



Screening Effect of Fodder Maize Varieties under Water Stress Conditions

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Abstract

One of the most critical limiting factors of plant productivity, especially arid and semi-arid environments is soil and water salinity. In Pakistan, salinity has a significant impact on soil in a variety of fields. During 2018-19 growing season, the current research was done at the National Agriculture Council, Islamabad, Pakistan. Sixty distinct cultivar/hybrid seeds were tested in this study from Punjab research institutes. On the basis of superior performing morphological traits, sixty top ten drought tolerant fodder maize cultivars/hybrids were screened. Sohni Dharti-623, Pahari, Afgoi, Sarhad, C905, Zaitoon maize -7786, Sarhad yellow, PSHW_404 hybrid white, NCEV-7004 and YH-5536 had the best survival rates. Screened fodder maize genotypes were additionally treated with polythene glycol 4000, 6000 and 8000 at different levels of drought stress (PEG @ 0,6 and 12%). The fresh weight of maize was found to be highest in Sohni Dharti-623 under control followed by Pahari. Sohni Dharti-262 had the longest root and shoot lengths with the control treatment followed by Pahari respectively.

Keywords: *Cultivar, Hybrid, PEG, Polythene glycol*

Introduction

Maize growth, development and productivity is mainly dependent on prevailing climatic conditions, the way it is produced, and more importantly genetic potential of cultivated varieties / hybrids. Among the environmental stresses, drought has drastic effect on the production of maize crop. The use of gibberellic acid (GA3) improves the water stress tolerance in maize plants by maintaining membrane permeability, enhancing chlorophyll concentration, leaf relative water content and nutrient concentrations in leaves. Selenium (Se) counteracts the abiotic stresses in plants induced by cold, drought, salinity, and heavy metals through the regulation of reactive oxygen species (ROS) and antioxidants, inhibition of uptake and translocation of salts, rebuilding of cell membrane and chloroplast structures, and recovery of the photosynthetic system.

The fore-given scenario of fodder production, its demand and scarcity in Pothwar region compels to contemplate about the improvement of fodder production for burgeoning number of livestock. Enhanced production of maize forage under water stress conditions could be spared for the preservation of silage to meet the fodder requirements during the critical periods of fodder shortage. For screening of drought tolerant maize varieties/hybrids, experiments were carried out at Pir Mehr Ali Shah Arid Agriculture University, Department of Agronomy in the Lab (in Petri dishes) and greenhouse (hydroponics as well as earthen pots).

Sixty maize varieties/hybrids were collected from different seed production institutes and companies from all over Pakistan. Seeds of these were sown in Petri dishes in lab # 04 of Agronomy Department in CRD arrangement.

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DOI: <http://dx.doi.org/10.21746/aps.2021.10.12.1>

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On the basis of seed germination indices and growth, the best performing six fodder maize varieties (Sohni Dharti, Pahari OPV, Afgoi, Sarhad Yellow, C-905, Zaitoon Maize-7786 and one hybrid (PSHW-0404 Hybrid White) were selected for further experimentation.

Then the water stress tolerance of these (varieties/hybrids) was assessed in the greenhouse through water potential developed by using polyethylene glycol (PEG) solution in plastic tubs. The PEGs of different molecular weights (4000, 6000 and 8000) were used at three levels (0, 6 and 9%) in the hydroponics solutions to grow maize plants in the plastic tubs. The analysed data regarding seedlings survival rate, root and plumule length and dry matter accumulation showed that the highest dry and fresh root and shoot weights of maize seedlings were recorded for Sohni Dharti variety under control (without application of PEG). Sohni Dharti @ 9% of PEG 6000 was followed by the PSHW-0404 Hybrid White maize.

From the solution culture studies in the greenhouse, five best performing varieties were selected. These selected varieties were further tested in earthen pots filled with loamy soil in greenhouse in the second half of the year to assess the effect of GA3 on plant growth and water stress tolerance, and Se was applied for enhancing the fodder / silage quality. The graded levels each of GA3 (0, 25, 50, 75 and 100 ppm) and Se (0, 0.25, 0.50, 0.75 and 1 ppm) were foliar applied to evaluate their effect on growth / drought tolerance and fodder/silage quality, respectively. Completely randomized design was used with three repeats.

In the greenhouse experiment, the data recorded on different agro-physiological parameters showed that foliar application of GA3-75 + Se-0.75 produced the highest dry matter (DM) yield of Afgoi (30.2 g plant⁻¹) and Pahari OPV (28.26 g plant⁻¹) varieties, respectively at 30 DAS. However, at 45 DAS, same treatment produced the highest value of DM for variety Sohni Dharti-226 (55.4 g plant⁻¹) followed by Afgoi (44.6 g plant⁻¹). Similarly, this treatment also rendered the

highest value of plant height for variety Sohni Dharti and Afgoi (57.4 cm and 55.7 cm). However, the least values of plant height were obtained in Control (no foliar application of GA3 and Se) for variety Sarhad Yellow (34.9 cm) and C905 (28.5 cm).

The highest values of leaf area index (LAI) at 30 DAS were obtained in Afgoi (1.94), Shoni Dharti-262 (1.84) and Sarhad Yellow (1.82) with the treatment of GA3-75 + Se-0.75 followed by Pahari (1.73 cm). Moreover, this treatment significantly increased LAI at 45 DAS in variety Sohni Dharti-623 (2.67) followed by GA3-50 + Se-0.50 in the same variety.

The highest value of net assimilation rate (1.60 g m⁻² day⁻¹) was obtained with the application of GA3-75 + Se-0.75 followed by the treatment of GA3-50 + Se-0.50 in variety Sohni Dharti-226 (1.48 g m⁻² day⁻¹). Similarly, the highest value of leaf area duration ((34.6 days) was found with foliar application of GA3-75 + Se-0.75 in variety Sohni Dharti-623 followed by Afgoi (31.74 days). The highest value of crop growth rate was obtained with GA3-75 + Se-0.75 in variety Afgoi (0.507 g m⁻² day⁻¹) and Sarhad Yellow (0.477 g m⁻² day⁻¹). The highest catalase activity (CAT) was recorded in Sohni Dharti-626 (4.71 µg g⁻¹) with GA3-75 + Se-0.75. Improvement in chlorophyll contents was higher (1.91 mg g⁻¹ FW) with GA3-75 + Se-0.75 in Sohni Dharti-623 that was at par with Pahari in the same treatment as compared with their respective control.

