



INTRA-ROW INTERCROPPING OF COWPEA AND CUCUMBER WITH OKRA AS INFLUENCED BY PLANTING DATE OF SECONDARY CROPS

Magdy A. A. Mousa, Mohamed, F. Mohamed, Mohamed H. Dokashi
and Emad-Elden F. E. Elnobi

Department of Horticulture, Faculty of Agriculture, Assiut University

ABSTRACT:

Okra (main crop) and cowpea or cucumber (secondary crops) were grown at the Experimental farm of Assiut University, in alternate hills 20 cm apart on 70 cm spaced rows. Okra was planted on April 1st (2004) or April 7th (2005). Cowpea was planted as intercrop with okra on three planting dates in 2004 (April 1st, 27th and June 6th) and four planting dates in 2005 (April 7th, 28th, May 16th and June 1st). Cucumber was planted as intercrop on two planting dates in 2004 (April 1st and 27th) and three planting dates in 2005 (April 7th, 28th and May 16th). Sole crop treatments were also involved in the intercrop system. Data indicated that okra/cowpea intercropping did not affect or increased okra pod yield. Cowpea, on average, produced 231 kg dry seed yield per feddan when planted either simultaneously or 3 weeks after planting okra. In terms of intercropping evaluation parameters, 'aggressiveness' suggested that okra was dominant crop. The land equivalent ratio (LER) of okra/cowpea intercropping for both of these planting dates and the two years was 1.2. With regard to cucumber, fruit yield was produced only when it was planted simultaneously with okra. Okra/cucumber intercropping based on simultaneous planting of both crops depressed okra pod yield to 83.2% of the pure stand okra cultivation. Intercropped cucumber yield as percent of sole culture was 71%. 'Aggressiveness' intercropping parameter suggested that cucumber was dominant crop. LER of okra/cucumber intercropping, on average, was 1.6 when both crops were simultaneously planted. To benefit from added cucumber and cowpea crops, it is recommended to plant them simultaneously on the same date of planting okra. It is also possibly to plant cowpea 3 weeks after planting okra.

INTRODUCTION:

Intercropping is a cultural system involves growing of two or more crops simultaneously on the same soil area. It has advantages in terms of intensity land uses and reduction of production risk for the small-scale farmer more than in sole cropping. Intercropping systems may offer several biological and socioeconomic advantages

as far as the agricultural sustainability is concerned. For instance, multiple cropping systems are used to control severe pests and diseases infestation in numerous plant crops as pod-sucking bugs in cowpea + maize (Olufemi *et al.*, 2001); arthropods in tomato + cucumber (Hummel *et al.*, 2002) and witchweed in maize + legume (Kuchinda *et al.*, 2003). On the other

hand, intercropping systems probably present serious competition resulting in low yields, besides weed problems, pests and diseases control and harvesting (Ofori and Gamedoagbao, 2005). The productivity of component crops in multiple cropping systems depend on several factors, including planting date, planting density, cultivated varieties, soil management and agriculture practices (fertilization, irrigation etc.) (Tsubo *et al.*, 2003).

Most intercropping research has focused on field crops such as corn (*Zea mays* L.), soybean (*Glycine max* L.), faba bean (*Vicia faba* L.) and Sugar beat (*Beta vulgaris* L.) (Galal, 1998; Santalla *et al.*, 2001; Kunchinda *et al.*, 2003; Tsubo *et al.*, 2005; Ghosh *et al.*, 2006). Intercropping field and vegetable crops has also been intensively investigated (El-gergawi and Abdalla, 2000; Olufemi *et al.*, 2001; El-shaikh and Bekheet, 2004). However, relatively few studies have addressed vegetables plus vegetables intercropping systems.

During the last decade relatively few studies were conducted on cultivating okra in multiple cropping systems. The majority of these studies were particularly concerned with intercropping okra with major field crops as maize, rice, soybean and sunflower (Muoneke *et al.*, 1997; Olsantan, 1998; Emuh and Agboola, 1999). Intercropping okra and vegetable crops have been rarely investigated (Adeniyi, 2001; Singh, 1993). In Egypt, a total of 16819 fedden are cultivated with okra and produced about 11238 tons immature seed pods. Okra is planted mainly in summer (March to April) and its production window is from May to October. The total cultivated area of okra in Middle and Upper Egypt is reported to be 9690 fedden with a productivity of 69663 tons of immature pods. Upwards there are no reports available on studying intercropping okra with other crops either in Middle and/or Upper Egypt. The

present intercropping study was conducted to investigate growth, development and yield of okra (main crop) with cowpea or cucumber (secondary crops).

MATERIALS AND METHODS:

The present within-row intercropping study was conducted during two consecutive summer growing season (2004 and 2005) in the Vegetables Research Station, Faculty of Agriculture, Assiut University. The soil texture was clay and pH 7.8, field capacity 42%, available phosphorus 9 ppm and total nitrogen 0.08%. Two separate experiments were conducted to assess growth, development and yield of okra (main crop) and either cowpea or cucumber (secondary crops). Accordingly, intercropping experiments were okra/cowpea and okra/cucumber. Each experiment was conducted in randomized complete-blocks (RCB) with 4 replicates in 2004 and with 3 replicates in 2005. Treatment plot consisted of 4 rows in 2004 and 5 rows in 2005. Each row was 3 m long and 0.7 m wide.

In all experiments, seeds of the okra (*Abelmoschus esculentus*) cultivar 'Balady' were planted on April 1st, 2004 and April 7th, 2005. Planting hills were spaces at 40 cm on northern side of rows. Secondary crops were planted in the mid-distance between okra. Cultural practices including irrigation, fertilization and pests and diseases control were applied as recommended for okra production (main crop). Nitrogen fertilization was avoided for cowpea and cucumber except once at the first true leaf stage.

Okra/Cowpea intercropping:

Seeds of the cowpea (*Vigna unguiculata*) cultivar Kafr el-shekh (Faculty of Agriculture, Tanta University) were planted as intercrop within okra rows on April 1st, 27th and June 1st in 2004 and on April 7th and 28th, May 16th and

June 1st in 2005. Cowpea sole crop was planted at the same within-row spaces as intercropped treatment on April 1st and April 7th in 2004 and 2005, respectively.

The following growth, development and yield parameters were assessed for both okra and cowpea on plot basis: days lapsed to 50% flowering and to 50% fruiting plants. The following parameters were recorded on using 10 randomly sampled plants: node of the first flower and of the first fruit, plant height (cm) at flowering and at the end of growing season, and number of pods/plant. Particular to cowpea, pod length (cm, 20 pod sample), number of seeds/pod (20 pod sample), weight of 1000 seeds and total dry seed yield per feddan (calculated based on the plot size) were determined. Particular to okra, average weight of 10 marketable pods and total pod yield per feddan (calculated based on the plot size) were recorded.

Okra/Cucumber intercropping:

Cucumber (*Cucumis sativus*) seeds (secondary crop) of the open-pollinated cultivar Beta alfa (Royal sluis seminis, 2700 Camino del sol Oxnard, ca 93030-7967, USA) were planted as intercrop on two different planting dates in 2004 (April 1st and 27th), and three planting dates in 2005 (April 7th and 28th and May 16th). Cucumber sole crop was planted at the same within-row spaces as intercropped treatment on April 1st and April 7th in 2004 and 2005, respectively. The same growth, development and yield parameters were assessed for okra as mentioned in for okra/cowpea intercropping. Particular to cucumber, average fruit weight, fruit length (cm), fruit diameter (cm), and percent pistillate flower were determined using randomly sampled 10 plants per plot). The total

fruit yield per feddan was calculated based on the plot size.

Intercropping Efficiency Parameters:

Land Equivalent Ratio (LER) was determined according to Willey (1979) where, $LER = \frac{\text{intercropping yield of main crop/pure stand yield of main crop} + \text{intercropping yield of secondary crop/pure stand yield of secondary crop}}{\text{intercropping yield of main crop/expected yield of main crop} - (\text{intercropping yield of secondary crop/expected yield of secondary crop})}$ and aggressiveness for main crop = $(\text{intercropping yield of main crop/expected yield of main crop}) - (\text{intercropping yield of secondary crop/expected yield of secondary crop})$ and aggressiveness for secondary crop = $(\text{intercropping yield of secondary crop/expected yield of secondary crop}) - (\text{intercropping yield of main crop/expected yield of main crop})$; the expected yield = yield of sole crop X the fraction of the area occupied (1.0 for okra and 0.5 for secondary crop in the presently used cropping system).

