Available online at www.ijpab.com

DOI: http://dx.doi.org/10.18782/2320-7051.7653

ISSN: 2320 – 7051

Int. J. Pure App. Biosci. **7 (3):** 613-624 (2019)

Research Article

Influence of 2-Chloroethyl Phosphonic Acid on Breaking Seed Dormancy in Virginia Type Cultivars of Groundnut (*Arachis hypogaea* L.)

R. Somla Naik[1*], V. Umamahesh[1], P. Sudhakar[1], D. Subramanyam[2] and P. Venkataram Muni Reddy[3]

[1]Department of Crop Physiology, S. V. Ageicultural College, Tirupati, ANGRAU A. P

[2]Department of Agronomy, S.V. Agricultural College, Tirupati, ANGRAU A. P

[3]Department of Soil Science & Agriculture Chemistry, RARS, Tirupati ANGRAU A. P

*Corresponding Author E-mail: rsnayak975@gmail.com

Received: 12.05.2019 | Revised: 17.06.2019 | Accepted: 26.06.2019

ABSTRACT

A laboratory study was conducted to know the influence of 2-chloroethyl phosphonic acid (CEPA) (Ethrel or Ethephon) on dormant virginia runner and virginia bunch type cultivars of groundnut. There were 10 genotypes (5 virginia runner and 5 virginia bunch) and six treatments replicated thrice in a two factorial CRD. The six treatments include water soaking of seeds for I hour (T_1), spraying of CEPA on seeds soaked in water for 1 hour (T_2), soaking of seeds in CEPA for one hour (T_3), 3 hours (T_4), 6 hours (T_5) and 12 hours periods (T_6). Among the different treatments tested T_5 (soaking of seeds in CEPA for 6 hours followed by three hours of shade drying period) recorded maximum mean germination percentage (24, 30 and 70 %) and seedling vigour index (0, 13.1 and 147.77) at 24, 48 and 72 hours after treatment respectively. At 72 hours after treatment soaking of seeds in CEPA for 6 hours had shown significantly highest reducing sugars (2.32) and total soluble proteins (28.2). Starch (63.5) and lipid content (33.1) at the same time period was observed to be decreased irrespective of the cultivars.

Key words: *Groundnut, Seed dormancy, Ethrel, 2-Chloroethyl phosphonic acid, Dormancy breaking.*

INTRODUCTION

Groundnut is an important oilseed crop around the world as well as in India. It is the second most important cultivated grain legume and the fourth largest edible oilseed crop in the world. Groundnut is cultivated over an area of 4.88 million hectares in India with 9.25 million tonnes of production and 1893 kg ha^{-1} productivity[31].

In groundnut seed dormancy is commonly observed in the subspecies hypogaea (Virginia type) though dormancy to a certain level may sometimes be found in the botanical varieties, vulgaris (Spanish type) and fastigata (Valencia type) of the sub species fastigiata[2]. Seed dormancy can be explained as failure of a viable seed to germinate even under ideal conditions[7].

Cite this article: Naik, S.R., Umamahesh, V., Sudhakar, P., Subramanyam, D. and Venkataram Muni Reddy, P., Influence of 2-Chloroethyl Phosphonic Acid on Breaking Seed Dormancy in Virginia Type Cultivars of Groundnut (*Arachis hypogaea* L.), *Int. J. Pure App. Biosci.* **7(3):** 613-624 (2019). doi: http://dx.doi.org/10.18782/2320-7051.7653

Normally, germination occurs under conducive environmental conditions when the seed is viable and released of dormancy if any. Primary seed dormancy occurs by exogenous and endogenous factors. Exogenous factors are those surrounding the seed. The most common exogenous type of seed dormancy is physical dormancy, or seed coat imposed that can be the result of seed coat impermeability to water or chemicals present in the seed coat. Methods used to overcome the coat imposed dormancy include soaking the seed in water, scarification and embryo excision[25]. However Nautiyal and Bandyopadhyay[20] reported that different parts of groundnut seeds are involved in imposing dormancy, which included not only the seed coat but also cotyledons and embryo (Endogenous causes). Further ABA deficiency during seed development is associated with lack of primary dormancy in the mature seed, whereas over expression of ABA biosynthesis genes can increase seed ABA content and enhance seed dormancy or delay germination[9].

Groundnut is cultivated in the winter-summer period, rainy and post-rainy seasons in India and prolonged seed dormancy is considered as an undesirable character. However, a short period (10-15 days) dormancy is required to prevent *in situ* seed germination in the field due to unseasonal rains at the time of crop maturity. In the light of intensive agriculture, prolonged dormancy makes the freshly harvested groundnut kernels unfit to use as seed material for the ensuing season. Therefore it is expedient to identify a proper and reliable method to break dormancy in different botanical types of groundnut. Breaking of seed dormancy by *2-Chloroethyl phosphonic acid* (CEPA) (Ethrel or Ethephon) was reported earlier by several authors in different crops[28,13,24]. Hence the present investigation was attempted to understand the role of 2- chloroethyl phosphonic acid, in breaking of dormancy in virginia type cultivars of groundnut.

MATERIALS AND METHODS

A lab experiment was conducted at department of Crop Physiology, S.V. Agricultural College, Tirupati during the *kharif* 2017. The experiment was laid out in completely randomized factorial design (CRFD) with 10 genotypes and 6 treatments replicated thrice. Where in T_1,T_2,T_3,T_4,T_5 and T_6 were control (water soaking for 1 hour), spraying of CEPA on seeds soaked in water for 1 hour, seeds soaked in CEPA for 1 hour, 3 hour, 6 hours and 12 hours soaking in CEPA respectively. All the seeds were shade dried commonly for three hours irrespective of treatments. The ten groundnut genotypes selected belongs to two botanical types viz., Virginia runners (GAUG 10, NCAC 2731, GJG HPS 1, Florigaint and Florunner) and Virginia bunch (Kadiri 7, Kadiri 8, Kadiri 1501, Kadiri 1454 and Tirupati 3). Freshly harvested seed material was procured to conduct the experiment with uniformity. Soaking treatments were imposed initially with 12 hours of soaking followed by 6, 3 hours hours and finally 1 hour soaking period simultaneously. At the end of 1hour soaking period the other two treatments viz., spraying of CEPA on seeds soaked in water for 1 hour and control treatments (water soaking for 1 hour) were also imposed. All the treatments were subjected to 3 hours of drying period.

After the completion of the drying period the seeds were kept for germination and the following observations were recorded on certain physiological parameters (germination percentage and seedling vigour index) and biochemical parameters (reducing sugars, total proteins, lipid percentage and starch content) at 24, 48 and 72 hours after treatment.

Germination percentage of seed was worked out by the following formula as suggested by ISTA, 1995.

$$\text{Germination \%} = \frac{\text{Number of seeds germinated}}{\text{Total number of seeds kept for germination}} \times 100$$

Seedling vigour index was calculated by the following formula suggested by Abdul baki and Anderson[1] and averaged

SVI = (Shoot length + Root length) × Germination percentage.

Reducing sugars (mg g^{-1}) were estimated by the method suggested by the Nelson[21]. Starch was hydrolyzed into simple sugars by dilute acids and the quantity of simple sugars was measured with a visible spectrophotometer (Model No: UV-1800, SHIMADZU UV Spectrophotometer). Starch was estimated by anthrone reagent as per the procedure described by Sadasivam and Manickam[26]. Estimation of total protein content in seeds of groundnut was done as per the method developed by Lowry *et al*.[18].

