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Summary

An exploratory field trial was conducted during the 2000 year, at the Experimental Farm of Shandaweel Agricultural Station, Sohag Upper Egypt, to observe the performance of 36 local and foreign pumpkin accessions and cultivars (*Cucurbita spp.*) sown at two dates, i.e., April 15th and August 15th. Then 16 pumpkin accessions were selected from former 36 pumpkin accessions based on some important phenotypic characters. The 16 pumpkin accessions sown in two field trials during 2001/2002 and 2002/2003 seasons at 4 dates to asses the vegetative and reproductive growth, fruit yield, yield attributes, fruit characters and fruit components of nutritional value.

The experiment layout was randomized complete block design with 3 replicates. Based on some important phenotypic characters, such as stem, leaf and peduncle shapes and seed margin etc., the sixteen pumpkin accessions were identified into three *C. species*, v.z., *pepo, maxima* and *moschata.* This morphological classification was confirmed by using the RAPD DNA fingerprint new technique. According to the two methods of identification, the sixteen accessions were designated as two *C. pepo,* four *C. maxima* and ten *C. moschata* photos are presented in the text showing the identification of the *Cucurbita* accessions according to the two methods of classification. The four sowing dates were March 15-18th, April 15-18th, August 15th and September 18th; which provided a wide range of variability in climatic conditions. The mean entire growth season temperatures were 26.1, 28.1, 22.5, and 19.0 $^{\circ}$C, respectively for March, April, August and Sept. sowings. The corresponding number of days with maximum temperature over 30 $^{\circ}$C during the entire growth seasons were in the order as named, 96.0, 114.0, 66.0 and 34.0 days. The day lengths in the same order were from 12,0 to 14,0 , 12,40 to 14.0,

12,40 to 10,0 and 12,0 to 10,0 hr. The solar energy level was the highest for April, follow by that of March, then August and finally Sept. (un published data). August sowing appeared the most optimal sowing date for the 3 *C. species* and their landrace accessions. The favourable climatic conditions prevailing in the growth period of August sowing expressed themselves in organ formation, plant growth and fruit yield. The vegetative growth of the 16 accessions, indicated by main vine length and leaf formation was enhanced by Aug. sowing. The reproductive growth expressed in male and female flower number, sex ratio (female to male %) and earliness of flowering as indicated by number of days to the first male and female flower opening, and the node position at which the first male and female flower appeared, were all promoted by August sowing. Also, fruit yield in ton/fed. or in thousand fruits per feddan was accelerated by August sowing. April sowing, on the other hand was the worst for all accessions, but to different degrees depending on the *C. species* and accessions. Most of the growth parameters were curtailed by sowing in April, but the unproductive growth was more injured compared to the vegetative growth and other growth traits. Accessions of *C. moschata* were less affected by the adverse climatic conditions than the accessions of *C. pepo* and *C. moschata,* i.e, *C. moschata* accessions were more tolerant for high temperature and longer days of April than the two other spaces. The six pumpkin accessions of *C. pepo* and *C. maxima* were so dramatically influenced by April sowing that they all failed to produce fruits. The two accessions of *C. pepo,* i.e., Connecticut Field and Jack'o Lantern cvs and Big Max cv of *C. maxima* developed flowers to anthesis of both seasons, but failed to set fruits. Lack of pollination in these cultivars was the cause of failure of fruit setting due to male functions, i.e., pollen grains loss in viability. The female functions, i.e., the pistil receptivity was not influenced. Preliminary test of the pollen grains

liberated from the anthers of the two *C. pepo* accessions and Big Max cv of *C. maxima*, using acetocharmine dye showed that the grains were not stained but appeared transparent indicating the loss of viability of the pollen grains. The three Demietta accessions of *C. maxima*, namely Kafr El-Battikh, Faraskur and El-Zarka, failed to develop flowers to anthesis of both sexes owing to high temperature and perhaps, long days of Apr. sowing. Sowing at the two other dates viz., March and Sept, also, worsely influenced vegetative and reproductive growth, male and female flower production, sex ratio, earliness of flowering of both sexes, yield and yield components and some fruit traits. This effect varied with *C. sp.* and accessions and date of these two sowings, i.e., March and Sept. *C. pepo* accessions were most adversely affected by March sowing, *C. maxima* accessions came next to *C. pepo* and finally were *C. moschata* which relatively thrived well under the climatic conditions of March sowing. The *C. moschata* accessions were most adversely influenced by Sept. sowing *C. pepo and maxima* accessions were less negatively influenced by Sept. compared to March sowing.