Statistical Analyses and Mean Separation Procedure:

Analysis of variance relevant to RCB experiments as described by Gomez and Gomez, (1984) was used providing that data of the intercropping treatments gave a number of error degrees of freedom suitable to conduct valid 'F' significance test. In such case, 'The Least Significant Difference' ($LSD_{0.05}$) was used for mean comparisons. Otherwise, where some intercropping failed to grow and/or give yield and consequently the error degrees of freedom was low to conduct a valid 'F' test, *student's 't'* test was used for mean comparisons (Steel and Torrie, 1980).

RESULTS:

Growth, development and yield of main crop (okra) in okra/cowpea intercropping:

Flowering and plant height traits: Number of days lapsed to 50% flowering was not affected with intercropping of cowpea on okra (Fig. 1-A). The position of the node of first flower showed significant changes only in 2005 (Fig. 1-B). Okra plants grown with cowpea that was planted on April 7th and 28th formed the first flower on lower node than the pure stand okra. On the other hand, those okra plants grown with secondary crop cowpea that was planted on May 16th and June 1st developed the first flower on higher node than its respective control (pure stand okra). Regardless of planting date for the secondary crop (cowpea), okra plants grown with cowpea was significantly shorter at flowering stage in both years than their respective pure stand culture (Fig. 1-C). However, okra plant height at the end of the growing season was reduced in only the second and fourth planting dates in 2005 (April 28th and June 1st) (Fig. 1-D).

Fruit traits and pod yield: Except planting cowpea on April 1st in 2004, the number of days lapsed to 50% fruiting okra plants did not differ from those pure stand okra (Fig. 2-A). Position of node for the first okra pod set (Fig. 2-B) and number of pods produced per plant was similar for all intercropping treatments and pure stand okra (Fig. 2-C). Harvested pod had significantly reduced weight only in 2005 (Fig. 2-D). As demonstrated in Figure (Fig. 2-E), total okra pod yield was not affected with intercropped cowpea in 2004. Planting cowpea on May 16th and June 1st 2005 also did not significantly influence okra yield of pods. However, cowpea planting on April 7th significantly increased okra pod yield while its planting on April 28th significantly reduced harvested pod yield of okra.

Growth, development and yield of secondary crop (cowpea) in okra/cowpea intercropping:

Flowering and plant height traits: Cowpea planted within okra rows on June 1st in 2004, and May 16th and June 1st in 2005 (i.e., 40 to 65 days after planting the main crop okra) failed to grow. Comparing with pure stand grown cowpea, those plants intercropped as secondary crop within okra rows showed significant delay to develop flowers when planted on April 1st (same planting date of the main crop okra) and 27th in 2004 (Fig. 3-A). No significant difference in days to 50% flowering was detected between cowpea planted on April 7th, 2005 (same planting date of the main crop okra) as secondary crop within okra rows and the pure stand. However, significantly delayed flowering was exhibited by cowpea planed on April 28th, 2005. Node of first flower showed similar results to days of 50% flowering, except for planting cowpea on April 1st, 2004 where no difference was detected compared with pure stand cowpea (Fig. 3-B). Obviously, cowpea plant height at both flowering time and the end of growing season increased when planted 3 - 4 weeks after planting okra (April 27th, 2004 and April 28th, 2005) as comparing with the pure stand (Fig. 3-C and 3-D). Increment in only plant height at the end of growing season was found when cowpea was planted at the same planting date of the main crop okra in 2004 (April 1st).

Fruit traits and pod yield: Cowpea intercropped within okra rows exhibited significant increase in number of days lapsed to 50% fruiting (Fig. 4-A) and node to form first fruit (Fig. 4-B) as compared to pure stand treatment. On the other hand, significant reduction occurred in number of pods produced

per plant (Fig. 4-C), pod length (Fig. 4-D) and total seed yield (Fig. 5-C). However, average weight of 1000-seeds was not affected (Fig. 5-B). Number of seeds per pod was significantly increased when cowpea was planted with okra at same planting date (April 1st) in 2004 (Fig. 5-A).

Growth, development and yield of main crop (okra) in okra/cucumber intercropping:

Flowering and plant height traits: No differences among intercropping and pure stand culture of okra were found in days lapsed to 50% flowering, except those grown simultaneously with cucumber (April 1st) in 2004 (Fig. 6-A). Node to first flower was not affected in both years (Fig. 6-B). However, significantly reduced plant height at flowering was shown by okra grown with cucumber planted either simultaneously (April 1st, 2004 and April 7th, 2005) with okra or later on April 27th in 2004 and April 28th in 2005 (Fig. 6-C). Planting cucumber on May 16th did not influence okra plant height. Height of okra plants at the end of growing season was reduced when it was grown with intercropped cucumber only in 2004 (Fig. 6-D).

Fruiting traits and pod yield: Except the slightly delayed fruiting of okra planted simultaneously with intercropped cucumber, there were no differences between okra pure stand and different intercropping treatments (Fig. 7-A). However, node of the first fruit was not influenced (Fig. 7-B). While average weight of harvested okra pods did not differ among various treatments (Fig. 7-D), the number of pods produced per plant and pod yield was significantly reduced when okra was planted simultaneously with cucumber (Fig. 7-C). Number of pods per plant increased when okra

was grown with cucumber planted on April 28th in 2005 but not total pod yield (Fig. 7-E).

Growth, development and yield of secondary crop (cucumber) in okra/cucumber intercropping:

Flowering and plant height traits: The number of days lapsed to 50% flowering increased in 2004 when cucumber was planted within okra rows on April 27th (Fig. 8-A). Node of first flower increased for planting on both April 1st and 27th in this year (Fig. 8-B). However, there were no differences detected among pure stand cucumber and the intercropped cultures in 2005 for both days to 50% flowering and the node of first flower. Plant height at flowering time, on the other hand, increased in both years, except planting on May 16th in 2005 where it significantly decreased (Fig. 8-C). At the end of growing season, plant height was greater for intercropped cucumber planted on either dates (April 1st and 27th) in 2004 than the pure stand (Fig. 8-D). However, intercropping cucumber did not influence plant height at end of growing season for all planting dates in 2005.

Fruit traits and pod yield: Intercropped cucumber produced fruits only when planted simultaneously with okra on the same planting date (Fig. 10-D). Comparing with pure stand culture of cucumber, no differences for days lapsed to 50% fruiting (Fig. 9-A), node of first fruit (Fig. 9-B) and average fruit weight (Fig. 9-D), length (Fig. 10-A) and diameter (Fig. 10-B) were shown by intercropped cucumber. Number of harvested fruits per plant in 2004 but not in 2005 was reduced (Fig. 9-C). Percent pistillate flowers (Fig. 10-C) did not significantly change in 2004 whereas it significantly elevated in 2005. Total fruit yield produced by

intercropped cucumber was significantly reduced in comparison to pure stand in 2004 (Fig. 10-D). Although tended to be lowered, total fruit yield in 2005 did not achieve significant deviation from pure stand culture.

‘Land equivalent ratio and ‘aggressiveness’:

Okra/Cowpea intercropping: ‘Land Equivalent Ratio’ (LER) was greater than 1.0 for okra/cowpea intercropping when both crops were planted simultaneously (i.e., April 1st in 2004 and April 7th in 2005) or cowpea was planted 3 weeks after planting cowpea (i.e., April 27th in 2004 and April 28th in 2005) (Table 1). Thus, intercropping on these dates increased the efficiency of culture soil use. As shown by LER values, the yield produced by okra and cowpea in 2004 would be produced from 13% (April 1st) and 23% (April 27th) additional soil area. For 2005, these area would be 39% (April 7th) and 8% (April 28th) larger than the soil area used for production of these crops. The values

of aggressiveness suggested that the main crop (okra) dominated over the secondary crop (cowpea) in the studied within-row intercropping system.

