République Libanaise
Bureau du Ministre d'Etat pour la Réforme Administrative
Centre des Projets et des Etudes sur le Secteur Public
(C.P.E.S.P.)

SEED LONGEVITY OF FIELD AND VEGETABLE CROPS UNDER NATURAL CONDITIONS OF STORAGE IN LEBANON

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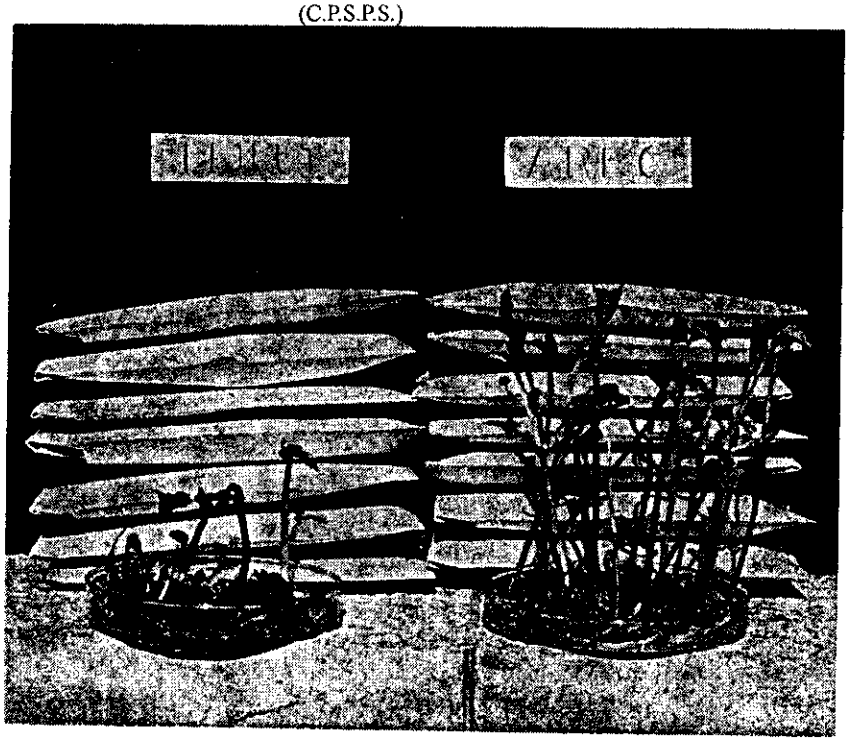

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الجمهورية اللبنانية
مكتب وزير الدولة لشؤون التنمية الإدارية
مركز مشاريع ودراسات القطاع العام

SEED LONGEVITY OF FIELD AND VEGETABLE CROPS UNDER NATURAL CONDITIONS OF STORAGE IN LEBANON

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Pnblication No 39

May 1969

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INTRODUCTION

Seed is a primary essential in successful crop production. Similarly, high seed viability is the important quality that supersedes all other seed quality factors. Seed storage under unfavorable conditions can be detrimental to seed longevity; great losses in crop production have resulted from the use of improperly stored seeds.

The average life span of seeds varies widely with different kinds of seed. The viability of any species of seed depends on its maturity, dormancy, physical conditions, and storage environment. The principal environmental factors influencing longevity of seed are temperature, relative humidity, and in some cases the level of oxygen in the storage atmosphere (3, 4, 5, 6). The subject of storage for maintainance of seed viability is thoroughly discussed by Owen (4).

Seedsmen of Lebanon handle large quantities of seed for sowing purposes every year. Many of these seeds are stored in porous containers (cloth or paper bags) under the natural environmental conditions of Beirut. Often a considerable amount of seed is stored for a few years before it is sold for planting. Since little or no information was available on the effect of storage

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under natural environmental conditions prevailing in Lebanon, the present study was undertaken to determine the influence of different environments in Lebanon on the longevity of commonly grown vegetable and field crop seeds.

