YIELD AND STORAGE ABILITY OF SOYBEAN SEEDS AS AFFECTED BY ETHEPHON APPLICATION AND RIPENING PERIOD

BY

El-Habbal*, M.S.; Nadia Y. Attia**
and Salwa, S. Gaweesh***

* Agron. Dept., Fac. Agric., Ain Shams Univ., Cairo.
** Agric. Biochem. Dept., Fac. Agric., Zagazig Univ., Moshtohor.
*** Plant Dept., National Research Center, Cairo.

ABSTRACT

Soybean plants (Glycin max L.) variety "Calland" were sprayed with ethephone at concentrations of 0.0, 1000 and 1500 ppm at flowering stage. The seeds were obtained at ripening periods of 100, 110 days and full maturity i.e. 120 days after sowing. Effect of ethephon application, ripening period and their interaction on yield, chemical constituents and germination percentage of soybean seed during storage were studied.

Seed yield was significantly affected by ethephon application at flowering stage by applied 1000 or 1500 ppm ethephon and 100 days harvest period. Crude protein content of the seeds was slightly affected by storage, while total carbohydrates showed remarkable proportional reduction. Oil content was gradually increased by increasing storage period. Highest germiantion percentage after 12 months of storage was obtained by 1500 ppm ethephon application and ripening periods of 100 and 110 days.

INTRODUCTION

Ethephon is (2-chloroethane phosphonic acid) which spontaneously breaks down releasing ethylene at pH 3.5 and above. Ethylene increases the respiration rate, maturity and rate, degradative enzymes (as protease, o -amylase, invertase, catalase and peroxidase) in ethylene treated tissues of a dicotyledonous plants (Krishnamoorthy, 1981).

Beevers (1968), reported that the increase in/or application of ethylene followed by an increase and accumulation in abscisic acid (ABA) which plays an important role as

inhibitor substance. The ethylene and ABA increase the senescence of the plant. Acceleration of senescence is accompanied by a decrease in protein synthesis rather than an increase in protein degradation.

Addicott and Lyon (1969), found that ABA content of cotton fruits was sharply increased twice during the development of the fruit. The first coincided with the abscission of immature fruits and the other with the dihiscence of mature bolls.

Fletcher and Kirkwood (1982), reported that ethephon decomposes to produce mainly ethylene. At very low concentrations, it has profound effects. These effects include inducting fruit abscission, promoting flowering and fruit ripening leading to increase early yields, rate of respiration and degradation enzymes. They also found that ethephone reduce maize lodging and inhanced yield.

The target of the present study was to study the effect of ethephon application on ripening period and their interactions on seed yield, germination percentage, and storage ability of soybean seeds periodically for 12 months of storage.

MATERIALS AND METHODS

Materials:

Soybean seeds variety "Calland" were grown at the Agric. Experimental Farm. Fac., Agric., Ain Shams Univ., Shoubra El-Kheima, Kaluobia Governorate in 1988 and 1989 growing season. The plants were sprayed with ethephon at a concentration of 0, 1000 or 1500 ppm at flowering stage. Treatments were arranged in a complete randomized block design in four replications. The experimental unit consisted of four ridges each of five meters in length and 60 cm in width. The seeds were obtained at ripening periods of 100, 110 days and at full maturity, i.e. at 120 days after sowing.

The obtained seeds were air dried till constant moisture content of about 8%. The seeds of every treatment were backed in paper bakages in two replicates and stored under ambient temperature (20°C$\pm$2) and relative moisture content of 50-70%. Samples were taken periodically every 2 months till 12 months of storage to estimate germination percentage and chemical composition.

Sample of about 50 g from each replicate was crushed and followed by fine grinding. The oil was extracted using Soxhlet apparatus using hexane as a solvent. The extracted oil was dried over anhydrous sodium sulfate and filtered. The defatted meal and extracted oil were desolventized under vacuum at 50°C.

Seed yield (kg/fad) was determined in three replications and the data were the average of the two growing seasons 1988 and 1989.