Fruit yield as indicated by tons/fed. or in thousand fruits per feddan varied with sowing date and *C. species* and their accessions. In both years, the highest fruit yield was that of August sowing and the lowest was that obtained from March sowing. The yield of Apr. sowing was, also, higher than of Sept. sowing, but the difference between Sept. and March sowing was less pronounced than that between April and March sowing. Regardless of sowing dates, *C. moschata* accessions significantly exceed both *C. pepo* and *C. maxima*. There was no significant difference between the latter two *C. species*. The reduction in fruit yield of *C. maxima* and *C. pepo*, especially the latter was much more pronounced with sowing in March. On the other hand, *C. moschata* produced the

lowest yield when sown in Sept, whereas the accessions of both *C. maxima* and particularly by *C. pepo*, produced the highest fruit yield following Aug. sowing when sown in Sept. In general *moschata* accessions were much more tolerante to adverse climatic conditions of April than the other two accessions. Many accessions of the ten *moschata* sp. did not show much difference in yield of Apr. compared to March sowing.

Fruit diminutions, i.e., length and diameter, varied with *C. sp.* and within pumpkin accessions. On the whole, difference in fruit length was more obvious than that of diameter. *C. moschata* had the longest fruit length and the shortest fruit diameter; fruits of *C. maxima* were nearly similar in fruit dimensions. *Pepo* fruits tended to be slightly higher in diameter than in length. The six accessions of *pepo* and *maxima* appeared higher in fruit dimension in Aug. than in March and Sept. sowings; in April they did not produce fruits because the two *pepo* accessions and Big Max of *C. maxima* flowered to anthesis of both sexes, but did not set fruits due to lack of pollination. The other 3 accessions of *C. maxima* (Demietta accessions) produced flower buds but did not proceed to anthesis. The reduction of *C. moschata* in fruit dimensions, in general, was less marked in March than in Sept.

Fruit shape index (length/diameter) was the highest in *C. moschata* followed by that of *maxima* and then *C. pepo*. Fruits of *moschata* sp. tended to be oblong more than that of *maxima*; *pepo* fruits had the apposite fruit shape index, i.e., slightly higher in diameter than in length. There were also differences in fruit shape index among accessions in relation to sowing date.

Flesh thickness of *C. maxima* fruits was higher than that of both *C. pepo* and *moschata*, and the thickness of the latter (*moschata*) was higher

than that of the former (*pepo*). Connecticut Field was always higher in flesh thickens than Jack'o Lantern. Thickness of flesh of the two *pepo* cultivars was the highest in August and the lowest in March sowing. *Maxima* accessions followed more or less the same trend as *C. pepo.* Flesh thickness of *C. moschata,* in contrast to the other species, was the highest in March followed by Apr. and finally that of Sept.

Flesh colour in *moschata* accessions was the deepest colour, followed by that of *maxima* and than that of *pepo*. Flesh colour of the two *pepo* cultivars was the deepest when sown in Aug., and Sept. was deeper in colour of fruits than March. *C. maxima* behaved similar to *C. pepo* in flesh colour with respect to sowing dates. On the other hand, *C. moschata* sown in Apr. had the deepest fruit flesh colour, March sowing came next in intensity of flesh colour.

Dry matter percent of *maxima* sp. was higher than that of *C. pepo* and *C. moschata*. Jack'o Lantern (*C. pepo*) was consistently higher in dry matter than Connecticut field, regardless of sowing dates. Both cultivars, however, had the highest dry matter content with sowing in March followed by that Aug., then Sept. Of the 4 *C. maxima,* Faraskur contained the highest dry matter then the other 3 accessions. In contrast, the ten *C. moschata* accessions were higher in dry matter percent when sown in Apr. than at the other 3 dates; fruits of Sept, sowing was the lowest in dry matter content when sown in Sept.

Concerning of total soluble solids content. TSS of *C. maxima*, opposite to dry matter content, were highest in Aug. followed by Sept., then March sowing. In the ten *C. moschata* TSS, in contrast to dry matter content, were greatest in Aug. followed by March, then Apr. and finally Sept.

The carotenoids content of fruits in mg/100 gm fresh weight, in contrast to dry matter and TSS, was the highest in *C. pepo* accessions and the lowest in *C. moschata*. The two cultivars of *C. pepo,* in particular Connecticut Field, contained the highest carotene value compared to all other accessions in the 3 sowing dates (August, Sept. and March). Big Max of *C. maxima* had the highest content Jach'o Lantern of *C. pepo* when Big Max was planted either in March or August. The other 3 maxima accessions had the highest carotene content when sown in Aug.; they, also were higher in content in Sept. than in March. The ten *C. maschata* contained the greatest values of carotene with sowing in Aug. these accessions contained similar value of carotenes when sown either in Sept. or March, but were higher than that of Apr. sowing. In general, carotene content was not positively linked with deepness in flesh colour, and also, with many of the morphological or biochemical traits such as flesh thickness, average fruit weight, dry matter and TSS.

Protein content was higher in *C. maxima* than in *C. pepo* or *C. moschata* accessions. The latter two species did not show any difference in protein between them. Jack'o Lantern of *C. pepo* was significantly higher in protein content than Connecticut Field (*C. pepo* also). Moreover Connecticut Field showed higher protein content with sowing in August, and no difference in protein content of this cultivars when sown in March or Sept. Conversely Jack'o Lantern did not differ significantly in protein with sowing either in March or August but its content declined with sowing in Sept. The four accessions of *C. maxima* continued higher protein when sown in August, and their protein content declined with sowing in March or Sept. The ten accessions of *C. moschata* fluctuated in protein content in reaction to sowing date. However, in general, the protein contents of these accessions were higher when sown either in

August or March than when sown in April or Sept. Of the *C. moschata* accessions, El-Edua (El-Minia) was consistently the highest at all sowing dates. Butternut cv did not differ from El-Edua (El-Minia) in August or March sowing.