MATERIALS AND METHODS

Seed lots of 12 species of field crops, both treated with surface chemical disinfectant (Ceresan containing 1.5 percent Hg as phenyl mercury acetate) and non-treated, together with 20 species of treated vegetable crops were used. All seeds were stored under natural environmental conditions in Beirut at the Seed Technology Laboratory, American University of Beirut and in the North Central Beqa'a Plain (1000 m above sea level) at the seed house of the Agricultural Research and Education Center (AREC). This storage experiment was started in 1961 for field crop seeds and in 1962 for vegetable seeds. The various crops, varieties, and weights of seed samples used in each storage site are given in Table 1. Field crop seeds were stored in small burlap bags and vegetable seeds in Manilla paper envelopes. Regular fumigation treatments with 68.5 percent Ethylenedichloride, 29.0 percent carbon tetrachloride, and 2.5 percent sulfur dioxide for the control of weevils were done throughout the experimental period.

Samples for determining seed germinability were taken annually starting in 1961 for field crop seeds and in 1962 for vegetable seeds. Seed germination tests were conducted according to the rules of the International Seed Testing Association (1).

RESULTS & DISCUSSION

Field Crop Seeds

It can be seen from Table 2 that after three years of storage in Beirut the non-treated seeds of wheat (Florence Aurore and Senator Capelli), barley (Tel Amara 25 and Athinais), corn, oats, soybean, and sugarbeet lost more than 50 percent of their capacity to germinate. Sorghum, vetch, lentils, and alfalfa maintained their viability slightly better. In one year of storage soybean decreased from 81 percent to 11 percent germination.

Table 1. Crops, varieties, and weights of seed samples stored in Beirut and at the AREC.

Crop	Scientific name	Variety	Wt. sample (g)
Field crops			
Alfalfa	*Medicago sativa*	Hairy Peruvian	200
Barley	*Hordeum vulgare*	Athinais	4000
Barley	*Hordeum distichom*	Tel Amara No. 25	4000
Corn	*Zea mays var. indentata*	S.D. 604	5000
Lentils	*Lens esculenta*	Local	3000
Oats	*Avena sativa*	Nortex	4000
Sorghum	*Sorghum vulgari*	Norghum	3000
Soybean	*Glycine max*	Lincoln	5000
Sugarbeet	*Beta vulgari*	Polyrave	3000
Vetch	*Vicia sativa*	Local	3000
Wheat	*Triticum aestivum*	Florence Aurore	4000
Wheat	*Triticum durum*	Senator Capelli	4000
Vegetable crops			
Cabbage	*Brassica oleracea var. capitata*	Golden Acre	100
Carrot	*Daucus carota*	Half-long Nantes	50
Cauliflower	*Brassica oleracea var. botrytis*	Burpeeana	100
Cucumber	*Cucumis sativus*	Marketer	350
Eggplant	*Solanum melongena var. esculentum*	Burpee's Black Beauty	100
Green Snap bean	*Phaseolus vulgaris*	Tender Pod	3000
Garden pea	*Pisum sativum*	—	4000
Lettuce	*Lactuca sativa*	Great Lakes	50
Muskmelon	*Cucumis melo*	Hearts of Gold	300
Okra	*Hibiscus esculentus*	Clemson Spineless	600
Onion	*Allium cepa*	Japanese	100
Pepper	*Capsicum spp.*	Yellow Oshkosh	100
Radish	*Raphanus sativus*	Cherry Belle	200
Squash	*Cucurbita maxima*	Caserta	1000
Spinach	*Spinacia oleracea*	Bloomsdale	150
Sweet corn	*Zea mays var. saccharata*	—	5000
Table beet	*Beta vulgaris*	Detroit Dark Red	250
Tomato	*Lycopersicon esculentum*	Rutgers	400
Turnip	*Brassica rapa*	Purple-Top White Globe	100
Watermelon	*Citrullus vulgaris*	—	1500

Table 2. Germination percentages of different kinds of non-treated field crop seeds stored in Beirut — 1961 to 1969.