Okra/Cucumber intercropping: Substantially, the ‘Land Equivalent Ratio’ (LER) exceeded 1.0 for okra/cucumber intercropping when both crops were planted simultaneously (i.e., April 1st in 2004 and April 7th in 2005) (Table 1). LER values indicated that the yield produced by okra and cucumber in 2004 would be produced from 46% additional soil area. For 2005, such area would be 68% larger than the soil area used for production of these two crops. Thus, intercropping on these dates increased the efficiency of using culture soil. The values of aggressiveness suggested that the secondary crop (cucumber) was a strong dominant over the main crop (okra) in the studied within-row intercropping system (Table 1).

Table (1): ‘Land Equivalent Ratio’ and ‘Aggressiveness’ values for intercropping of cowpea and cucumber (secondary crops) with okra (main crop) when cowpea was planted on three dates in 2004 [April 1st (I), 27th (II) and June 6th (III)] and four planting dates in 2005 (April 7th (I), 28th (II), May 16th (III) and June 1st (IV)], while cucumber was planted on two dates in 2004 [April 1st (I) and 27th (II)] and three planting dates in 2005 (April 7th (I), 28th (II) and May 16th (III)].

Okra/Cucumber					
2004					
Parameter Sowing date	Land Equivalent Ratio			Aggressiveness	
	Okra	Cowpea	Sum	Okra	Cowpea
I	1.0	0.13	1.13	0.75	-0.75
II	1.07	0.16	1.23	0.73	-0.73
III	0.99	0.00	0.99	0.99	-0.99
2005					
I	1.25	0.14	1.39	0.97	-0.97
II	0.90	0.18	1.08	0.54	-0.54
III	1.01	0.00	1.01	1.01	-1.01
IV	0.98	0.00	0.98	0.98	-0.98
2004					
Parameter Planting date	Okra/Cucumber			Aggressiveness	
	Okra	Cucumber	Sum	Okra	Cucumber
I	0.84	0.62	1.48	- 0.39	0.39
II	0.99	0.00	0.99	0.99	-0.99
2005					
I	0.82	0.86	1.68	- 0.73	0.73
II	0.95	0.00	0.95	0.95	- 0.95
III	0.98	0.00	0.98	0.98	- 0.98

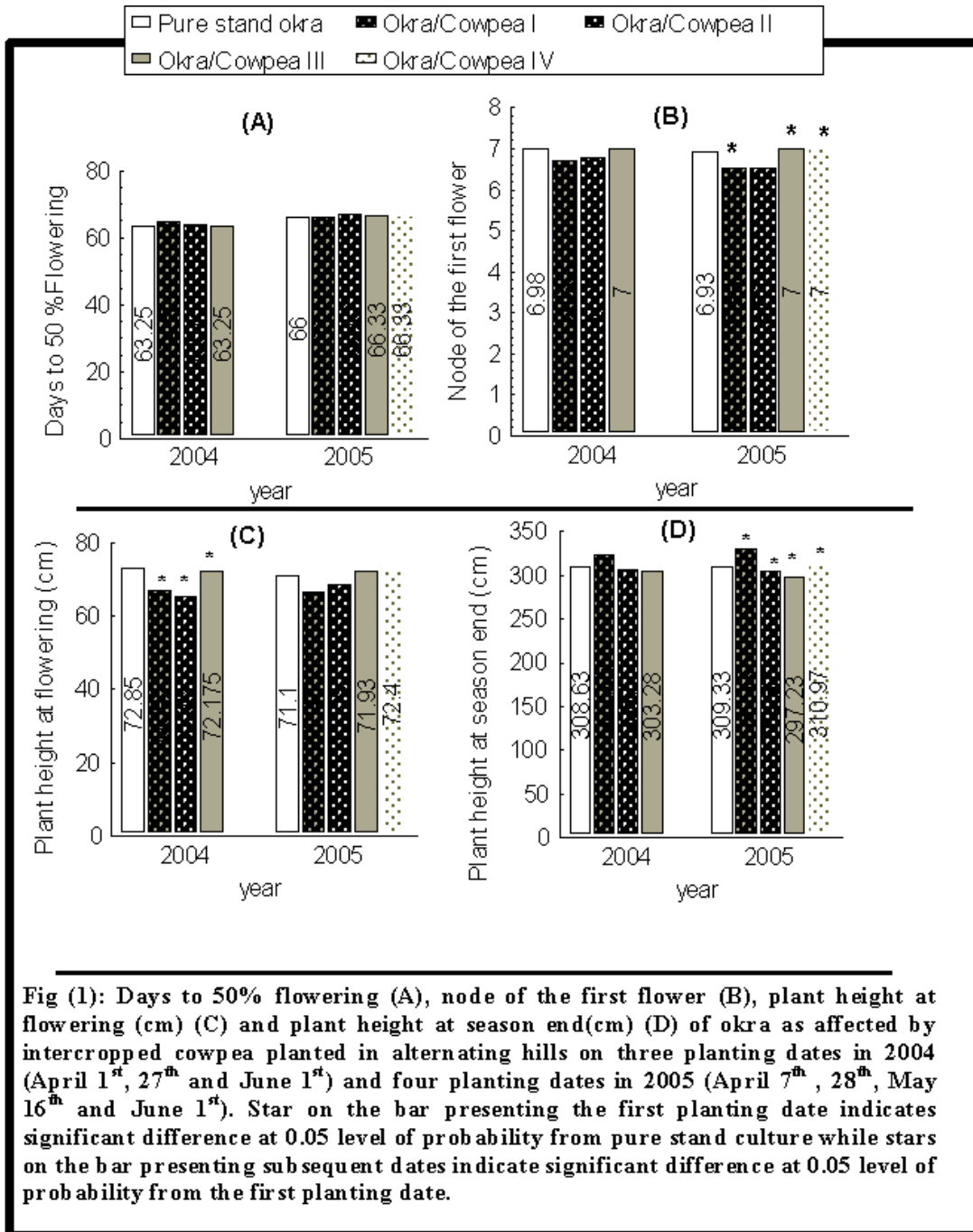


Fig (1): Days to 50% flowering (A), node of the first flower (B), plant height at flowering (cm) (C) and plant height at season end (cm) (D) of okra as affected by intercropped cowpea planted in alternating hills on three planting dates in 2004 (April 1st, 27th and June 1st) and four planting dates in 2005 (April 7th, 28th, May 16th and June 1st). Star on the bar presenting the first planting date indicates significant difference at 0.05 level of probability from pure stand culture while stars on the bar presenting subsequent dates indicate significant difference at 0.05 level of probability from the first planting date.