Oil content in seeds was estimated by the Soxhlet apparatus. Lipid was extracted from groundnut genotypes following the method suggested by Sadasivam and Manickam[26] using petroleum ether as a solvent. It is then distilled off completely, dried the oil, weighed and the percentage of oil was calculated, where in,

$$\text{Lipid percentage (\%)} = \frac{\text{Weight of oil}}{\text{Weight of sample}} \times 100$$

Statistical analysis

The mean values of the data were statistically analyzed following completely randomized factorial design (CRFD) for laboratory studies; significance was tested by referring to `F' table of Fisher and Yates[10].

RESULTS AND DISCUSSION

Physiological parameters

Germination percentage (%)

The perusal of the data showed that germination percentage increased gradually from 24 hours to 48 hours after the treatments were imposed. There was an abrupt raise in germination percentage at 72 hours after treatment irrespective of cultivars. At 24, 48 and 72 hours after treatment significantly higher percentage of germination was recorded with T_5 (seeds soaked in CEPA for 6 hours) (24, 30 and 70%) followed by T_6 (seeds soaked in CEPA for 12 hours) (15.67, 21 and 57%), and other treatments. The germination percentage was found to be the lowest with the control treatment (seeds soaked in water for one hour (0, 0 and 44%).

Among varieties K 1501 and Kadiri 8 (Virginia bunch botanical type) recorded significantly highest germination percentage (60 & 53.3) followed by GJG HPS1 (Virginia runner botanical type) (50%) and other varieties at 72 hours after treatment. However, 100 percent germination was recorded in Kadiri 8 and GJG HPS 1 with T_5 (seeds soaked in CEPA for 6 hours) and T_6 (seeds soaked in CEPA for 12 hours) at 72 hours after treatment. However K 1501 recorded 100 percent germination with T_4 (seeds soaked in CEPA for 3 hours) and T_5 (seeds soaked in CEPA for 6 hours) treatments. The botanical type Florigaint recorded 100 percent germination with T_5 (seeds soaked in CEPA for 6 hours). The results clearly showed that the germination percentage of different botanical varieties of groundnut was improved with 6 hours soaking in CEPA followed by 3 hours of shade drying (T_5). The mean germination percentage increased by 66% with T_5 (seeds soaked in CEPA for 6 hours) compared to T_1 (Table 1). The results obtained were in line with Deepthiranjan[8] where in a similar improvement in germination percentage was observed in groundnut when the seeds were pre-soaked in ethrel solution compared to control in groundnut.

Ketring and Morgan[16] showed that the highest increment of germination occurred in the first 24 hours period of germination at 10^{-3} and 5 x 10^{-4} M CEPA in groundnut.

Ethrel at 10 µg/mL induced higher percent germination of intact seed and better seedling growth in tea. The lower three concentrations (10, 50 and 100 µg/mL) were highly

stimulatory and they evoked equal response inducing 97 percentage germination. Whereas the higher three concentration 250, 500 and 1000 µg/mL were supraoptimal and recorded 93, 90 and 83% germination respectively in tea seeds[3].

Seedling vigour index

The seedling vigour index (SVI) was observed to be zero at 24 hours after treatment. No root or shoot growth was found to be of measurable size and hence the SVI for all the treatments and varieties after 24 hours was recorded as zero. The seedling vigour index showed a steep increase from 48 hours to 72 hours irrespective of genotypes. Significantly higher seedling vigour index was observed with T_5 (seeds soaked in CEPA for 6 hours) (13.1 & 147.8) followed by T_6 (seeds soaked in CEPA for 12 hours) (12.9 & 86.3), T_4 (seeds soaked in CEPA for 3 hours) (5.6 & 53.9) and other treatments at 48 and 72 hours after treatment respectively.

Among varieties K 1501 (11.88, 103.88) followed by Kadiri 8 (8, 84.10) recorded significantly high seedling vigour index and the lowest values were observed with K7 (1.18, 6.58) at 42 and 72 hours after treatment (Table 2, Fig 1).

The interaction effect was significantly superior in K 1501 (306.6) followed by Kadiri 8 (266.6) and GJG HPS 1 (236.6) with seeds soaked in CEPA for 6 hours (T_5).

Ketring[17] also reported that ethrel when tested in different concentrations broke the dormancy in the seeds of groundnut planted in the vermiculite/sand mixture. The seedling emergence was observed to be varied with different concentrations of ethrel, where in the final emergence in dormant control was just 10 per cent.

Biochemical parameters

Reducing sugars (mg g^{-1})

Generally, sugars increase as germination progressed due to an increase in hydrolysis of starch. The predominant formation of glucose from starch reserves in the endosperm by the action of α-amylase and accompanying hydrolytic enzyme (s) eventually mobilize this sugar to the actively growing tissues of embryo. The data showed a gradual increase in reducing sugars from 24 hours to 72 hours after the treatments were imposed irrespective of cultivars. Significantly higher reducing sugars was recorded with T_5 (seeds soaked in CEPA for 6 hours) (1.66, 2.41 and 2.32) followed by T_6 (seeds soaked in CEPA for 12 hours) (1.46, 1.74 and 2.05), T_4 (seeds soaked in CEPA for 3 hours) (1.38, 1.66 and 1.70) and other treatments at 24, 48 and 72 hours after treatments.

Among varieties K1501 (2.38) recorded significantly highest reducing sugars followed by Kadiri 8 (1.90), GAUG 10 (1.85) and others at 72 hours after treatment.

The interaction was significantly highest in K1501 (3.12) with T_5 (seeds soaked in CEPA for 6 hours) followed by K7 (2.96) and Kadiri 8 (2.87) which were found at par. (Table 3, Fig 2)

Watanabe[30] reported more sucrose and glucose contents in the seed when both ethylene and gibberellins were used combinedly. The sucrose content significantly increased under combination of gibberellins and ethylene when compared to control.

Starch content (mg g^{-1})

Starch in cotyledons breaks down to smaller molecules such as glucose and fructose to provide energy for cell division while the seeds mature and grow[29]. Ohtsubo *et al*.[22] explained that carbohydrates breakdown in seeds in which α-amylase activities were found to be parallel with the pattern of starch breakdown.

Irrespective of cultivars a gradual decrease in starch content was recorded from 24 hours to 48 hours and 72 hours after the treatments were imposed. Significantly higher starch content was observed with T_1 (water soaking for 1 hour) (142.1, 122 and 103.9) followed by T_2 (spraying of CEPA on seeds soaked in water for 1 hour) (128.7, 109.7 and 93.2), T_3 (seeds soaked in CEPA for 1 hour) (122.6, 104.4 and 91.2) and other treatments at 24, 48 and 72 hours after treatments. Among the treatment T_5 (seeds soaked in CEPA for 6

hour) recorded significantly lowest starch content compared to control.

Among varieties K1501 (62.5) recorded significantly lowest starch content followed by Kadiri 8 (71.9), TPT 3 (78.4) and others at 72 hours after treatment.