Crop	1961	1962	1963	1964	1965	1966	1967	1968	1969
Wheat (F. Aurore)	86	80	76	25	0	0	0	0	0
Wheat (S. Capelli)	91	72	60	35	5	0	0	0	0
Barley (Tel Amara 25)	86	76	70	45	15	0	0	0	0
Barley (Athinais)	93	84	76	30	0	0	0	0	0
Corn	97	90	82	30	5	0	0	0	0
Oats	95	86	72	48	10	0	0	0	0
Sorghum	—	81	80	58	20	0	0	0	0
Vetch	85	84	86	55	25	0	0	0	0
Soybean	81	11	15	0	0	0	0	0	0
Lentils	95	92	91	63	50	25	0	0	0
Alfalfa	79	80	73	54	30	24	15	9	5
Sugarbeet	84	70	38	20	22	0	0	0	0

Treated seeds of wheat (Florence Aurore and Senator Capelli), barley (Tel Arama 25 and Athinais), corn, soybean, and sugarbeet germinated 50 percent and less after three years of storage in Beirut (Table 3). The germination percentage of soybean dropped from 81 at the beginning of the storage period to 43 in 1962 and to zero in 1964. A few seeds of treated and non-treated alfalfa germinated after 7 and 8 years of storage (Tables 2 & 3). The latter finding was probably due to the presence of some seeds with hard seed coat in the original sample.

With the exception of soybean relatively little decrease in germination was found in either the treated or the non-treated field crop seeds which were stored at the Agricultural Research and Education Center in the Beqa'a (Tables 4 & 5). The germination of the non-treated soybean was reduced to 50 percent after two years and the treated soybean after three years. The seeds of soybean were dead at the end of eight years of storage whereas the majority of the seeds of the other crops germinated above 70 percent.

Even though a little benefit from the seed treatment was observed (compare Table 2 with 3 and 4 with 5), treating the seed with chemical disinfectant was not a major factor in influencing seed longevity under the conditions of this experiment. No seedling abnormalities attributable to chemical toxicity during the germination tests were observed.

Table 3. Germination percentages of different kinds of treated field crop seeds stored in Beirut — 1961 to 1969.

Crop	1961	1962	1963	1964	1965	1966	1967	1968	1969
Wheat (F. Aurore)	99	94	80	40	15	0	0	0	0
Wheat (S. Capelli)	89	91	78	50	20	0	0	0	0
Barley (Tel Amara 25)	91	80	75	40	10	0	0	0	0
Barley (Athinais)	83	87	81	35	15	0	0	0	0
Corn	98	95	85	40	20	0	0	0	0
Oats	91	87	75	54	20	5	0	0	0
Sorghum	—	91	90	72	60	3	0	0	0
Vetch	94	90	85	60	35	0	0	0	0
Soybean	81	43	20	0	0	0	0	0	0
Lentils	95	95	91	72	50	21	2	0	0
Alfalfa	84	82	70	52	35	15	10	7	0
Sugarbeet	86	70	40	24	16	0	0	0	0

Table 4. Germination percentages of different kinds of non-treated field crop seeds stored at the AREC — 1961 to 1969.

Crop	1961	1962	1963	1964	1965	1966	1967	1968	1969
Wheat (F. Aurore)	86	83	85	86	78	80	82	71	xx
Wheat (S. Capelli)	91	89	85	86	84	83	83	62	59
Barley (Tel Amara 25)	86	86	88	85	80	84	83	82	56
Barley (Athinais)	93	87	86	93	85	90	91	84	83
Corn	97	91	92	92	80	82	85	85	83
Oats	95	85	86	85	85	81	82	81	70
Sorghum	—	88	89	80	70	77	74	76	73
Vetch	96	94	87	95	90	92	89	89	86
Soybean	81	71	50	46	25	20	11	1	0
Lentils	95	93	88	88	88	90	90	93	82
Alfalfa	97	85	84	82	70	75	78	73	71
Sugarbeet	—	91	82	80	80	84	87	88	85

xx No seed left.