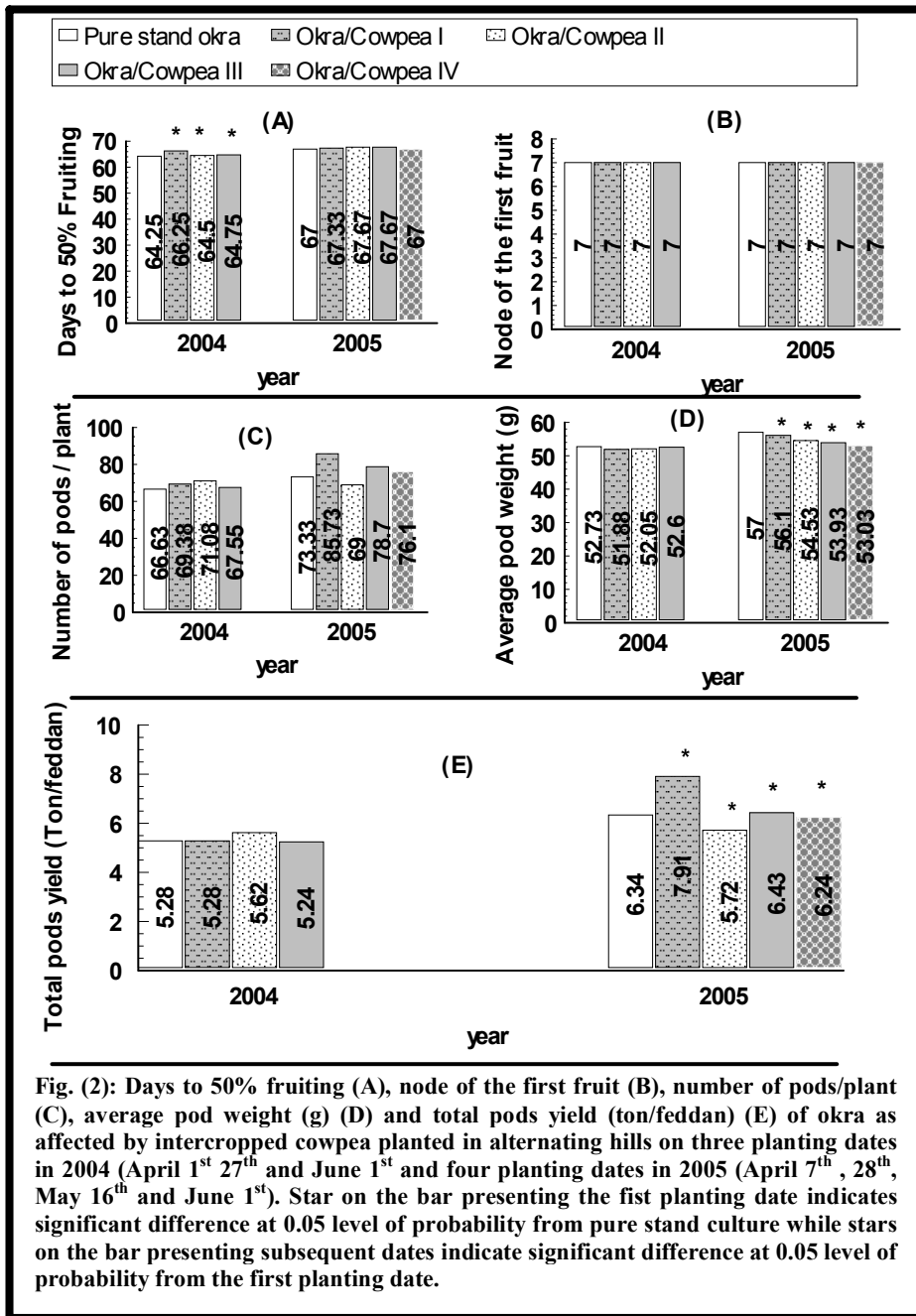
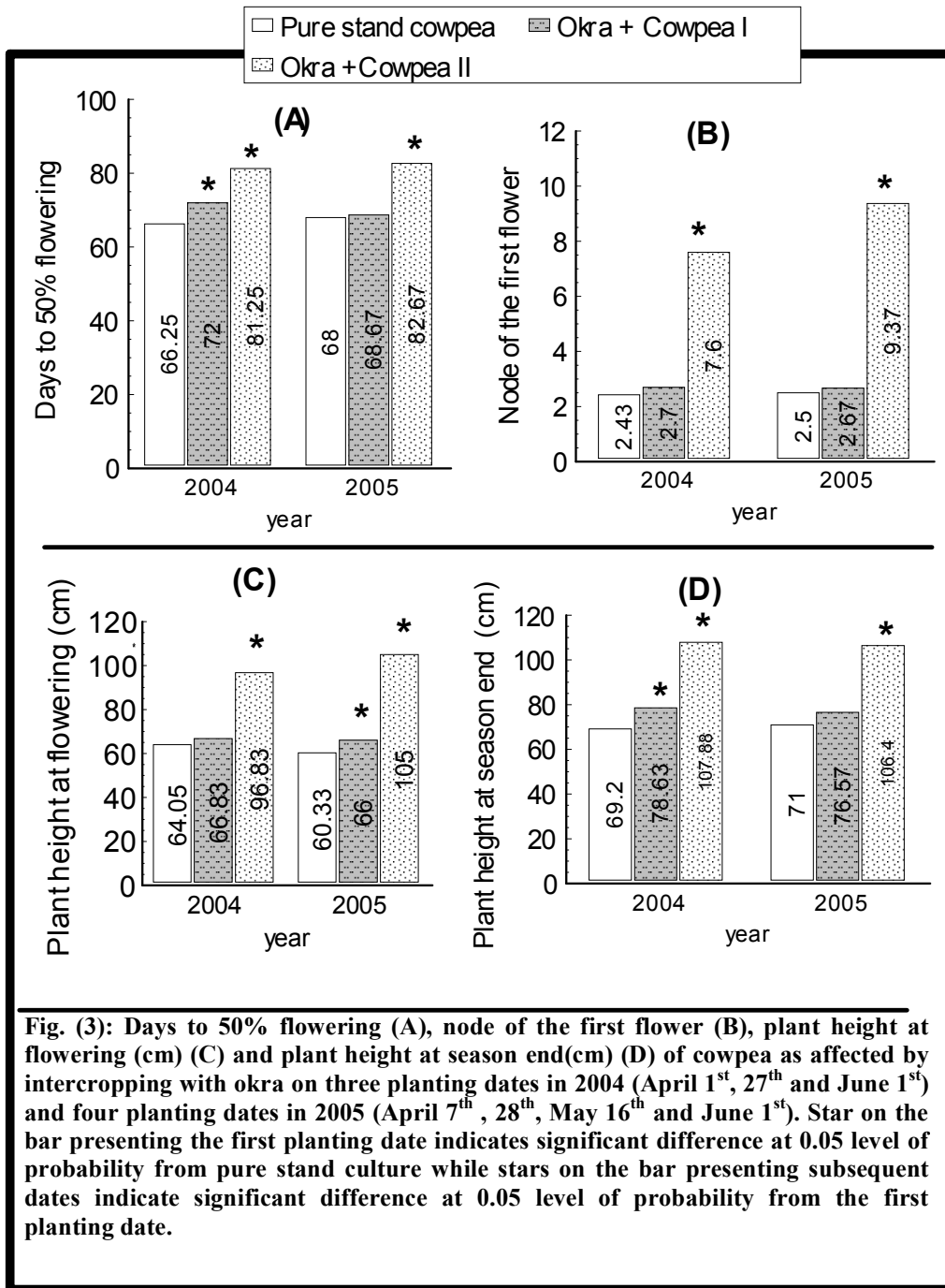
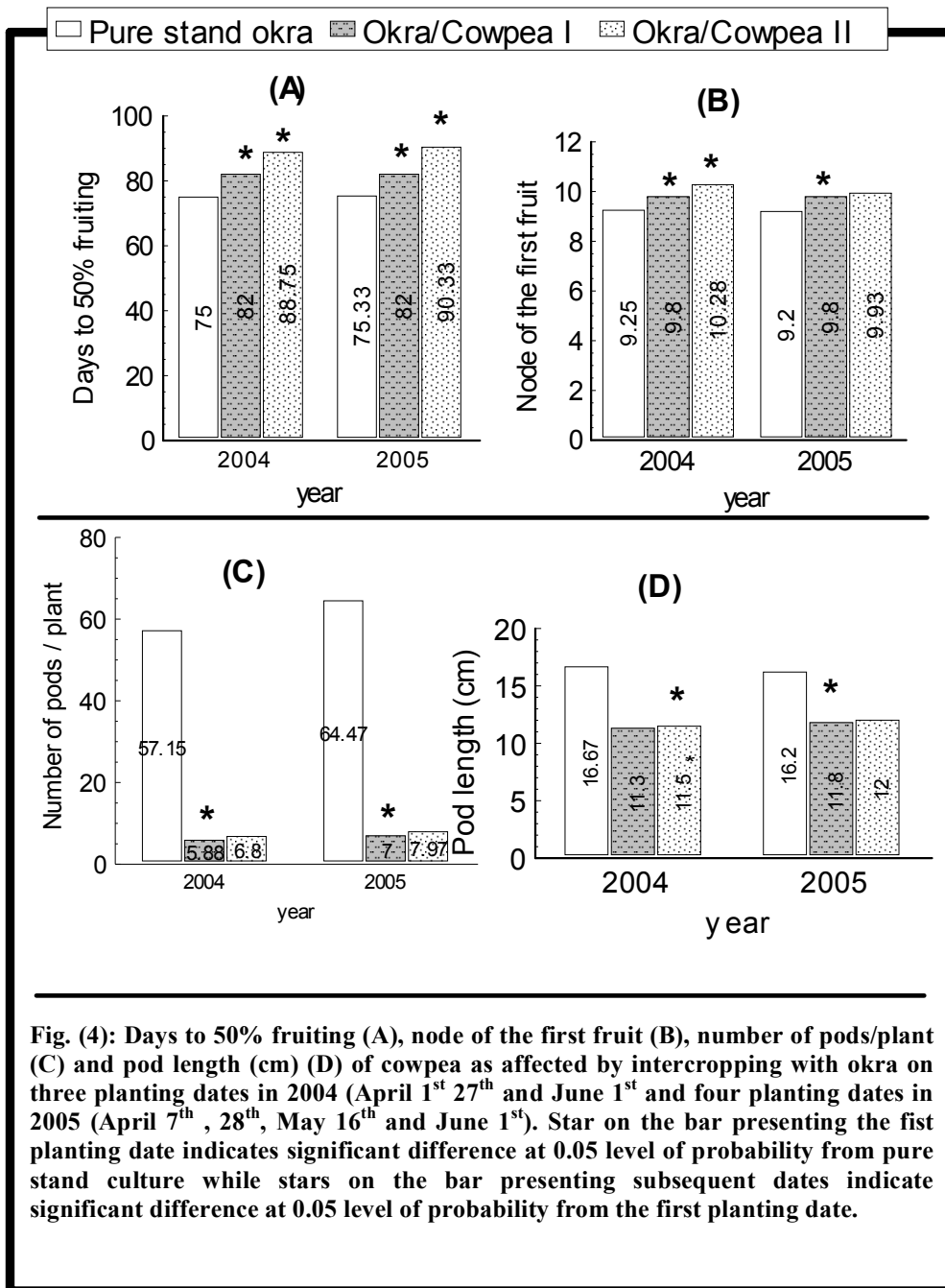


