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PHENOLOGICAL STAGES AND GROWING DEGREE DAYS FOR DIFFERENT SOYBEAN CULTIVARS

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ABSTRACT

Nine soybean cultivars belonging to different maturity groups (MG) in the green house of Crop Physiol. Res. Dept., Giza, 2007 and 2008 seasons. The main objectives were to study the initiation and duration of the different growth stages, growing degree days (GDD) and heat unit efficiency (HUE) in relation to yield and other plant traits.

Results indicated that completely unrolled leaf at unifoliolate node (V_1) needed about 191°C GDD and this amount was almost constant for cultivars. Number of days (ND) and GDD accumulation for the initiation of reproductive stages varied significantly among cultivars. The earliest cultivar was "Giza 83" (MG II), while the latest was either "Holladay" or "*Toano*" (MG V). Cultivars of MG IV, *i.e.*, "Giza 21", "Giza 22", "Giza 111" and "Crawford" needed more days to the initiation of reproductive stages than those of "Giza 35" (MG III) or MGII cultivars. Similar results were obtained when GDD was taken into consideration.

There were significant differences among cultivars in the length of vegetative growth, flowering period, pod formation, seed filling and reproductive growth durations and their degree days sum. "Giza 83" had the shortest stage durations and needed the lowest GDD for full rate of phenological stage. However, "Holladay" and "*Toano*" had the longest durations and accumulated the most GDD during all developmental stages. Other cultivars were in-between, due to their maturity groups.

Cultivars of MG V surpassed the others in plant traits and yield, while "Giza 83" (MG II) had the lowest values of these traits and the rest cultivars were in-between. Concerning HUE in seed yield, all cultivars followed the same trend of their productivity with no significant differences between MG IV and MG V cultivars.

Keywords: Soybean – cultivars – growing degree days – phenological stages.

INTRODUCTION

Soybean [*Glycin max* (L.) Merrill] is an annual plant commercially grown primarily for oil and protein production. Eventhough morphological diversity exists. The soybean is generally a plant which grows 90-120 cm in height with the first leaves simple and opposite and all other leaves alternate and trifoliolate. All above ground vegetative parts are covered with pubescence. Branches may develop from buds in the lower leaf axils. Flowers develop in all leaf axils which give rise to 0-5 pods with 1-5 seeds per pod. Plants are either determinate or indeterminate in flowering and developmental habit. (Carlson, 1973).

Using the adaptable cultivars is necessary for economical yield. There were significant differences among soybean cultivars in growth traits, yield and its components (Beaver *et al.*. 1985; El-Hariri *et al.*, 1994; Hefni *et al.*, 1994; Abdel-Gawad and El-Batal, 1995). Additional descriptive information about morphological and physiological response of cultivars to temperature will be assist in breeding programs which are designed to improve seed yield through more precise adaptation under Egyptian conditions. The vegetative soybean has lower and upper temperature optima, a temperature plateau in which maximal development accurs between a lower-optimum and an upper – optimum temperatures (Boote *et al.*, 1998). The linear relationship between development rate and average daily temperature (ADT) is extrapolated to the x axis to define T_b, at which development ceases, and the optimum temperature (T_{opt}), is define as the temperature at which development rate is maximal.

At temperature above T_{opt} , the linear decline in development rate may also be extrapolated to the x axis to define T_c , the upper temperature limit at which development ceases (Olivier and Annandale, 1998), as for muskmelon (Baker and Reddy, 2001) with a single temperature optimum.