Methods:

1- Germination percentage was determined in four replicates after 7 days.

2- Oil percentage (% dry seeds), ester, acid, peroxide and iodine values were determined according to the oficial methods as reported in AOAC (1975).

3- Total nitrogen was determined in defatted meal using micro-kjeldahl apparatus according to AOAC (1975). Crude protein was calculated by multiplying total nitrogen percentage by 6.25. The results were calcualted as percentage of dry seeds.

4- Carbohydrate fractions in defatted meal including reducing sugars, disaccharides and total available carbohydrates were evaluated using Shaffer and Hartmann method as reported in AOAC (1975). The results were calculated as percentage of dry seeds.

5- Dry matter content was estimated at 105°C.

Statistical analysis:

Germination percentage in four replicates and chemical composition of the stored seeds in two replicates were statistically analyzed according to Snedecor and Cochran (1967). Duncan's multiple range was used to compare between means according to Duncan (1955). The results followed by different alphapitical letters were significant at 5% level of significance.

RESULTS AND DISCUSSION

1- **Ethephon application:**

Application of 1000 ppm ethephon increased significantly the seed yield reaching 1.24 T/fad. Whereas, increasing ethephon concentration had no significant effect on seed

yield comparing to the untreated plants being 1.04 and 0.96 T/fa, respectively.

It was noteworthy found from table 1 that employing 1500 ppm ethephon increased significantly the germination percentage at every storage period followed by 1000 ppm and the control untreated plants. Also, the germination percentage was markedly inhibited at 4 months of storage then increased gradually by delaying the storage period till reached its maximal values after 12, 10 and 12 months by applying 0, 1000 and 1500 ppm ethephon, respectively.

The total available carbohydrates and oil percentage of soybean seeds were significantly affected by ethephon application these contents were in descending relationship with applying 0, 1000 and 1500 ppm ethephon at harvest and after 2 months of storage at ampient temeprature. Total available carbohydrates had a marked graual decreases as a result of prolonging storage period till 1 months. These decreases could be attributed to the degradation of poly-saccharides under the effect of amylase and phosphorylase enzymes in respiratory metabolism.

The data in table (1) show insignificant differences between means of total available carbohydrates after 4 months and up to 12 months of storage period. On the contrary, the oil percentage in seeds was markedly increased versus storage period being the highest for the control untreated plants. Whereas, employing 1000 or 1500 ppm ethephon had statistically the same effect on seed oil content. A reverse relationship was found between total available carbohydrates and oil content in one hand and crude protein content on the other one. It means that crude protein was significantly increased by employing 1000 ppm ethephon. Its content was slightly increased versus storge period in the control untreated sample, while ethephon treatments had a negligible effect on seed protein content.

The means of mono and disacharides would presumably enhanced versus storage period. The highest results were found at 4 months of storage, i.e., in January. This was probably due to lowering ambient temperature, decreasing respiration rate and subsequently accumulating the more simple carbohydrates in soybean seeds. The data exhibited slight differences in soluble sugars as a result of ethephon treatments.

The obtained data (Table 1) indicate also that the reduction in total carbohdyrates was outnumbered that of

Table 1. Effect of ethephon application during flowering of soybean plants on germination percentage and some chemical constituents (% dry seeds) of the seeds during storage at ambient temperature.