Phosphorus content was the highest in *C. maxima* than in *C. pepo* or *C. moschata* accessions, but the difference between the latter two spices was small. Of the two *pepo* cultivars, Jack'o Lantern exceeded Connecticut Field and both showed similar content of phosphorus with sowing at the three dates of March, Sept. and August. Conversely Connecticut Field gave the lowest content with sowing in Sept. *C. maxima* did not exhibit consistent pattern in response to sowing dates. Also, in *C. moschata* ten accessions there was no consistent trend of phosphorus in relation to sowing date.

Pumpkin accessions appeared rich in potassium content. This content ranged form 181.7 mg/100 gm fresh weight in North Sinia accession sown in Sept. to 285.9 for El-Edua (El-Minia) sown in April. The two *C. pepo* cultivars contained the highest potassium content with sowing in March and the lowest in Sept. sowing, but Jack'o Lantern was significantly higher in potassium than Connecticut Field. The 4 *C. maxima* performed exactly as *C. pepo*. Faraskur of *C. maxima* accessions was always the highest in potassium than El-Zarka of the same *sp.* in March, Aug. and Sept. The ten accessions of *C. moschata*, apposite to those of *C. maxima*, contained the highest potassium when sown in April; March sowing came second, then Aug. and finally Sept. El-Edua accession was the richest of all *C. moschata* at all dates, but Pepa (Bani Suef) had similar value as El-Edua when the former was sown in March.

Sodium contents in contrast to potassium, were externally low. *C. maxima* and *moschata* were higher in sodium. *C. pepo*. Connecticut Field

was always lower in sodium than Jack'o Lantern in March, Aug. and Sept. sowings. The two *pepo* accessions containted the highest sodium content sown in Sept. The 4 *C. maxima* were exactly the same as *C. pepo*. On the other hand, the ten accessions of *C. moschata* gave the highest sodium content when sown in Sept. and the lowest in Apr. sowing. However, Marsa Matrouh and El-Edua were the highest in potassium when sown in Sept. and Apr.

In an attempt to stimulate flower development in the 3 Demietta accessions of *C. maxima*, namely Kafer El-Battikh, Faraskur and El-Zarka when sown in Apr. at Shandaweel upper Egypt, three trials were conducted, i.e., photoperiod, seed vernalization and grafting experiments.

In the photoperiodic experiment, the 3 Demietta accessions sown in April were exposed either to the natural day length which ranged from 12,5 to 14,0 hr (long day treatment) or plants of three accessions were subjected to 10,0 hr of sun light and 14,0 hr darkness (short photoperiod). Results showed that both photoperiod treatments failed to stimulate flowering of both sexes in the 3 Demietta accessions, it was concluded that temperature is more important than photoperiod in flower development of the pumpkins.

In the vernalization experiment, imbibed seeds of three accessions were exposed to cold treatment for 2, 5 and 10 days at 4-5 °C in the refrigerator. Unvernalized seeds along with the cold treated seeds were sown in April. Results showed that either two or five days imbibed seed vernalization could not induce flower to anthesis of both sexes in the 3 Demietta accessions. Ten days of seed vernalization, on the other hand, stimulated flower to anthesis of both sexes which set fruits and produced fruit yields. It was concluded, hence, that seeds of the three Demietta accessions could be vernalized and cold requirement for those accessions

is a must in order to stimulate their flower development. This seems not strange as the *C. maxima* originated in regions of North America characterized by low temperature; and for this reason these accessions are adapted to cold weather of Demietta province from where the accessions seeds were obtained.

In the grafting experiment, the three aforementioned accessions of Demietta were grafted as receptors onto El-Edua (El-Minia) *C. moschata* as a rootstock (donner) grafting enhanced the vegetative growth of the 3 accessions when sown in Apr. compared to intact plant accessions (non-Grafted). Moreover, grafting stimulate male flower development to anthesis in the 3 Demietta accessions, but entirely failed to stimulate female flowers over the two years. On the other hand, the control plants of the rootstock El-Edua grown intact with their own roots (non-grafted) developed normal flowers of both sexes and set fruits. Why the three accessions produced only male flower was explained by many reasons. One of these reasons as that, since the major hormones supplied by rootstocks to scions are cytokinins and sex expression is mostly controlled gibberelines or internal ethylene, the effect of rootstock on sex expression is not as significant as changes in other character. Another reason was that El-Edua as a rootstock (*C. moschata*) was not the right choice, since it has been reported that *C. moschata* are less effective in induction of flowering than *pepo* or other species when the formers were used as rootstock for other species.