Growing degree days (GDD) is a measure of the heat amount needed for plants to grow and develop. If a plant it too cold, it can not grow, however at some minimum temperature, growth begins. The warmer the plant is the faster it grows up to a maximum temperature when growth stops. Growth and development rates of plants are assumed to be roughly linear between the minimum and maximum threshold temperatures. Temperature above the threshold maximum may cause it to stop growth and development or that the rate of change remains constant. Seed growth is influenced by temperature through a direct effect on seed metabolism and on other growth processes (Egli and Wardlaw, 1980). Pod formation is sensitive to low temperature (Hume and Jackson, 1981). Seddigh and Jolliff (1984 a) stated that low temperature restrict seed growth rate and favor partitioning of photosynthesis to vegetative organs and pods walls. They (1984 b) indicated also that warmer night temperature considerably shortened the time period of R_1 and R_2, while little additional effect on the subsequent reproductive development was observed. However, R_7 was hastened by higher night temperature. Philbrook and Oplinger (1989) reported that harvest delays can ultimately result in plant deterioration, increased seed losses, harvesting difficulties and reductions in net yield. El-Batal and Abdel-Gawad (1995) found that number of days and GDD for all reproductive stages initiation were significantly varied among soybean cultivars. Plant growth is in general strongly related to air temperature which is found to be a limiting factor for growth potential, thus the growing season (GS) is rather short at high latitudes. Different species respond differently to air temperature; some are sensitive to lower temperature, while others are more resistant to cold climate (Menzel, 2002; Sparks and Menzel, 2002). As a good indicator of energy available for biological growth during the GS, an increase in the degree-days sum may lead to heavier growth of the crops already present. A marked increase in GS and GDD, as the scenario indicates, may also result in the introduction of new species-plants and insects. Problems may therefore accur such as damage caused by increased numbers of insects and a higher risk of plant disease (Skaugen and Tveito, 2004).

Soybean germplasm had a reservoir of variability for seed filling duration (Reicosky *et al.*, 1982). Delayed flowering genotypes had demonstrated potential for high yields (Board and Hall, 1984; Cregan and

Hartwing, 1984). An exploitable system for increasing seed yield by selecting for increased duration of reproductive and seed filling periods was found by Metz *et al.* (1984); Hanson (1985); Smith and Nelson (1986 and 1987). Among genotypes, Boerma and Ashley (1988) reported that improved cultivars had the longer filling period, which increased over the years of variety improvement. Genotypes differed in rate of change for specific seed density (Hanson, 1988), indicating a genetically controlled aspect of seed maturation rate for the selected developmental period, which have high heritability (Pfeiffor and Egli, 1988). In five cultivars, considerable intervarietal variation was recorded by Reddy *et al.* (1989) for days to flower initiation, days to maturity and period from flower initiation to maturity. Based on data of Wilkerson *et al.* (1989), this occurs about eight physiological days (days at optimal conditions for full rate of development) after sowing and period to the first true leaf (V_1 stage). El-Batal and Abdel-Gawad (1991) reported that cultivars differed in length of reproductive stages and degree-days sum, indicating that late flowering cultivar had high yield. Specific seed density increased with seed maturation (Hanson, 1991). Increasing reproductive period through increase seed filling duration had an associated increase in seed yield for a set of favorable environments (Hanson, 1992 a). He (1992 b) found also that genotypes selected for increased, as compared with decreased, seed filling duration had greater seed yield under favorable field conditions. El-Batal and Abdel-Gawad (1995) indicated that cultivars significantly differed in the length of vegetative growth, flowering period, pod formation, seed filling and reproductive growth durations as well as their GDD accumulation. The length of vegetation period has increased through advanced onset of the beginning of the growing season (BGS) in med-latitudes (Menzel and Fabian, 1999). The BGS shows distant year-to-year variability (Chmielewski and Rotzer, 2002).

GDD is a good indicator for the time period of phenological development stages between emergence and physiological maturity of plants. It is often described as occurring at a rate proportional to the average daily temperature minus a lower temperature limit (Purcell, 2003). Therefore, the present research was aimed to study the growth stages duration and their GDD accumulation for different soybean cultivars under Giza environmental conditions.