Ehephon	Storage period (months)						
PPm	0	2	4	6	8	10	12
	Germination percentage						
0	-	67.0b	59.7b	60.7b	60.7c	62.7c	64.3b
1000	-	74.3a	57.0b	63.3b	65.7b	68.7b	68.7b
1500	-	71.7ab	64.7a	68.7a	70.3a	72.7a	76.7a
	Crude protein						
0	30.8b	32.2a	31.7a	32.3a	32.3a	31.9a	32.0a
1000	31.7ab	32.1a	32.1a	32.3a	31.9a	31.5a	31.6a
1500	32.2a	32.3a	31.7a	31.9a	32.2a	32.4a	32.3a
	Oil						
0	23.5a	24.3a	26.0a	25.8a	26.5a	28.1a	29.3a
1000	23.6a	23.7ab	24.9b	24.8b	25.4b	26.5b	27.0b
1500	22.9b	23.1b	24.4b	24.5b	24.9c	26.3b	27.8b
	Total available carbohydrates						
0	18.7a	17.8a	16.7a	14.4a	12.6a	9.6a	8.8a
1000	17.9b	17.4ab	16.7a	14.2a	12.5a	9.7a	8.5a
1500	17.7b	16.9b	16.2a	14.1a	12.4a	10.2a	8.7a
	Monosaccharides						
0	0.1a	0.3a	0.6a	0.6a	0.6a	0.4a	0.8a
1000	0.1a	0.3a	0.8a	0.5a	0.6a	0.5a	0.7a
1500	0.1a	0.4a	0.8a	0.5a	0.6a	0.6a	0.8a
	Disaccharides						
0	2.3a	2.2a	4.3a	3.1a	3.3a	3.3a	3.7a
1000	2.3a	2.0a	4.1a	3.2a	3.1a	3.6a	3.8a
1500	2.2a	1.9a	4.2a	3.2a	3.5a	3.5a	3.8a

sugars increase due to the comsumption of invert sugars in Kreb's cycle to obtaine the need energy for keeping the seeds physiologically active. This observation is in agreement with those previously noted by El-Shimi & Damir (1984) and Abdel-Aal & Rahma (1986).

The available data in table 2 suggested that oil ester value was slightly changed versus ethephon application and storage period of the seeds. Also, the acid value exhibited slight gradual increases till 12 months of storage indicating low activity of lipase enzymes. Whereas, ethephon application contributed a slight effect on each of iodine and acid values at every storage period. It is worth mentioning that iodine and peroxide values were gradually decreased till 6 and 4 months of storage, respectively. Proloning storage period led to remarkable increment till reached their maximal values at the end of storage period. Additionally, ethephon applied at a rate of 1500 ppm increased significantly the oil peroxide value at 8, 10 and 12 months of storage.

Norris (1979), attributed the reductun in peroxide value to hydrolysis of hydroperoxides and form conjugated double bonds. These unsaturated double bonds do not react with iodine during the dtermination of iodine value. Consequently, the iodine and peroxide values were decreased gradually during storage till 4-6 months. Thereafter, the peroxide value was further increased due to oxidation of double bonds under the effect of lipo-oxygenase enzyme. This oxidation might accured the isolated double bonds which subsepuently led to increase the iodine value.

2- Ripening period:

As expected in table 3, the highest seed yield was obtained at physiological maturity stage, i.e., 100 days from sowing. As the plants aged towards full maturity, the seed yield was significantly decreased being 1.30, 1.05 and 0.90 T/fad at 100.100 and 120 days of ripening period, respectively. The decreases in seed yield at full maturity could be attributed to the reduction in translocation rate of such assimilates and/or the photosynthetic efficiency of plant canopy might own much for the reduction of this criteria at the later stages of development. These results are in harmony with those of Hanway & Thompson (1967) and Noureldin et al., (1986).

Table 4 indiactes as significant decrease in crude protein versus ripening period. Whereas, the maximum oil and total available carbohydrates values were found in

Table 2. Effect of ethephon application during flowering of soybean plants on some chemcal characteristics of the oil during seed storage at ambient temperature.

