Standardization of drying methods for improved seed quality of groundnut and sesame seeds

Padronização de métodos de secagem para melhoria da qualidade de sementes de amendoim e gergelim

Estandarización de métodos de secado para mejorar la calidad de las semillas de cacahuete y sésamo

DOI:10.34117/bjdv10n4-031

Submitted: Mar 15th, 2024
Approved: Apr 1th, 2024

V. Vijaya Geetha
PhD in Agriculture, Seed Science and Technology
Institution: Tamil Nadu Agricultural University
Address: Vegetable Research Station, Tamil Nadu Agricultural University
Palur 607 102, Cuddalore District, Tamil Nadu, India
E-mail: geetha_seed@rediffmail.com

K. Parameswari
PhD in Agriculture, Seed Science and Technology
Institution: Tamil Nadu Agricultural University
Address: Agricultural College & Research Institute, TNAU, Kudumiyanmalai,
Tamil Nadu, India
E-mail: parameswarikali@gmail.com

A. Thanga Hemavathy
PhD in Agriculture, Plant Breeding and Genetics
Institution: Tamil Nadu Agricultural University
Address: Agricultural College & Research Institute, TNAU, Coimbatore, Tamil Nadu,
India
E-mail: hemavathy.tnau@gmail.com

S. Ambika
PhD in Agriculture, Seed Science and Technology
Institution: SRM University
Address: SRM College of Agricultural Sciences, Vendhar Nagar,
Madurranthagam Taluk, Chengalputtu, Tamil Nadu, India
E-mail: ambikasingaram@gmail.com

S. Kavitha
PhD in Agriculture, Seed Science and Technology
Institution: Tamil Nadu Agricultural University
Address: Agricultural College & Research Institute, TNAU, Coimbatore, Tamil Nadu,
India
E-mail: kavitha.s@tnau.ac.in
ABSTRACT
India is one of the important oilseeds grower and importer of edible oils. Oil crops are rich sources of oils, proteins, minerals, vitamins and dietary fibers. Oilseed crops like groundnut, sesame and sunflower are the second most important determinant of agricultural economy, next to cereals within the segment of field crops. India stands fourth in oil production next to USA, China & Brazil. Drying of seeds plays a major role in maintaining the quality of seeds. Drying of Rabi harvested Groundnut as well as Sesame seeds is a very big challenge as far as Tindivanam is concerned. Since the seeds were exposed to very hot sun, it leads to cracking of seed coat which in turn leads to poor germination. Hence, to avoid exposing the groundnut as well as sesame seeds to very high temperature, the seed drying method is to be standardized for each seeds. To find the suitable seed drying methods for Groundnut TMV 13 and Sesame TMV 7, the seeds of Groundnut TMV 13 and Sesame TMV 7 were subjected to three methods of drying viz., Sun drying (Completely under sun), Shade drying (under tree shade)and Partial shade drying (morning under shade and evening under sun). The pods were dried to the uniform moisture content of 9% and packed in cloth bags and stored under ambient condition for ten month at Oilseeds Research Station, Tindivanam. The seeds were evaluated for Moisture content, Germination percentage, Shoot length, Root length, Vigour index, Dry Matter production, Electrical Conductivity and Field Emergence at monthly interval. Seed storage studies revealed that the decrease in germination was faster in seeds groundnut seeds. The germination per cent decreased from 95.7 to 49.3 per cent during 10 months of storage. The vigour parameters like root and shoot length, dry matter production of seedlings, vigour index values and field emergence per cent decreased with increase in storage period. The seeds dried under shade registered maximum germination percent (79.4 percent), vigour index (2098), Dry matter Production (2.89 mg/seedling), Electrical Conductivity 0.312 ds/m and Field emergence (72.5 percent). Similar trend has been observed for Sesame seeds also. In sesame, Minimum fluctuation in seed moisture content was observed in sesame seeds under different drying methods. The shade dried sesame seeds with initial moisture content of 8 per cent, stored in cloth bag recorded the highest germination (83.8 per cent), longest root and shoot length, maximum dry matter accumulation (34.4 mg), maximum vigour index (1219) and field emergence (80.8 per cent) at end of tenth month of storage.