Production of fodder crops is being restricted due to climatic changes and urbanization. In Pothwar during summer, sorghum is grown traditionally as fodder crop by the farmers, but it results in poor quality fodder due to high hydrocyanic acid content. The presence of hydrocyanic acid, non-palatability and lesser fiber content in sorghum make it a poor and less attractive choice for animals. No investigations have been undertaken on the use of plant growth promoting substances, viz., GA3 and nutrition improvement strategies (through the use of Se) for enhancing fodder maize quality, which

ultimately augments the production of quality maize silage. Under this situation, one approach is to screen the drought tolerant fodder maize varieties / hybrids under stressed conditions, and the other could be the exogenous application of suitable growth regulators (GA3) for sufficient biomass production and moisture stress tolerance and the use of Se for quality improvement of maize fodder / silage. In the proposed plan of work, an effort was made to screen the moisture stress tolerant fodder maize varieties

/ hybrids. For improving the stress tolerance and plant growth of fodder maize varieties, GA3 was used along with selenium (an essential nutrient for animals / human growth and metabolism) to enhance the quality of fodder / silage produced under varied moisture stress environments. Sixty (60) fodder maize varieties / hybrids were collected from different maize research institutes / companies for the purpose stated above (Table 1).

Table 1: List of fodder maize varieties / hybrids with sources

Sr. No.	Name	Source	Sr. No	Name	Source
1.	FH-1292	AARI	31	P-1543	Pioneer
2.	FH-1012	AARI	32	AFGOI-	Pir Sabak Nowshera
3.	FH-1114	AARI	33	Azam-OPV	Pir Sabak Nowshera
4.	FH-793	AARI	34	Iqbal-OPV	Pir Sabak Nowshera
5.	FH-988	AARI	35	Jalal-OPV	Pir Sabak Nowshera
6.	MS-2010	FRI Sargodha	36	Pahari-OPV	Pir Sabak Nowshera
7.	MS-2015	FRI Sargodha	37	Sarhad Yellow OPV	Pir Sabak Nowshera
8.	MS-2018	FRI Sargodha	38	30Y-87	Pioneer
9.	Pearl White	FRI Sargodha	39	Tiger	American line
10.	SGD-10	FRI Sargodha	40	AAS-9633	Ali Akbar Group
11.	SGD-12	FRI Sargodha	41	C-905	FMC
12.	SGD-1501	FRI Sargodha	42	C-7065	FMC
13.	SGD-16	FRI Sargodha	43	C-8314	-
14.	SGD-18	FRI Sargodha	44	HC-11 ⁺	-
15.	SGD-20	FRI Sargodha	45	Sohni Dharti-626	-
16.	SGD-22	FRI Sargodha	46	Zaitoon Maize-7786	-
17.	HICORN H.C-9091	ICI	47	Maxim 70M70	American line
18.	HICORN H.C-2040	ICI	48	Sohrab-909	-
19.	NEELUM	MMRI-Sahiwal	49	CZP-White	-
20.	YH-5536	MMRI-Sahiwal	50	Desi. Yellow	-
21.	DK-6724 Monsanto	Monsanto	51	PSHW-0404 hybrid yellow	Pir Sabak Nowshera
22.	QPHM-200	MSM-NARC	52	PSHW-0404 hybrid	Pir Sabak Now-

				yellow	shera
23.	H.N.GOLD	MSM-NARC	53	PSHW-0404 Hybrid White	Pir Sabak Now-shera
24.	EV-1297	NARC	54	PSHW-0404 hybrid white	Pir Sabak Now-shera
25.	NCEV/1530-10	NARC	55	PSHW-0404 hybrid white	Pir Sabak Now-shera
26.	NCEV/1270-3	NARC	56	PSHW-0404 hybrid white	Pir Sabak Now-shera
27.	NCEV/1270-4	NARC	57	PSHW-0404 hybrid white	Pir Sabak Now-shera
28.	NCEV/1270-5	NARC	58	PSHW-0404 hybrid yellow	Pir Sabak Now-shera
29.	NCEV/7004	NARC	59	PAK Hybrid-9067	-
30.	Haq Nawaz Gold	NARC	60	Babar Hybrid	Pir Sabak Now-shera

Material and methods

Rate of Survival

Survival rate is the survival percentage which was calculated by determining the

$$\text{Rate of survival} = \frac{\text{Number of plants survived}}{\text{Total number of seedlings}} \times 100$$

Root and shoot length

After 28 days, three plants were randomly selected for study, taking from each replicate of each treatment. The seedlings were cut into root and shoot parts and their lengths were measured (cm).

Fresh and dry weight of seedling

After measuring the root and shoot length as described above, fresh weight of seedlings was recorded. Then the root and shoot were put into paper envelop separately and placed into the preheated oven (70°C) for 48 hours. After cooling in desiccators, the dry weight was taken.

Leaf area

The leaf area (cm² plant⁻¹) was estimated according to Wang *et al.* (2012) as follows:

$$\text{Leaf area} = \text{Leaf length} \times \text{maximum leaf width} \times 0.75$$

Leaf area index

Leaf area index (LAI) was calculated as the ratio of leaf area to land area (Hunt, 1978).

$$\text{LAI} = \frac{\text{Leaf area}}{\text{Land area}}$$

ratio between survived plants and total number of seedlings multiplied by 100 at 28 days after germination by using the formula as:

Fresh and dry weight plant⁻¹

Dry matter accumulation (g plant⁻¹) was determined by collecting two plants at random from each Petri dish. Soon after harvest each sample was weighed to determine the fresh weight. Each plant sample was chaffed, thoroughly mixed and then oven dried to estimate the dry weight plant⁻¹.

Plant growth rate

Plant growth rate (PGR) (g m⁻² day⁻¹) was calculated as proposed by Hunt (1978) for each harvest after 15 days interval.

$$\text{PGR} = \frac{W_2 - W_1}{T_2 - T_1}$$

Where W₁ and W₂ are the total dry weights harvested at times T₁ and T₂ respectively. Mean PGR was calculated between first harvest and the last harvest.

Leaf area duration

Leaf area duration (LAD) was estimated according to the formula suggested by Hunt (1978) as

$$\text{LAD} = \frac{\text{LAI}_1 + \text{LAI}_2}{2} \times T_2 - T_1$$

Where LAI_1 and LAI_2 are the leaf area indices at time T_1 and T_2 , respectively.

Net assimilation rate

Net assimilation rate (NAR) was calculated by using the formula of Hunt (1978).

$$NAR = \frac{TDM}{LAD}$$

Where, TDM and LAD are the final total dry matter and leaf area duration, respectively.

Total chlorophyll content

Total chlorophyll contents (%) were determined by spectrophotometer at 652 nm (Koleyoreas, 1958).

Superoxide dismutase activity

Activity of superoxide dismutase (SOD) was assessed by PAGE technique. For this purpose, proteins and enzymes were separated as mentioned by Hakimi and Khosropour (2015) using electrophoresis.

Catalase activity

Activity of catalase (CAT) activity was measured spectrophotometrically at room temperature by monitoring the decrease in absorbance at 240 nm resulting from the decomposition of H_2O_2 . Catalase activity was measured according to the method of Aebi (1983).

Results and Discussion

In-vitro screening of maize varieties / hybrids for drought tolerance

Selection criteria of maize varieties / hybrids for drought tolerance in hydroponic experiment

Six seeds of each variety/ hybrid collected from different public and private research institutes/ companies were sown in Lab in Petri dishes. Seven varieties/ hybrids

were selected on the basis of following germination and growth parameters.