Ethephon	Storage period (months)						
PPm	0	2	4	6	8	10	12
	Ester value						
0	185.9	187.0	188.4	184.8	186.6	186.3	187.1
1000	185.8	186.6	188.6	185.6	184.2	184.4	184.3
1500	187.3	188.4	185.0	184.2	184.9	185.4	185.9
	Iodine value						
0	119.0	114.4	104.8	97.3	113.2	120.4	127.8
1000	119.3	111.8	107.1	100.5	115.4	122.0	129.8
1500	119.1	112.3	106.2	97.0	117.0	121.2	131.3
	Peroxide value						
0	3.0	1.7	0.7	2.1	4.7	7.1	9.5
1000	2.7	1.8	0.9	1.9	4.3	6.5	9.1
1500	3.5	2.0	0.8	1.9	6.1	12.7	13.2
	Acid value						
0	0.7	0.4	0.5	0.5	0.8	1.0	1.4
1000	0.7	0.4	0.5	0.6	0.9	1.0	1.3
1500	0.5	0.4	0.4	0.6	1.1	1.2	1.3

Table 3. Effect of ethephon application, ripening period and their interactions on yield (T/fad) of soybeen plants and germination percentage of the seeds during storage at ambient temperature.

Ripening period (days)	Ethephom (ppm)	Seed yield	Germination °/° at different storage periods (months) 2	4	6	8	10	12
	0	1.14c"	76	67	66	65	67	70
100	1000	1.55a	72	50	44	48	51	56
	1500	1.22b	91	79	85	81	79	81
Average		1.30A	80	65	65	65	66	69
	0	0.92b	62	54	58	55	53	57
110	1000	1.20a	84	61	76	76	77	75
	1500	1.02b	66	61	63	65	68	80
Average		1.05B	71	59	66	65	66	71
	0	0.82b	63	58	58	62	68	66
120	1000	0.98a	67	60	70	73	78	75
	1500	0.89b	58	54	58	65	71	69
Average		0.90B	63	57	62	67	72	70

* Capital letters to compaire between means of the average.
** Small letters to compaire between means of the interaction.

Table 4. Effect of ripening period of soybean plants and storage period at ambient temperature on protein , oil and carbohydrates content of the seeds (% dry matter).

Ripening period (days)	Starage period (months)						
	0	2	4	6	8	10	12
	Crude protein						
100	32.3a	33.2a	32.3a	32.7a	32.3a	31.9a	31.8a
110	31.6b	33.2a	31.4b	30.6b	30.6b	31.7a	31.3a
120	30.9c	31.8b	30.3c	30.4b	30.0b	29.7b	30.4b
	Oil						
100	23.0b	23.3b	24.8b	24.9b	25.1b	26.9b	27.8b
110	23.8a	24.1a	25.8a	25.4a	26.0a	27.4a	29.7a
120	23.2b	23.6b	24.7b	24.8b	25.7a	26.6b	27.6b
	Tatal available carbohydrates						
100	18.2b	17.4b	16.2b	14.4a	13.3b	10.2b	8.7a
110	18.0b	17.4b	16.5b	13.7b	12.3b	10.1b	8.4a
120	19.9a	19.2a	17.3a	14.8a	14.1a	11.2a	9.1a
	Monosaccharides						
100	0.1a	0.2a	0.4a	0.5a	0.5a	0.5a	0.8a
110	0.1a	0.5a	0.9a	0.4a	0.5a	0.4a	0.6a
120	0.1a	0.5a	0.9a	0.6a	0.7a	0.7a	0.9a
	Disaccharides						
100	2.4a	1.5b	4.2a	3.1a	3.4a	3.4a	3.2a
110	2.2a	1.8b	4.2a	3.3a	3.2a	3.5a	3.9a
120	2.2a	2.7a	4.3a	3.3a	3.0a	3.5a	4.0a

Table 5. Effect of ripening period of soybean plants and storage period at ambient temperature on some chemical constituents of the oil.