Keywords: groundnut, sun drying, shade drying, partial shade drying, storage, germination, vigour.
RESUMO
A Índia é um dos maiores produtores de sementes oleaginosas e importador de óleos comestíveis. As oleaginosas são fontes ricas de óleos, proteínas, minerais, vitaminas e fibras alimentares. As culturas de sementes oleaginosas, como amendoim, gergelim e girassol, são o segundo fator determinante mais importante da economia agrícola, ao lado dos cereais no segmento de culturas de campo. A secagem de sementes desempenha um papel importante na manutenção da qualidade das sementes. A secagem de sementes de amendoim e gergelim colhidas na safra Rabi é um grande desafio para a Tindivanam. Como as sementes foram expostas ao sol muito quente, isso leva à rachadura do revestimento da semente, o que, por sua vez, leva a uma germinação ruim. Portanto, para evitar a exposição das sementes de amendoim e de gergelim a temperaturas muito altas, o método de secagem de sementes deve ser padronizado para cada uma delas. Para encontrar os métodos adequados de secagem de sementes para o TMV 13 do amendoim e o TMV 7 do gergelim, as sementes do TMV 13 do amendoim e do TMV 7 do gergelim foram submetidas a três métodos de secagem, a saber: secagem ao sol (completamente sob o sol), secagem à sombra (sob a sombra de uma árvore) e secagem à sombra parcial (manhã sob a sombra e tarde sob o sol). As vagens foram secas até o teor de umidade uniforme de 9%, embaladas em sacos de tecido e armazenadas em condições ambientais por dez meses na Oilseeds Research Station, Tindivanam. As sementes foram avaliadas quanto ao teor de umidade, porcentagem de germinação, comprimento do broto, comprimento da raiz, índice de vigor, produção de matéria seca, condutividade elétrica e emergência de campo em intervalos mensais. Os estudos de armazenamento de sementes revelaram que a diminuição da germinação foi mais rápida nas sementes de amendoim. A porcentagem de germinação diminuiu de 95,7% para 49,3% durante 10 meses de armazenamento. Os parâmetros de vigor, como o comprimento da raiz e do broto, a produção de matéria seca das mudas, os valores do índice de vigor e a porcentagem de emergência no campo diminuíram com o aumento do período de armazenamento. As sementes secas à sombra registraram a porcentagem máxima de germinação (79,4%), índice de vigor (2098), produção de matéria seca (2,89 mg/plântula), condutividade elétrica 0,312 ds/m e emergência de campo (72,5%). Tendência semelhante também foi observada nas sementes de gergelim. No gergelim, foi observada uma flutuação mínima no teor de umidade das sementes sob diferentes métodos de secagem. As sementes de gergelim secas à sombra com teor de umidade inicial de 8%, armazenadas em saco de pano, registraram a maior germinação (83,8%), maior comprimento de raiz e broto, acúmulo máximo de matéria seca (34,4 mg), índice de vigor máximo (1219) e emergência em campo (80,8%) no final do décimo mês de armazenamento.

Palavras-chave: amendoim, secagem ao sol, secagem à sombra, secagem à sombra parcial, armazenamento, germinação, vigor.

