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Suraj S Pokale
P. G. Student, Section of Agricultural Botany (Plant Physiology), College of Agriculture Nagpur, Dr. Panjabrao Deshmukh Krishi Vidyapeeth Akola, Maharashtra, India

SB Amarshettiwar
Associate Professor, College of Agriculture Mul, Dr. Panjabrao Deshmukh Krishi Vidyapeeth Akola, Maharashtra, India

Sapana B Baviskar
Assistant Professor, Section of Agricultural Botany, College of Agriculture Nagpur, Dr. Panjabrao Deshmukh Krishi Vidyapeeth Akola, Maharashtra, India

Sakshi Vilas Ingle
P.G. Student, Section of Agricultural Botany (Genetics and Plant Breeding), Dr. PDKV University Akola, College of Agriculture Nagpur, Maharashtra, India

Corresponding Author:
Sakshi Vilas Ingle
P.G. Student, Section of Agricultural Botany (Genetics and Plant Breeding), Dr. PDKV University Akola, College of Agriculture Nagpur, Maharashtra, India

Investigation into drought tolerance linked with biochemical traits affecting linseed yield under rainfed condition

Suraj S Pokale, SB Amarshettiwar, Sapana B Baviskar and Sakshi Vilas Ingle

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Abstract
During the Rabi season of 2022, a study on drought tolerance was conducted under rainfed conditions, as well as in laboratory settings, involving 10 genotypes of linseed. The experimental design utilized Randomized Block Design (RBD) for field trials and Completely Randomized Block Design (CRBD) with three replications for laboratory conditions. This study was conducted at the Research Farm of the All India Coordinated Research Project on Linseed and Mustard, College of Agriculture, Nagpur. The primary aim was to identify biochemical traits associated with drought tolerance and their correlation with yield and yield-contributing characteristics in linum usitassimum genotypes under rainfed conditions. Observations were recorded on various biochemical parameters including total phosphorus, chlorophyll, nitrogen, potassium, and proline content in leaves. Additionally, the oil content in seeds was estimated. Among the linseed genotypes studied, PKV NL-260 exhibited significantly higher leaf proline content during water stress conditions at the grain filling stage, followed by NL-369 and NL-371. Similarly, PKV NL-260 recorded the highest leaf total chlorophyll content, followed by NL-369 and NL-371. Regarding seed yield, PKV NL-260 showed the highest performance, followed by NL-369 and NL-371, surpassing the performance of the national check (NC) T-397 by 53.73%, 39.75%, and 34.48%, respectively.

Keywords: Linseed, biochemical, proline, water stress

Introduction
Linseed is also known as flax seed *Linum usitatissimum*, belongs to family Linaceae. In temperate region it is used as a food crop and also used for fiber purpose. Linseed is also used in textile industry it is used for making bedsheets, underclothes through Linen which is the byproduct of Linseed. It is mainly used for oil purpose it is an oilseed crop. Seeds of linseed are used for both edible and non-edible oil purpose. The oil is used in industry for painting and varnishing purpose (Matheson, 1976) [15]. The oil of linseed has Alpha-linolenic acid which is high in nutrition quality and is also good for health (Wood, 1997) [33]. Linseed has omega-3 fatty acid, fiber it is a very high demanding crop in western country due to its various uses as food and it is also an industrially important crop (Morris, 2003) [17].
Crop production is limited by various environmental stresses, among them drought stress being more detrimental than other stresses. It affects the growth of plant its quality gets deteriorated water stress also affects its production potential as well as the development, wilting symptoms are observed on the plants (Shao *et al.*, 2009) [27]. Yield losses up to 60-100 per cent are estimated as a result of long period of drought at various stages in different crop species. Insufficient water affects various characters of plants, there is no vigorous growth, photosynthesis, respiration, various biochemical pathways, metabolic pathways, enzyme production etc alters which ultimately reduces the yield of plant (Garg *et al.* 1998) [9]. Drought leads to a major problem on the growth of plant and if it gets associated with rise in temperature and certain deficiencies in soil will affect the production throughout the world. Water stress if observed during reproductive stage reduces the thousand seed weight and seed yield. It also reduces number of days to flowering and harvest index compared with the irrigated crop. Reduction in grain yield is due to significant reduction in capsule $plant^{-1}$, seeds $capsule^{-1}$ and seed weight under water stress conditions (Hochman, 1982) [12].

