# Original Research Article
# Performance of Sesame Seeds Produced From Plants Subjected to Water Stress for Early Selection of Tolerant Genotypes


## ABSTRACT

Intra-seasonal drought episodes during the life cycle of plant growth of sesame affect physiological quality of seeds harvested. For this purpose, in this study, we explored the following water treatments: W1 (Irrigation throughout the cycle, non-stress treatment), W2 (water stress at the vegetative growth phase), W3 (water stress at the flowering to early pod formation), W4 (water stress at the fruit maturation phase) and W5 (water stress in all phases); for their effect on germination capacity and seedling from the produced seeds of four sesame varieties ("SN 203", "SN 403", "SN 01-06", "Ngong"). Such studies allowed evaluating the performance of the seeds harvested from the plants subjected to water stress availability during the different phenological phases of each variety. The produced seeds were evaluated by reduction rate (%) of germination percentage, first germination count, germination speed index, mean germination time, coefficient of velocity of germination, seedling emergence, seedling length, seedling fresh weight and seedling dry weight. In general, sesame seeds from plants grown under water deficit display reduction in performance. In water stress at the fruit maturation phase (W4) and water stress in all phases (W5), the sesame varieties tested are more sensitive for both germination capacity and seedling and for seedling respectively; so that water limitation during these periods results in the production of seeds with reduction in performance more intense. Among the varieties tested, "SN 01-06" and "Ngong" were the most tolerant genotypes. These results will be used for extension of sesame and for genetic improvement program.



*Keywords: Germination capacity; performance; seedling; seeds; sesame; water stress.*

## 1. INTRODUCTION

Sesame (*Sesanum indicum* L.) is described as a remunerative crop in international trade [1]. It is for this reason that it is beginning to generate more interest in Cameroon where he still has the status of underutilized crop. In Cameroon, sesame production is unevenly distributed on almost the whole territory, with sudano-sahelian regions (arid and semi-arid areas) producing more than other regions. However, these Sudano-Sahelian regions face a major climatic constraint: drought-spells during the rainy season.

In fact, drought is a serious problem for crop production in arid and semi-arid areas of the world. Despite having an optimal range of between 500 and 650 mm of water during its production cycle [2], intra-seasonal drought episodes due to climate change are strongly linked to the yield loss of sesame crops in the Sudano-Sahelian zone [3, 4, 5], particularly when they reach critical stages during their growth and development cycle [1,6]. Indeed, not all stages of development have the same vulnerability; and the resulting consequence on vegetative growth, flowering, and maturity and consequently on the physiological quality of harvested seeds differ [5, 7, 8].

Moreover, seed characteristics are usually essential elements in seedling establishment and plant development to obtain high seed yield [9]. It is known that in addition to suitable climatic conditions, for a successful crop, it is necessary to use seeds of high physiological quality, as this contributes to high productivity, whereas seeds of low quality compromise an adequate stand of plants, directly affecting productivity. The most vigorous seeds are generally more resistant to such abiotic stresses as a soil water deficit, for example [8, 10, 11].

However, this is not always easy, partly because of the lack of simple, less costly and reliable breeding methods, to select drought-tolerant plants. Therefore, researchers have often used certain agronomic and physiological parameters taken under stress conditions during growth and development of plant, and have considered them as interesting stress tolerance indicators, making it easier to select early suitable varieties [4, 5, 6, 8, 12,13,14, 15, 16, 17].

Thus, the aim of this study was to evaluate the performance of the seeds harvested from the plants subjected to water stress during the different phenological phases of four sesame varieties for early selection of the tolerant genotypes using drought tolerance indicators. Such studies allowed for extension of sesame in the Sudano-Sahelian regions of Cameroon and for genetic improvement program.

## 2. MATERIAL AND METHODS

### 2.1 Plant Material

The material of the present study consisted of 4 sesame varieties: “SN 203”, “SN 403”, “SN 01-06” from Niger [18, 19], and a local variety that we have called "Ngong" for the occasion because it came from the locality of Ngong in the Northern region of Cameroon.