RESUMEN
India es uno de los principales productores de semillas oleaginosas e importador de aceites comestibles. Los cultivos oleaginosos son ricas fuentes de aceites, proteínas, minerales, vitaminas y fibras dietéticas. Los cultivos de semillas oleaginosas como el cacahuete, el sésamo y el girassol son el segundo determinante más importante de la economía agrícola, junto a los cereales dentro del segmento de los cultivos de campo. India ocupa el cuarto lugar en la producción de aceite junto a EE.UU., China y Brasil. El secado de las semillas desempeña un papel importante en el mantenimiento de la calidad de las semillas. Para Tindivanam, el secado de las semillas de cacahuete y sésamo cosechadas en Rabi supone un gran reto. Como las semillas se exponen a un sol muy...
caliente, se agrieta la cubierta de la semilla, lo que a su vez provoca una germinación deficiente. Por lo tanto, para evitar la exposición de las semillas de cacahuate y sésamo a temperaturas muy altas, el método de secado de semillas debe ser estandarizado para cada semilla. Para encontrar los métodos adecuados de secado de semillas de cacahuate TMV 13 y sésamo TMV 7, las semillas de cacahuate TMV 13 y sésamo TMV 7 se sometieron a tres métodos de secado: secado al sol (completamente al sol), secado a la sombra (a la sombra de los árboles) y secado a la sombra parcial (por la mañana a la sombra y por la tarde al sol). Las vainas se secaron hasta alcanzar un contenido de humedad uniforme del 9%, se envasaron en bolsas de tela y se almacenaron a temperatura ambiente durante diez meses en la Estación de Investigación de Semillas Oleaginosas de Tindivanam. Se evaluó el contenido de humedad de las semillas, el porcentaje de germinación, la longitud de los brotes, la longitud de las raíces, el índice de vigor, la producción de materia seca, la conductividad eléctrica y la emergencia en el campo a intervalos mensuales. Los estudios de almacenamiento de semillas revelaron que la disminución de la germinación fue más rápida en las semillas de cacahuate. El porcentaje de germinación disminuyó del 95,7% al 49,3% durante 10 meses de almacenamiento. Los parámetros de vigor como la longitud de raíces y brotes, la producción de materia seca de las plántulas, los valores del índice de vigor y el porcentaje de emergencia en campo disminuyeron con el aumento del período de almacenamiento. Las semillas secadas a la sombra registraron el máximo porcentaje de germinación (79,4%), índice de vigor (2098), producción de materia seca (2,89 mg/plántula), conductividad eléctrica 0,312 ds/m y emergencia en campo (72,5%). También se ha observado una tendencia similar en las semillas de sésamo. En sésamo, se observó una fluctuación mínima en el contenido de humedad de las semillas bajo diferentes métodos de secado. Las semillas de sésamo secadas a la sombra con un contenido inicial de humedad del 8 por ciento, almacenadas en bolsas de tela, registraron la mayor germinación (83,8 por ciento), la mayor longitud de raíz y brote, la máxima acumulación de materia seca (34,4 mg), el máximo índice de vigor (1219) y la emergencia en campo (80,8 por ciento) al final del décimo mes de almacenamiento.

Palabras clave: cacahuate, secado al sol, secado a la sombra, secado a la sombra parcial, almacenamiento, germinación, vigor.

1 INTRODUCTION

Groundnut [Arachis hypogea (L.)] is an important oilseeds crop and it has vital role in the diet of rural and urban. Groundnut also known as peanut is considered as one of the most important oilseed crops and grown throughout the world. Sesame (Sesamum indicum) commonly known as til (Hindi) is an ancient oilseed crop of India. It is called as ‘queen’ of oilseeds by virtue of its excellent oil quality (Vijaya Kumar et al., 2014). Seed is being a biological or living entity, deterioration in is inevitable and inexorable. Deterioration occurs with advance in ageing, during storage, number of biotic and abiotic factors influences the storage of seeds (Kumar et al., 2014). Maintenance of quality of seed during storage is a big menace due its quick viability loss. The extent of seed
deterioration depends on many factors which includes species, seed containers, seed treatment, storage environment, duration of storage period and initial quality of seeds. Different chemicals can be used for protection of seeds. Groundnut being a poor storer, Storing of groundnut seeds after harvest till the next cropping season without deteriorating the quality of seed for successful and quality seed production. The loss of seed viability is more severe in groundnut produced during Rabi season and harvested in the summer season and about more than fifty per cent viability could be lost within 4-5 months of storage. Seed storage in groundnut is an imperative, seasonal demand, dormancy, specificity of planting time, necessity of carry over and need of buffer seed stock. Seeds with high oil content appear to lose their germination and vigour in a short time despite the precaution taken during harvesting and drying. High temperature and high relative humidity cause severe and rapid deterioration of viability and vigour of groundnut seeds. The environmental conditions that exist during the growth period and harvesting time affects the seed quality and storability. Thus, the environment / provenance plays a major role in determining the seed storability and quality.