MATERIALS AND METHODS

Nine soybean cultivars from different maturity groups, i.e., Giza 83, Giza 82 (MG II), Giza 35 (MG III), Giza 21, Giza 22, Giza 111, Crawford (MG IV), Holladay and *Toano* (MG V) were grown in the green house of Crop Physiology Research Department at Giza, ARC, in 2007 and 2008 seasons. The objective of this study was to investigate the phenological stages initiation, development stages duration, growing degree days (GDD) accumulation and heat unit efficiency (HUE) of seed yield, using the complete block design with four replications. 200 kg calcium superphosphate (15.5% P_2O_5) and 30 kg ammonium nitrate (33.5% N)/ fed were added after seedbed preparation to the experimental soil. Seeds were inoculated with the effective strain of *Rhizobium japonicum* and drilled on the ridges at the rate of 40 kg/fed. Sowing date was 20 and 21 May of both seasons, respectively. Each plot consisted of five ridges, two meters long and 60 cm apart. The recommended cultural practices for growing soybean were performed.

Development stages were determined as described by Fehr *et al.*, (1971) upon 30 plants in each plot and was considered to be attained when at least 60% of the plants were at the desired stage (Waddington *et al.*, 1983) as follow:

V_1 Completely unrolled leaf at unifoliolate node.
R_1 One flower at any node.
R_2 Flower at node immediately below the uppermost node with a completely unrolled leaf.
R_3 Pod 0.5 cm long at one of the four uppermost nodes with a completely unrolled leaf.
R_4 Pod 2 cm long at one of the four uppermost nodes with a completely unrolled leaf.
R_5 Beans beginning to develop (can be felt when the pod is squeezed) at one of the four uppermost nodes with a completely unrolled leaf.
R_6 Pod containing full size green beans at one of the four uppermost nodes with a completely unrolled leaf.
R_7 Pods yellowing; 50% of leaves yellow; physiological maturity.
R_8 95% of pods brown; harvest maturity.

Therefore, the development stages durations studies were:

V_1 to R_1 Vegetative growth period (VG).
R_1 to R_3Flowering period (FP).
R_3 to R_5Pod formation period (PF).
R_5 to R_7Seed filling period (SF).
R_1 to R_7Reproductive growth period (RG).

Data of development stages initiation was recorded. Number of days (ND) was calculated from sowing time to the initial of each stage and for the durations. Using a base temperature (development rate zero) of 6°C (Hesketh *et al.*, 1973), GDD were calculated through the summation of daily temperature above threshed temperature according to Major *et al.* (1975) by the equation of:

$$GDD = \sum\left[\frac{T_{max} + T_{min}}{2} - 6\right]$$

Where

T_{max} and T_{min} refer to maximum and minimum air temperature of any day.

At harvest time, five guarded plants were randomly taken from each plot to measure plant height (cm), number of pods, seeds and biological weights per plant (g). All plants of each plot (6 m^2) were harvested to determine the biological weight per plot. After threshing, the mean of 100 – seed weight (g) was calculated from three samples. Seeds per plot were weighted, then seeds and weights were transformed to yields per feddan (kg) and harvest index was calculated. Seed yield per fed, in grams, was divided by the GDD at R_8 to calculate heat unit efficiency (HUE).

Data were statistically analysed according to the procedure outlined by Stell and Torrie (1984). Means were compared using the least significant difference (LSD) test at 0.05 level of probability.

RESULTS AND DISCUSSION

A. Development stages initiation:

The results indicated that, while the final number of days (ND) from planting to the initiation of different growth stages for soybean cultivars under study (Table 1) and their growing degree days (GDD) accumulation (Table 2) were significantly varied in all reproductive stages, there were not significantly differed in the beginning of vegetative stage (V_1). It is rather of interest to note that soybean seeds needed about 191°C GDD up to V_1 and this amount was almost constant irrespective of temperature changes due to ND about nine days as a mean of both seasons. In this respect, Wilkerson *et al.* (1989) reported that soybean seeds took about eight physiological days after sowing to V_1 stage. While, El-Batal and Abdel-Gawad (1995) found that this stage needed about 185°C GDD. Regarding ND for all reproductive stages, earlier cultivar was "Giza 83" (MGI), while the latest cultivars were "Holladay" and "*Toano*" (MGV).

Table (1): Number of days (ND) from planting to the initiation of phenological stages for different soybean cultivars under study, in 2007 and 2008 seasons.