Fig. (2): Days to 50% fruiting (A), node of the first fruit (B), number of pods/plant (C), average pod weight (g) (D) and total pods yield (ton/feddan) (E) of okra as affected by intercropped cowpea planted in alternating hills on three planting dates in 2004 (April 1st 27th and June 1st and four planting dates in 2005 (April 7th, 28th, May 16th and June 1st). Star on the bar presenting the first planting date indicates significant difference at 0.05 level of probability from pure stand culture while stars on the bar presenting subsequent dates indicate significant difference at 0.05 level of probability from the first planting date.





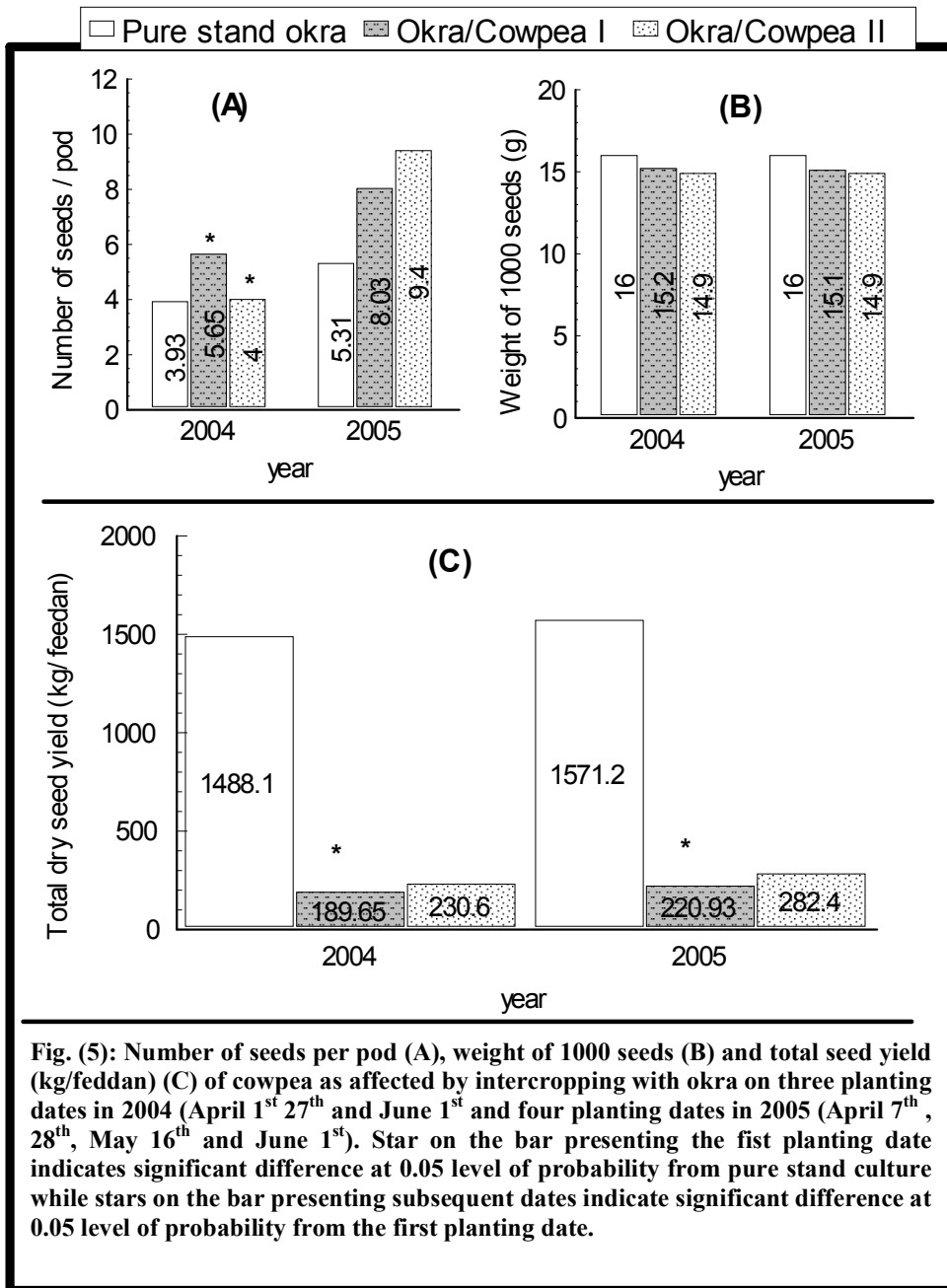
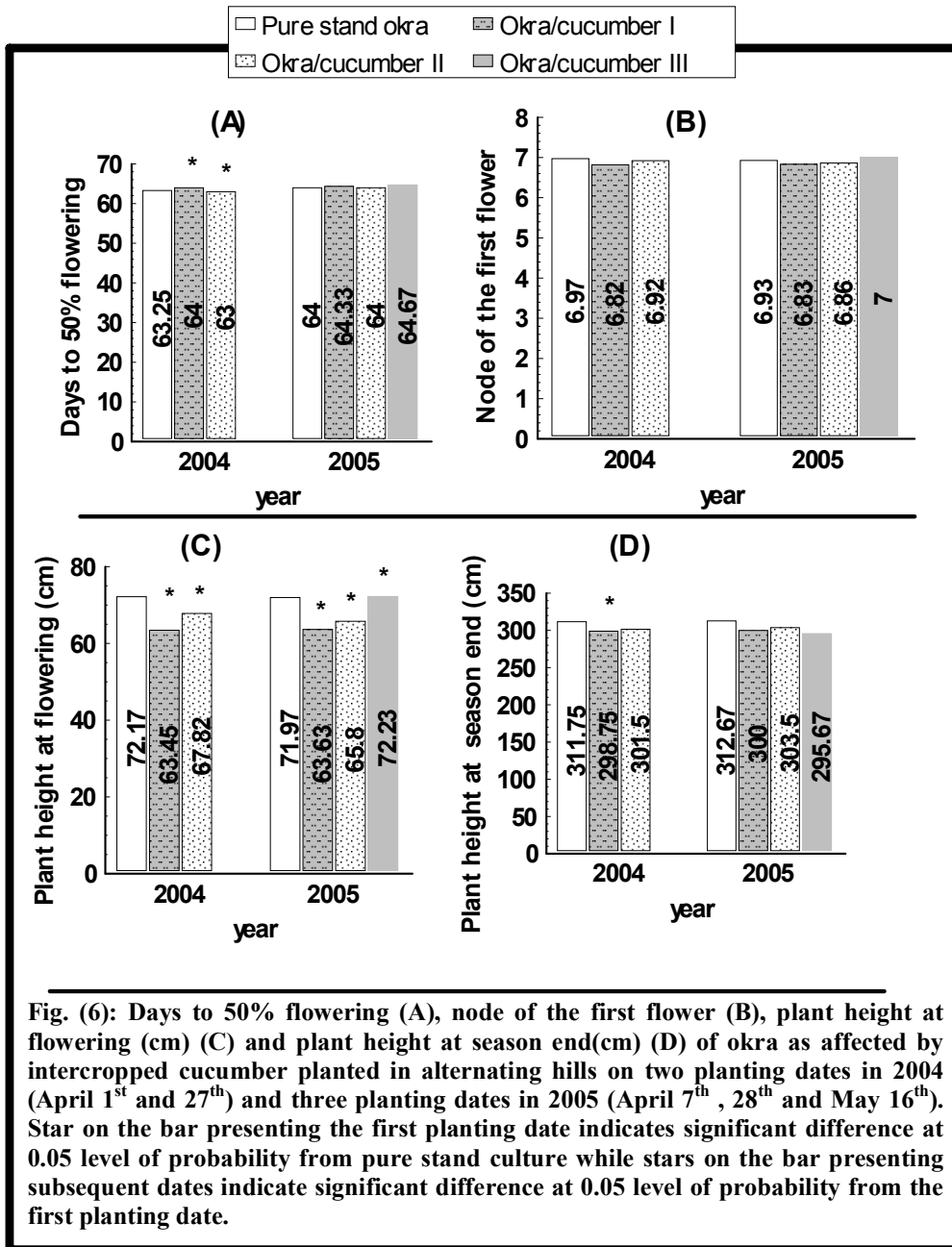