Table 5. Germination percentages of different kinds of treated field crop seeds stored at the AREC — 1961 to 1969.

Crop	1961	1962	1963	1964	1965	1966	1967	1968	1969
Wheat (F. Aurore)	99	96	90	90	89	84	87	78	xx
Wheat (S. Capelli)	89	87	87	88	85	89	87	75	80
Barley (Tel Amara 25)	91	87	80	80	80	80	64	47x	62
Barley (Athinais)	93	92	85	85	85	80	79	76	60
Corn	98	96	88	88	90	90	86	78	88
Oats	91	85	87	85	85	88	90	78	70
Sorghum	—	90	92	92	90	89	92	88	84
Vetch	94	89	93	93	90	90	79	84	80
Soybean	81	69	75	50	20	26	11	1	0
Lentils	95	92	92	92	94	95	95	93	81
Alfalfa	85	87	85	84	83	73	77	69	70
Sugarbeet	—	93	80	80	85	84	89	90	80

x Low percentage mainly due to insect damage.

xx No seed left.

Vegetable Seeds

The data presented in Table 6 is evidence that after three years of storage in Beirut the vegetable seeds of onion, table beet, cabbage, cauliflower, turnip, pepper, muskmelon, squash, carrot, okra, lettuce, green snap bean, eggplant, spinach, watermelon, and sweetcorn had lost more than 50 percent of their viability. Onion, pepper, lettuce, and spinach were dead after three years of storage. Tomato, peas, and cucumber seed, on the other hand, germinated 71, 37, and 18 percent respectively after seven years of storage.

Many of the vegetable seeds stored at the AREC maintained fairly high viability levels for rather long periods of time (Table 7). In particular, cabbage, turnip, tomato, carrot, radish, watermelon, pea, and table beet maintained high germination percentages for six or seven years. Muskmelon and lettuce maintained high germination percentages for five years, after which

there was a marked decrease. Onion germinated well for one year only, after which its germination dropped to 40 percent and then decreased gradually in the successive years to zero percent in 1969.

The decrease in germination capacity of all vegetable and field crop seeds occured much faster in Beirut than at the AREC in the Beqa'a. Although species differences affect the rate of loss of viability, the storage environment proved to be the major controlling factor in seed longevity. The two main environmental factors that affect seed viability are temperature and relative humidity. The monthly changes of temperature and relative humidity for the two storage places are shown in Figures 1 & 2 respectively. It can be seen

Table 6 Germination percentages of different kinds of treated vegetable seeds stored in Beirut — 1962 to 1969.

Crop	1962	1963	1964	1965	1966	1967	1968	1969
Onion	93	90	10	0	0	0	0	0
Table beet	88	81	80	40	36	17	xx	xx
Cabbage	85	80	50	10	0	0	0	0
Cauliflower	92	86	62	25	1	0	0	0
Turnip	90	85	74	20	0	0	0	0
Pepper	89	83	20	0	0	0	0	0
Muskmelon	83	75	40	25	1	1	0	0
Cucumber	86	92	80	70	30	18	15	18
Squash	90	85	65	30	10	0	0	0
Tomato	93	85	90	80	86	75	64	71
Carrot	87	82	60	25	0	0	0	0
Okra	83	69	70	40	3	3	0	0
Lettuce	90	74	30	0	0	0	0	0
Green snap bean	87	80	65	20	0	0	0	0
Radish	88	83	81	78	42	1	0	0
Eggplant	87	82	60	18	1	0	0	0
Spinach	84	75	10	0	0	0	0	0
Watermelon	—	84	40	30	19	3	0	0
Pea	—	86	89	75	44	39	37	37
Sweet corn	—	91	80	40	12	3	0	0

xx No seed left.

Table 7. Germination percentages of different kinds of treated vegetable seeds stored at the AREC — 1962 to 1969.