Further, Florigaint recorded significantly lowest starch content (50.2) with T_6 which was at par with K 1501 with T_4 (60.6) T_5 (50.6) and T_6 (59.3), K1454 with T_5 (53.6) and T_6 (62.6), GAUG 10 with T_5 (65.1) and NCAC 2731 (65.3) (Table 6, Fig 4).

Francoise *et al*.[11] suggested that exogenous application of ethylene releasing compound might induce GA_3 which activate α-amylase that can digest the available carbohydrates into simple sugars through which energy and nutrition were easily available to faster growing seedlings. Similarly Vidal-Valverde *et al*.[29] also reported that the carbohydrate content is changed during germination and the growth of embryo depends on these carbohydrates for their energy needs.

Total soluble proteins (%)

Storage proteins are the major source of amino acids for the growing embryo, and released amino acids are used to make the necessary enzymes and components for seedling growth[5].

Irrespective of cultivars total soluble proteins gradually increased from 24 hours to 72 hours after the imposition of the treatments. Significantly higher total soluble proteins was observed with T_5 (seeds soaked in CEPA for 6 hours) (24.81, 26.84 and 28.2) followed by T_6 (seeds soaked in CEPA for 12 hours) (23.96, 26.28 and 27.50), T_4 (seeds soaked in CEPA for 3 hours) (23.94, 26.14 and 26.71) and other treatments at 24, 48 and 72 hours after treatments.

At 72 hours after treatment GJG HPS 1 (27.85), GAUG 10 (27.73), K1501 (27.62), Florunner (27.41), Florigaint (27.06) and NCAC 2731 (26.9) were found to be on par and recorded significantly highest total soluble protein content, whereas the lowest was found in Kadiri 7 (24.62) which was at par with Kadiri 8 (25.92) and K1454 (25.51) and TPT 3 (25.4).

Further the interaction effect of treatment and varities were found to be nonsignisicant at all the time periods i.e 24, 48 and 72 hours after imposition of the treatments. (Table 4, Fig 3).

Sekhon and Singh[27] also reported an increase in protein content and a better incorporation of amino acids in to proteins in wheat. Ethephon application at a specific stage of the crop increased protein content in the seeds of pigeonpea genotypes[23].

Similar increase in concentration of grain protein and protein content per grain was also observed with ethephon application in barley[6,19].

Lipid content (%)

During the germination of lipid rich seeds, there is a conversion of lipids into carbohydrates, particularly sucrose. Lipolysis is initiated by lipase followed by β-oxidation, glyoxylate cycle and reversal of glycolysis to produce sugars from fatty acids.

The data indicated a gradual decrease in lipid content from 24 hrs to 72 hrs after the imposition of the treatments irrespective of cultivars. Significantly higher lipid content was observed with T_1 (seeds soaking in water for 1 hour) (42.9, 41.7 and 39.6) followed by T_2 (spraying of CEPA on seeds soaked in water for 1 hour) (41.9, 39.9 and 37.6), T_3 (seeds soaked in CEPA for 1 hour) (41.2, 38.9 and 35.9) and other treatments at 24, 48 and 72 hours after treatments. Among the treatment T_5 (seeds soaked in CEPA for 6 hours) recorded the significantly lowest lipid content when compared to control and it was on par with T_6 (seeds soaked in CEPA for 12 hours) (34.8)

No significant difference among the varieties with respect to lipid content was observed at 48 and 72 hours after treatment. However, K1501 recoded significantly lowest lipid content (30.5) with T_5 (seeds soaked in CEPA for 6 hours) (Table 5).

The fat content decreases with increase in the time of germination. This might be because of usage of fat as the major source of carbon for seed growth[4]. Hahm *et al*.[12] also suggested that fatty acids are oxidized to carbon dioxide and water to generate energy for germination. The fall in the lipid content

was coincided with maximal activity of alkaline lipase resulted in a depletion of lipids, supports the active role of alkaline lipase in the breakdown of lipids during germination of sesame seeds[14].

Ethrel has shown a primitive effect on conversion of lipid in to sugars through glyoxylate cycle under water stress conditions in soybean seeds[28].

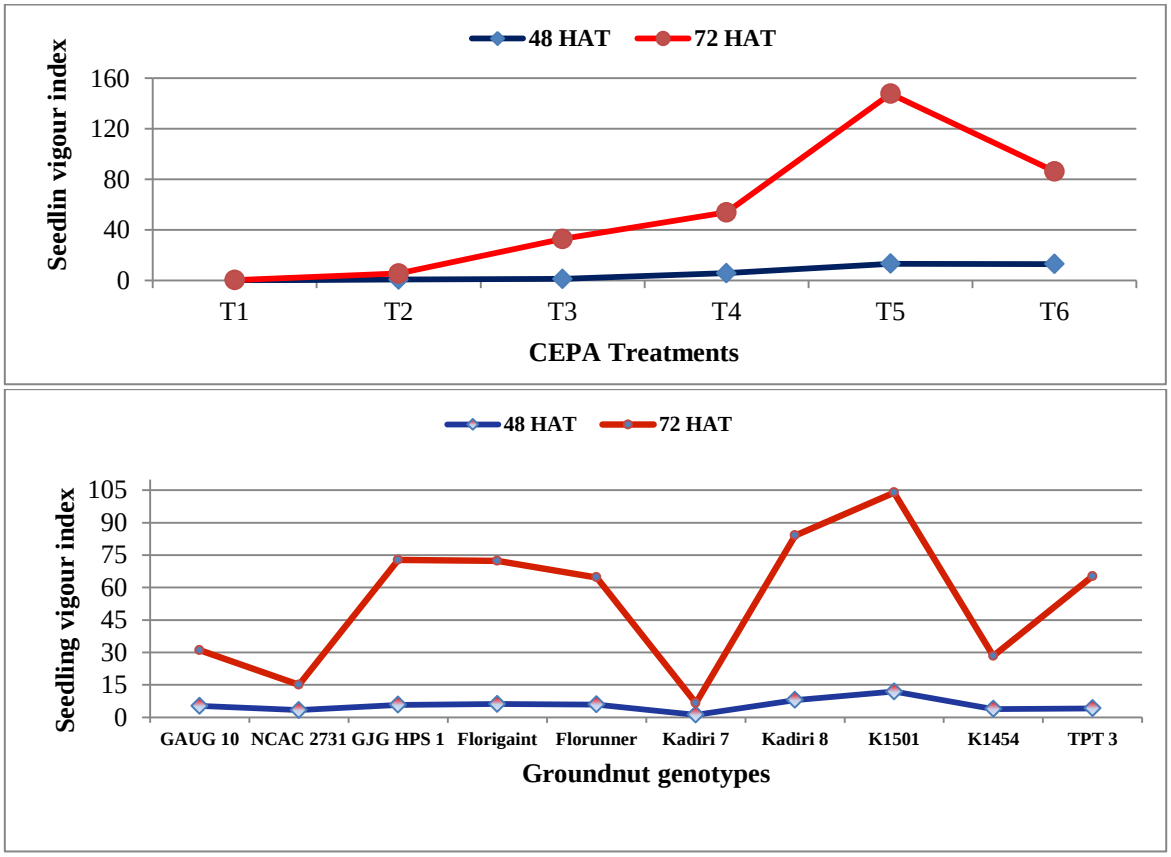

Fig. 1: Effect of CEPA on seedling vigour index of virginia type cultivars of groundnut exposed to different time intervals