Fig. (5): Number of seeds per pod (A), weight of 1000 seeds (B) and total seed yield (kg/feddan) (C) of cowpea as affected by intercropping with okra on three planting dates in 2004 (April 1st 27th and June 1st and four planting dates in 2005 (April 7th, 28th, May 16th and June 1st). Star on the bar presenting the first planting date indicates significant difference at 0.05 level of probability from pure stand culture while stars on the bar presenting subsequent dates indicate significant difference at 0.05 level of probability from the first planting date.



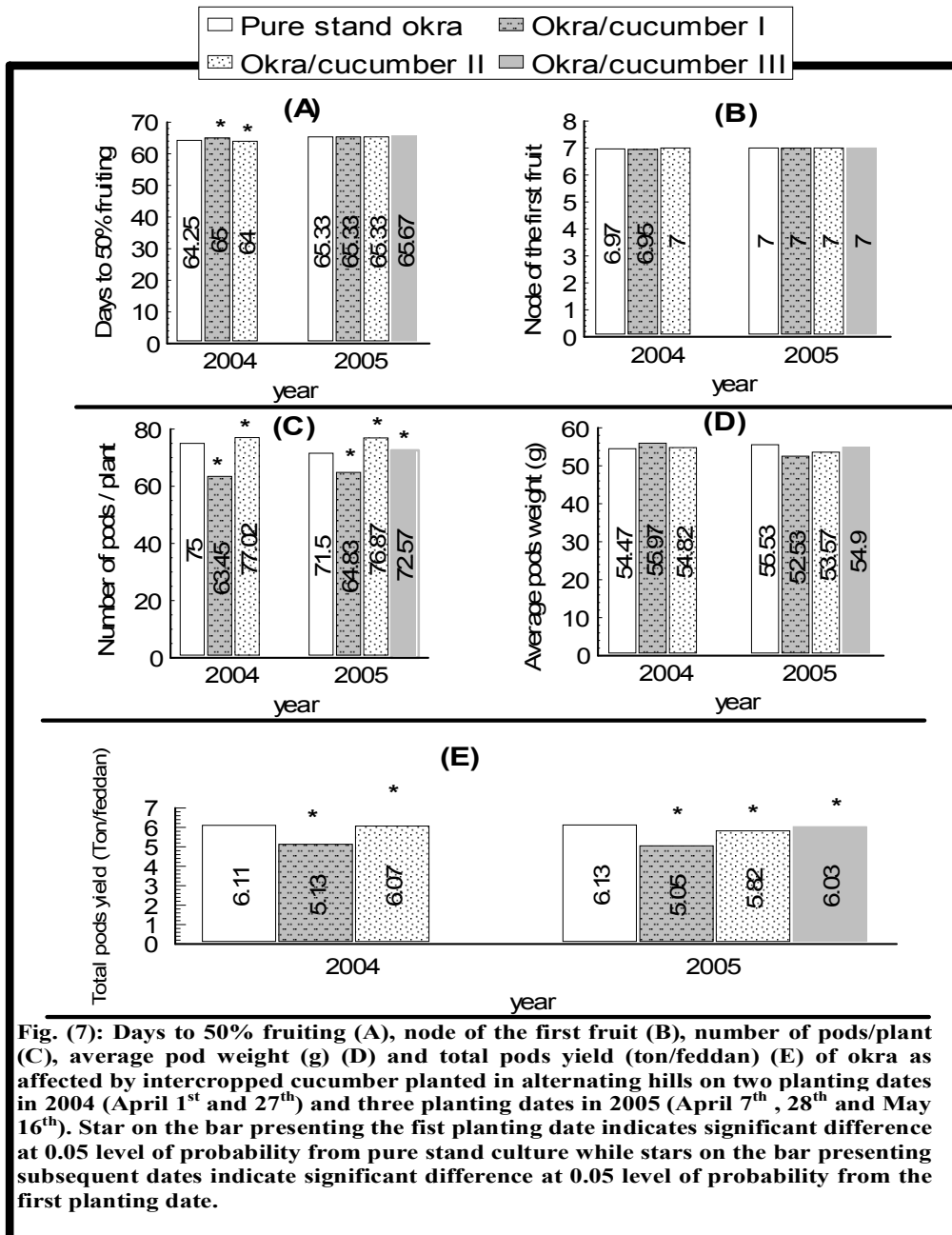


Fig. (7): Days to 50% fruiting (A), node of the first fruit (B), number of pods/plant (C), average pod weight (g) (D) and total pods yield (ton/feddan) (E) of okra as affected by intercropped cucumber planted in alternating hills on two planting dates in 2004 (April 1st and 27th) and three planting dates in 2005 (April 7th, 28th and May 16th). Star on the bar presenting the first planting date indicates significant difference at 0.05 level of probability from pure stand culture while stars on the bar presenting subsequent dates indicate significant difference at 0.05 level of probability from the first planting date.