2 MATERIALS AND METHODS

Freshly harvested seeds of groundnut TMV 13 and Sesame TMV 7 obtained from Oilseeds Research Station, Tindivanam formed the base material for the study. The seeds were subjected to the following treatments

$T_1$ – Sun drying (Morning and Evening)
$T_2$ – Shade drying (Completely under shade)
$T_3$ – Partial Shade drying (Partially under tree shade)

After drying, the pods were dried to the uniform moisture content of 8 % and packed in cloth bags and stored under ambient condition for ten month. The seeds were evaluated at bimonthly interval for first six months and monthly interval from sixth months onwards for its quality parameters viz., Germination Percentage (ISTA,1999), Root length (cm), Shoot length (cm), Dry matter production (g 10 seedling$^{-1}$), Vigour index (Abdul-Baki and Anderson, 1973), Electrical Conductivity (dsm$^{-1}$) (Presley, 1958), Oil Content % (Sadasivam and Manickam, 1995) and Field Emergence (%).
3 RESULTS

3.1 GROUNDNUT

Fluctuation and significant difference in moisture content was observed due to seed treatment and Period of storage (Table.1). Among the various seed treatments, the Seeds dried under shade registered the minimum fluctuation in moisture content (8.4 to 8.65 per cent). The decline in germination from 95 per cent to 47 per cent was observed during storage period (Table. 1). The vigour parameters like root and shoot length, dry matter production and vigour index values (Table. 2) were decreased with advancement of storage period, irrespective of drying methods and decrease in these parameters was rather slow in shade dried seeds. Dry matter production due to treatments and period of storage was significant (Table.2). Among the various drying methods, Shade dried seeds registered the maximum dry matter (2.89 g) followed by Partial shade drying (2.71 g). The electrical conductivity in the seed leachate increased with increase in storage period from 0.126 to 0.614 dSm$^{-1}$ (Table.3). Field emergence potential of the shade dried seed was maximum (72.2%) compared to Sun dried (67.8%) and Partial Shade dried (69.9 %) (Table.3).

3.2 SESAME

In the present study a significant difference was noticed between drying methods and period of storage. Here the moisture fluctuations occurs due to very hot temperature after six months of storage (Table.4). Decline in germination is the last physiological phenomenon in the process of ageing. In the present study, reduction in germination was noticed in seeds produced under rainfed as well as irrigated condition over a period of storage. The germination per cent decreased from 88 to 82 per cent in shade dried seed after 10 months of storage and 87 to 78 per cent in sun seed. (Table.4). Vigour is usually characterized by the weight of the seedlings after a period of growth and it is essentially a physiological phenomenon influenced by the reserve metabolites, enzyme activities and growth regulators. Vigour index value, which is the totality of germination and seedling growth has been regarded as a good index to measure the vigour of seeds. Loss of vigour precedes loss of viability. In the present study, the vigour index value decreased with increase in storage period from 1502 to 1076 at the end of 10 months period and decrease
in vigour index value was faster in sun dried seed compared to shade dried seeds. (Table.5) Dry matter production due to drying methods and period of storage was significant (Table.5). Shade drying method registered the maximum dry matter (36.73 mg) compared to control (34.92 mg). The initial electrical conductivity was higher in shade dried seed than in sun dried seed. This clearly showed that the sun dried seed might have experienced a slight injury to membrane due to higher temperature prevailed during drying. The increase in electrical conductivity with the advancement of storage period. (Table.6). The field emergence potential is considered to be an important parameter for assessing the potentiality of seeds to perform better under field conditions. The present study revealed that, as the storage period advanced field emergence potential reduced gradually, irrespective of seed drying methods. Among the different drying methods, shade dried seeds registered maximum seed field emergence (82.3%) compared to sundried (79.8 %). (Table.6).