Cultivar	V_1	R_1	R_2	R_3	R_4	R_5	R_6	R_7	R_8
					2007				
Giza 83	9.5	29.3	35.6	42.5	50.2	58.7	65.7	72.0	78.8
Giza 82	9.2	32.5	39.6	47.3	56.5	65.0	72.5	80.8	88.0
Giza 35	9.0	36.6	44.6	54.0	64.0	73.2	82.5	92.0	100.5
Giza 21	8.7	41.5	51.0	62.5	72.2	83.8	95.2	105.3	116.0
Giza 22	8.8	42.2	51.5	63.5	73.1	85.0	96.0	106.0	116.5
Giza 111	8.6	41.7	51.1	62.7	72.6	84.5	95.8	105.8	117.0
Crawford	8.8	41.8	51.3	62.3	72.0	84.0	95.7	105.5	116.8
Holladay	8.4	48.1	58.6	70.3	82.7	96.2	108.2	121.5	133.6
Toano	8.5	47.8	59.0	70.0	82.2	96.1	108.0	121.0	133.0
LSD at 0.05	NS	3.1	3.5	3.8	4.1	4.7	5.1	5.5	5.8
					2008				
Giza 83	9.7	28.4	34.7	42.0	49.7	58.2	65.8	73.3	80.0
Giza 82	9.4	31.4	38.7	46.9	55.8	65.2	73.5	82.2	89.5
Giza 35	9.3	36.0	44.3	53.6	64.0	74.4	84.1	93.3	102.6
Giza 21	9.0	41.2	50.4	62.2	73.5	85.7	97.0	107.5	118.0
Giza 22	9.1	41.9	51.3	63.4	74.9	87.1	98.0	109.0	118.8
Giza 111	9.0	41.5	50.6	62.6	74.0	86.4	97.7	108.6	119.6
Crawford	9.1	41.4	50.7	62.0	73.3	85.9	97.5	108.0	119.1
Holladay	8.7	47.8	58.2	71.5	84.7	98.2	111.0	123.5	135.7
Toano	8.8	47.5	58.5	71.0	84.5	97.9	110.5	123.0	135.0
LSD at 0.05	S	3.0	3.4	3.9	4.3	4.9	5.4	5.8	6.2

Other cultivars such as "Giza 82" (MG II), "Giza 35" (MG III) or those of (MG IV), i.e., "Giza 21", "Giza 22", "Giza 111" and "Crowford" were in-between. Such results should be expected according to their maturity groups, indicating that ND was increased with increasing number of maturity group. The ranking of cultivars concerning GDD was the same as when ND was considered. This suggested that accumulated heat units, using GDD method, could be a good indicator for the time period between emergence to physiological maturity of plants. Data, however, indicated that accumulative heat units might be of limited value for the prediction of all reproductive development stages in soybean plants receiving various temperature regimes. Similar results were obtained by Reddy *et al.* (1989); El-Batal and Abdel-Gawad (1991 and 1995); Boote *et al.* (1998); Olivier and Annandale (1998); Baker and Reddy, 2001) as well as Skaugen *et al.* (2004).

Table (2): Growing degree days (GDD) from planting to the initiation of phenological stages for different soybean cultivars under study, in 2007 and 2008 seasons.