Crop	1962	1963	1964	1965	1966	1967	1968	1969
Onion	93	91	40	25	25	4	1	0
Table beet	88	88	80	78	84	80	80	40
Cabbage	85	91	85	80	78	75	76	70
Cauliflower	92	91	90	80	76	63	63	44
Turnip	90	97	85	90	92	90	92	71
Pepper	89	85	60	65	65	56	45	58
Muskmelon	83	82	55	60	50	53	0	0
Cucumber	86	93	85	85	80	81	57	56
Squash	90	92	90	80	76	71	47	10
Tomato	93	96	85	88	86	82	78	84
Carrot	87	89	80	84	84	82	80	xx
Okra	83	86	76	64	52	30	26x	53
Lettuce	90	87	80	75	66	58	0	0
Green snap bean	87	90	85	76	66	68	45x	76
Radish	88	85	90	78	85	75	74	71
Eggplant	87	82	75	70	73	53	50	64
Spinach	84	81	50	40	37	31	17x	42
Watermelon	—	84	78	76	63	67	45x	82
Peas	—	86	80	85	87	78	80	87
Sweet corn	—	91	84	86	90	73	67	54

x Low percentage mainly due to insect damage.

xx No seed left.

from these two figures that the average temperature and average relative humidity values throughout the year are higher in Beirut than at the AREC. During the high temperature months of June, July, August, and September the relative humidity of the AREC was relatively low ranging from 55 to 58.5 percent as compared to that in Beirut which ranged from 69 to 73 percent. High temperature and high relative humidity occurring together constitute a highly unfavorable condition for seed storage. According to Toole (5) and Toole and Toole (7) these two environmental factors are additive and constitute the major factor in determining seed longevity. In addition, it is