4 DISCUSSION

The moisture content of the seed plays a prime role in determination of storability of any seed and it increases with advances in storage period. The moisture content at which seeds were stored had a significant effect on seed longevity has been reported by many authors (Ellis et al., 1990; Nakamura, 1975; Zheng, 1994). The decline in germination during storage may be due to depletion of food reserves, decline in synthetic activity as reported by Heydecker (1972) and Roberts (1972) or may be due to the physiological ageing process. The superiority of shade dried seeds in maintaining higher germination (79.4 %) compared to Sun drying (75.9 per cent) in storage was due to safe drying method which protect the seed coat from cracking their by maintaining its germination percent. Similar result was obtained by Shakuntala (2009) in sunflower. Seedling length and dry matter production of the seedling are the manifestations of the physiological efficiency of the germinating seeds which depends on the seed vigour. This might be due to faster deterioration of cell membrane and also oxidation of polyunsaturated fatty acids in the membrane lipid compounds involving free radicle chain reaction (Srivastava, 1975). The field emergence is the ultimate measures of seed vigour (Tonkan, 1969). In the present study, field emergence per cent also followed the same trend as that of germination per cent in respect of drying methods.
5 CONCLUSION

From the above study, it is concluded that the seeds dried under shade especially the rabi crop maintains the germination and other vigour parameters during its storage. The seeds of groundnut and sesame dried under shade registered highest vigour and viability upto 8 months of storage compared to other treatments under ambient condition.
REFERENCES


### ANNEXES

Table 1. Effect of drying methods on Moisture Content and Germination Percentage in Groundnut TMV 13

<table>
<thead>
<tr>
<th>Treatment</th>
<th>P0</th>
<th>P2</th>
<th>P4</th>
<th>P6</th>
<th>P7</th>
<th>P8</th>
<th>P9</th>
<th>P10</th>
<th>Mean</th>
<th>P0</th>
<th>P2</th>
<th>P4</th>
<th>P6</th>
<th>P7</th>
<th>P8</th>
<th>P9</th>
<th>P10</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sun drying</td>
<td>8.1</td>
<td>8.6</td>
<td>8.8</td>
<td>8.7</td>
<td>8.4</td>
<td>8.1</td>
<td>8.1</td>
<td>8.0</td>
<td>8.35</td>
<td>95</td>
<td>92</td>
<td>89</td>
<td>85</td>
<td>74</td>
<td>66</td>
<td>59</td>
<td>47</td>
<td>75.9</td>
</tr>
<tr>
<td>Shade drying</td>
<td>8.4</td>
<td>8.8</td>
<td>9.1</td>
<td>9.0</td>
<td>8.8</td>
<td>8.4</td>
<td>8.3</td>
<td>8.2</td>
<td>8.63</td>
<td>97</td>
<td>94</td>
<td>91</td>
<td>89</td>
<td>78</td>
<td>70</td>
<td>63</td>
<td>53</td>
<td>79.4</td>
</tr>
<tr>
<td>Partial shade</td>
<td>8.3</td>
<td>8.6</td>
<td>8.9</td>
<td>8.7</td>
<td>8.5</td>
<td>8.3</td>
<td>8.2</td>
<td>8.1</td>
<td>8.45</td>
<td>96</td>
<td>93</td>
<td>90</td>
<td>87</td>
<td>76</td>
<td>68</td>
<td>61</td>
<td>48</td>
<td>77.4</td>
</tr>
<tr>
<td>Mean</td>
<td>8.27</td>
<td>8.67</td>
<td>8.93</td>
<td>8.80</td>
<td>8.57</td>
<td>8.27</td>
<td>8.20</td>
<td>8.10</td>
<td>8.48</td>
<td>96.0</td>
<td>93.0</td>
<td>90.0</td>
<td>87.0</td>
<td>76.0</td>
<td>68.0</td>
<td>61.0</td>
<td>49.3</td>
<td>77.5</td>
</tr>
<tr>
<td>P</td>
<td>0.041</td>
<td>0.025</td>
<td>0.073</td>
<td>0.499</td>
<td>0.305</td>
<td>0.864</td>
<td>0.999</td>
<td>0.612</td>
<td>1.730</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CD(0.05)</td>
<td>0.084</td>
<td>0.051</td>
<td>0.145</td>
<td>0.037</td>
<td>0.023</td>
<td>0.064</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Prepared by the authors