1. Survival rate (%)
2. Plumule length (cm)
3. Radical length (cm)

Survival rate, plumule and radical length in maize varieties/hybrids

Seeds of 60 fodder maize varieties / hybrids was collected from different maize research institutes /companies viz. Maize Research Program, NARC, Islamabad, Maize and Millet Research Institute, Yousaf Wala (Sahiwal), Noor Traders, Farooq abad, (Sheikhupura), Tanveer Spray Centre, Pattoki (Okara), Fodder Research Institute (Sargodha) and Monsanto Seeds

The analysed data showed that the highest survival rate in maize varieties viz. Sohni Dharti, Pahari, Afgoi, Sarhad Yellow, C905, Zaitoon Maize-7786, PSHW-0404 Hybrid White , NCEV-7004, Pearl White and YH-5536. The highest plumule length was observed in Sohni Dharti (14.33cm), Pahari PV(14.667 cm), Afgoi (15.300 cm) Sarhad Yellow also in C905 and Zaitoon Maize-7786 (15 cm) in both. Highest value of radical length was recorded for Sohni Dharti (26.35 cm) Pahari (25.35 cm), Afgoi, Sarhad Yellow, C905, 7786 were 22.4, 24.4, 23.1, 22.4 cm, respectively followed by Zaitoon Maize-7786 was 22.4 cm (Table 2).

Germination percentage is first leading step toward the establishment of all traits in plants (Bayoumi *et al.*, 2010). The coincidence of external environment and hormonal factors control the overall process of germination.

Table 2 : Varietal performance regarding survival rate, plumule and radical length in Lab

Sr.#	Name of Variety / hybrid	Rate of survival (%)	Plumule (cm)	Radical (cm)
1	Sonhi Dharti	80 a	14.33 a	26.35 a
2	Pahari OPV	80 a	14.66 a	25.35 ab
3	Afgoi	80 a	15.30 a	24.35 abc
4	Sarhad Yellow	80 a	15 a	24.35 abc
5	C905	80 a	15 a	23.08 ab...d
6	Zaitoon Maize-7786	80 a	15 a	22.35 b-e
7	PSHW-0404 Hybrid White	80 a	12 b	20.85 cd...f
8	Ncev/7004	80 a	11.60 b	20.68 c-g
9	Pearl White	80 a	11 b	21.35 cd...f
10	Yh-5536	80 a	11 b	20.35 de...g
11	PSHW-0404 Hybrid White	80 a	8.67 c	18.85 ef...i
12	Sohni Dharti-626	64 b	8.23 cd	19.35 ef...h
13	Sarhad Yellow Opv	68 b	8.00 cde	18.08 fg...j
14	PSHW-0404 Hybrid White	65 b	5.66 h-k	18.35 fg...i
15	PSHW-0404 Hybrid White	64 b	6.00 g-j	17.01 gh...l
16	Neelum	66 b	6.16 ghi	17.08 gh...k
17	Fh-1114	60 b	6.66 fgh	15.85 hi...n
18	Ms-2010	66 b	7.00 efg	16.08 hi...m
19	Sgd-22	65 b	7.00 efg	16.35 hi...m
20	Ncev/70040	67 b	7.00 efg	16.35 hi...m
21	Tiger	66 b	7.00 efg	16.35 hi...m
22	Fh-1012	66 b	7.00 efg	16.35 hi...m
23	PSHW-0404 Hybrid Yellow	43 c	7.00 efg	15.35 ij...n
24	C-8314	40 c	7.00 efg	15.08 jk...p
25	Haq Nawaz Gold	40 c	7.50 def	15.28 ij...o
26	Ms-2018	40 c	8.00 cde	15.35 ik...o
27	P-1543	40 c	8.06 cde	15.35 ij...o
28	Dk-6724 Monsanto	40 c	5.00 jk...n	14.23 kl..q
29	Qphm-200	40 c	5.33 ij..m	14.35 kl...o
30	Fh-988	40 c	5.33 i..m	14.35 k..q
31	Ms-2015	40 c	5.333 ij..m	13.73 kl...r
32	C-7065	40 c	5.50 ij..l	13.85 kl...r
33	Fh-1292	40 c	4.00 n-q	13.35 lm...r
34	Desi. Yellow	40 c	4.16 nop	13.35 lm...r
35	Pak. Hybrid-9067	40 c	4.16 nop	12.85 m...r
36	Fh-793	40 c	4.16 nop	12.35 op...r
37	H.N.Gold	40 c	4.166 nop	12.35 no...r
38	Hicorn H.C-9091	40 c	4.1667 nop	12.35 no...r
39	Sgd-12	40 c	4.167 nop	12.08 op...r
40	Sgd-10	40 c	4.33 m-p	11.51 pqr
41	Sgd-1501	40 c	4.50 lm..o	11.24 qr
42	Maxim 70M70	40 c	4.66 kl..o	11.35 qr
43	Pshw-0404 Hybrid Yellow	0 d	4.66 kl..o	11.35 qr
44	Hc-11+	0 d	4.66 kl..n	11.35 qr
45	Iqbal-Opv	4.16 d	5.00 jk..n	11.18 qr
46	Babar Hybrid	4.16 d	4.00 no..q	11.35 qr
47	Jalal-Opv	4.17 d	00 no..q	10.74 qrs

48	Ncev/1270-3	0.00 d	3.83 opq	11.16 qr
49	Sohrab-909	0.00 d	3.83 opq	11.35 qr
50	Czp-White	0.00 d	3.33 pqr	11.35 qr
51	30y-87	0.00 d	3.00 qr	10.35 rs
52	Ncev/1530-10	0.00 d	3.00 qr	7.11 s
53	Ev-1297	0.00 d	3.00 qr	0.00 t
54	Azam-Opv	0.00 d	3.00 qr	0.00 t
55	Aas-9633	0.00 d	2.33 r	0.00 t
56	Hicorn H.C-2040	0.00 d	0.00 s	0.00 t
57	Sgd-16	0.00 d	0.00 s	0.00 t
58	Sgd-18	0.00 d	0.00 s	0.00 t
59	Sgd-20	0.00 d	0.00 s	0.00 t
60	Ncev/1270-4	0.00 d	1.00 s	2.116 t

Critical T value= 1.96, CV (%) = 7.01



Experiment 1: Selection of different maize varieties / hybrids by in-vitro screening for drought

Experiment II: Screening of maize varieties for drought tolerance under hydroponics culture

Seven varieties / hybrids were screened out in solution culture against different levels of water stress created by adding

PEG as per treatment required. The collected fodder maize genotypes were undertaken in the lab using polyethylene glycol 4000, 6000 and 8000. All the genotypes were studied in the lab under variable levels of drought stress created

by using PEG @ 0, 6, and 12 %. Ten varieties/hybrids were selected in for each tub and three plants were taken each variety in each tub with three replications. Hydroponic media was prepared in plastic tubes in each tub 900 and 1800 g PEG were diluted in 15 Liter distilled water in each tub. Plants were supported with help of thermo coal sheath and proper aeration was provided with air stones.