Cultivar	V_1	R_1	R_2	R_3	R_4	R_5	R_6	R_7	R_8
				2007					
Giza 83	206	638	790	967	1148	1350	1530	1702	1864
Giza 82	200	715	890	1080	1296	1510	1714	1922	2100
Giza 35	195	815	1016	1238	1483	1733	1965	2198	2415
Giza 21	188	944	1167	1445	1707	1997	2277	2535	2784
Giza 22	190	960	1180	1470	1730	2026	2298	2554	2795
Giza 111	185	950	1170	1450	1717	2014	2293	2548	2805
Crawford	190	950	1175	1440	1702	2002	2290	2540	2800
Holladay	180	1100	1346	1655	1970	2303	2608	2900	3160
Toano	182	1092	1356	1647	1965	2300	2603	2890	3145
LSD at 0.05	NS	70	82	95	105	118	130	141	153
				2008					
Giza 83	205	633	785	961	1143	1347	1523	1698	1857
Giza 82	198	707	882	1075	1290	1510	1703	1910	2086
Giza 35	196	816	1014	1237	1484	1724	1954	2180	2410
Giza 21	190	942	1160	1440	1703	1993	2273	2523	2772
Giza 22	190	960	1183	1470	1736	2027	2298	2560	2792
Giza 111	188	950	1166	1450	1715	2010	2290	2550	2810
Crawford	190	947	1170	1435	1698	1998	2286	2535	2800
Holladay	182	1097	1347	1654	1970	2303	2605	2896	3163
Toano	185	1090	1353	1642	1964	2296	2593	2884	3147
LSD at 0.05	NS	68	80	92	104	115	126	137	147

B. Development stages duration:

Data in Table (3) reveale that cultivars significantly differed in the length of vegetative growth period (VG) and consequently from flowering to physiological maturity or reproductive growth period (RG) and its parts duration. Differences in flowering period (FP), pod formation (PF) and seed filling (SF) between cultivars may be affected their ability to compensate for short periods of adverse growing conditions and hence their response to varying environments. "Giza 83" had the shortest time for all development stages duration under study. Whereas, cultivars which had the longest stages period were "Holladay" and "*Toano*". Other cultivars were in-between, indicating the genetically controlled aspect of stages duration for cultivars maturity group. Similar findings were reported by Reicosky *et al.* (1982); Hanson (1988); Pfeiffor and Egli (1988); El-Batal and Abdel-Gawad (1995); Menzel (2002); Sparks and Menzel (2002).

Table (3): Development stages duration (days) and growing degree days (GDD) for different soybean cultivars under study, in 2007 and 2008 seasons.

Cultivar	Days					GDD				
	VG V_1 to R_1	FP R_1 to R_3	PF R_3 to R_5	SF R_5 to R_7	RG R_1 to R_7	VG V_1 to R_1	FP R_1 to R_3	PF R_3 to R_5	SF R_5 to R_7	RG R_1 to R_7
2007										
Giza 83	19.8	13.2	16.2	13.3	43.0	446	329	383	302	1064
Giza 82	23.3	14.8	17.7	15.8	47.4	521	365	430	412	1207
Giza 35	27.6	17.4	19.2	18.8	55.0	620	423	495	465	1383
Giza 21	32.8	21.0	21.3	21.5	63.8	757	500	552	538	1590
Giza 22	33.4	21.3	21.5	21.0	63.8	770	510	556	528	1594
Giza 111	33.1	21.0	21.8	21.3	64.0	765	500	564	534	1598
Crawford	33.0	20.5	21.7	21.5	63.7	760	490	562	538	1590
Holladay	39.7	22.2	26.0	25.3	73.4	920	555	648	598	1800
Toano	39.3	22.2	26.1	24.9	73.2	910	555	653	590	1798
LSD at 0.05	2.4	1.2	1.4	1.3	3.9	54	31	35	34	100
2008										
Giza 83	18.8	13.6	16.2	15.1	45.0	428	328	386	350	1065
Giza 82	22.0	15.5	18.3	17.0	50.3	510	368	435	400	1203
Giza 35	26.7	17.6	20.8	19.0	57.3	620	420	487	457	1365
Giza 21	32.2	21.0	23.5	21.8	66.3	753	498	553	530	1580
Giza 22	32.8	21.5	23.7	22.0	67.1	768	510	557	532	1600
Giza 111	32.5	21.0	23.8	22.2	67.0	760	500	560	539	1600
Crawford	32.3	20.6	24.0	22.0	66.6	757	488	563	537	1588
Holladay	39.0	23.7	26.7	25.3	75.7	915	557	650	593	1800
Toano	38.7	23.5	27.0	25.0	75.5	908	552	654	588	1794
LSD at 0.05	2.3	1.4	1.6	1.5	4.5	50	32	37	35	104