Stem of linseed crop also has much importance in biological fiber industry. Linseed fiber has good strength, light weight and is gaining momentum as key ingredient in the manufacturing industry i.e., used for the production of paper, coarse textiles, rope, fiber board, molded panels and as insulation material. Despite the potential applications of linseed fiber, particularly in composites and bio-based industries, its production remains economically marginal (Rennebaum *et al*., 2002) [22]. This could be attributed to the widespread cultivation of traditional linseed varieties, which prioritize high seed and oil yields over stem and fiber yields. However, there has been a recent surge in interest in breeding and cultivating dual-purpose linseed varieties (Foster *et al*., 1997; Easson and Molloy, 2000) [8, 7], which can be harvested for both seeds and fibers.

Materials and Methods

The project entitled, Investigation into drought tolerance linked with biochemical traits affecting linseed yield under rainfed conditions. was carried out during the rabi season of 2022 at the AICRP on Linseed and Mustard farm, located at the College of Agriculture, Nagpur (MS). The experiment followed a Randomized Block Design (RBD) with 10 different genotypes and three replications. The tested genotypes included NL-339, NL-367, NL-369, NL-371, NL-407, NL-408, TL-99, LSL-93, PKV NL-260 (LC), and T-397 (NC). Each gross plot measured 3.00 m x 2.20 m, while the net plot size was 2.40 m x 2.00 m, with a spacing of 30 cm x 10 cm. Five plants were randomly selected from each plot, and data were collected at 30, 45, 60, and 90 days after sowing (DAS) on total chlorophyll content. Nitrogen, phosphorus, and potassium content in the leaves were calculated at 60 and 90 DAS. Total chlorophyll content in oven-dried leaves was estimated using the colorimetric method suggested by Bruinsma (1982) [3]. Nitrogen content in leaves was determined using the micro Kjeldahl method described by Somichi *et al*. (1972) [28], while phosphorus content was estimated using the vanadomolybdate yellow color method outlined by Jackson (1967) [13].
The potassium content in leaves was determined using the digestion flame photometer with the di-acid extract method outlined by Jackson (1967) [13]. Oil content in the seeds was measured using a Soxhlet apparatus, following the method described by Shankaran (1965) [26].

$$\text{Oil \%} = \frac{W_2 - W_1}{W_0} \times 100$$

Where,
W1= The weight of the extraction flask before adding oil
W2=the weight of the extraction flask with oil
W0=the weight of the seed taken were measured.

Proline content in leaf tissues for each treatment and replication was estimated at 75 days after sowing (DAS) using the method proposed by Bates *et al*. (1973) [2].

$$\underset{(\mu \text{ g g}^{-1} \text{ tissue})}{\text{Proline content}} = \frac{34.11 \times OD_{520} \times V(\mu \text{ g}^{-1} \text{ fresh leaf tissues})}{2 \times f}$$

Where,
V = The total volume of extract
f = The grams of a fresh leaf
2 = The volume of the extract taken

The leaf relative water content was determined using the method outlined by Barrs and Weatherly (1962) [1] in the drought tolerance study.

$$\text{RWC (\%)} = \frac{\text{The fresh weight} - \text{An oven dry weight}}{\text{The turgid weight} - \text{An oven dry weight}} \times 100$$

The Promptness Index (PI) as described by George was used in this study, (1967) [10].
$PI = nd_2\,(1.00) + nd_4\,(0.75) + nd_6\,(0.50) + nd_8\,(0.25)$
PI = Promptness Index.
nd_2, nd_4, nd_6 and nd_8 = The percentage of seeds that germinated was observed on the 2nd, 4th, 6th, and 8th days following the method outlined by George (1967) [10].