Following data of growth parameters were recorded:

1. Fresh and dry weight plant⁻¹ (g)
2. Root and Shoot length (cm)

Fresh and dry weight per plant

The fresh weight of maize was highest in Sohni Dharti under control (6.25 g) followed by Pahari (5.93 g) and the least was recorded at 6% and at 9% of PEG 4000 in PSHW-0404 hybrid white (1.93g) followed by Sohni Dharti at 9% PEG 6000 (1.77 g). Among the maize varieties the maximum fresh weight per plant was recorded in Sohni Dharti was (4.23 g) per

plant (Table-3). Moreover, the highest dry weight per plant viz., 3.95g and 3.95g were recorded with Pahari and Afgoi among the other varieties and treatments respectively. Among treatments the control had fresh weight (4.85 g) and followed by 3.56 g at 4000 PEG and least (1.58g.) was found in 6000 PEG .

Data on the interaction of different levels of PEG and varieties showed the highest dry matter was in Sohni Dharti-623 under control (6.25 g) followed by same variety under control (6.13g). It was least in PSHW-0404 Hybrid White (0.78 g) with 6000 PEG @ 9% followed by 6000 PEG @ 9% in C905 (1.14g). Overall, the highest dry weight was recorded in Sohni Dharti (4.23 g) followed by Pahari (3.95g). Under different PEG levels more dry weight was in control (2.76 g) as compared to other treatments and least was in 8000 PEG (2.95g).

These results were similar to those of Ahmad *et al.*, (2009) who reported that PEG induces water stress at germination

Table 3: Effect of different levels of PEG on fresh weight plant⁻¹(g) of maize varieties

Varieties	Control		PEG 4000		PEG 6000		PEG 8000		
	0%	0%	6%	9%	6%	9%	6%	9%	
	----- plant ⁻¹ (g) -----								
Sohni Dharti-626	6.25a	6.13 b	5.37e f	4.34 hi	2.29 vwx	1.91 zab	4.46 h	3.1p qrs	4.23 A
Pahari	5.93b c	5.70 cd	5.16 fg	3.74 m	2.06 xyz	1.77 zab	4.18 ij	3.04q rs	3.95 B
Afgoi	5.46d e	5.27 ef	4.4 hi	3.26 opq	1.99 yz	1.64 bcd	3.90 kl	2.84 st	3.59 C
Sarhad Yellow	4.96 g	4.90 g	4.14 ijk	2.91 rs	1.88 zav	1.46 de	3.47no	2.53u v	3.28 D
C905	4.35h i	4.37 hi	3.57 mn	2.58 tu	1.63 cd	1.14fg	3.12 qr	2.39u v	2.89 E
Zaitoon Maize 7786	3.97j kl	4.00 jkl	3.11 pqr	2.25w xy	1.4 def	0.93 gh	2.56 uv	2.04x y	2.53 F
PSHW-0404 Hybrid White	3.22o pq	3.35 nop	3.02 qrs	1.93 za	1.23 ef	0.78 h	2.08xz	1.67z ab	2.16 G
Mean	4.85 A		3.56 B		1.58 C		2.95 D		

LSD for levels = 2.89 Treatments = 3 Varieties = 4.26 and Interaction = 5.88 CV (%) = 5.53

Table 4: Effect of different levels of PEG on dry weight plant⁻¹ (g) of maize varieties/ hybrids

Varieties	Control		PEG 4000		PEG 6000		PEG 8000		Mean
	No PEG	No PEG	6%	9%	6%	9%	6%	9%	
	----- plant ⁻¹ (g) -----								
Sohni Dha-626	2.5 b	2.76a	2.15de	1.74gh	0.91st	0.76 wxy	1.78 g	1.24 nop	1.73 A
Pahari	2.38c	2.56 b	2.06 ef	1.49 jkl	0.82 uvw	0.71w xy	1.67 hi	1.21 nop	1.61 B
Afgoi	2.18 d	2.37bc	1.76gh	1.30 mn	0.79 vw	0.66 wyz	1.56 ij	1.13 pq	1.47 C
Sarhad Yellow	1.99f	2.20 d	1.65 hi	1.16 op	0.75 wxy	0.58 ab	1.38 lm	1.01 rs	1.34 D
C905	1.74g h	1.96 f	1.43kl	1.03 qr	0.65 za	0.45 cd	1.25 no	0.95 rst	1.18 E
Zaitoon - 7786	1.59 ij	1.80 g	1.24no p	0.91 tuv	0.56 abc	0.37 de	1.02qr s	0.81 uv	1.04 F
Pshw-0404 Hybrid White	1.28 mn	1.50 jk	1.21no p	0.77 wx	0.493 bc	0.313 e	0.83u vw	0.67xyz	0.88 G
Mean			1.42 B		0.633 D		1.183 C		
2.061 A									

LSD for treatments = 4.20 varieties = 3.69 levels = 2.80 and Interaction = 5.88 CV (%) = 5.64

Root and shoot length

Interactive effect of variety, treatment and levels was significant on roots of maize. The highest root length was measured in Sohni Dharti-623 (13.13 cm) with control treatment followed by Pahari (12.52 cm) with the same treatment. However, the lowest root length was obtained at 9% level of PEG-6000 with PSHW-0404 hybrid white (1.65 cm). Different varieties, treatment levels effect was significant on shoot of maize. The highest value was obtained at control on variety Sohni Dharti and Pahari OPV (17.81g and 16.457g) respectively. However, least value was obtained at 9% level of PEG-6000 in variety Zaitoon Maize7786 (2.55 cm)

and PSHW-0404 Hybrid white (2.15 cm).

Overall effect of treatment was significantly different. Highest value obtained at levels of control which was 13.88 cm followed by 9.72cm under control and PEG-4000 respectively. Varieties were significantly different and highest value obtained in Sohni Dharti (11.70 cm) followed by Pahari OPV (10.91 cm) and least in PSHW-0404 Hybrid white (6.18 cm).

Germination percentage is first leading step toward the establishment of all traits in plants Bayoumi *et al.*, 2010. Germination process is controlled by environmental and hormonal factors. Light, oxygen, temperature degree and water availability play important role among other factors.