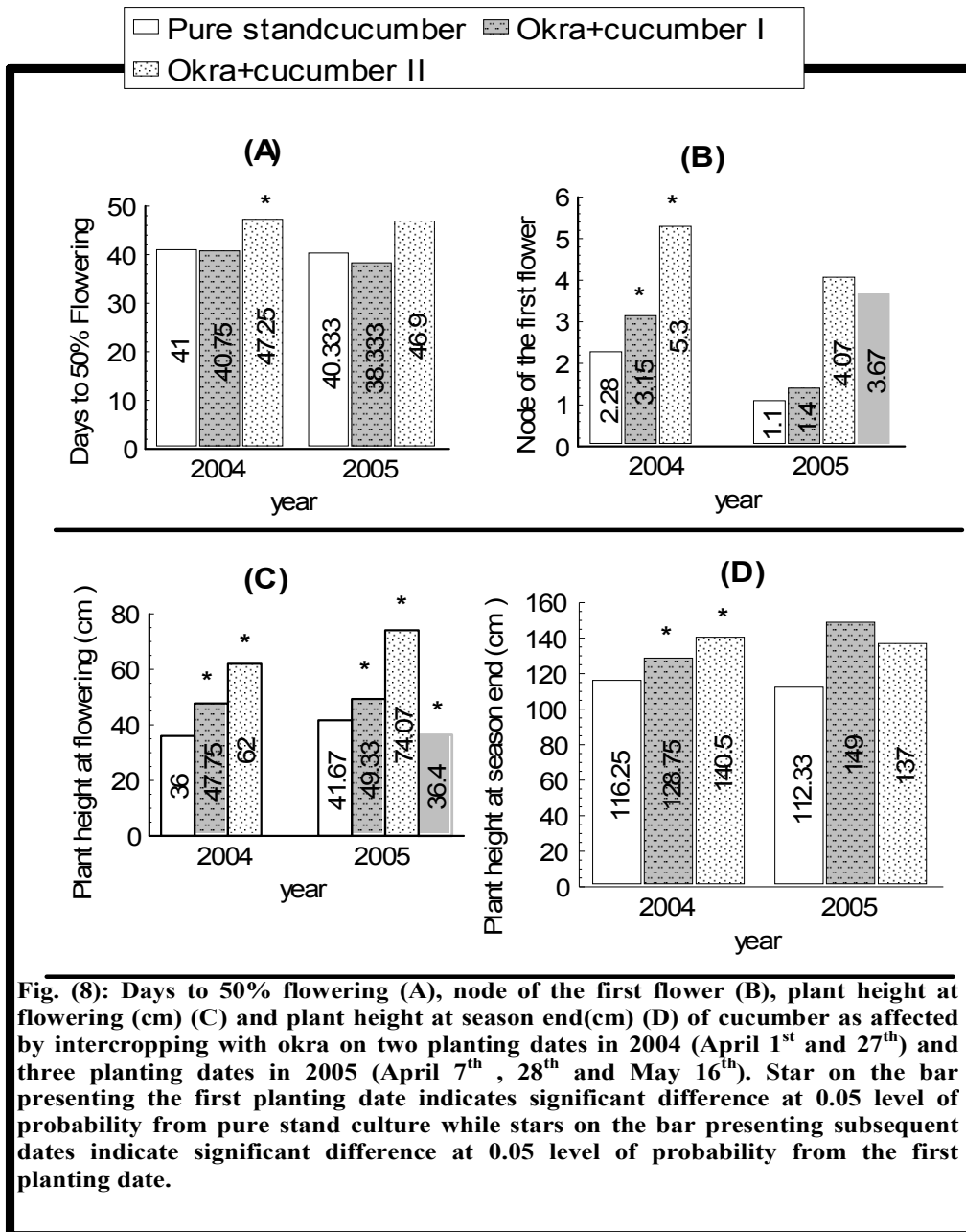
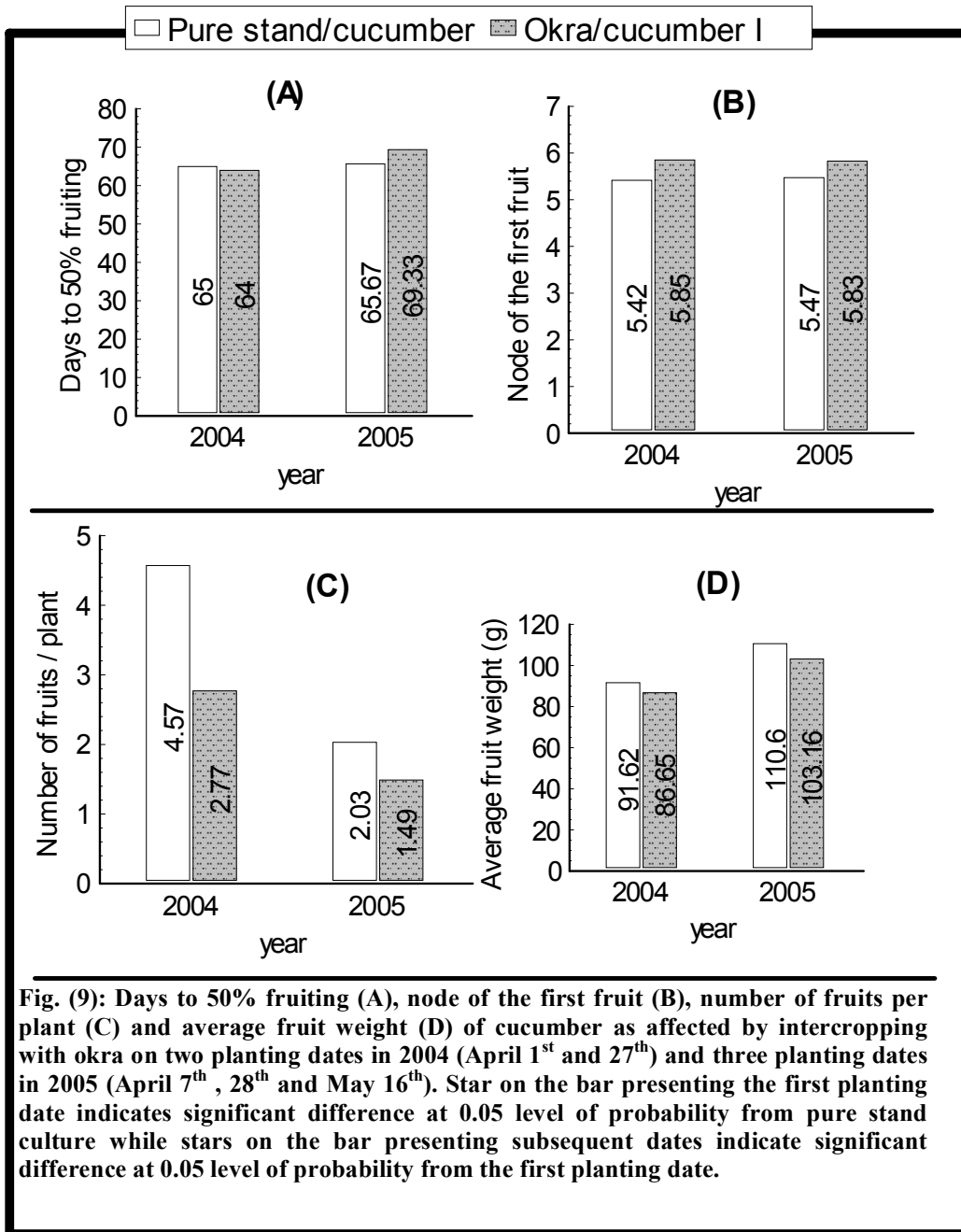


Fig. (8): Days to 50% flowering (A), node of the first flower (B), plant height at flowering (cm) (C) and plant height at season end(cm) (D) of cucumber as affected by intercropping with okra on two planting dates in 2004 (April 1st and 27th) and three planting dates in 2005 (April 7th, 28th and May 16th). Star on the bar presenting the first planting date indicates significant difference at 0.05 level of probability from pure stand culture while stars on the bar presenting subsequent dates indicate significant difference at 0.05 level of probability from the first planting date.