Table 2. Effect of drying methods on Vigour index and Dry Matter Production (mg 10 seedling\(^{-1}\)) in Groundnut TMV 13

<table>
<thead>
<tr>
<th>Treatment</th>
<th>P0</th>
<th>P2</th>
<th>P4</th>
<th>P6</th>
<th>P7</th>
<th>P8</th>
<th>P9</th>
<th>P10</th>
<th>Mean</th>
<th>P0</th>
<th>P2</th>
<th>P4</th>
<th>P6</th>
<th>P7</th>
<th>P8</th>
<th>P9</th>
<th>P10</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sun drying</td>
<td>3306</td>
<td>2972</td>
<td>2537</td>
<td>2193</td>
<td>1769</td>
<td>1379</td>
<td>1109</td>
<td>672</td>
<td>1890</td>
<td>3.31</td>
<td>3.25</td>
<td>3.13</td>
<td>3.00</td>
<td>2.69</td>
<td>2.36</td>
<td>1.79</td>
<td>2.71</td>
<td></td>
</tr>
<tr>
<td>Shade drying</td>
<td>3434</td>
<td>3093</td>
<td>2757</td>
<td>2412</td>
<td>2020</td>
<td>1589</td>
<td>1273</td>
<td>901</td>
<td>2098</td>
<td>3.42</td>
<td>3.36</td>
<td>3.22</td>
<td>3.10</td>
<td>2.91</td>
<td>2.69</td>
<td>2.35</td>
<td>2.05</td>
<td>2.89</td>
</tr>
<tr>
<td>Partial shade</td>
<td>3379</td>
<td>3032</td>
<td>2691</td>
<td>2349</td>
<td>1832</td>
<td>1476</td>
<td>1183</td>
<td>763</td>
<td>1990</td>
<td>3.36</td>
<td>3.28</td>
<td>3.16</td>
<td>3.06</td>
<td>2.81</td>
<td>2.48</td>
<td>2.25</td>
<td>1.88</td>
<td>2.79</td>
</tr>
<tr>
<td>Mean</td>
<td>3373</td>
<td>3032</td>
<td>2661</td>
<td>2317</td>
<td>1872</td>
<td>1480</td>
<td>1187</td>
<td>776</td>
<td>1992</td>
<td>3.36</td>
<td>3.30</td>
<td>3.17</td>
<td>3.05</td>
<td>2.80</td>
<td>2.51</td>
<td>2.26</td>
<td>1.91</td>
<td>2.80</td>
</tr>
<tr>
<td>P</td>
<td>13.790</td>
<td>8.445</td>
<td>23.886</td>
<td>0.018</td>
<td>0.011</td>
<td>0.031</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CD(0.05)</td>
<td>27.582</td>
<td>16.891</td>
<td>47.774</td>
<td>0.037</td>
<td>0.023</td>
<td>0.064</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Prepared by the authors
Table 3. Effect of drying methods on Electrical Conductivity (dSm⁻¹) and Field Emergence Percentage in Groundnut TMV 13