Ripening period (days)	Starage period (months)						
	0	2	4	6	8	10	12
	Ester value						
100	184.6	187.8	189.7	184.7	186.5	186.4	186.6
110	186.9	187.2	188.7	186.8	188.3	187.1	187.8
120	187.6	187.0	183.6	181.1	180.9	182.5	182.9
	Iodine value						
100	116.5	109.3	102.5	94.7	116.1	121.7	128.4
110	120.8	115.4	107.4	99.3	117.3	121.5	128.3
120	120.2	113.8	108.2	100.7	112.2	120.4	132.2
	peroxide value						
100	0.4	1.4	0.3	1.7	3.9	6.4	8.9
110	0.9	1.9	1.1	2.2	4.6	8.5	9.7
120	1.4	2.2	0.9	1.4	6.7	11.4	13.3
	Acid value						
100	0.9	0.4	0.4	0.5	0.8	1.1	1.6
110	0.7	0.4	0.4	0.6	0.8	1.0	1.3
120	0.4	0.4	0.5	0.6	1.1	1.0	1.1

the seed after 110 and 120 days, respectively. The mono and disaccharides were found to be stable with slight diferences versus ripening period. Storage of soybean seeds at ambient temperature was slightly affected their contents of crude protein. Whereas, the total available carbohydrates had remarkable proportional reduction. This reduction was attributed to the activity of respiration enzymes and oxidation of available carbohydrates. Therefore, the seed oil content was gradually increased reaching its maximal values at the end of storage.

On the other side, the carbohydrate hydrolyzing enzymes were responsible for increasing reducing and non reducing sugars. The rate of hydrdysis was overcome oxidation processes which subsequeatly led to their proportional accumulation in the seeds during storage.

The data in table (5) indicate clearly that ester, iodien and peroxide values were increased by the approach of maturity. Promeranz (1976), attributed the increase of oil unsaturation to high activity of dehydrogenase enzymes and formation of unsaturated fatty acids from saturated ones. The acid value was also differed and ranged between 0.4 to 0.9.

Generally it was found corresponded positive relationship between each of ester, iodine, peroxide and acid values. these results are true when the storage period was prolonged from 6 up to 8 months.

3- Effect of interactions:

The seed yield of sobyean plants was significantly affected by employing ethephon at flowering stage and ripening period (Table 2). The maximum yield was found when 1000 or 1500 ppm ethephon applied and 100 days of harvest period being 1.55 and 1.22 T/fad., respectively. Whereas, the best germination percentage after 12 months of storage was found by applying 1500 ppm ethephon and ripening period of 100 and 110 days.

All the other interaction treatments were not significant at 5% level of significance.

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تأثير الايتيفون ومدة النضج على المحصول وكفاءة تخزين بذور فول الصويا

محمد سامى الحبال* نادية يحيى عطية**
سلوى جاويش***

* قسم المحاصيل - كلية الزراعة - جامعة عين شمس - القاهرة
** قسم الكيمياء الحيوية - كلية الزراعة - جامعة الزقازيق - مشتهر
*** معمل النبات - المركز القومى للبحوث - القاهرة

تم رش نباتات فول الصويا بمادة الايتيفون بتركيزات صفر، ١٠٠٠، ١٥٠٠ جزء فى المليون خلال فترة الازهار وتم الحصول على البذرة بعد ١٠٠، ١١٠ يوم وعند تمام النضج بعد ١٢٠ يوم من الزراعة وذلك لدراسة تأثير الرش بالاينيفون وطول فترة النضج على التركيب الكيماوى ونسبة الانبات خلال فترة التخزين للبذور.

تأثر محصول البذره معنويا بالرش بالايتيفون اثناء الازهار وبطول فترة النضج وكان اعلى محصول هو عند استخدام تركيزات ١٠٠٠، ١٥٠٠ جزء فى المليون وبعد ١٠٠ يوم من الزراعة. تأثر محتوى البذور من البروتين الخام تأثيرا طفيفا بالتخزين. انخفض محتوى البذور من الكربوهيدرات انخفاضا ملحوظا بينما زاد محتواها من المواد الدهنية بزيادة طول فترة التخزين. كانت اعلى نسبة انبات للبذور بعد ١٢ شهر تخزين وعند رش النباتات بجرعات ١٠٠٠، ١٥٠٠ جزء فى المليون وفترة نضج ١٠٠، ١١٠ يوم.