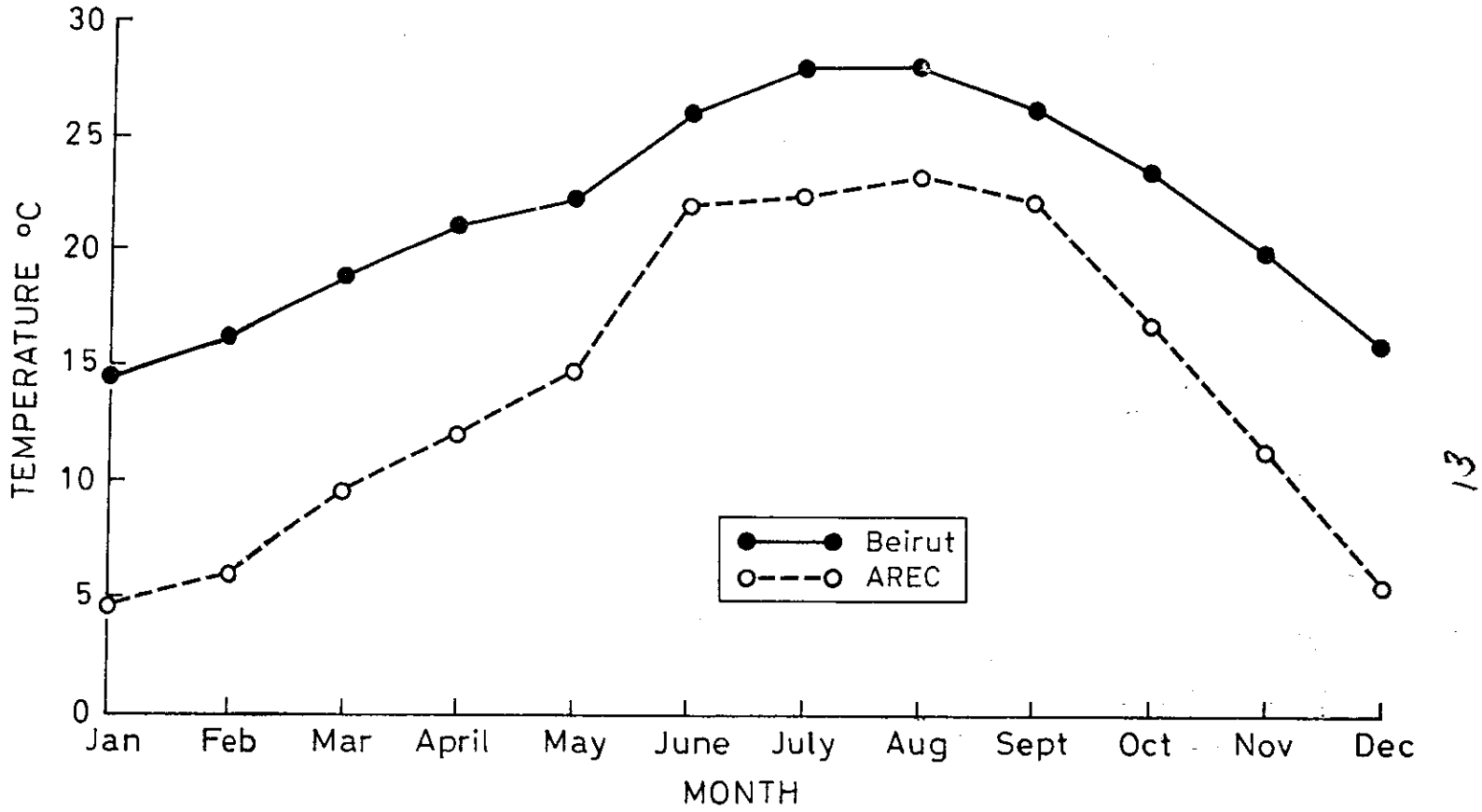

Fig. 1. Monthly temperatures in Beirut and AREC, 1961-1969

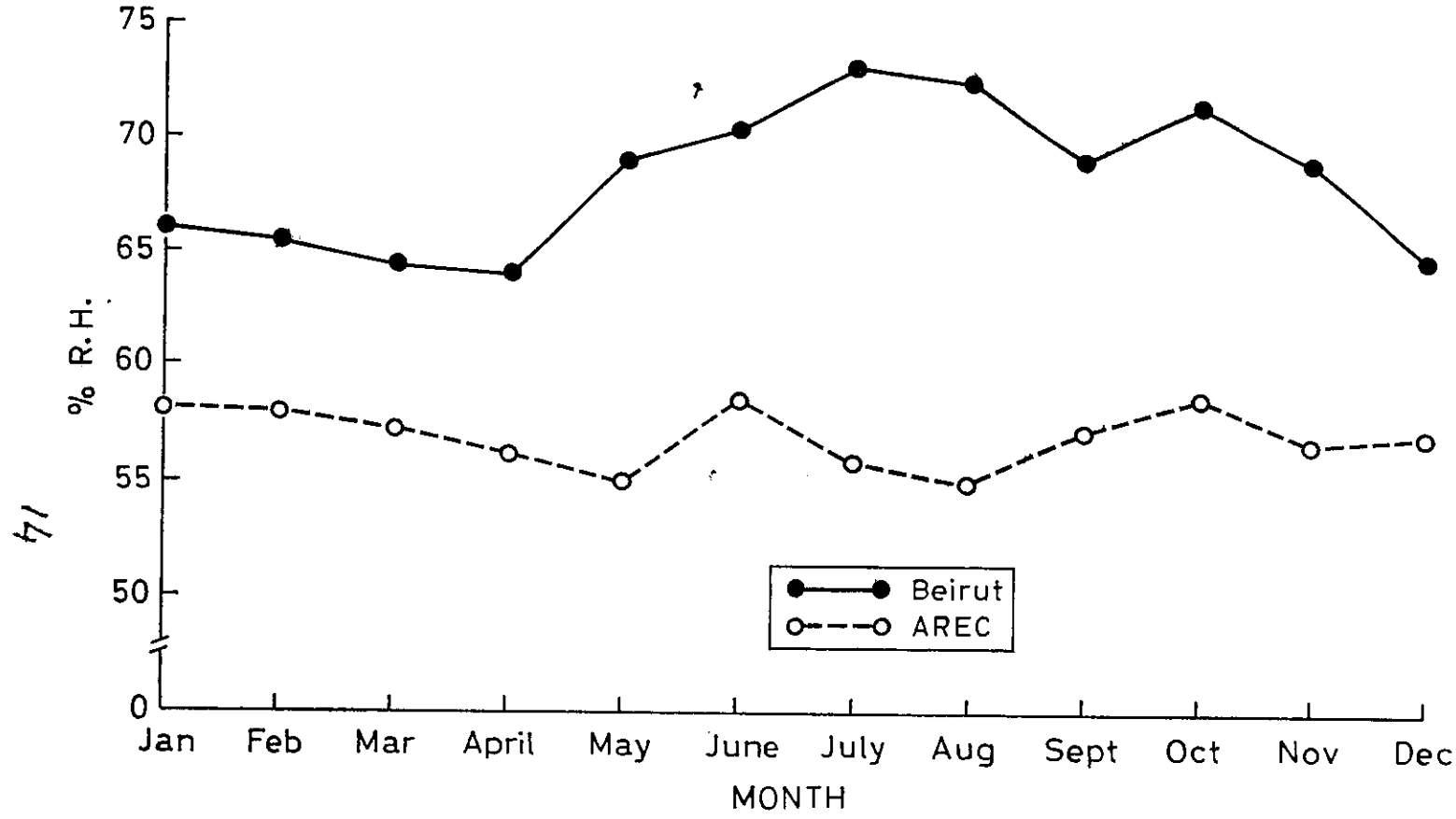

Fig. 2. Monthly ralative humidity in Beirut and AREC, 1961-1969.

probable that the high seed viability levels that were maintained at the AREC, Beqa'a are connected with reduced partial pressure of oxygen. It seems probable that the combination of relatively low temperature, low relative humidity, and reduced partial pressure of oxygen at the AREC have reduced the rate of respiration and consequently resulted in higher seed longevity at the AREC than in Beirut (2).

SUMMARY

Twelve species of field crops and 20 species of vegetable crops were stored under natural environmental conditions at the Agricultural Research and Education Center in the Beqa'a and at the Seed Technology Laboratory, American University of Beirut, Lebanon. The storage period for field crops was from 1961 to 1969 and for vegetable crops from 1962 to 1969.

Although the germination percentages of a variety of species differed, the decrease in germination capacity of all the vegetable and field crop seeds occurred much faster in Beirut than in the Beqa'a.