<table>
<thead>
<tr>
<th>Treatment</th>
<th>P0</th>
<th>P2</th>
<th>P4</th>
<th>P6</th>
<th>P7</th>
<th>P8</th>
<th>P9</th>
<th>P10</th>
<th>Mean</th>
<th>P0</th>
<th>P2</th>
<th>P4</th>
<th>P6</th>
<th>P7</th>
<th>P8</th>
<th>P9</th>
<th>P10</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sun drying</td>
<td>0.127</td>
<td>0.159</td>
<td>0.196</td>
<td>0.237</td>
<td>0.303</td>
<td>0.45</td>
<td>0.52</td>
<td>0.635</td>
<td><strong>0.328</strong></td>
<td>95</td>
<td>92</td>
<td>87</td>
<td>80</td>
<td>74</td>
<td>56</td>
<td>40</td>
<td>18</td>
<td><strong>67.8</strong></td>
</tr>
<tr>
<td>Shade drying</td>
<td>0.125</td>
<td>0.153</td>
<td>0.193</td>
<td>0.225</td>
<td>0.294</td>
<td>0.432</td>
<td>0.486</td>
<td>0.587</td>
<td><strong>0.312</strong></td>
<td>96</td>
<td>94</td>
<td>90</td>
<td>84</td>
<td>78</td>
<td>61</td>
<td>48</td>
<td>29</td>
<td><strong>72.5</strong></td>
</tr>
<tr>
<td>Partial shade</td>
<td>0.126</td>
<td>0.155</td>
<td>0.195</td>
<td>0.228</td>
<td>0.298</td>
<td>0.396</td>
<td>0.498</td>
<td>0.62</td>
<td><strong>0.315</strong></td>
<td>95</td>
<td>93</td>
<td>89</td>
<td>81</td>
<td>76</td>
<td>58</td>
<td>42</td>
<td>25</td>
<td><strong>69.9</strong></td>
</tr>
<tr>
<td>Mean</td>
<td><strong>0.126</strong></td>
<td><strong>0.156</strong></td>
<td><strong>0.195</strong></td>
<td><strong>0.230</strong></td>
<td><strong>0.298</strong></td>
<td><strong>0.426</strong></td>
<td><strong>0.501</strong></td>
<td><strong>0.614</strong></td>
<td><strong>0.318</strong></td>
<td>95.3</td>
<td>93.0</td>
<td>88.7</td>
<td>81.7</td>
<td>76.0</td>
<td>58.3</td>
<td>43.3</td>
<td>24.0</td>
<td>70.0</td>
</tr>
</tbody>
</table>

Source: Prepared by the authors

Table 4. Effect of drying methods on Moisture Content and Germination Percentage in Sesame TMV 7

<table>
<thead>
<tr>
<th>Treatment</th>
<th>P0</th>
<th>P2</th>
<th>P4</th>
<th>P6</th>
<th>P8</th>
<th>P10</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sun drying</td>
<td>8.0</td>
<td>8.1</td>
<td>8.3</td>
<td>8.5</td>
<td>8.2</td>
<td>8.1</td>
<td><strong>8.20</strong></td>
</tr>
<tr>
<td>Shade drying</td>
<td>8.1</td>
<td>8.2</td>
<td>8.4</td>
<td>8.6</td>
<td>8.3</td>
<td>8.1</td>
<td><strong>8.28</strong></td>
</tr>
<tr>
<td>Partial shade drying</td>
<td>8.0</td>
<td>8.1</td>
<td>8.2</td>
<td>8.5</td>
<td>8.3</td>
<td>8.2</td>
<td><strong>8.22</strong></td>
</tr>
<tr>
<td>Mean</td>
<td><strong>8.03</strong></td>
<td><strong>8.13</strong></td>
<td><strong>8.30</strong></td>
<td><strong>8.53</strong></td>
<td><strong>8.27</strong></td>
<td><strong>8.13</strong></td>
<td><strong>8.23</strong></td>
</tr>
</tbody>
</table>

Source: Prepared by the authors
Table 5. Effect of drying methods on Vigour index and Dry matter production (mg 10 seedling-1) and in Sesame TMV 7