### 2.2 Experimental Site

The experiment to obtain the seeds was carried out from April 16 to July 25, 2018, in a greenhouse of Garoua Multipurpose Research Station of Institute of Agricultural Research for Development (IRAD), in the State of Sanguéré – Paul, department of Bénoué, district of Garoua III, Northern region of Cameroon, located at latitude 09º16’15’’ North, longitude 13º27’27’’ East at an elevation of 273.54 meters. The city of Sanguéré-Paul is located in a Sudano-Sahelian climate.

## 2.3 Sowing

The plants were grown in soil collected from the agricultural sector of Garoua Multipurpose Research Station. Cultivation was in polystyrene pots filled with 15 kg of air-dry soil which have been watered for 3 successive days. Sowing was carried out using 15 seeds per pot at a depth of about 2 cm. Two-pot planting was carried out on the 15th days after sowing (DAS).

## 2.4 Water Stress Treatments

Water stress be applied in the different phenological phases, namely: W1 (Irrigation throughout the cycle, non-stress treatment); W2 (water stress of 10 days at the vegetative growth phase); W3 (water stress of 10 days at the flowering to early pod formation phase); W4 (water stress of 10 days at the fruit maturation phase) and W5 (water stress in all phases).

## 2.5 Evaluation of Seeds Performance

At 101 days after sowing, the seeds were harvested and taken to the laboratory for processing and testing to evaluate their performance.

Seed of each treatment were surface-sterilized by a 3 min treatment with a 0.8% sodium hypochlorite solution and then rinsed several times with distilled water. A randomized complete block design was used with 4 varieties and 5 water treatments (W1 to W5). Four replications of 25 seeds per treatment placed on filter paper on petri dishes (90 mm) were allowed to germinate in an incubator in room temperature. For each treatment, germination was recorded every day for 6 days. Seed were considered to have germinated when the radicle protruded from the seed coat (=1 mm) whereas emergence coincides with hypocotyls appearance [4]. Germination percentage (GP) and first germination count (FGC) were counted 6 and 3 DAS respectively [8]. Germination speed index corrected by the number of seeds tested (GSIc), mean germination time (MGT) and coefficient of velocity of germination (CVG) were calculated [20] after counting the germinated seeds daily until the sixth DAS.

To evaluate the seedlings, experiment was carried out in a randomized complete block design with 4 varieties and 5 water treatments (W1 to W5) and with five replications of 20 seeds (4 seeds per pot) per treatment. Seedling emergence (SE), seedling length (SL), seedling fresh weight (SFW) and seedling dry weight (SDW) were recorded 14 DAS according to Silva et al. [8]. SFW and SDW were obtained from the mass of 10 seedlings.

For each parameter, genotype drought tolerance was calculated as: Reduction rate (%) = (1- (Vs/Vp)) x 100; where Vs and Vp mean parameter performance value under stress and non-stress conditions, respectively [4].

## 2.6 Statistical Analysis

All statistical analysis were performed for reduction rate (%) using the General Linear Model (GLM) procedure in SAS 9.3 software. ANOVA results were considered significant at $p<0.05$ and means comparisons were done using Ryan-Einot-Gabriel-Welsch Multiple Range Test (REGWQ).

# 3. RESULTS

## 3.1 Germination capacity

Reduction rate (%) of germination percentage (RGP), first germination count (RFGC) and germination speed index corrected by the number of seeds tested (RGSIc) were influenced not only by variety and water stress treatments but also by their interaction; whereas it was not significant for reduction rate (%) of mean germination time (RMGT) and coefficient of velocity of germination (RCVG) (Table 1).

Of the four varieties tested, “Ngong” (74.15%) showed the highest mean of RGP 6 days after sowing (DAS) of seed obtained from plants cultured on different water stress treatments, whereas “SN 403” showed the lowest (17.05%; Table 2). Among the four water stress treatments used, seeds from W4 (water stress at fruit maturation phase) showed greater mean RGP (68.53%), whereas, W2 (water stress at vegetative growth phase) and W3 (water stress at flowering to early pod formation phase) water stress treatments showed the lowest (less than 30%; Table 2). Analysis of variance for effect of variety x water stress treatments interaction sliced by variety for RGP was significant only for varieties “SN 403” ($P<0.05$) and “SN 01-06” ($P<0.01$; Table 3). All the genotypes showed reduction in performance of seeds on all the water stress treatments used ranging from 9.09% to 83.59%, except varieties “SN 403” (-13.63%) and “SN 01-06” (-7.69%) on W3 and W2 water stress treatments respectively (Table 4).