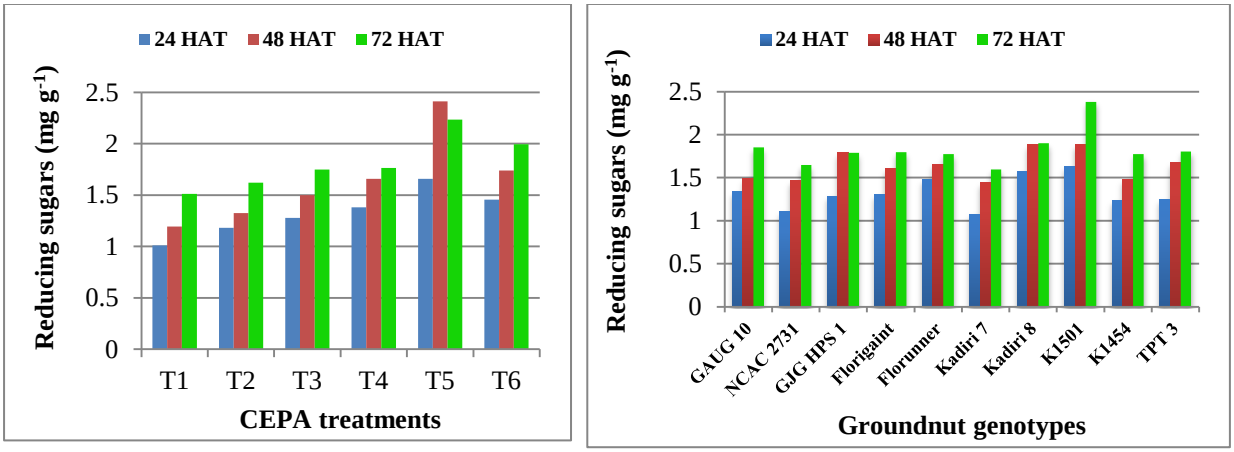

Fig. 2: Effect of CEPA on reducing sugars of virginia type cultivars of groundnut exposed to different time intervals

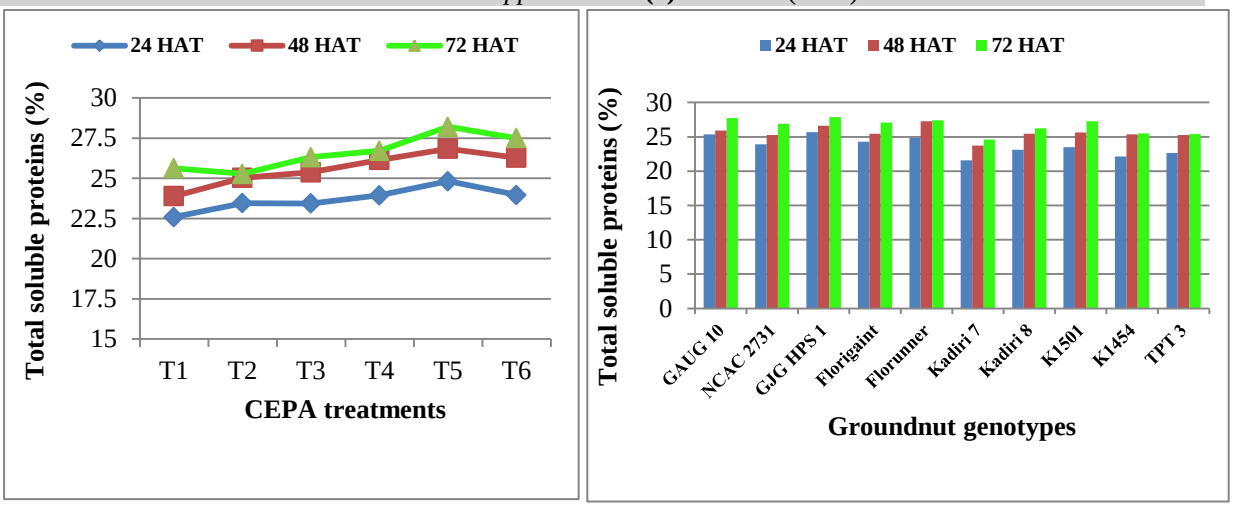

Fig. 3: Effect of CEPA on total soluble proteins of virginia type cultivars of groundnut exposed to different time intervals

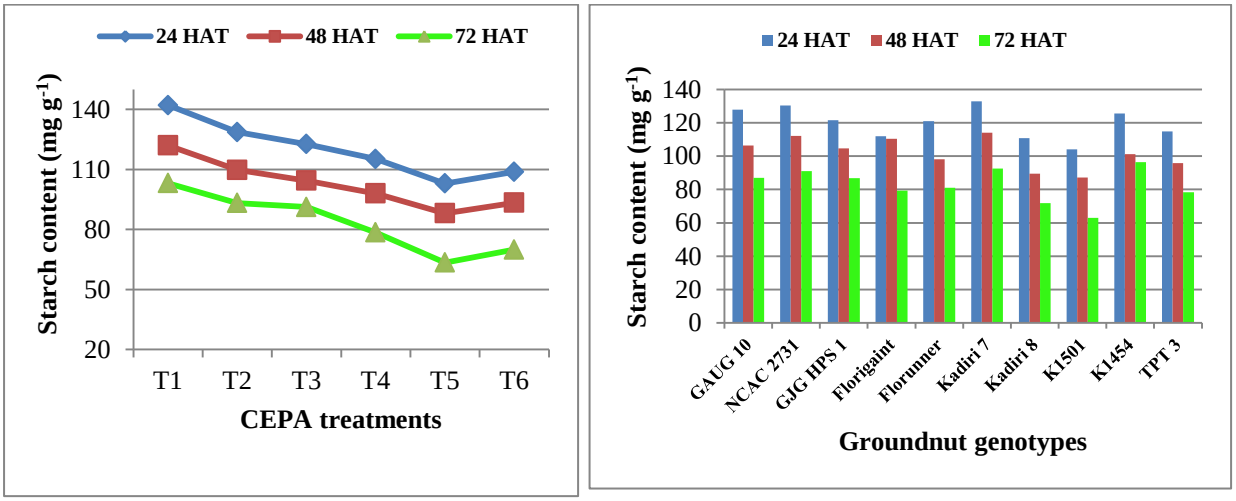

Fig. 4: Effect of CEPA on starch content of virginia type cultivars of groundnut exposed to different time intervals

Table 1: Effect of CEPA on germination percentage (%) of virginia type cultivars of groundnut exposed to different time intervals