<table>
<thead>
<tr>
<th>Treatment</th>
<th>P0</th>
<th>P2</th>
<th>P4</th>
<th>P6</th>
<th>P8</th>
<th>P10</th>
<th>Mean</th>
<th>P0</th>
<th>P2</th>
<th>P4</th>
<th>P6</th>
<th>P8</th>
<th>P10</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sun drying</td>
<td>1479</td>
<td>1386</td>
<td>1295</td>
<td>1205</td>
<td>1080</td>
<td>975</td>
<td><strong>1237</strong></td>
<td>38.0</td>
<td>37.1</td>
<td>35.0</td>
<td>34.2</td>
<td>33.5</td>
<td>31.7</td>
<td><strong>34.92</strong></td>
</tr>
<tr>
<td>Shade drying</td>
<td>1531</td>
<td>1470</td>
<td>1394</td>
<td>1327</td>
<td>1253</td>
<td>1189</td>
<td><strong>1361</strong></td>
<td>38.8</td>
<td>38.1</td>
<td>37.1</td>
<td>36.7</td>
<td>35.3</td>
<td>34.4</td>
<td><strong>36.73</strong></td>
</tr>
<tr>
<td>Partial shade drying</td>
<td>1496</td>
<td>1436</td>
<td>1336</td>
<td>1245</td>
<td>1156</td>
<td>1064</td>
<td><strong>1289</strong></td>
<td>38.2</td>
<td>37.3</td>
<td>36.1</td>
<td>34.7</td>
<td>33.8</td>
<td>32.2</td>
<td><strong>35.38</strong></td>
</tr>
<tr>
<td>Mean</td>
<td><strong>1502</strong></td>
<td><strong>1431</strong></td>
<td><strong>1341</strong></td>
<td><strong>1259</strong></td>
<td><strong>1163</strong></td>
<td><strong>1076</strong></td>
<td><strong>1295</strong></td>
<td><strong>38.33</strong></td>
<td><strong>37.50</strong></td>
<td><strong>36.07</strong></td>
<td><strong>35.20</strong></td>
<td><strong>34.20</strong></td>
<td><strong>32.77</strong></td>
<td><strong>35.68</strong></td>
</tr>
</tbody>
</table>

P = 11.969
T = 8.463
PxT = 20.731

CD(0.05) = 23.943
Source: Prepared by the authors

Table 6. Effect of drying methods on Electrical Conductivity (dSm-1) and Field Emergence Percentage in Sesame TMV 7

<table>
<thead>
<tr>
<th>Treatment</th>
<th>P0</th>
<th>P2</th>
<th>P4</th>
<th>P6</th>
<th>P8</th>
<th>P10</th>
<th>Mean</th>
<th>P0</th>
<th>P2</th>
<th>P4</th>
<th>P6</th>
<th>P8</th>
<th>P10</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sun drying</td>
<td>0.076</td>
<td>0.088</td>
<td>0.107</td>
<td>0.147</td>
<td>0.206</td>
<td>0.260</td>
<td><strong>0.147</strong></td>
<td>84</td>
<td>82</td>
<td>80</td>
<td>79</td>
<td>78</td>
<td>76</td>
<td><strong>79.8</strong></td>
</tr>
<tr>
<td>Shade drying</td>
<td>0.078</td>
<td>0.085</td>
<td>0.097</td>
<td>0.141</td>
<td>0.199</td>
<td>0.254</td>
<td><strong>0.142</strong></td>
<td>85</td>
<td>84</td>
<td>83</td>
<td>82</td>
<td>80</td>
<td>80</td>
<td><strong>82.3</strong></td>
</tr>
<tr>
<td>Partial shade drying</td>
<td>0.077</td>
<td>0.087</td>
<td>0.102</td>
<td>0.144</td>
<td>0.203</td>
<td>0.258</td>
<td><strong>0.145</strong></td>
<td>82</td>
<td>82</td>
<td>81</td>
<td>80</td>
<td>79</td>
<td>78</td>
<td><strong>80.3</strong></td>
</tr>
<tr>
<td>Mean</td>
<td><strong>0.077</strong></td>
<td><strong>0.086</strong></td>
<td><strong>0.102</strong></td>
<td><strong>0.144</strong></td>
<td><strong>0.203</strong></td>
<td><strong>0.257</strong></td>
<td><strong>0.145</strong></td>
<td><strong>83.7</strong></td>
<td><strong>82.7</strong></td>
<td><strong>81.3</strong></td>
<td><strong>80.3</strong></td>
<td><strong>79.0</strong></td>
<td><strong>78.0</strong></td>
<td><strong>80.8</strong></td>
</tr>
</tbody>
</table>

P = 0.060
T = 0.041
PxT = 0.105

CD(0.05) = 0.121
Source: Prepared by the authors
Fig. 1. Shade drying method

Source: Prepared by the author

Fig. 2. Partial Shade drying

Source: Prepared by the author

Fig. 3. Seedling evaluation

Source: Prepared by the author
Fig. 4. Field Emergence

Source: Prepared by the author