Similar results were found for reduction rate (%) of first germination count (RFGC) with respect to varieties, water stress treatments and their interaction but at different levels (Table 2; Table 4); calculated 3 DAS of seeds harvested from plants subjected to different water stress treatments. However, effect of variety x water stress treatments interaction sliced by variety for RFGC was significant for all the varieties except “Ngong” (Table 3).

From the seed vigor, evaluated by the germination speed index, reduction rate (RGSIc), calculated 6 DAS, it is possible to see in Table 2 that, for all the genotypes, seeds vigor has decreased; variety “Ngong” (75.25%) showed the highest reduction in performance of seeds whereas variety “SN 403” (19.80%) showed the lowest. Among the four water stress treatments used, seed from W4 and W5 (water stress in all phases) water stress treatments showed the highest reduction in performance of seeds (more than 50%) whereas, W2 and W3 showed the lowest (less than 29%). Effect of variety x water stress treatments interaction sliced by variety for RGSIc was significant for all the varieties except “Ngong” (Table 3) where W2 to W5 were similar with ranging from 55.58% to 83.36% (Table 4). All the others genotypes showed reduction in performance of seeds on all the water stress treatments used at different levels, except varieties “SN 403” (-26.46%) and “SN 01-06” (-6.18%) on W3 and W2 water stress treatments respectively (Table 4) where their seeds were increase in vigor. The highest RGSIc was observed on W3 for variety “SN 203” (77.19%), on W4 for varieties “SN 403” (55.67%) and “SN 01-06” (86.26%). The lowest RGSIc was observed on W2 for varieties “SN 203” (13.44%) and “SN 01-06” (-6.18%), on W3 for variety “SN 403” (-26.46%; Table 4).

Although effects of variety, water stress treatments used and their interaction were not significant for reduction rate (%) of mean germination time (RMGT) and coefficient of velocity of germination (RCVG) (Table 1), it is possible to see in table 2 that for all the genotypes, we recorded increase in performance of the seeds for RMGT whereas RCVG showed reduction in performance of the seeds (less than 20%). It was the same with regard to the water stress treatments used to produce seeds, but at different levels.

## 3.2 Seedling

After 14 DAS of seeds harvested from plants subjected to different water stress treatments, reduction rate (%) of seedling emergence (RSE), seedling length (RSL), seedling fresh weight (RSFW) and seedling dry weight (RSDW) were recorded (Table 2).

Variety, water stress treatments used to get the seeds and their interaction had a significant effect on reduction rate (%) of seedling emergence (RSE; Table 1). Of the four varieties tested, “SN 203” (32.85%) and “SN 403” (27.18%) showed the highest mean of RSE, whereas “SN 01-06” (6.75%) “Ngong” (16.34%) showed the lowest (Table 2). Among the four water stress treatments used, seed from W5 (28.28%) showed greater mean RSE, whereas, W4 (14.52%) water stress treatments showed the lowest (Table 2). Analysis of variance for effect of variety x water stress treatments interaction sliced by variety for RSE was significant only for varieties “SN 203” ($P<0.01$) and “Ngong” ($P<0.05$; Table 3). Although the highest RGP were greater than 50% (Table 4), RSE had the highest less or equal to 50% according to variety and water stress treatment used (Table 5). The lowest RSE were ranging from 0% to 15.714% (Table 5).

For the parameter reduction rate (%) of seedling length (RSL), only the variety and the interaction variety x water stress treatments had significant effects (Table 1). Of the four varieties tested, “SN 203” (17.21%) and “SN 403” (10.10%) showed the highest mean of RSL, whereas “Ngong” (-11.71%) showed the lowest (Table 2). Although the water stress treatments used did not have a significant effect, we noted a rate ranging from 2.29% to 7.45% (Table 2). It can be seen that the effect of variety x water stress treatments interaction sliced by variety for RSL was significant only for variety “SN 403” (Table 3). For this variety, the highest RSL was observed on W5 (19.61%) water stress treatment and the lowest on W2 (-7.95%). For all the others varieties, only “SN 203” showed reduction of his performance in all the water stress treatments with RSL less than 25% (Table 5).