The germination stress index (GSI) is

$$\text{Germination stress index (\%)} = \frac{\text{PI of stressed seeds (PIS)}}{\text{PI of controlled seeds (PIC)}} \times 100$$

The Dry matter stress tolerance index was determined according to Sammer Raza (2012) [24].

$$\text{Dry matter stress index (DMSI) (\%)} = \frac{\text{Dry matter of stressed seeds (DMS)}}{\text{Dry matter of controlled seeds (DMC)}} \times 100$$

Test weight, number pods, grain yield per plant, per plot, per hectare as well as harvest index was calculated after harvest. Data were analysed statistically using the method suggested by Panse and Sukhatme (1958) [19]

Results and Discussion

Biochemical parameters

Total chlorophyll content in the leaves ($mg^{-1}g$)

The chlorophyll, a green pigment located in the chloroplasts of all green plant cells and tissues, serves as an essential photosynthetic pigment capable of absorbing light energy for carbohydrate synthesis. It reflects the photosynthetic capacity of plant tissues. At 60 days after sowing (DAS), the total chlorophyll content in leaves ranged from 1.753 to 2.335 mg g^{-1}. Notably, the check genotype PKV NL-260 (LC) exhibited the highest chlorophyll content at 2.335 mg g^{-1}, significantly surpassing all other genotypes studied. The chlorophyll content of NL-367 (1.753 mg g^{-1}), TL-99 (1.809 mg g^{-1}), NL-339 (1.811 mg g^{-1}), NL-408 (1.825 mg g^{-1}), LSL-93 (1.840 mg g^{-1}), NL-371 (1.846 mg g^{-1}), NL-407 (1.875 mg g^{-1}), NL-369 (1.880 mg g^{-1}), and T-397 (NC) (1.994 mg g^{-1}) were comparable to each other but significantly lower than that of PKV NL-260 (LC). These findings align with those reported by Singh *et al*. (2003).

Nitrogen content in the leaves (%)

Nitrogen is a crucial element in mineral fertilizers, exerting significant influence on plant growth, appearance, and fruit production or quality compared to other essential elements. It is a vital component of proteins and protoplasm, essential for overall plant growth. Insufficient nitrogen can lead to chlorosis and stunted growth, while moderate doses are necessary for optimal plant growth and fruiting. Adequate nitrogenous compounds are necessary in every plant cell for normal cell division, growth, and respiration. At 60 days after sowing (DAS), leaf nitrogen levels ranged from 0.85% to 1.01%. Among the genotypes, PKV NL-260 (LC) exhibited the highest leaf nitrogen content at 1.01%, followed by LSL-93 (1.00%), NL-407 (0.96%), T-397 (NC) (0.95%), and NL-408 (0.93%), which were statistically similar. These values were significantly higher than those of NL-367 (0.85%), NL-369 (0.87%), NL-339 (0.89%), NL-371, and TL-99 (0.92% each). Notably, NL-367 (0.85%) had the lowest nitrogen content compared to PKV NL-260 (LC) (1.01%) and T-397 (NC) (0.95%). Nitrogen, primarily present in the form of proteins, is actively transported and is concentrated in young, tender plant tissues such as shoot tips, buds, and new leaves (Jain, 2010) [14].

The Phosphorus content in the leaves (%)

Phosphorus is vital for the formation of grain as it serves as an important constituent of protoplasm, nucleic acids, and proteins.

At 60 DAS leaf phosphorus content was recorded from 0.126 to 0.186%. At this stage P content was significantly maximum in the PKV NL-260 (LC) (0.186%), LSL-93 (0.176%), NL-407 (0.172%) and T-397 (NC) (0.167%) and was found at par with each other. Genotypes NL-339 and TL-99 each (0.126%), NL-367 (0.132%), NL-408 (0.143%), NL-369 (0.153%) and NL-371 (0.157%) showed the significantly lower leaf phosphorus content when compared with check genotype PKV NL-260 (LC) (0.186%) and genotypes NL-369 (0.153%) and NL-371 (0.157%) found at par with national check T-397 (0.167%). Whereas genotypes NL-339 and TL-99 each (0.126%) were found significantly lowest in leaf P content than both check varieties. Evidence from the data indicates a gradual decrease in phosphorus content from 60 to 90 days after sowing (DAS). This trend may be attributed to the translocation of leaf phosphorus and its utilization for the development of food storage organs, as suggested by Sagare and Naphade (1987) [22].