Table.5 Effect of different concentration of polyethyglycole (PEG) induced water stress treatments on root length of selected maize genotypes

	Control	PEG 4000	PEG 6000	PEG 8000	Mea
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									n
Varieties	0%	0%	6%	9%	6%	9%	6%	9%	
Sohni Dharti-626	13.133 a	13.29 3a	11.29 3def	9.123 hi	4.82tu v	4.027 xyza	9.38h	6.51op q	8.94 75A
Pahari	12.523 b	12.25 bc	10.85f g	7.863l m	4.34v wx	3.723 yzab	8.787ij	6.393o pq	8.34 13B
Afgoi	11.47 de	11.69 7cd	9.24h i	6.86n o	4.18w xy	3.453 abc	8.203k l	5.973q r	7.63 46C
Sarhad yellow	10.427 g	10.89 efg	8.703i jk	6.127 pq	3.97x yzab	3.08c d	7.293 mn	5.32st	6.97 63D
C905	9.143 hi	9.61h	7.503 m	5.437 rs	3.42b c	2.393 ef	6.563o p	5.017s tu	6.13 58E
Zaitoon Maize7786	8.34jk l	9.087 hi	6.543 opq	4.727 uvw	2.94c de	1.96fg	5.39st	4.293v wxy	5.41 F
PSHW-0404 Hybrid white	6.76n o	8.243 jkl	6.347 opq	4.06x yz	2.587 de	1.657 g	4.391u vwx	3.513z abc	4.69 46G
Mean		10.49A	7.477B		3.325D		6.216C		

LSD for levels = 2.89 treatments = 3.69 varieties = 4.26 and Interaction = 5.88CV (%) = 5.24

Table.6 Effect of different concentration of polyethyglycole (PEG) induced water stress treatments on shoot length of selected maize genotypes

	Control		PEG 4000		PEG 6000		PEG 8000		Me an
Varieties	0%	0%	6%	9%	6%	9%	6%	9%	
Sohni Dharti-626	17.07ab	17.81 a	14.68 def	11.86ij kl	6.26w xyz	5.23y zabc	12.19ij	8.46q rs	11.70A
Pahari	16.277b c	16.45 7bc	14.11 efg	10.22 mnop	5.64x yzab	4.84a bcd	11.42jk lm	8.31rs t	10.91B
Afgoi	14.91de	15.64 7cd	12.01 ijk	8.92p qrs	5.43y zab	4.49b cde	10.66l mno	7.76st uv	9.98C
Sarhad yellow	13.56fg h	14.51 def	11.32j klm	7.96st u	5.16z abc	4.00c def	9.48op qr	6.91u vwx	9.11D
C905	11.887ij kl	13.03 ghi	9.75n opq	7.07 t- w	4.44b cdef	3.11f gh	8.53op qrs	6.52v wxy	8.04E
Zaitoon Maize7786	10.84kl mn	12.35 hij	8.51q rs	6.14w xyza	3.82d efg	2.55g h	7.01tu vw	5.58x yzab	7.10F
PSHW-0404 Hybrid white	8.71qrs	11.25j klm	8.25r stu	5.28yz abc	3.37ef gh	2.15h	5.86wx yzab	4.56b cde	6.18G
Mean		13.88A	9.72B		4.32D		8.09C		

LSD for levels = 2.89 treatments = 3.69 varieties = 4.26 and Interaction = 5.88 CV (%) = 5.24



Experiment: - 2 Preparation of seed bed and sowing of maize cultivar/hybrids



Experiment 2: Plantation/transfer of maize varieties/hybrids in hydroponic media

Greenhouse Experiment

Total dry matter accumulation at 30 days after sowing

Data related to Total Dry Matter (TDM) at 30 days after sowing (DAS) revealed that the interaction of variety and treatment was not significant on TDM of maize varieties/ hybrids. The highest value was obtained at GA₃-75 + Se-0.75 foliar application in Afgoi (30.2 g) and Pahari OPV (28.26 g) respectively. However, least value was obtained at GA₃-0 + Se-0.0 foliar application in variety Sohni Dharti (12.93 g) and C905 (13.63 g).

Foliar application of different levels of GA₃+ Se did not affect the TDM significantly. The highest value of TDM

(25.02 g) was obtained at GA₃-75 + Se-0.75 followed by treatment GA₃-50 + Se-0.50 (22.39 g). However, varieties differed significantly and the highest value was obtained in variety Afgoi (24.55 g) followed by Sarhad Yellow (21.14 g) and the least was found in Sohni Dharti (15.97 g).

Gibberillic acid in plants lies on signal transduction pathways and leads to elongation of plant vegetative parts (Asghar *et al.*, 2015). Rani *et al.* (2005) reported that the critical Se concentration (77 µg g⁻¹) in plant tissues, above which decreases the maize yield.

Table 7: Effect of different treatments on the total dry matter accumulated (TDM) per pot at 30 days

Treatment	Sohni Dharti-626	Pahari OPV	Afghoi	Sarhad Yellow	C905	Mean
GA ₃ -0 + Se-0.0	12.93m	16ijkl	19.9efg	15.43jklm	13.63klm	15.58 D
GA ₃ -25 + Se-0.2	15.46 jklm	20.63efg	24.1cd	18.6fghi	16.7 ij	19.1C
GA ₃ -50 + Se-0.5	18.43 ghi	24.4cd	27.76ab	21.2ef	20.16efg	22.39 B
GA ₃ -75 + Se-0.75	19.63efgh	28.26 a	30.2a	25.3bc	21.7de	25.02 A
GA ₃ -100 + Se-1.0	13.4l m	16.43 ij	20.76efg	17.06 hij	16.16 ijk	16.76 D
Mean	15.97E	21.14B	24.54A	19.52C	17.67 D	

LSD for treatments = 0.517 varieties=0.517 and Interaction = 1.157 CV (%) = 2.93

Total dry matter (TDM) accumulation at 45 days after sowing

Data related to TDM at 45 DAS revealed that the interactive effect of variety and treatment was significant. The highest value was obtained at GA₃-75 + Se-0.75 foliar application on variety Sohni Dharti (55.40 g) followed by Afgoi (44.60 g). However, the least value was obtained at GA₃-0 + Se-0.0 (Control) in variety Sarhad Yellow (12.23 g) and C905 (10.80 g). However, the foliar application of different levels of GA₃+Se affected TDM significantly. The highest value of TDM (42.97 g) was obtained at GA₃-75 + Se-0.75

followed by at 50 and GA₃-50 + Se-0.50 (35.04 g). Among varieties, the highest value obtained in variety Sohni Dharti (38.10 g) and the least in C 905 (18.13 g) (Table 8).

Se at 0.05-0.75 ppm improves the quality of maize fodder (*Zea mays* L.) under drought stress as Se peroxide affect the cell membrane lipids which effect on redox enzyme (Nawaz *et al.*, 2002) but at higher concentration (> 0.75 ppm) Se shows negative physiological effects. Similarly, that uptake of high concentration of Se supresses growth of plants (Spallholz and Hoffman,2002).