For reduction rate (%) of seedling fresh weight (RSFW), significant effects of variety, water stress treatments used to get the seeds and their interaction were found (Table 1). It can be seen that among the four varieties, reduction in performance of the seeds was recorded for “SN 203” (6.96%) and “SN 403” (17.63%; Table 2). For the four water stress treatments used, only W5 (11.13%) showed reduction in performance (Table 2). Effect of variety x water stress treatments interaction sliced by variety for RSFW was significant for varieties “SN 403” and “Ngong” (Table 3). Increase in performance of the seeds at different levels was recorded on all the water stress treatments used for varieties “SN 01-06” and “Ngong”, on W2 for variety “SN 403” and on W3 for variety “SN 203” (Table 5).

From the reduction rate (%) of seedling dry weight (RSDW), it is possible to see in Table 1 that effects of variety, water stress treatments used to get the seeds and their interaction were strongly significant ($P < 0.001$; Table 1). Increase in performance of the seeds was observed in all the varieties at different levels, except “SN 403” (20.12%). Among the four water stress treatments used to produce seeds, only W5 (21.28%) showed reduction in performance of the seeds (Table 2). Effect of variety x water stress treatments interaction sliced by variety for RSDW was significant for all the varieties except “SN 01-06” (Table 3) with increase in performance of the seeds (Table 3). For the others varieties, increase in performance of the seeds at different levels was observed on W2 and W3 water stress treatments for variety “SN 203”, on W2 for variety “SN 403” and on W2 , W3 and W4 for variety “Ngong” (Table 5).

## 4. DISCUSSION

Our results clearly showed that germination capacity and seedling of seeds harvested from plants subjected to water stress availability during the different phenological phases were influenced by the variety, water stress treatments used and their interaction (Tables 1, 2) and confirmed many others studies which showed that seeds performance was influenced by the genotype and the quality of irrigation during cultivation [4, 8, 15, 16]. In fact, a plant's response to water stress is complex because it depends on both the severity of the stress, its duration, the stage of development of the plant when the state took place [5].

In water stress at fruit maturation phase (W4) and water stress in all phases (W5), reduction in performance of seeds was more intense for germination percentage (GP), first germination count (FGC) and germination speed index (GSIc; Table 2). This result may be related to the fact that the phase of fruiting in most plants displays the greatest levels of water consumption, with this phase being among the most sensitive to a condition of water deficit. In fact, this phase starts during the reproductive phase (flowering to pod formation) when the first capsule is formed [1]. Similar results were found in sesame crop, where the authors attributed the period of flowering to fruit maturation as being the most critical to the crop as regards water deficit with the GP test [8]. In contrast, Silva et al. [8] also found that when the water deficit occurs during fruit maturation, no reduction in seed quality is seen with the FGC test. In view of the above, the thesis of the influence of genetic factors would become more plausible.

Water stress at the vegetative growth phase (W2) and water stress at the flowering to early pod formation (W3) resulted in lowest intensity of the reduction in performance of the seeds in all the varieties tested for GP, FGC and GSIc (Table 4). From these results it can be inferred that such environmental conditions would affect less the germination and vigor in sesame seeds. Indeed, in most cases, the early flowers will not make capsules. In sesame it is normal for the white portion (corolla) of the flower to drop off the plant in the evening. The part of the flower that makes the capsule will remain on the plant. This stage ends when there are 5 pairs of capsule nodes [1]. The varieties "SN 403" and "SN 01-06" are distinguished by the increase in performance of the seeds during these 2 phases (Table 4). It can be deduced that such environmental conditions favor the expression of germination and vigor in sesame seeds according to the genotype. This type of response is also found in other species, such as lentil cultivars where genotypic differences were evident in germination percentage under severe drought stress [17].