GDD accumulation through the development stages were significantly varied among cultivars. The ranking of cultivars concerning temperatures summation was the same ranking when days summation was considered. "Holladay" and "*Toano*" needed the most value of GDD for full rate of development stages compared to other cultivars. While, "Giza 83" needed the smallest heat units accumulation due to its maturity group. These results are in agreement with those obtained by Metz *et al.* (1984); Hanson (1985); Smith and Nilson (1986 and 1987); Hanson (1991); El-Batal and Abdel-Gawad (1995); Menzel and Fabian (1999); Chmielewski and Rotzer (2002) as well as Purcell (2003).

C. Plant traits and yield:

Data in Table (4) show that there were significant differences among cultivars for all studied traits in both seasons. It is clear that cultivars from (MGV) i.e. "Holladay" and "*Toano*" surpassed the others in plant height, number of pods / plant, 100-seed weight, seed and biological weights/plant, seed and biological yields/fed as well as harvest index. On the other hand, "Giza 83" (MGII) had the lowest values of such traits. In-between, cultivars froms (MG IV) gave higher values of such traits than those of "Giza 35" (MG III) or "Giza 82" (MG II). These differences can be due to the variations in the length of vegetative growth stages period and their heat units accumulation for soybean cultivars under study which attributed to their maturity groups. In this connection, significant differences in growth traits, yield and its components among soybean cultivars were observed by Beaver *et al.* (1985); El-Batal and Abdel-Gawad (1991); El-Hariri *et al.* (1994); Hefni *et al.* (1994); Abdel-Gawad and El-Batal (1995) as well as Hassanein and Ahmed (1996).

Table (4): Plant traits, yield and heat unit efficiency (HUE) of seed yield (kg/fed) for different soybean cultivars under study, in 2007 and 2008 seasons.

Cultivar	Plant height (cm)	Number of pods / plant	100-seed weight (g)	Seed weight / plant (g)	Biological weight / plant (g)	Seed yield / fed (kg)	Biological yield / fed (kg)	Har-vest index (%)	HUE (g/ fed)
					2007				
Giza 83	61.5	31.8	15.49	12.30	34.57	712	1995	35.68	382
Giza 82	67.2	38.0	15.93	15.14	40.75	958	2550	37.57	456
Giza 35	73.7	45.8	16.55	18.96	48.49	1442	3600	40.06	597
Giza 21	81.0	55.3	17.31	23.93	58.33	1989	4705	42.27	714
Giza 22	81.5	55.5	17.34	24.05	58.45	2001	4715	42.44	716
Giza 111	81.8	55.6	17.39	24.38	58.81	2046	4825	42.40	729
Crawford	81.2	55.4	17.37	24.06	58.60	2006	4735	42.37	716
Holladay	90.3	64.8	18.35	27.72	65.93	2295	5345	42.94	726
Toano	90.4	64.8	18.46	27.50	66.07	2261	5245	43.11	719
LSD at 0.05	5.3	3.6	0.56	1.83	4.47	143	349	1.72	50
					2008				
Giza 83	61.2	32.0	15.52	12.41	34.73	719	2005	35.85	387
Giza 82	67.0	38.1	15.91	15.15	40.69	955	2535	37.67	458
Giza 35	74.0	45.1	16.52	19.05	48.40	1445	3605	40.08	600
Giza 21	81.7	55.4	17.33	24.02	58.36	1991	4710	42.27	718
Giza 22	81.3	55.5	17.36	24.10	58.56	2005	4730	42.39	718
Giza 111	81.5	55.4	17.42	24.58	58.75	2053	4845	42.36	731
Crawford	81.6	55.4	17.38	24.08	58.53	2012	4740	42.45	719
Holladay	90.6	64.7	18.40	27.79	65.98	2280	5300	43.02	721
Toano	90.5	64.4	18.52	27.60	66.10	2256	5255	42.93	717
LSD at 0.05	5.1	3.8	0.54	1.87	4.57	145	354	1.67	52