The crop seeds that germinated 50 percent or less after three years of storage in Beirut were the following: Wheat, barley, corn, oats, soybean, sugarbeet, onion, table beet, cabbage, cauliflower, turnip, pepper, muskmelon, squash, carrot, okra, lettuce, green snap bean, eggplant, spinach, watermelon, and sweet corn. Practically all these seeds became non-viable after five years of storage.

In the Beqa'a, however, all the vegetable seeds (except onion and spinach) and all the field crop seeds germinated between 64 and 93 percent after three years of storage. Seeds that germinated above 50 percent after seven or eight years were the following: Wheat, barley, corn, oats, sorghum, vetch, lentils, alfalfa, sugarbeet, cabbage, turnip, pepper, cucumber, tomato, okra, green snap bean, radish, eggplant, watermelon, pea, and sweetcorn. Soybean, onion, lettuce, and muskmelon were the only crop seeds which completely lost their viability after seven or eight years of storage.

Among the vegetable and field crop seeds tested, it was found that

onion and soybean were the most sensitive and that tomato and alfalfa were the most resistant to the unfavorable storage atmosphere of Beirut.

In conclusion, this study reveals that the Beqa'a has favorable environmental conditions for seed storage whereas the environmental conditions of Beirut contribute to rapid loss of seed viability. Therefore, if seeds were to be stored under natural conditions it is recommended that Beqa'a be utilized for this purpose.