Our study also showed that, FGC test reflected what was confirmed by GP and GSIc tests. In fact, FGC test is based on the principle that seed samples with higher percentage of normal seedlings in this first assessment germinate faster than the others; thus, it is an indirect analysis of seed germination [21]. Moreover, this test may best represent differences in speed of germination speed across varieties compared to speed germination indices [20].
Mean germination time (MGT) of seeds was not reduced in performance (increased) during all the different water deficit tests; on the contrary, the time required for germination decreased (Table 2). However, the lower the MGT, the faster a population of seeds has germinated [22]. This is contrary to what our study has shown with reduced performances in germination rate and vigor of the seeds. A possible explanation for this is that stress might affect some functions pleiotropically causing such dysfunction of the close relationship between these variables.

The variable coefficient of velocity of germination (CVG) showed reduction in performance of all the seeds tested on all water stress treatment used (Table 2). The CVG gives an indication of the rapidity of germination. It increases when the number of germinated seeds increases and the time required for germination decreases [23]. However, our study found that seed performance was reduced for GP, FGC, GSIc and CVG but not for MGT.

Seedling emergence in a bed is of paramount importance in seed production programs, since this test approaches the reality of the field, where the seedlings are exposed to the conditions of weather and temperature of the growing region [8]. Our study revealed that for the variable seedling emergence (SE), all the varieties showed reduction in performance of the seeds produced from all the water stress treatments but at different levels; varieties "SN 01-06" and "Ngong" were the most tolerant genotypes (Tables 2, 5). This confirmed the work on sugar beet of Sadeghian and Yavari [24] who reported that seedling growth severely diminished under drought stress however genetic differences were monitored among the varieties. Moreover, Dodig et al. [25] showed on their works on wheat that, the effect of drought stress was most informative for differentiating between the genotypes for the studied seedling traits. In water stress in all phases (W5), reduction in performance of seeds was more intense for SE (Table 2); similar to the results obtained for the variables seedling fresh weight (SFW) and seedling dry weight (SDW). This result can be attributed to the occurrence of a water restriction during the development period of the seeds, which may have affected the deposition of reserves, the proper formation of cell membranes and the correct establishment of the hydrolytic enzyme system of the seeds [26]. Our results corroborate Silva et al. [8] who showed that there was a reduction in the physiological quality of the seeds of sesame when comparing treatments in stress throughout the cycle and in full irrigation. In this respect, the lower quality seen in seeds produced under restricted irrigation may be related to three main factors: 1) the need for more time to repair cell structures; 2) the slow recovery of enzyme activity; and 3) the decreased ability to remobilize assimilates [27, 28], all a direct or indirect consequence of the growing environment.

For seedling length (SL) and seedling fresh weight (SFW), the reduction rate (%) showed that varieties “SN 01-06” and “Ngong” were the most tolerant genotypes with an increase in performance of the seeds tested (Table 2). For seedling dry weight (SDW), the reduction rate (%) showed that varieties “SN 203”, “SN 01-06” and “Ngong” were the most tolerant genotypes with an increase in performance of the seeds tested (Table 2). In general, water stress treatment decreased seedling dry weight [15]. Improve seedling fresh and dry weight might be due to increased cell division within the apical meristem of seeding roots, which caused an increase in plant growth [29] according to the genetic makeup.

In this study, we identified performance of seeds produced from water stress in different phenological phases of sesame varieties. These results will be used for extension of the more drought tolerant genotypes in the Sudano-Sahelian regions of Cameroon and for genetic improvement program.