Table 8: Total dry matter accumulated (TDM) per plant at 45 days after sowing in maize varieties/ hybrids

Treatment	Sohni Dharti-626	Pahari OPV	Afghoi	Sarhad Yellow	C905	Mean
GA ₃ -0 + Se-0.0	49.23def	43.91ghi	38.08jkl m	34.94mno	28.48p	38.93B
GA ₃ -25 + Se-0.2	53.88 abc	47.08efg	39.71ijkl	37.22klm	30.84op	41.75 A
GA ₃ -50 + Se-0.5	55.65 ab	49.42cdef	40.76 ijk	38.40jklm	32.18 nop	43.28 A
GA ₃ -75 + Se-0.75	57.44 a	50.78 cde	41.84hij	35.48 lmn	32.53 nop	43.62 A
GA ₃ -100 + Se-1.0	51.73 bcd	45.97 fgh	37.23kl m	34.7mno	28.68p	39.66 B
Mean	53.59A	47.43B	39.52C	36.15D	30.54E	

LSD for treatments= 0.517 varieties=0.5172 and Interaction= 19.108 CV (%) = 8.17

Plant height (cm)

Data related to plant height revealed that the interactive variety and treatment effect was not significant on plant height of maize. The highest value was obtained at 75ppm+0.75ppm foliar application of GA₃ & Se respectively on variety Sohni Dharti (57.444cm and 55.656cm). However, least value was obtained at 0ppm and 0ppm foliar application of GA₃+Se in variety Sarhad Yellow (34.944cm) and C905 (28.489cm).

Overall effect of foliar application of Se+GA₃ on treatment was not significantly different. Highest value obtained at T4(75ppmGA₃+0.75ppmSe) which was 43.62cm followed by 43.287cm under treatment 50ppmGA₃+0.5ppmSe.

Varieties was significantly different and highest value obtained in variety Sohni Dharti (53.591cm) followed by Pahari OPV (47.438cm) and least in C905 i.e 30.549cm (Table.9)

Gibberellic acid in plants found on signal transduction pathways leading to elongation of plant vegetative parts. GA₃ promotes cell elongation through releasing DELLA mediated inhibition of BZR1 transcription factor which increase plant height (He *et al.*, 2013). Similar results were reported by Fathel and Lahmood (2013). GA₃ foliar spray under favored condition it increase development of more suitable cultivars (Shaddad *et al.*, 2013).

Table. 9 Effect of Selenium and Gibberellic acid on plant height of Maize genotypes

Treatment	Sohni Dharti-626	Pahari OPV	Afghoi	Sarhad Yellow	C905	Mean
-----grams-----						
GA ₃ -0 + Se-0.0	20.86 h	17.167ij	15.76j	12.23 lm	10.80 lm	15.36 E
GA ₃ -25 + Se-0.2	36.60 c	26.983 e	24.15 fg	19.45 hi	15.53jk	24.54 C
GA ₃ -50 + Se-0.5	46.70 b	38.367 c	36.66 c	29.91 d	23.58 fg	35.04 B
GA ₃ -75 + Se-0.75	55.40 a	46.500 b	44.60 b	37.83 c	30.53 d	42.97 A
GA ₃ -100 + Se-1.0	30.93 d	24.4fg	21.91 gh	13.20 kl	10.20 h	20.13 D

Mean	38.10 A	30.69 B	28.620 C	22.527D	18.130 E
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LSD for treatments=8.545 varieties= 8.545 and Interaction= 0.527 CV (%) = 5.17

Leaf Area Indices (30 days after sowing)

The highest leaf area indices were attained in Afgoi, shoni dehri and sarhad yellow under interactive effect of GA₃ 75ppm and selenium 0.75ppm 1.94 1.84 and 1.82 respectively followed by Pahari OPV 1.73. Least significant effect was observed in sarhad yellow under control 0.70g followed by C905 was 0.73g. However mean value in treatment under treatment for LAI was highest in 75ppm of GA₃ and

0.75ppm of selenium 1.82. Sohni Dharti had LAI highest in mean value 1.50 followed by Afgoi 1.27 and Sarhad yellow 1.25 cm² least was in C905 1.04 (Table .10)

Increased in leaf area with GA₃ and NAA might be related to the fact that GA and NAA promote leaf area through the increase of cell division and cell expansion in higher plant (Lakshmipathi *et al.*, 2014).

Table 10: Effect of different treatments on the Leaf area index (LAI) at 30 days after sowing in the selected maize genotypes

Treatment	Sohni Dharti-626	Pahari OPV	Afghoi	Sarhad Yellow	C905	Mean
GA ₃ -0 + Se-0.0	1.00 i	0.87 jk	0.76 klm	0.70 m	0.67 m	0.80 E
GA ₃ -25 + Se-0.2	1.51 e	1.20 h	1.04 i	0.99 i	0.84 jkl	1.12 C
GA ₃ -50 + Se-0.5	1.67 bc	1.53 de	1.56 cde	1.50 ef	1.34 g	1.52 B
GA ₃ -75 + Se-0.75	1.94 a	1.73 b	1.94 a	1.86 a	1.63 bcd	1.82 A
GA ₃ -100 + Se-1.0	1.39 fg	1.01 i	0.95 ij	0.88 j	0.73 lm	0.99 D
Mean	1.50 A	1.27 B	1.25 B	1.19 C	1.04 D	

LSD for treatments= 0.023 varieties= 0.023 and interaction = 0.662 CV (%) = 4.49

Leaf Area Indices at 45 days after sowing

Gibberellic acid and selenium at concentration of 75 and 0.75 ppm were highly effect on LAI at 45 days on genotype Sohni Dharti 2.67 cm² followed by under same genotype at 50 and 0.50 ppm of GA₃ and Se. However least effect was observed at 0ppm of GA₃ and Se in C905 was 0.95 cm² followed by 1.01 cm² at 100 and 1 of GA₃ and Se. Main effect of treatment and varieties on means also significant the highest LAI was under 75

and 0.75 ppm GA₃ and Se 2.27 cm² least was in 0ppm. In genotype highest in Sohni Dharti 2.09 cm² followed by 1.90 cm² in pahari OPV least was in 1.33 cm² C905 (Table. 11)

Gibberellic acid effectively increased the leaf area of maize plants. Similar by Lakshmipathi *et al.* (2014), depicted that application of GA₃, ethrel and NAA significantly increased the leaf area of cashew variety Bhaskara.