D. Heat unit efficiency (HUE):

HUE (Table 4) for seed yield/fed can be used as a measure for cultivar efficiency under various agroecological conditions. Cultivars were significantly differed in this traits, indicating that those from "MG V" were superior in HUE followed by others from "MG IV", without significant differences between there. The lowest value of HUE was obtained from "Giza 83" (MG II). "Giza 35" (MG III) had higher value of this trait than that of "Giza 82" (MG II). These results may be attributed to the length of vegetative and reproductive growth stages for different cultivars and their ability of yielding under favorable environments, indicating that delayed flowering cultivars and consequently physiological maturity have demonstrated potential for high yields. The general trend of these data is in agreement with those reported by Board and Hall (1984); Hanson (1992 a and b) as well as El-Batal and Abdel-Gawad (1995).

CONCLUSION

In the light of the obtained results, it is preferable to grow the adaptable soybean cultivars of MG V or IV which outyielded the others. Such cultivars which need the highest value of HUE are more tolerant to high temperature when planting in May. For the cultivars of MG II, early sowing at the beginning of the growing season is recommended to increase the length of vegetation period and yield.

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المراحل الفينولوجية ودرجات الحرارة المتجمعة لأصناف فول الصويا

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زرعت تسعة أصناف من فول الصويا تتبع مجموعات نضج مختلفة فى صوبة قسم بحوث فسيولوجيا المحاصيل بالجيزة خلال موسمى الزراعة ٢٠٠٧، ٢٠٠٨ بهدف دراسة بداية المراحل الفينولوجية ومدة هذه المراحل ودرجات الحرارة المتجمعة وكفاءة استخدام الوحدات الحرارية وعلاقتها بالمحصول.

أظهرت النتائج أن إنبات البذور يحتاج إلى حوالى ١٩١°م من الزراعة حتى بداية مرحلة النمو الخضرى وهى غالبا ثابتة لجميع الاصناف، فى حين اختلفت الأصناف فى عدد الايام ودرجات الحرارة المتجمعة من الزراعة حتى بداية المراحل الاخرى، وكان الصنف المبكر هو "Giza 83" من مجموعة النضج الثانية، والمتأخرة صنفا مجموعة النضج الخامسة وهما "Halloday"، "*Toano*"، وكانت باقى الاصناف متوسطة حيث احتاجت أصناف مجموعة النضج الرابعة وهى "Giza 21" ، "Giza 22" ، "Giza 111" ، "Crawford" لمدد أطول ودرجات حرارة أعلى من الصنف "Giza 35" من مجموعة النضج الثالثة والذى كان متأخرا عن الصنف "Giza 82" من مجموعة النضج الثانية.

إختلفت الأصناف معنويا فى طول المراحل الفينولوجية ودرجات الحرارة المتجمعة خلال هذه المراحل وهى مرحلة النمو الخضرى، وفترة التزهير، وتكوين القرون، وامتلاء البذور. ومرحلة النمو الثمرى وهى من بداية التزهير حتى النضج الفسيولوجى، وتميز الصنف " Giza 83" بقصر هذه المراحل واحتياجه إلى أقل درجات حرارة متجمعة لإتمام هذه المراحل، فى حين احتاجت أصناف المجموعة الخامسة إلى فترات أطول ودرجات حرارة أعلى للوصول إلى نهاية كل مرحلة، وكانت باقى الأصناف متوسطة القيم تبعا لمجموعات النضج التابعة لها.

وعلى ذلك تفوقت أصناف مجموعة النضج الخامسة فى صفات النبات والمحصول، بينما كان الصنف "Giza 83" أقل الأصناف إنتاجا، وكانت قيم باقى الأصناف وسطا فى هذه الصفات، وكان ترتيب الأصناف بالنسبة لكفاءة استخدام الوحدات الحرارية فى المحصول هو نفس ترتيب انتاجيتها بدون فروق معنوية بين أصناف مجموعتى النضج الخامسة والرابعة.