		24 Hours After Treatment							48 Hours After Treatment							72 Hours After Treatment						
S. No	**Genotypes**	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**T_6**	**Mean**	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**T_6**	**Mean**	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**T_6**	**Mean**
1	GAUG 10	0.0	0.0	0.0	0.0	20.0	20.0	**6.67**	0.0	10.0	10.0	10.0	20.0	20.0	**11.67**	20.0	40.0	20.0	40.0	40.0	40.0	**33.33**
2	NCAC 2731	0.0	0.0	0.0	0.0	30.0	10.0	**6.67**	0.0	0.0	0.0	0.0	30.0	30.0	**10.00**	0.0	0.0	40.0	20.0	40.0	80.0	**30.00**
3	GJG HPS 1	0.0	0.0	10.0	20.0	20.0	10.0	**10.00**	0.0	0.0	10.0	20.0	30.0	20.0	**13.33**	0.0	0.0	20.0	80.0	100.0	100.0	**50.00**
4	Florigaint	0.0	0.0	0.0	0.0	30.0	20.0	**8.33**	0.0	0.0	0.0	10.0	30.0	30.0	**11.67**	0.0	10.0	60.0	60.0	100.0	40.0	**45.00**
5	Florunner	0.0	0.0	0.0	10.0	10.0	30.0	**8.33**	0.0	10.0	10.0	20.0	20.0	20.0	**13.33**	0.0	20.0	80.0	40.0	80.0	40.0	**43.33**
6	Kadiri 7	0.0	0.0	0.0	10.0	10.0	0.0	**3.33**	0.0	0.0	0.0	10.0	20.0	10.0	**6.67**	0.0	20.0	20.0	30.0	60.0	40.0	**28.33**
7	Kadiri 8	0.0	0.0	0.0	10.0	30.0	20.0	**10.00**	0.0	0.0	10.0	30.0	40.0	20.0	**16.67**	0.0	20.0	20.0	80.0	100.0	100.0	**53.33**
8	K1501	0.0	0.0	10.0	20.0	30.0	10.0	**11.67**	0.0	10.0	10.0	30.0	30.0	20.0	**16.67**	20.0	40.0	80.0	100.0	100.0	20.0	**60.00**
9	K1454	0.0	0.0	0.0	10.0	30.0	20.0	**10.00**	0.0	0.0	0.0	0.0	40.0	20.0	**10.00**	0.0	40.0	40.0	40.0	40.0	30.0	**31.67**
10	TPT 3	0.0	0.0	0.0	0.0	30.0	10.0	**6.67**	0.0	10.0	0.0	10.0	40.0	20.0	**13.33**	0.0	10.0	20.0	80.0	40.0	80.0	**38.33**
	Mean	**0.00**	**0.00**	**2.00**	**8.00**	**24.00**	**15.00**		**0.00**	**4.00**	**5.00**	**14.00**	**30.00**	**21.00**		**4.00**	**20.00**	**40.00**	**57.00**	**70.00**	**57.00**	

24 HAT				48 HAT				72 HAT			
	T	V	TxV		T	V	TxV		T	V	TxV
CD	0.866	0.671	2.11	**CD**	1.377	1.066	3.374	**CD**	3.785	2.932	9.272
SE (d)	0.436	0.338	1.070	**SE (d)**	0.696	0.539	1.704	**SE (d)**	1.911	1.480	4.682
SE(m)	0.309	0.239	0.757	**SE(m)**	0.492	0.381	1.205	**SE(m)**	1.351	1.047	3.310

T1 Control (water soaking for 1 hour)
T2 CEPA Spraying (spraying Of CEPA on seeds soaked in water for 1 hour)
T3 1hour soaking in CEPA and shade drying for three hours
T4 3 hour soaking in CEPA and shade drying for three hours
T5 6 hour soaking in CEPA and shade drying for three hours
T6 12 hour soaking in CEPA and shade drying for three hours

Table 2: Effect of CEPA on seedling vigour index of virginia type cultivars of groundnut exposed to different time intervals

		48 Hours After Treatment							72 Hours After Treatment						
S. No	**Genotypes**	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**T_6**	**Mean**	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**T_6**	**Mean**
1	GAUG 10	0.0	1.1	0.0	17.3	5.3	8.0	**5.28**	0.0	0.7	0.7	20.0	138.0	26.6	**31.00**
2	NCAC 2731	0.0	0.0	0.0	0.0	8.0	12.0	**3.33**	0.7	10.7	0.7	20.0	44.0	14.0	**15.02**
3	GJG HPS 1	0.0	0.0	0.0	1.3	8.0	25.5	**5.80**	1.3	4.0	45.3	9.3	236.6	140.0	**72.75**
4	Florigaint	0.0	0.0	3.7	6.7	9.0	17.3	**6.12**	0.0	1.7	4.7	150.0	173.3	104.0	**72.28**
5	Florunner	0.0	1.7	1.0	2.3	14.0	16.7	**5.95**	0.0	14.7	128.0	10.7	186.6	48.0	**64.67**
6	Kadiri 7	0.0	0.0	0.0	1.6	2.8	2.7	**1.18**	0.0	0.0	9.3	21.3	5.3	3.6	**6.58**
7	Kadiri 8	0.0	0.0	0.0	0.0	25.0	23.0	**8.00**	0.0	0.0	2.0	86.7	266.6	149.3	**84.10**
8	K1501	0.0	1.3	5.0	15.0	38.0	12.0	**11.88**	0.0	0.0	110.0	46.7	306.6	160.0	**103.88**
9	K1454	0.0	0.0	1.7	11.0	7.6	3.0	**3.88**	0.0	17.3	20.0	30.0	56.0	46.7	**28.33**
10	TPT 3	0.0	1.3	0.0	1.2	13.3	9.0	**4.13**	0.0	4.5	7.3	144.0	64.7	170.6	**65.18**
	Mean	**0**	**0.54**	**1.14**	**5.64**	**13.1**	**12.92**		**0.2**	**5.36**	**32.8**	**53.87**	**147.77**	**86.28**	

48 HAT				72 HAT			
	T	V	TxV		T	V	TxV
CD	0.746	0.578	1.828	**CD**	6.935	5.372	16.988
SE (d)	0.376	0.292	0.923	**SE (d)**	3.502	2.713	8.579
SE(m)	0.266	0.206	0.652	**SE(m)**	2.477	1.918	6.066

T1 Control (water soaking for 1 hour)
T2 CEPA Spraying (spraying Of CEPA on seeds soaked in water for 1 hour)
T3 1hour soaking in CEPA and shade drying for three hours
T4 3 hour soaking in CEPA and shade drying for three hours
T5 6 hour soaking in CEPA and shade drying for three hours
T6 12 hour soaking in CEPA and shade drying for three hours

Table 3: Effect of CEPA on reucing sugars (mg g^{-1}) of virginia type cultivars of groundnut exposed to different time intervals