Table 11: Effect of different treatments on the Leaf area index (LAI) at 45 days after sowing in the selected maize genotypes

Treatment	Sohni Dharti-626	Pahari OPV	Afghoi	Sarhad Yellow	C905	Mean
GA ₃ -0 + Se-0.0	1.37 i	1.18 jk	1.14jkl	1.06 klm	0.95m	1.14E
GA ₃ -25 + Se-0.2	2.06 d	1.82 ef	1.74fg	1.37i	1.25 ij	1.65 C
GA ₃ -50 + Se-0.5	2.50 b	2.26c	2.08d	1.90 e	1.58 h	2.07 B
GA ₃ -75 + Se-0.75	2.67 a	2.49b	2.24c	2.10 e	1.83ef	2.27 A

GA ₃ -100 + Se-1.0	1.84ef	1.77f	1.61gh	1.13 jkl	1.01l m	1.47 D
Mean	2.09A	1.90B	1.76C	1.51D	1.33E	

LSD for treatments=0.2962 varieties= 0.2962 and Interaction=1.1050 CV (%)= 3.26

Net assimilation rate (g m⁻² day⁻¹)

Data related to leaf area revealed that the interactive variety and treatment effect was not significant on NAR of maize. The highest value was obtained at 75ppm+0.75ppm foliar application of GA₃ & Se respectively on variety Sohni Dharti (1.60 g m⁻² day⁻¹) and 1.48g m⁻² day⁻¹ in 50 and 0.50 ppm GA₃ and Se applications. However, least value was obtained at 100ppm and 1ppm foliar application of GA₃+Se in variety C905 (0.97 g m⁻² day⁻¹) (Table. 12).

Overall effect of foliar application of Se+GA₃ on treatment was highly significant. Highest value obtained at 75ppmGA₃+0.75ppmSe which were 1.38 g m⁻² day followed by 1.28 g m⁻² day⁻¹ under treatment 50ppmGA₃+0.50ppmSe.

Varieties also have significant different and highest value obtained in variety Sohni Dharti (1.37g m⁻² day⁻¹) and least in C905 i.e 0.97g m⁻² day⁻¹.

Table 12: Effect of different treatments on the net assimilation rate (NAR) g m⁻² day⁻¹ of the selected maize genotypes

Treatment	Sohni Dharti-626	Pahari OPV	Afgho i	Sarhad Yellow	C905	Mean
GA ₃ -0 + Se-0.0	1.17 gh	1.11ghi	1.10 ghi	0.91kl	0.88i	1.03 D
GA ₃ -25 + Se-0.2	1.36 cd	1.19fg	1.15 ghi	1.09 hi	0.98jk	1.15 C
GA ₃ -50 + Se-0.5	1.48 b	1.34cde	1.33 cde	1.17gh	1.07ij	1.28 B
GA ₃ -75 + Se-0.75	1.60 a	1.46 b	1.41 bc	1.27 ef	1.17g h	1.38 A
GA ₃ -100 + Se-1.0	1.27 def	1.17 gh	1.13 ghi	0.87i	0.77 m	1.04 D
Mean	1.37A	1.25B	1.23B	1.06 C	0.97 D	

LSD for treatments= 0.097 varieties=0.097 and Interaction=0.217 CV (%)= 4.50

Leaf area duration (days)

Data related to LAD revealed that the interactive variety and treatment effect was significant on LAD of maize. The highest value was obtained at 75ppm+0.75ppm foliar application of GA₃ & Se respectively on genotype Sohni Dharti (34.61days) followed by pahari OPV 31.43 days under same concentration of GA₃ and Se. However, least value was obtained without application of GA₃+Se in C905 12.32 days. Overall effect of foliar application of Se+GA₃ on treatment was highly significant. Highest value obtained

at 75ppm+0.75ppm which was 30.72 days followed by 26.96 days under treatment 50ppmGA₃+0.50 ppm Se.

Among genotypes highest value obtained in variety Sohni Dharti (26.98) followed by Pahari OPV (23.86 days) and least in C905 i.e 17.84 days (Table.13).

Gibberellic acid is one of the most important growth stimulating substances used for cell division and elongation thus promoting growth and development in many plant species (Noori 2014).

Table 13: Effect of different treatments on the Leaf area duration (LAD) of the selected maize genotypes

Treatment	Sohni Dharti-626	Pahari OPV	Afghoi	Sarhad Yellow	C905	Mean
GA ₃ -0 + Se-0.0	17.81 k	15.44 lm	14.31 mn	13.32 no	12.23 o	14.62 E
GA ₃ -25 + Se-0.2	26.85 ef	22.69 h	20.93 i	17.81 k	15.75 l	20.81 C
GA ₃ -50 + Se-0.5	31.36 b	28.55 cd	27.37 de	25.55 fg	21.99 hi	26.96 B
GA ₃ -75 + Se-0.75	34.61 a	31.74 b	31.43 b	29.78 c	26.04 ef	30.72 A
GA ₃ -100 + Se-1.0	24.29 g	20.87 i	19.25 j	15.12 lm	13.19 no	18.54 D
Mean	26.98 A	23.86 B	22.66 C	20.32 D	17.84 E	

LSD for treatments=0.494 varieties= 0.494 and Interaction= 0.217 CV (%)= 3.94

Crop growth rate (g m⁻² day⁻¹)

Genotypes and treatments effect was significant on CGR of maize. The highest value was obtained at 75ppm+0.75ppm foliar application of GA₃ & Se respectively on variety Afgoi and Sarhad Yellow (0.5067 and 0.4767 g m⁻² day⁻¹) respectively. However, least value was obtained at 0ppm and 0ppm foliar application of GA₃+Se in variety Sohni Dharti (0.21g m⁻² day⁻¹) and Pahari OPV (0.176 g m⁻² day⁻¹) (Table. 14).

Overall effect of foliar application of Se + GA₃ was highly significant. Highest value obtained at (75ppmGA₃+0.75ppmSe) which was 0.4053 g m⁻² day⁻¹ followed by 0.3667 under treatment

50ppmGA₃+0.5ppmSe. Varieties was also significantly different, and the highest value obtained in variety Afgoi (0.438) followed by Sarhad Yellow (0.3713g m⁻² day⁻¹) and least in Pahari OPV i.e 0.23 g m⁻² day⁻¹)

The performance, maize crop accelerated growth with foliar application of gibberellic acid and Se, Various growth parameters, like LAI, LAD, NAR, and TDM, were reduced under drought stress and without growth enhancer. It has been previously reported that gibberellic acid is helpful in enhancing growth of wheat, maize, and tomato under water stress conditions (Kaya *et al.*, 2006; Maggio *et al.*, 2010).

Table 14: Effect of different treatments on the crop growth rate (CGR) of the selected maize genotypes

Treatment	Sohni Dharti-626	Pahari OPV	Afghoi i	Sarhad Yellow	C905	Mean
GA ₃ -0 + Se-0.0	0.21lm	0.176 n	0.360e	0.276 hi	0.236jk	0.252E
GA ₃ -25 + Se-0.2	0.266i	0.226 kl	0.44c	0.34ef	0.293 h	0.313 C
GA ₃ -50 + Se-0.5	0.2967gh	0.26ij	0.473 b	0.443c	0.36e	0.366 B
GA ₃ -75 + Se-0.75	0.3267f	0.293 h	0.506 a	0.476 b	0.423 cd	0.405 A
GA ₃ -100 + Se-1.0	0.24jk	0.200 mn	0.41d	0.32fg	0.323 f	0.298 D
Mean	0.268D	0.2313E	0.438 A	0.3713B	0.3273 C	

LSD for treatments=0.011 varieties=0.011 and Interaction= 0.010 CV (%)= 5.45

Antioxidants enzymatic activity:

