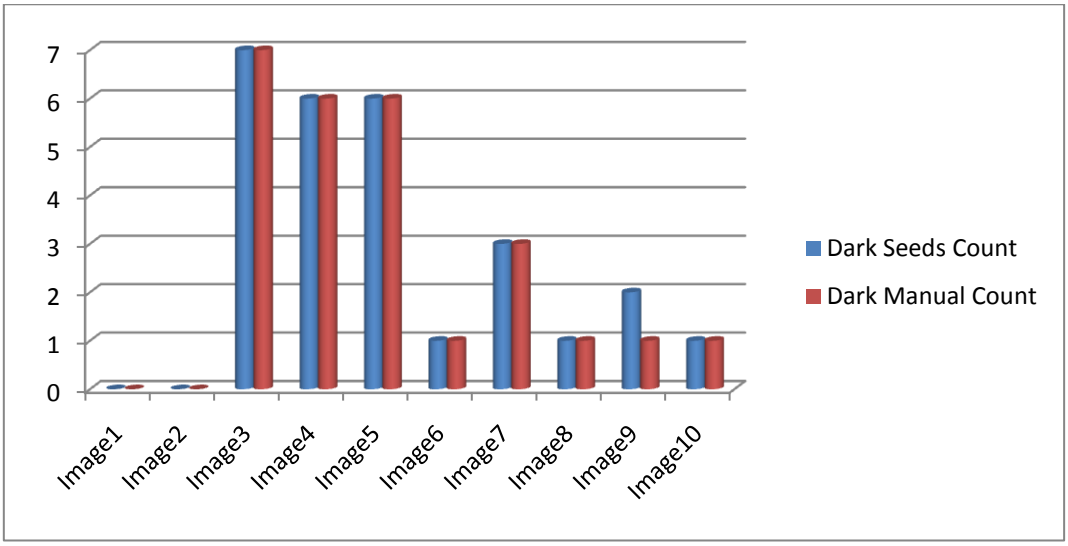

Figure 4 – Comparison between manual count and SeedCount for dark seeds

A good indicative of quality is the overall colour of the sample. As SeedCount measures colour on individual seeds, it is able to calculate a precise average as shown on table 4. The result is expressed on CIELAB values in order to follow a well established colour standard; however, it can be presented in any other standard.

The ‘a’ value is an indicator of how ‘red’ the sample is. As sample “Image3” had the highest percentage of discoloured seeds, it can be seen that it had the lowest ‘a’ value with 27.4 whereas the average of the rest is between 29 and 30.

Conclusion

Despite the absence of numerical data to compare with the results obtained, the instrument gave consistent results with the observation methods described above. Hence, SeedCount is an excellent tool to measure physical characteristics of lentils.

A new SeedCount module to measure lentils can be further developed based on samples and reference values provided by the customer.