		24 Hours After Treatment							48 Hours After Treatment							72 Hours After Treatment						
S. No	**Genotypes**	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**T_6**	**Mean**	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**T_6**	**Mean**	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**T_6**	**Mean**
1	GAUG 10	1.04	0.96	1.20	2.10	1.78	0.96	**1.34**	1.14	1.54	0.87	0.80	1.59	3.00	**1.49**	2.10	1.89	1.76	2.04	1.95	1.37	**1.85**
2	NCAC 2731	0.81	1.01	0.93	0.95	1.95	0.99	**1.11**	1.10	1.35	2.07	1.18	0.84	2.26	**1.47**	1.15	1.33	1.63	1.34	0.99	3.44	**1.65**
3	GJG HPS 1	1.34	1.13	1.60	1.26	1.46	0.92	**1.29**	1.55	1.16	1.46	3.46	1.99	1.14	**1.79**	1.03	2.04	1.08	2.11	1.92	2.55	**1.79**
4	Florigaint	1.07	1.23	1.09	1.38	1.20	1.83	**1.30**	0.92	1.15	1.45	0.94	3.28	1.90	**1.61**	1.85	1.28	2.39	1.74	1.97	1.55	**1.80**
5	Florunner	1.04	1.13	1.15	1.47	2.25	1.84	**1.48**	1.05	1.39	1.83	2.33	2.29	1.06	**1.66**	1.40	1.23	2.01	1.58	2.00	2.43	**1.78**
6	Kadiri 7	1.24	0.88	1.21	1.09	1.09	0.95	**1.08**	1.50	1.30	1.11	1.61	2.08	1.03	**1.44**	1.90	1.35	1.03	1.04	2.96	1.29	**1.60**
7	Kadiri 8	0.79	1.05	1.30	1.38	2.08	2.81	**1.57**	1.08	1.15	1.88	1.36	4.24	1.62	**1.89**	1.16	1.24	2.03	1.85	2.87	2.24	**1.90**
8	K1501	1.09	1.85	1.34	2.45	1.04	2.02	**1.63**	1.08	1.15	1.88	1.36	4.24	1.62	**1.89**	1.39	3.42	2.68	2.58	3.12	1.09	**2.38**
9	K1454	0.91	1.26	1.50	0.79	2.11	0.84	**1.24**	1.52	1.17	1.38	1.58	1.81	1.39	**1.48**	1.40	1.23	2.01	1.58	2.00	2.43	**1.78**
10	TPT 3	0.77	1.30	1.46	0.95	1.62	1.40	**1.25**	0.99	1.89	1.07	1.97	1.76	2.39	**1.68**	1.26	1.30	1.65	1.09	3.45	2.07	**1.80**
	Mean	**1.01**	**1.18**	**1.28**	**1.38**	**1.66**	**1.46**		**1.19**	**1.33**	**1.50**	**1.66**	**2.41**	**1.74**		**1.46**	**1.63**	**1.83**	**1.70**	**2.32**	**2.05**	

24 HAT				48 HAT				72 HAT			
	T	V	TxV		T	V	TxV		T	V	TxV
CD	0.0487	0.037	0.119	**CD**	0.095	0.073	0.234	**CD**	0.088	0.068	0.216
SE (d)	0.0246	0.019	0.060	**SE (d)**	0.048	0.037	0.118	**SE (d)**	0.044	0.345	0.109
SE(m)	0.0174	0.0135	0.042	**SE(m)**	0.034	0.026	0.083	**SE(m)**	0.031	0.024	0.077

T1 Control (water soaking for 1 hour)
T2 CEPA Spraying (spraying Of CEPA on seeds soaked in water for 1 hour)
T3 1hour soaking in CEPA and shade drying for three hours
T4 3 hour soaking in CEPA and shade drying for three hours
T5 6 hour soaking in CEPA and shade drying for three hours
T6 12 hour soaking in CEPA and shade drying for three hours

Table 4: Effect of CEPA on total soluble proteins (%) of virginia type cultivars of groundnut exposed to different time intervals

		24 Hours After Treatment							48 Hours After Treatment							72 Hours After Treatment						
S. No	**Genotypes**	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**T_6**	**Mean**	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**T_6**	**Mean**	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**T_6**	**Mean**
1	GAUG 10	23.61	23.80	24.04	27.36	26.38	26.78	**25.33**	23.71	25.97	24.22	26.55	27.98	26.92	**25.89**	25.66	29.67	27.57	27.23	28.01	28.22	**27.73**
2	NCAC 2731	23.84	23.20	23.95	24.16	25.42	22.96	**23.92**	24.09	23.84	25.37	25.65	26.60	26.04	**25.27**	26.57	26.12	26.21	26.35	28.15	27.98	**26.90**
3	GJG HPS 1	21.71	26.70	26.47	26.21	27.36	25.56	**25.67**	25.17	26.29	27.94	26.69	27.06	26.48	**26.60**	28.26	27.42	29.03	26.75	28.59	27.06	**27.85**
4	Florigaint	23.55	24.76	23.38	24.98	25.63	23.46	**24.29**	23.70	25.20	24.55	26.12	26.34	26.64	**25.43**	25.17	25.56	26.96	27.49	29.13	28.07	**27.06**
5	Florunner	23.39	26.48	25.60	23.53	25.49	24.61	**24.85**	26.72	28.56	25.81	28.14	28.73	25.71	**27.28**	27.08	25.23	26.99	28.26	28.85	28.03	**27.41**
6	Kadiri 7	21.07	21.29	21.56	20.56	23.06	21.94	**21.58**	22.14	22.22	23.54	23.54	24.97	26.01	**23.74**	23.15	24.67	23.82	24.73	25.02	26.35	**24.62**
7	Kadiri 8	21.83	23.23	22.53	23.01	24.62	23.51	**23.12**	24.01	23.65	24.88	25.31	28.00	26.77	**25.44**	25.04	22.94	25.30	26.45	28.01	27.75	**25.92**
8	K1501	22.88	21.89	22.03	23.76	23.99	26.23	**23.46**	24.03	25.01	25.54	26.03	26.99	26.31	**25.65**	28.33	23.86	27.02	28.47	30.62	27.43	**27.62**
9	K1454	21.89	21.92	21.90	22.03	22.41	22.51	**22.11**	22.42	23.33	25.20	27.86	27.13	26.22	**25.36**	23.84	24.03	25.38	25.57	27.51	26.72	**25.51**
10	TPT 3	22.12	21.23	22.90	23.81	23.77	22.06	**22.65**	22.90	26.15	26.75	25.52	24.58	25.69	**25.27**	23.13	23.21	24.86	25.76	28.07	27.37	**25.40**
	Mean	**22.59**	**23.45**	**23.44**	**23.94**	**24.81**	**23.96**		**23.89**	**25.02**	**25.38**	**26.14**	**26.84**	**26.28**		**25.62**	**25.27**	**26.31**	**26.71**	**28.20**	**27.50**	

24 HAT				48 HAT				72 HAT			
	T	V	TxV		T	V	TxV		T	V	TxV
CD	1.34	1.73	NS	**CD**	1.427	1.842	NS	**CD**	1.488	1.921	NS
SE (d)	0.676	0.873	2.138	**SE (d)**	0.72	0.929	2.276	**SE (d)**	0.751	0.969	2.374
SE(m)	0.478	0.617	1.512	**SE(m)**	0.509	0.657	1.61	**SE(m)**	0.531	0.685	1.679

T1 Control (water soaking for 1 hour)
T2 CEPA Spraying (spraying Of CEPA on seeds soaked in water for 1 hour)
T3 1hour soaking in CEPA and shade drying for three hours
T4 3 hour soaking in CEPA and shade drying for three hours
T5 6 hour soaking in CEPA and shade drying for three hours
T6 12 hour soaking in CEPA and shade drying for three hours

Table 5: Effect of CEPA on lipid content (%) of virginia type cultivars of groundnut exposed to different time intervals