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**Table 1. Analysis of variance for effects of variety, water stress treatments and their interaction on means of reduction rate (%) of germination percentage (RGP), first germination count (RFGC), germination speed index corrected (RGSIc), mean germination time (RMGT), coeffcient of velocity of germination (RCVG), seedling emerging (RSE), seedling length (RSL), seedling fresh weight (RSFW) and seedling dry weight (RSDW) of seed obtained from four sesame varieties planted on four water stress treatments**

| | | F-value | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Source** | **Df** | **RGP (%)** | **RFGC (%)** | **RGSIc (%)** | **RMGT (%)** | **RCVG (%)** | **RSE (%)** | **RSL (%)** | **RSFW (%)** | **RSDW (%)** |
| Variety | 3 | $9.44^{***}$ | $8.14^{***}$ | $8.64^{***}$ | 2.51 | 2.26 | $14.27^{***}$ | $27.41^{***}$ | $31.12^{***}$ | $31.73^{***}$ |
| Water stress | 3 | $6.52^{***}$ | $8.30^{***}$ | $8.13^{***}$ | 1.58 | 1.47 | $5.05^{***}$ | 0.36 | $8.11^{***}$ | $13.43^{***}$ |
| Interaction | 9 | $2.10^{*}$ | $2.76^{*}$ | 2.48* | 1.11 | 1.04 | $2.52^{*}$ | $3.89^{***}$ | $2.93^{**}$ | $4.51^{***}$ |

* Significant at $p < 0.05$; ** Significant at $p < 0.01$; *** Significant at $p < 0.001$

**Table 2. Means of reduction rate (%) of germination percentage (RGP), first germination count (RFGC), germination speed index corrected (RGSIc), mean germination time (RMGT), coefficient of velocity of germination (RCVG), seedling emerging (RSE), seedling length (RSL), seedling fresh weight (RSFW) and seedling dry weight (RSDW) of seed obtained from four sesame varieties planted on four water stress treatments**

| | **RGP (%)** | **RFGC (%)** | **RGSIc (%)** | **RMGT (%)** | **RCVG (%)** | **RSE (%)** | **RSL (%)** | **RSFW (%)** | **RSDW (%)** |
|---|---|---|---|---|---|---|---|---|---|
| **Variety** | | | | | | | | | |
| SN 203 | $45.19^{b}$ | $58.33^{ab}$ | $54.06^{ab}$ | $-20.29^{a}$ | $19.10^{a}$ | $32.85^{a}$ | $17.21^{a}$ | $6.96^{a}$ | $-3.03^{b}$ |
| SN 403 | 17.05c | $20.83^{c}$ | $19.80^{c}$ | $-1.769^{a}$ | $1.43^{a}$ | $27.18^{a}$ | $10.10^{a}$ | $17.63^{a}$ | $20.12^{a}$ |
| SN 01-06 | $34.62^{bc}$ | $30.56^{bc}$ | $36.15^{bc}$ | $-8.815^{a}$ | $8.41^{a}$ | $6.75^{b}$ | $-2.20^{b}$ | $-13.05^{b}$ | $-2.48^{b}$ |
| Ngong | $74.15^{a}$ | $78.06^{a}$ | $75.25^{a}$ | $-1.734^{a}$ | $1.40^{a}$ | $16.34^{b}$ | $-11.71^{c}$ | $-42.04^{c}$ | $-41.56^{c}$ |
| **Water stress** | | | | | | | | | |
| W2 | $25.29^{b}$ | $16.75^{b}$ | $25.19^{b}$ | $0.27^{a}$ | $-0.23^{a}$ | $15.34^{bc}$ | $2.29^{a}$ | $-7.13^{b}$ | $-8.33^{b}$ |
| W3 | $29.80^{b}$ | $33.84^{b}$ | $28.92^{b}$ | $-7.98^{a}$ | $7.595^{a}$ | $24.99^{ab}$ | $3.66^{a}$ | $-21.49^{b}$ | $-19.97^{b}$ |
| W4 | $68.53^{a}$ | $72.30^{a}$ | $71.88^{a}$ | - | 15.62 | $14.52^{c}$ | $7.45^{a}$ | $-9.53^{b}$ | - |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | 16.15 a | a | | | | 10.20[b] |
| W5 | 45.63[ab] | 64.43[a] | 58.49[a] | -8.42[a] | 6.97[a] | 28.28[a] | 5.91[a] | 11.13 a | 21.28[a] |

W2 to W5 are the water stress treatment used. Data in columns displaying the same letters are not significantly different at $p < 0.05$ according to Ryan-Einot-Gabriel-Welsch Multiple Range Test