The potassium content in leaves (%)

Potassium serves as a vital macronutrient involved in numerous physiological processes. Insufficient potassium in plants induces alterations in metabolite concentrations and gene transcription, as well as enzyme activity. At 60 days after sowing (DAS), leaf potassium levels ranged from 0.332% to 0.407%. The highest leaf potassium content was significantly observed in genotype PKV NL-260 (LC) (0.407%), followed closely by LSL-93 (0.404%), T-397 (0.390%), NL-407 (0.385%), and NL-408 (0.374%), all statistically similar. Conversely, NL-371 (0.356%), TL-99 (0.354%), NL-339 (0.353%), NL-369 (0.347%), and NL-367 (0.332%) exhibited significantly lower leaf potassium content compared to both PKV NL-260 (LC) (0.407%) and T-397 (0.390%). Analysis reveals a decrease in potassium content from 60 to 90 DAS, possibly due to nutrient translocation and its utilization for grain development in linseed. This decline may be attributed to the faster nutrient uptake by younger plants and their relatively higher physiological activities during the early growth stages (Sagare & Naphade, 1987) [22].

The Seed oil content (%)

Linseed, primarily recognized as an oilseed crop, is characterized by genetically controlled traits such as oil, protein, and sucrose content, as well as appearance. However, plant nutrition can significantly influence the expression of these quality traits. Seed oil content is particularly pivotal in determining seed quality. Under rainfed conditions, substantial variations were observed in oil content. The range of seed oil content spanned from 34.15% to 39.79%. Notably, the national check genotype T-397 exhibited the highest oil content at 39.79%.

than all other genotype followed by LSL-93 (37.66%) and PKV NL-260 (LC) (36.60%). Significantly lower seed oil content was recorded in genotypes LSL-93 (37.66%), PKV NL-260 (LC) (36.60%), NL-339 (36.30%), TL-99 (35.83%), NL-371 (35.76%), NL-408 (35.44%), NL-369 (35.09%), NL-367 (35.04%) and NL-407 (34.15%). When compared with check genotype T-397 (NC) (39.79%). NL-407 (34.15%) recorded significantly lowest oil content in seed than both check genotypes. Highest seed oil content was recorded by national check variety T-397 which is correlated with higher DMSI & GSI which indicated the moisture stress tolerance. Ghaemi (2019) [11] reported similar findings, indicating that the highest percentage of essential oil was associated with mild drought stress during the flowering stage, while the greatest amount of linalool was attributed to mild drought stress during the fruiting stage.

Proline content (μ g g^{-1} tissue)

Under moderate to severe stress conditions, the concentration of the amino acid proline increases more than any other amino acid, aiding in drought tolerance by acting as a storage pool for nitrogen (Stewart, 1985) [31]. The present study revealed a significant increase in proline content due to moisture stress, with leaf proline content ranging from 20.37 to 31.18 µg g^{-1} tissue, indicating a higher range observed under rainfed conditions. Significant variation in proline content was observed among genotypes. PKV NL-260 (LC) exhibited the highest proline content at 31.18 µg g^{-1} tissue, followed by NL-369 at 30.39 µg g^{-1} tissue, while NL-371 showed 27.53 µg g^{-1} tissue, all statistically similar. Conversely, NL-407, NL-339, and LSL-93 were lower, with 24.64 µg g^{-1} tissue, 24.63 µg g^{-1} tissue, and 22.84 µg g^{-1} tissue, respectively, all comparable to each other and significantly lower than the local check genotype PKV NL-260 (LC) at 31.18 µg g^{-1} tissue. Genotypes NL-408, TL-99, and NL-367 were significantly lower, with proline contents of 22.06 µg g^{-1} tissue, 22.04 µg g^{-1} tissue, and 20.37 µg g^{-1} tissue, respectively, compared to the check genotypes PKV NL-260 (LC) at 31.18 µg g^{-1} tissue and T-397 (NC) at 23.91 µg g^{-1} tissue. Phutela *et al*. (2002) [18] observed increased proline content in Brassica juncea cultivar seeds under stress conditions, while Din *et al*. (2011) [6] reported enhanced accumulation of proline in the leaf of all cultivars under drought stress. This accumulation of proline during drought stress enhances survival and tissue water status, indicating that genotypes with high proline content under stress conditions can tolerate drought.