		24 Hours After Treatment							48 Hours After Treatment							72 Hours After Treatment						
S. No	**Genotypes**	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**T_6**	**Mean**	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**T_6**	**Mean**	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**T_6**	**Mean**
1	GAUG 10	42.0	43.9	41.2	44.1	44.5	37.2	**42.2**	40.8	38.7	39.2	36.9	35.1	40.4	**38.5**	37.4	38.1	38.6	39.7	31.2	33.1	**36.4**
2	NCAC 2731	42.0	40.3	45.2	39.7	43.1	44.5	**42.5**	46.2	41.7	40.6	37.9	33.7	37.5	**39.6**	37.4	39.6	39.1	35.0	39.3	31.4	**37.0**
3	GJG HPS 1	42.5	40.2	40.9	38.6	40.2	41.7	**40.7**	39.8	38.9	44.3	41.5	32.5	38.9	**39.3**	40.8	35.8	30.9	35.4	34.8	34.9	**35.4**
4	Florigaint	43.9	41.7	42.0	43.9	40.9	38.9	**41.9**	43.5	40.5	37.5	35.8	40.7	39.0	**39.5**	40.9	38.2	33.6	34.4	34.5	35.4	**36.2**
5	Florunner	38.8	41.3	46.3	40.9	39.4	40.2	**41.2**	38.6	40.2	39.6	38.7	41.5	35.0	**38.9**	40.0	35.7	36.9	39.5	30.9	33.1	**36.0**
6	Kadiri 7	46.9	43.7	40.4	39.0	41.2	43.7	**42.5**	41.7	42.2	37.0	38.3	40.8	40.6	**40.1**	41.3	40.1	40.4	36.9	31.9	35.5	**37.7**
7	Kadiri 8	43.3	40.8	38.5	38.9	40.6	41.4	**40.6**	41.9	40.3	37.4	36.0	35.6	37.9	**38.2**	39.9	37.9	36.7	29.1	32.8	35.1	**35.3**
8	K1501	43.2	42.4	39.0	38.3	40.6	38.8	**40.4**	40.3	40.5	33.2	38.1	34.4	34.4	**36.8**	37.7	35.0	31.4	37.5	30.5	33.1	**34.2**
9	K1454	44.8	40.3	42.9	42.9	38.4	41.2	**41.8**	41.5	36.8	38.8	37.1	37.8	39.0	**38.5**	40.6	34.9	36.5	32.4	33.2	39.3	**36.2**
10	TPT 3	41.9	44.0	35.1	44.7	40.3	42.0	**41.3**	42.2	39.0	41.3	40.5	33.6	37.2	**39.0**	40.3	40.3	34.8	36.6	32.1	36.6	**36.8**
	Mean	**42.9**	**41.9**	**41.2**	**41.1**	**40.9**	**41.0**		**41.7**	**39.9**	**38.9**	**38.1**	**36.6**	**38.0**		**39.6**	**37.6**	**35.9**	**35.7**	**33.1**	**34.8**	

24 HAT				**48 HAT**				**72 HAT**			
	T	V	TxV		T	V	TxV		T	V	TxV
CD	1.830	1.417	4.484	**CD**	NS	2.190	6.928	**CD**	NS	2.170	6.862
SE (d)	0.924	0.716	2.264	**SE (d)**	1.428	1.106	3.498	**SE (d)**	1.414	1.095	3.465
SE(m)	0.653	0.506	1.601	**SE(m)**	1.010	0.782	2.473	**SE(m)**	1.000	0.774	2.450

T1 Control (water soaking for 1 hour)
T2 CEPA Spraying (spraying Of CEPA on seeds soaked in water for 1 hour)
T3 1hour soaking in CEPA and shade drying for three hours
T4 3 hour soaking in CEPA and shade drying for three hours
T5 6 hour soaking in CEPA and shade drying for three hours
T6 12 hour soaking in CEPA and shade drying for three hours

Table 6: Effect of CEPA on starch content (mg g^{-1}) of virginia type cultivars of groundnut exposed to different time intervals

		24 Hours After Treatment							**48 Hours After Treatment**							**72 Hours After Treatment**						
S. No	**Genotypes**	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**T_6**	**Mean**	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**T_6**	**Mean**	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**T_6**	**Mean**
1	GAUG 10	140.9	146.0	138.4	126.0	105.3	110.7	**127.9**	124.5	121.2	115.4	106.1	80.0	90.7	**106.3**	100.9	106.0	93.4	86.0	65.1	70.7	**87.0**
2	NCAC 2731	146.5	147.0	133.4	126.0	103.2	125.5	**130.3**	126.3	93.5	105.6	127.0	107.3	113.4	**112.2**	108.5	102.1	98.4	86.0	65.3	85.5	**91.0**
3	GJG HPS 1	136.2	131.6	130.8	127.3	98.1	105.8	**121.6**	125.2	110.8	111.6	90.6	85.2	104.2	**104.6**	105.2	91.6	90.8	87.3	70.2	75.8	**86.8**
4	Florigaint	153.0	100.8	101.4	110.6	100.6	105.2	**111.9**	133.0	110.8	161.4	85.8	83.2	87.7	**110.3**	113.0	80.8	105.3	75.0	52.1	50.2	**79.4**
5	Florunner	145.2	136.8	120.1	115.3	102.1	105.9	**120.9**	115.9	110.4	100.1	85.9	80.6	95.3	**98.0**	98.6	90.4	80.1	75.3	70.6	70.9	**81.0**
6	Kadiri 7	147.2	130.4	138.6	130.9	124.2	125.6	**132.8**	116.2	110.9	106.0	118.6	127.2	105.5	**114.1**	107.2	96.8	96.2	91.3	77.9	85.6	**92.5**
7	Kadiri 8	117.9	113.5	109.6	109.9	105.8	108.5	**110.9**	97.9	85.3	89.6	89.9	85.8	88.5	**89.5**	84.2	73.5	69.6	69.9	65.8	68.5	**71.9**
8	K1501	117.5	106.5	105.9	100.6	93.6	100.0	**104.0**	116.8	86.5	80.6	85.9	73.6	80.0	**87.2**	72.2	66.5	65.9	60.6	50.6	59.3	**62.5**
9	K1454	178.2	161.8	135.9	95.0	89.6	92.6	**125.5**	141.9	158.2	69.7	92.2	69.6	75.0	**101.1**	138.2	130.8	121.4	75.0	53.6	62.6	**96.9**
10	TPT 3	138.6	112.2	112.1	110.3	107.4	108.5	**114.8**	118.6	87.4	90.3	88.5	92.1	97.5	**95.7**	98.6	88.5	77.1	70.3	67.4	68.5	**78.4**
	Mean	**142.1**	**128.7**	**122.6**	**115.2**	**103.0**	**108.8**		**122.0**	**109.7**	**104.4**	**98.0**	**88.1**	**93.4**		**103.1**	**93.2**	**91.2**	**78.5**	**63.5**	**69.9**	

24 HAT				**48 HAT**				**72 HAT**			
	T	V	TxV		T	V	TxV		T	V	TxV
CD	6.864	8.861	21.706	**CD**	5.8	7.488	18.342	**CD**	4.908	6.337	15.522
SE (d)	3.462	4.47	10.949	**SE (d)**	2.926	3.777	9.252	**SE (d)**	2.476	3.196	7.829
SE(m)	2.448	3.161	7.742	**SE(m)**	2.069	2.671	6.542	**SE(m)**	1.751	2.26	5.536

T1 Control (water soaking for 1 hour)
T2 CEPA Spraying (spraying Of CEPA on seeds soaked in water for 1 hour)
T3 1hour soaking in CEPA and shade drying for three hours
T4 3 hour soaking in CEPA and shade drying for three hours
T5 6 hour soaking in CEPA and shade drying for three hours
T6 12 hour soaking in CEPA and shade drying for three hours

CONCLUSION

Among the different treatments used, the seeds soaked in CEPA for six hours (T_5) recorded significantly highest germination percentage and seedling vigour index irrespective of the varieties. This increase in germination percentage was supported by the biochemical changes in the seed composition during germination. It was observed that at 72 hours after treatment, seeds soaked in CEPA for 6 hours recorded highest reducing sugars with a concomitant decrease in starch and lipid content. The highest conversion of starch and lipid into sugars was further supported by the corresponding increase in total soluble protein content in the seeds soaked in CEPA for 6 hours followed by three hours of drying period.