ملخص نتائج الدراسة التي أجريت على تخزين بذور بعض المحاصيل الحقلية والمحاصيل الخضرية في مركز الابحاث والتعليم الزراعي في البقاع ومختبر البذور في كلية الزراعة في الجامعة الاميركية في بيروت ــ لبنان .

تم تخزين اثني عشر صنفا من بذور المحاصيل الحقلية وعشرين صنفا من بذور الخضروات تحت ظروف عادية في كل من مركز الابحاث والتعليم الزراعي في البقاع ومختبر البذور في كلية الزراعة في الجامعة الاميركية في بيروت .

كانت فترة تخزين بذور المحاصيل الحقلية من سنة ١٩٦١ ــ ١٩٦٩ بينما كانت فترة تخزين بذور الخضروات من سنة ١٩٦٢ ــ ١٩٦٩ .

وبالرغم من أن النسبة المئوية للانبات تختلف باختلاف اصناف انواع هذه المحاصيل الا ان نسبة التدني في قوة انباتها كانت أسرع في بيروت منها في منطقة البقاع . وتتلخص نتائج هذه الدراسة فيما يلي :

١ ــ ان بذور المحاصيل الحقلية وبذور محاصيل الخضروات التي كانت نسبة انباتها ٥٠٪ أو أقل بعد أن خزنت لمدة ثلاث سنوات في بيروت هي : قمح ــ شعير ــ ذرة صفراء ــ شوفان ــ فاصوليا الصويا ــ شمندر سكري ــ بصل ــ شمندر عادي ــ ملفوف ــ قرنبيط ــ لفت ــ فلفل ــ بطيخ ــ شمام ــ كوسى ــ جزر ــ باميا ــ خس ــ باذنجان ــ فاصوليا حقلية ــ سبانخ وذرة حلوة . وزيادة على ذلك فقد وجد ان بذور المحاصيل السالفة الذكر قد فقدت مقدرتها على الانبات بعد خمس سنوات من التخزين .

٢ ــ ان بذور محاصيل الخضروات باستثناء البصل والسبانخ وجميع بذور المحاصيل الحقلية بعد ٣ سنوات من التخزين في البقاع تراوحت نسبة انباتها بين ٦٤ ــ ٩٣٪ .

٣ ــ ان البذور التي نبتت بنسبة اكثر من ٥٠٪ بعد ٧ ــ ٨ سنوات من التخزين في البقاع هي : قمح ــ شعير ــ ذرة صفراء ــ شوفان ــ ذرة بيضاء ــ كرسنة (بيقيه) ــ عدس ــ فصه ــ شمندر سكري ــ ملفوف ــ لفت ــ فلفل ــ خيار ــ بندورة ــ بامية ــ فاصوليا حقلية ــ فجل ــ باذنجان ــ بطيخ بازللا وذرة حلوة . اما البذور التي فقدت حيويتها في نفس المدة من التخزين فهي : فاصوليا الصويا ــ بصل ــ خس وشمام . وقد لوحظ ان بذور الخس والشمام قد فقدا حيويتهما بصورة ملحوظة في اخر سنتين من فترة التخزين بينما كان فقدان حيوية بذور البصل وفاصوليا الصويا تدريجيا .

٤ — ان بذور البصل وفاصوليا الصويا هما أكثر الانواع حساسية لظروف التخزين الغير ملائمة ، وان بذور البندورة والفصة هما أكثر الانواع تحملا لمثل هذه الظروف الغير ملائمة للتخزين في بيروت .

يستنتج من هذه الدراسة ان منطقة البقاع تمتاز بظروف جوية ملائمة لتخزين البذور بينما الظروف الجوية في بيروت تساعد على فقدان حيوية البذور بسرعة . لذلك ينصح بتخزين البذور في الظروف العادية في منطقة البقاع .

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