Drought tolerance study

Relative water content (%)

Statistically significant differences were observed in the Relative Water Content (RWC) data across different growth stages. At 45 days after sowing (DAS), RWC ranged from 64.27% to 72.50%, while at 60 DAS, it ranged from 61.67% to 68.77%. By 90 DAS, the RWC range was recorded between 51.66% and 64.53%. Genotype NL-339 exhibited the significantly highest Leaf Relative Water Content (LRWC) at 64.53%, surpassing both check genotypes, although these genotypes were statistically similar to each other. In contrast, NL-367 recorded the significantly lowest LRWC at 51.66%, followed by TL-99 at 53.77%, with both genotypes being statistically similar. Our findings align with previous studies by Son *et al*. (2011) [29], Seyni *et al*. (2010) [25], and Pinto *et al*. (2014) [21] in sesame, which noted a decrease in RWC by 12-13% under water stress conditions. These results suggest that plants adapt their vegetative apparatus by reducing leaf area, leaf water content, radial, and vertical growth to withstand water stress conditions.

The germination stress index (%)

The range of the germination stress index spanned from 38.33% to 51.67%, with the highest index observed in genotype PKV NL-260 (LC) at 51.67%, followed by NL-369 at 50.42% and NL-371 at 49.71%, all showing statistical similarity. Notably, more than 50% of germination occurred under water stress conditions, indicating the drought tolerance of these genotypes, consistent with the findings of Dharanguttikar *et al*. (2015) [5]. Furthermore, based on stress parameters, NBeG 47-1, PBC-161, and BBG-2 were identified for germination, GJG-1010 and PBC-161 for seedling growth, and NBeG 47-1 and PBC-161 for higher dry matter production, highlighting their drought tolerance as reported by Debez *et al*. (2004) [4]. These observations emphasize the significant impact of water stress on germination.

The dry matter stress index

Statistically significant findings were observed regarding the dry matter stress index, which ranged from 72.93% to 94.43%. Notably, the highest dry matter stress index was recorded in genotype PKV NL-260 (LC) at 94.43%, followed by NL-369 at 93.04%, NL-371 at 92.56%, and NL-339 at 92.50%.

The yield and yield contributing characters

Yield is a multifaceted attribute influenced by various traits, internal plant mechanisms, and environmental elements. In this study, we examined the impact of water stress on yield and associated parameters, including the number of seed capsules per plant, 1000 seed weight (g), number of capsules per plant, seed yield per plant, per plot, and per hectare, as well as harvest index. The obtained data and subsequent findings are discussed under the following headings.

The number of capsules per plant

The number of capsules per plant ranged from 29.00 to 61.67 capsules. Genotype T-397 exhibited the highest number of capsules per plant at 61.67, followed by NL-369 at 61.00 and NL-371 at 53.67, all statistically similar (Sravanti *et al*., 2022) [30].

The test weight (1000 Seed Weight) (g)

The test weight ranged from 5.61 to 7.92 grams. LSL-93 exhibited the highest test weight at 7.92 grams compared to both the check genotypes PKV NL-260 (LC) at 7.59 grams and T-397 (NC) at 5.75 grams. These findings are consistent with those reported by Maurya *et al*. (2022) [16], who observed that increases in growth-related traits are reflected in yield-related traits. Additionally, Pande *et al*. (1970) [18] reported a slight decrease in test weight under stressed conditions.