Super oxide dismutase (SOD) and Catalases (CAT) activities of both these antioxidants under drought stress significantly increased and this increase was more in the case of Sohni Dharti with treatment where GA₃ was used @ 100pm and Selenium applied @ 1 ppm. Results also indicated that the maximum Catalase

activity was observed in Sohni deharti-626 with 75 and 0.75 ppm GA+Se (4.706 $\mu\text{g g}^{-1}$). However, the minimum activity of the catalases was determined in C-905 with control treatment. Similar to catalases the highest activity SOD was observed in Sohni deharti-626 with 75 and 0.75 ppm GA+Se (178.7 $\mu\text{g g}^{-1}$). (Table.15)

Table.15: Effect of different treatments on the Catalase ($\mu\text{g g}^{-1}$) activity in maize genotypes under drought stress

Treatments	Sohni Dharti-626	Pahari OPV	Afghoi	Sarhad Yellow	C905	Mean
	----- $\mu\text{g g}^{-1}$ ----- -----					
GA ₃ -0 + Se-0.0	3.436 gh	3.0403 ij	2.883 ij	2.063 k	1.235 m	2.531 E
GA ₃ -25 + Se-0.2	4.04 cd	3.810 def	3.594 efg	3.149 hi	2.110 k	3.340 C
GA ₃ -50 + Se-0.5	4.420 ab	4.1567 bc	3.850 de	3.577 efg	2.347 k	3.670 B
GA ₃ -75 + Se-0.75	4.706 a	4.3800 b	4.020 cd	3.785 def	2.854 j	3.9493A
GA ₃ -100 + Se-1.0	3.934 CD	3.523 FG	3.160 HI	2.830 J	1.672 L	3.024 D
Mean	4.107 A	3.782 B	3.501 C	3.081 D	2.043 E	

LSD for treatments=0.128 varieties=0.128 and Interaction=0.143 CV (%)=5.31

Table.16: Effect of different treatments on SOD activity ($\mu\text{g g}^{-1}$) in maize genotypes under drought stress

Treatments	Sohni Dharti-626	Pahari OPV	Afghoi	Sarhad Yellow	C905	Mean
	----- $\mu\text{g g}^{-1}$ ----- -----					
GA ₃ -0 + Se-0.0	106.5 hi	104.77 i	91.3 j	72.1 I	0.83 m	75.1 E
GA ₃ -25 + Se-0.2	132.4 e	119.4 fg	114.7 gh	110.7 ghi	88.17 jk	113.1 C
GA ₃ -50 + Se-0.5	152.9 b	141.5 cd	133.2 de	128.1 ef	108.4 hi	132.8 B
GA ₃ -75 + Se-0.75	178.7 a	149.2 bc	141.5 cd	133.4 de	113.3 ghi	143.2 A
GA ₃ -100 + Se-1.0	125.7 ef	109.97 hi	108.6 hi	92.8 j	80.4 kl	103.5 D
MEAN	139.2 A	124.99 B	117.8 C	93.1 D	92.52 D	

LSD for treatments= 4.005 varieties= 4.008 Interaction=8.962 CV (%)=4.81



Maize crop after application of GA₃ and Se

Experiment - 3 Foliar application of Gibberellic acid (GA₃) and Selenium (Se)



Total Chlorophyll Contents

Drought stress significantly affected chlorophyll contents in maize, while application rate of Se and GA₃ improved the chlorophyll contents.

The improvement in chlorophyll contents was maximum with T₄ treatment (1.913 mg g⁻¹ FW) in V₁ that was at par with V₂ in the same treatment compared with their respective control. The lowest total chlorophyll contents (0.786 mg g⁻¹ FW)

were observed in V₅ with control treatment (Table-18).

Foliar application of gibberellic acid greatly stimulates the accumulation of nutrients, such as chlorophyll, in plants and their cellular components. Gibberellic acid stimulates photosynthesis, which in turn increases the production of chlorophyll. (Abuzar, Sadozai *et al.* 2011: Kaya, Tuna *et al.* 2006).

Table.17: Effect of different treatments on the total chlorophyll contents (mg g⁻¹ FW) in maize genotypes under drought stress

Treatments	Sohni Dharti-626	Pahari OPV	Afghoi	Sarhad Yellow	C905	Mean
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GA ₃ -0 + Se-0.0	1.41 h	1.33 ij	1.26 jk	0.97 l	0.78 m	1.15 E
GA ₃ -25 + Se-0.2	1 1.69de	1.59 efg	1.56 g	1.26 jk	1.00 l	1.42 C
GA ₃ -50 + Se-0.5	1.81 bc	1.71 cd	1.66 def	1.43 h	1.30 j	1.58 B
GA ₃ -75 + Se-0.75	1.91 a	1.83 ab	1.75 bcd	1.56 fg	1.44 h	1.70 A
GA ₃ -100 + Se-1.0	1.56 g	1.46 h	1.41 hi	1.19 k	0.93 l	1.31 D
Mean	1.67 A	1.58 B	1.53 C	1.28 D	1.09 E	

LSD for treatments=0.043 varieties=0.042 Interaction=0.096 CV(%)=4.08



Experiment - 3 Foliar application of Gebrilic acid (GA₃) and Selenium (Se)



Maize crop after application of GA₃ and Se



Conclusion

The collection of sixty different cultivar/hybrid seed carried out from

research institutes of Punjab. Out of sixty top ten drought tolerant fodder maize cultivar/hybrid were screened on the

bases of excellent performing morphological characteristics. The highest survival rate was in maize cultivar of Sohni Dharti-623, Pahari, Afgoi, Sarhad yellow, C905, Zaitoon maize-7786, PSHW-0404 hybrid white, NCEV-7004, Pearl white and YH-5536. Screened out fodder maize genotypes also treated with polyethylene glycol 4000, 6000 and 8000 under variable levels of drought stress PEG @ 0, 6, and 12 %. It was assessed that the fresh weight of maize was highest in Sohni Dharti-623 under control followed by Pahari. Dry weight also highest in Sohni Dharti-623. The highest root and shoot length were measured in Sohni Dharti-623 with control treatment followed by Pahari respectively. The graded levels each of GA₃ Sohni Dharti, Afgoi and Sarhad yellow performed best at 75ppm of GA application and 0.75 of Se after foliar spray. On bases of all these assessments two cultivar/hybrids one Sohni dehrti-262 and other Afgoi selected for field experiment under different locations.

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Source of support: Nil; **Conflict of interest:** Nil.

Cite this article as:

Rasheed, M., Shah, H., Muhammad, Z.U. G.H., Saqlain, Y., Hamid, S., Salma, S., Masaood, K. "Screening Effect of Fodder Maize Varieties under Water Stress Conditions". *Annals of Plant Sciences*.10.12 (2021) pp. 4350-4371.

DOI: <http://dx.doi.org/10.21746/aps.2021.10.12.1>