**Table 3 Analysis of variance for effect of variety x water stress treatments interaction sliced by variety for reduction rate (%) of germination percentage (RGP), first germination count (RFGC), germination speed index corrected (RGSIc), seedling emerging (RSE), seedling length (RSL), seedling fresh weight (RSFW) and seedling dry weight (RSDW) of seed obtained from four sesame varieties planted on four water stress treatments**

| | | F-value | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Variety** | **Df** | **RGP (%)** | **RFGC (%)** | **RGSIc (%)** | **RSE (%)** | **RSL (%)** | **RSFW (%)** | **RSDW (%)** |
| SN 203 | 3 | 2.31 | 3.22* | 3.05* | 5.78** | 0.83 | 1.60 | 3.75* |
| SN 403 | 3 | 3.40* | 4.71** | 5.01** | 2.33 | 9.59*** | 5.88** | 9.09*** |
| SN 01-06 | 3 | 6.10** | 8.59*** | 6.95*** | 1.33 | 1.00 | 0.35 | 0.39 |
| Ngong | 3 | 1.06 | 0.26 | 0.68 | 3.18* | 1.69 | 10.24*** | 14.21*** |

* Significant at $p < 0.05$; ** Significant at $p < 0.01$; *** Significant at $p < 0.001$



**Table 4 Effect of variety x water stress treatments interaction on reduction rate (%) of germination percentage (RGP), first germination count (RFGC) and germination speed index corrected (RGSIc) of seed obtained from four sesame varieties planted on four water stress treatments**

| | RGP (%) | | | | RFGC (%) | | | | RGSIc (%) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Variety | W2 | W3 | W4 | W5 | W2 | W3 | W4 | W5 | W2 | W3 | W4 | W5 |
| SN 203 | 16.66 | 66.66 | 61.11 | 33.33 | 12.50 | 87.50 | 62.50 | 75 | 13.44 | 77.19 | 64.04 | 64.04 |
| SN 403 | 9.09 | -13.63 | 54.54 | 18.18 | 5.55 | -27.77 | 55.55 | 50 | 11.01 | -26.46 | 55.67 | 38.98 |
| SN 01-06 | -7.69 | 15.38 | 76.92 | 53.84 | -33.33 | 11.11 | 88.88 | 55.55 | -6.18 | 9.39 | 86.20 | 55.17 |
| Ngong | 83.07 | 50.76 | 81.53 | 83.59 | 82.25 | 64.57 | 82.25 | 84.94 | 82.49 | 55.58 | 81.58 | 83.36 |

W2 to W5 are the water stress treatments used

**Table 5 Effect of variety x water stress treatments interaction on reduction rate (%) of seedling emerging (RSE), seedling length (RSL), seedling fresh weight (RSFW) and seedling dry weight (RSDW) of seed obtained from four sesame varieties planted on four water stress treatments**

| Variety | RSE (%) | | | | RSL (%) | | | | RSFW (%) | | | | RSDW (%) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | W2 | W3 | W4 | W5 | W2 | W3 | W4 | W5 | W2 | W3 | W4 | W5 | W2 | W3 | W4 | W5 |
| SN 203 | 15.71 | 27.14 | 38.57 | 50 | 15.64 | 13.82 | 19.18 | 24.70 | 11.20 | -6.14 | 6.64 | 39.21 | -0.91 | -21.56 | 0.61 | 49.54 |
| SN 403 | 21.25 | 17.50 | 32.50 | 37.50 | -7.95 | 12.19 | 16.54 | 19.61 | -7.13 | 14.42 | 22.08 | 47.04 | -11.26 | 18.31 | 24.64 | 55.98 |
| SN 01-06 | 1.351 | 12.16 | 13.51 | 0 | 0.58 | 1.76 | -6.58 | -4.58 | -13.26 | -15.13 | -17.89 | -5.91 | -0.58 | -9.94 | -2.33 | 2.92 |
| Ngong | 23.07 | 1.28 | 15.38 | 25.64 | -1.20 | -13.14 | -9.51 | -20.84 | -22.39 | -76.06 | -50.72 | -10.49 | -23.62 | -67.03 | -71.70 | 2.47 |

W2 to W5 are the water stress treatments used