Seed yield

The check genotype PKV NL-260 (LC) recorded the highest seed yield. The range in seed yield per plant, per plot, and per hectare was from 1.77 grams, 226.56 grams, and 472 kilograms in genotype NL-367 to 3.56 grams, 502.34 grams, and 1046.73 kilograms in genotype PKV NL-260 (LC) respectively. Seed yield is influenced by morpho-physiological parameters such as plant height, total dry matter production, leaf area, number of seeds, and test weight, all of which are considered as yield-contributing parameters.

Harvest index (HI)

Genotype NL-369 exhibited the significantly highest harvest index at 34.17%, while NL-367 showed the minimum at 24.59%. The range of harvest index spanned from 24.59% to 34.17%.

Conclusion

Based on the findings of the present investigation, the following conclusions were drawn. Biochemical parameters such as total chlorophyll content, NPK content, proline content in leaves, and oil content in seeds showed significantly higher values in PKV NL-260, followed by NL-369 and NL-371, which are considered drought-tolerant genotypes. NL-339 and T-397 exhibited moderately higher values and are categorized as moderately tolerant. Conversely, genotypes NL-367, TL-99, LSL-93, NL-408, and NL-407 are considered drought-susceptible as they showed lower values in these parameters.

The total chlorophyll content in leaves had a direct effect on yield due to a high photosynthetic rate, ultimately contributing to overall growth in the linseed crop. However, none of the genotypes showed significant increments in yield attributing characters under rainfed moisture stress conditions compared to the best-performing PKV NL-260 local check genotype. PKV NL-260, followed by NL-369 and NL-371, recorded significantly highest values for yield and yield attributing traits, such as number of capsules per plant, test weight, seed yield per plant, seed yield per plot, and seed yield per hectare, indicating their drought tolerance.

Genotypes NL-339 and T-397 recorded moderately high values for yield and yield attributing traits and are classified as moderately tolerant to drought. On the other hand, NL-367, TL-99, LSL-93, NL-408, and NL-407 recorded the lowest values in these traits and are considered drought-susceptible genotypes.

Regarding seed yield, genotypes PKV NL-260, NL-369, NL-371, and NL-339 recorded higher yields compared to the national check variety T-397. NL-369, NL-371, and NL-339 were identified as drought-tolerant genotypes based on Relative Water Content (RWC), Germination Stress Index (GSI), and Dry Matter Stress Index (DMSI), being comparable to PKV NL-260.

In conclusion, local check PKV NL-260 showed superiority under rainfed moisture stress conditions, with NL-369 and NL-371 also displaying drought tolerance. Therefore, these genotypes could be utilized in further linseed crop improvement programs. NL-339 and T-397 exhibited moderate tolerance, while NL-367, TL-99, LSL-93, NL-408, and NL-407 were considered drought-susceptible genotypes. NL-407 and LSL-93, despite showing dwarfism and higher branching with high dry matter production but low yields, could be valuable in breeding programs aimed at converting vegetative growth to reproductive growth for further linseed crop improvement.

Table 1: The total chlorophyll content (mg g^{-1}), Nitrogen content in the leaves (%), Phosphorous in leaves (%), Potassium content in leaves (%) Proline content (μ g g^{-1} tissue) and Oil content (%)