REFERENCES

1. Abdul-baki, A. A. and Anderson, J. D., Vigour determination in soybean seed by multiple criteria. *Crop Science*. **13:** 630-33 (1973).
2. Bailey, W. K. and Bear, J. E., Seed dormancy of different botanical types of peanut, *Arachis hypogaea* L. *Journal of*

American Peanut Research Education. **3:** 221 (1973).

3. Barman, T. S. and Sarma, C. M., Effect of ethrel (2-Chloroethyl phosphonic acid) on germination and seedling growth of tea *Camellia Sinensis* (L.) O. Kuntz. *Indian Journal of Plant Physiology*. **28(4):** 413-417 (1958).
4. Bau, H., Villaume, C., Nicolas, J. and Mejean, L., Effect of germination on chemical composition, biochemical constituents and antinutritional factors of soya bean (*Glycine max*) seeds. *Journal of the Science of Food and Agriculture*. **73(1):** 1-9 (1997).
5. Bewley, J. D. and Black, M., Seeds: physiology of development and germination. 2nd Edition. Plenum Press, New York and London (1994).
6. Bulman, P. and Smith, D. L., Yield and grain protein response of spring barley to ethaphon and triadimefon. *Crop Science*. **33:** 798- 803 (1993).
7. De Castro, R. D. and Hilhorst, H. W. M., Dormancy, germination and the cell cycle in developing and imbibing tomato seeds. *Revista Brasileira de Fisiologia Vegetal*. **12:** 105-136 (2000).
8. Deepthi, R., Role of ethrel and storage in breaking seed dormancy in groundnut. *M. Sc. Thesis*. Seed science and technology, College of Agriculture, Junagadh Agricultural University (2018).
9. Finkelstein, R. R., Gampala, S. S. L., Rock, C. D., Abscisic acid signaling in seeds and seedlings. *Plant Cell*. **14:** S15–S45 (2002).
10. Fisher, R. A. and Yates, F., Statistical tables for bio-logical, agricultural and medical research. *Oliver and Boyd*, London. 145 (1963).
11. Francoise, C., Xia, Q., Bailly, C. and Bouteau, H., Ethylene, a key factor in the regulation of seed dormancy. *Frontier in Plant Science*. **5:** 539-542 (2014).
12. Hahm, T., Park, S. and Lo, Y. M., Effects of germination on chemical composition and functional properties of sesame (*Sesamum indicum* L.) seeds. *Bioresource Technology*. **100(4):** 1643-1647 (2008).
13. Hanumanthappa, D., Vasudevan, S. N., Maruthi, K., Maruthi, J. B. and Sebastian, A., Efficacy of dormancy breaking methods in paddy genotypes. *Journal of Applied and Natural Science*. **8(2):** 634 – 639 (2016).
14. Hemalatha, K. P. J. and Siva Prasad, D., Changes in the metabolism of lipids and carbohydrates during Germination of sesame (*Sesamum Indicum* l.) seeds. *Indian Journal of Plant Physiology*. **10(2):** 127-132 (2005).
15. ISTA, Understanding seed vigour. Zurich, Switzerland: *ISTA Vigour Test Committee*. **6:** (1995).
16. Ketring, D. L. and Morgan, P. W., Physiology of Oil Seeds I. Regulation of dormancy in virginia-type peanut seeds. *Plant Physiology*. **45:** 268-273 (1970).
17. Ketring, D. L., Physiology of oil seeds. VI. A means to break dormancy of peanut *(Arachis* hypogaea L.) seeds in the field. *Peanut Science*. **4:** 42-45 (1977).
18. Lowry, O. H., Rosenbrough, N. J., Farr, A. L. and Randall, R. J., Protein measurement with the folin phenol reagent. *Journal of Biochemistry*. **193:** 265-375 (1951).
19. Ma, B. L., Leibovitch, S. and Smith, D. L., Plant growth regulator effects on protein content and yield of spring barley and wheat. *Journal of Agronomy and Crop Science* **172:** 9-18 (1994b).
20. Nautiyal, P. C. and Bandyopadhyay, A., *In situ* sprouting and regulation of fresh seed dormancy in Spanish type groundnut (*Arachis hypogaea* L.). *Field Crop Research*. **70:** 233-241 (2001).
21. Nelson, N., A photometric adaptation of the Somogy's method for determination of glucose. *Journal of Biochemistry*. **153:** 375-380 (1944).
22. Ohtsubo, K., Suzuki, K., Yasui, Y. and Kasumi, T., Bio-functional components in the processed pregerminated brown rice by a twin-screw extruder. *Journal of Food Composition and Analysis*. **18(4):** 303–316 (2005).

23. Pahwa, K., Effect of plant growth regulators on manipulation of source-sink relationships in pigeonpea. Ph.D. dissertation. Punjab Agricultural University, Ludhiana, India (2013).
24. Pallavi, H. M., Gowda, R., Shadakshari, Y. G. and Vishwanath, Study on Occurrence and Safe Removal of Dormancy in Sunflower (*Helianthus annuus* L.). *Research Journal of Agricultural Sciences.* **1(4):** 341-344 (2010).
25. Ren, C. and Kermode, A. R., Analyses to determine the role of the megagametophyte and other seed tissues in dormancy maintenance of yellow cedar (*Chamaecyparis nootkatensis*) seeds: morphological, cellular and physiological changes following moist chilling and during germination. *Journal of Experimental Botany,* **50:** 1403-1419 (1999).
26. Sadasivam, S. and Manickam, A., Biochemical methods for agricultural sciences. Wiley-Eastern Ltd. New Delhi. 187-188 (1992).
27. Sekhon, N. K. and Singh, G., Effect of growth regulators and date of sowing on grain development in wheat *Indian Journal Plant Physiology*. **37:** 1-4 (1994).
28. Sharma, R., Grewal, M. K. and Singh, G., Effect of ethrel on lipid metabolism in soybean germinating under moisture stress. *Indian Journal of Plant Physiology*. **29:** 207-210 (1986).
29. Vidal-Valverde, C., Frias, J., Sierra, I., Blazquez, I., Lambein, F. and Kuo, Y., New functional legume foods by germination: effect on the nutritive value of beans, lentils and peas. *European Food Research and Technology*. **215(6):** 472-477 (2002).
30. Watanabe, H., Honma, K., Adachi, Y. and Fukuda, A., Effects of combinational treatment with ethephon and gibberellic acid on rice seedling growth and carbohydrate mobilization in seeds under flooded conditions. *Plant Production Science*. **21(4):** 380–386 (2018).
31. www.indiastat.com (2017-18).