Genotypes	Biochemical analysis											
	Total chlorophyll content (mg g^{-1})				Nitrogen in leaves (%)		Phosphorous in leaves (%)		Potassium content in leaves (%)		Proline content (μ g g^{-1} tissue)	Oil content (%)
	30 DAS	45 DAS	60 DAS	90 DAS	60 DAS	90 DAS	60 DAS	90 DAS	60 DAS	90 DAS	At harvest	At harvest
NL-339	0.873	1.226	1.811	1.370	0.89	0.85	0.126	0.113	0.353	0.261	24.63	36.30
NL-367	0.845	1.241	1.753	1.225	0.85	0.80	0.132	0.103	0.332	0.243	20.37	35.04
NL-369	1.117	1.411	1.880	1.282	0.87	0.83	0.153	0.114	0.347	0.254	30.39	35.09
NL-371	1.246	1.464	1.846	1.240	0.92	0.86	0.157	0.127	0.356	0.264	27.53	35.76
NL-407	1.036	1.420	1.875	1.478	0.96	0.91	0.172	0.148	0.385	0.292	24.64	34.15
NL-408	1.055	1.323	1.825	1.523	0.93	0.88	0.143	0.115	0.374	0.281	22.06	35.44
TL-99	0.891	1.276	1.809	1.266	0.92	0.86	0.126	0.103	0.354	0.262	22.04	35.83
LSL-93	1.014	1.347	1.840	1.259	1.00	0.95	0.176	0.138	0.404	0.311	22.84	37.66
PKV NL-260 (LC)	1.326	1.727	2.335	1.775	1.01	0.94	0.186	0.143	0.407	0.311	31.18	36.60
T-397 (NC)	1.140	1.421	1.994	1.627	0.95	0.90	0.167	0.152	0.390	0.297	23.91	39.79
SE (m) ±	0.06	0.07	0.08	0.09	0.03	0.02	0.007	0.006	0.011	0.010	0.54	0.56
CD at 5%	0.18	0.21	0.25	0.20	0.08	0.07	0.021	0.017	0.033	0.029	1.61	1.66

Table 2: Relative water content (%), Germination stress index (%) and Dry matter stress index (%)

Genotypes	Drought tolerant observations					
	Relative water content (%)				Germination stress index (%)	Dry matter stress index (%)
	30 DAS	45 DAS	60 DAS	90 DAS		
NL-339	75.03	70.29	66.65	64.53	47.92	92.50
NL-367	76.30	67.45	64.45	51.66	36.67	72.93
NL-369	76.03	65.49	63.61	59.01	50.42	93.04
NL-371	76.49	64.27	61.67	59.14	49.71	92.56
NL-407	76.66	68.33	63.33	60.42	45.83	89.93
NL-408	75.66	64.50	62.57	58.81	40.83	75.95
TL-99	74.26	69.50	65.11	53.77	38.33	73.39
LSL-93	76.49	68.83	65.50	58.75	42.50	83.24
PKV NL-260 (LC)	74.92	72.50	68.77	57.99	51.67	94.43
T-397 (NC)	74.83	70.00	67.67	57.30	44.58	87.12
SE (m) ±	1.05	1.42	1.63	1.99	1.31	0.66
CD at 5%	-	4.22	4.84	5.92	3.79	1.92

Table 3: Test weight, Number of capsules $plant^{-1}$, Seed yield $plant^{-1}$ (g), Seed yield $plot^{-1}$ (kg), Seed yield ha^{-1} (q) and Harvest index (%)

Genotypes	Test weight (g)	Number of capsules $plant^{-1}$	Seed yield $plant^{-1}$ (g)	Seed yield $plot^{-1}$ (kg)	Seed yield ha^{-1} (q)	Harvest index (%)
NL-339	7.18	44.33	2.78	358.62	747.13	28.99
NL-367	7.52	29.00	1.77	226.56	472.00	24.59
NL-369	6.19	61.00	3.45	458.41	955.01	34.17
NL-371	6.51	53.67	3.22	441.14	919.04	33.81
NL-407	7.17	48.33	2.44	336.26	700.55	23.41
NL-408	6.15	50.33	2.26	305.55	636.56	25.38
TL-99	5.61	34.00	1.84	251.62	524.22	24.00
LSL-93	7.92	37.67	2.51	326.30	679.79	25.92
PKV NL-260 (LC)	7.59	57.67	3.56	502.43	1046.73	30.97
T-397 (NC)	5.75	61.67	2.31	328.02	683.38	26.17
SE (m) ±	0.09	2.79	0.18	24.04	50.09	1.63
CD at 5%	0.26	8.29	0.53	71.44	148.83	4.83

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