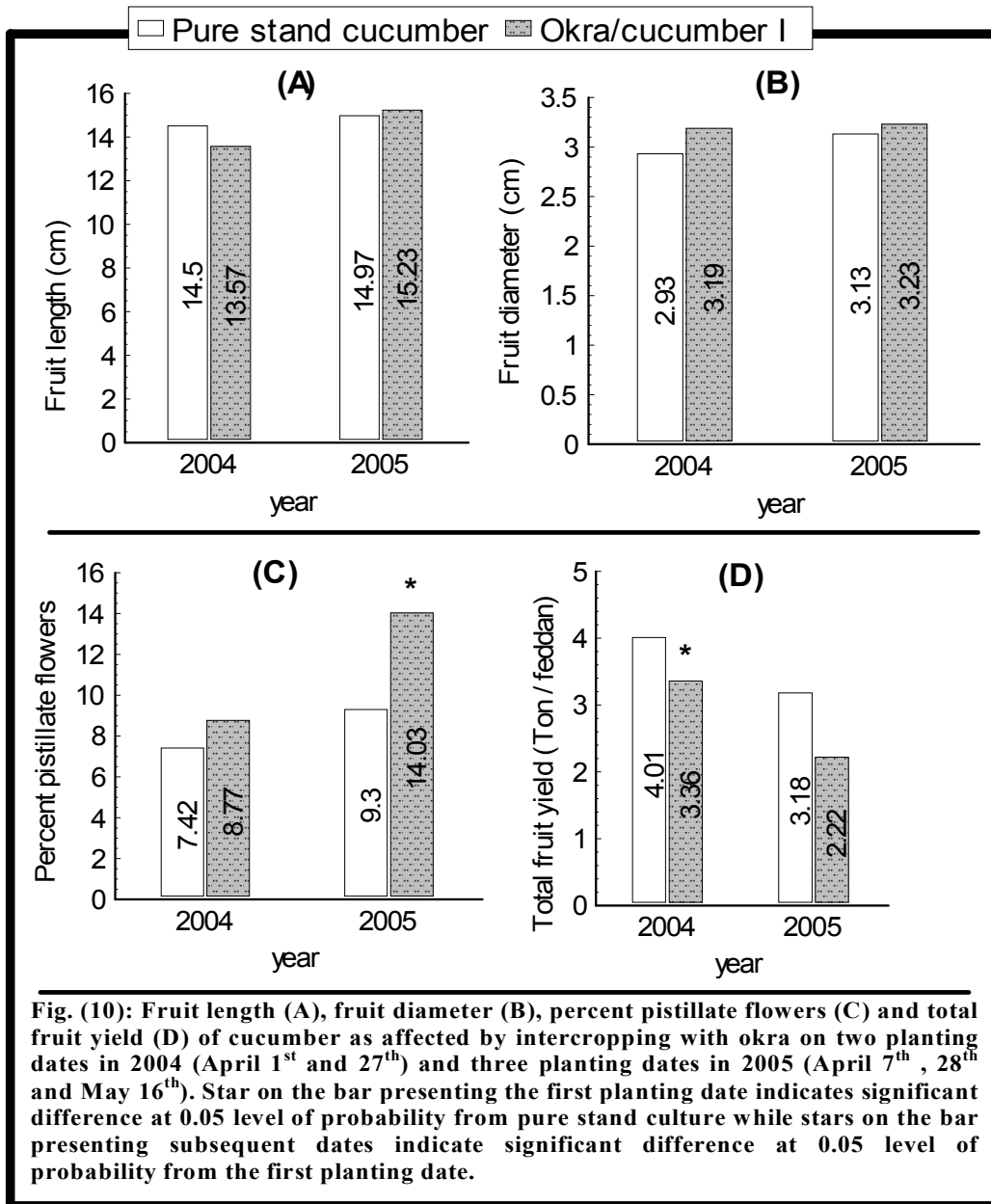


Fig. (10): Fruit length (A), fruit diameter (B), percent pistillate flowers (C) and total fruit yield (D) of cucumber as affected by intercropping with okra on two planting dates in 2004 (April 1st and 27th) and three planting dates in 2005 (April 7th , 28th and May 16th). Star on the bar presenting the first planting date indicates significant difference at 0.05 level of probability from pure stand culture while stars on the bar presenting subsequent dates indicate significant difference at 0.05 level of probability from the first planting date.

DISCUSSION:

The commonly grown okra cv 'Balady' in Upper Egypt occupies the land for relatively long season (5-6 months). The crop is produced as sole crop and while mature plants have vigorous growth, they usually grow slowly in the first month after seed planting. The present study suggests a possible production of secondary fast growing summer vegetables in a within-row intercropping system involving okra as main crop.

Concerning intercropped cowpea, on average, 231 kg dry seed yield per feddan was obtained when planted on the same date or 3 weeks after planting okra. From the agronomical point of view, this amount seems reasonable when taking in account that within okra rows intercropped cowpea was almost one half the plant density of sole culture. Noticeably average 1000-seed weight of intercropped cowpea did not differ from those produced by sole cowpea culture in the present study. In contrast to results reported by (Singh, 1993; Muoneke *et al.*, 1997), no reduction in okra yield was detected when cowpea was intercropped with it.

During growth and development, crop plants intercept and absorb growth factors (light energy, water and nutrients) and use them to produce biomass (Trenbath, 1986). Some part of this biomass is the harvestable yield. The needed growth factors are distributed variously in space and time. Therefore, crop complementary and supplementary relations determine the magnitude of intercrop competition (Ofori and Gamedoaghao, 2005). In intercropping system involving legume crop, supplementary relation would exist due to nitrogen fixation. Consequently, okra may not suffer competitions for N supplies when grown with cowpea. Data of the present study showing

sometimes increase in okra yield grown with cowpea intercrop substantiate the lack of critical competition for such prominent nutrient growth factor.

Complementarities would occur when growth pattern of component crops in an intercrop differ in critical period of high demand for resources (Iragavarapu and Randall, 1996). Complementary relation between okra cowpea may be weak since both okra and cowpea are erect plants and competition for light may seriously stands (Ofori and Gamedoaghao, 2005). Cowpea plants, especially when grow 3 weeks after planting okra, tended to develop etiolating stem and show delay in flowering and fruiting (Fig. 3-A, 3-D and 4-A). In comparison with sole cowpea crop, depression in seed yield of intercropped cowpea was accompanied with severe reduction in number of pod produced per plant. In contrast, okra especially in the second year tended towards produce increased yield (Fig. 2-E).

Plant architectural traits, therefore, as being an important factor to provide complementarities between intercropping component crop has been considered in breeding programs of cowpeas (Nelson and Robichaux, 1997). However, selection for improved yield under sole cropping may not necessarily lead to improved yield under intercropping and different plant traits may be more appropriate for cultivars intended for use under intercropping than for those intended for use under sole cropping. Obviously, cowpea planted within rows of okra later during 5th or 7th week after planting okra in the present study failed completely to grow. Thus, use of different planting date here presented a potential amendment to enhance complementarities in

okra/cowpea intercrop production (Muoneke *et al.*, 1997).

The yield results of cowpea and okra intercropping suggest that cowpea was not strong competitive to okra. As shown by intercropping evaluation parameters ('aggressiveness' Table 1), obviously okra was dominant crop plant in this intercropping system. However, 'land equivalent ratio' of okra/cucumber intercropping based on these planting in a within row alternate hills was greater than 1.0 indicating higher combined yield production than sole cropping of okra. Since no substantial costs were added, income return would be increased from okra/cowpea intercropping.

With regard to cucumber, on average, 3 tons of cucumber fruits per feddan were obtained when it was planted at the same date with okra. This yield was 71% of sole cucumber crop obtained at no substantial additional costs. Worthwhile to mention that cucumber was planted in mid-spaces between okra plants grown 40 cm apart and their plant density were almost 50% lower comparing with pure stand culture. However, cucumber yield came out on expense of 1 ton/feddan okra yield. Depression in okra yield was consistently accompanied by reduction in plant height at flowering stage, and number of produced pods per plant (Fig. 7-C). Since plant height at the end of the season and node of first pod was not affected, depressed yield can be attributed to reduction occurred in fruit set.

Higher yield advantage can be realized in intercropping system when growth patterns in terms of time (growth rapidity and maturity period) and space (plant architecture) of component crops (Ghosh *et al.*, 2006) can establish complementarities. Results of cucumber and okra crop yield suggest that

cucumber was a strong competitive to okra. In terms of intercropping evaluation parameters ('aggressiveness' Table 1), cucumber dominated over okra crop. Okra and cucumber are plants with different architecture and likely they were not in critical competitions for light interception during the initial critical fast growth period of cucumber (Sharaiha *et al.*, 2004). Okra plants while they grew vigor later in the production season, they did not seem to develop sufficient deeply penetrating roots during the first month. On the other hand, cucumber growth progressed faster but may have most of its effective absorption surface (root) in the top soil later. Thus okra and cucumber may rather faced considerable competition for nutrient supplies from growing soil. Such situation may be overcome using additional fertilizer supplies especially N ones. But it needs to be evaluated as it will add an additional production cost.

Cucumber intercropped within okra rows when planted 3 or 5 weeks after okra planting was subjected to deep shading by okra plants. In comparison to sole culture, cucumber plants showed etiolated stems (Fig. 8-D) and produced no pistillate flowers (Fig. 10-C). As result, these plants did not produce fruits. Thus intercropping evaluation parameter for 'aggressiveness' showed dominance for okra while land equivalent ratio was or very close to 1.0 indicating no yield benefit from an added cucumber crop to growing okra main crop. The land equivalent ratio of okra-cucumber intercropping based on simultaneous planting in a within row alternate hills was greater than 1.0 indicating higher combined crop outcome than sole cropping of okra.

In practical sense, however, okra per unit price is usually at least as twice as that for cucumber. Simply, 1 ton of okra would account for 2 tons of cucumber as far as the cash return is concerned. Thus, intercropping of cucumber

with okra may outcome to add cash return of one ton cucumber fruits per feddan. On the other hand, intercropping seemed to enhance cucumber fruit quality since those fruits were smother, shiner and straighter than those produced from pure stand plants. Partial shade provided by okra plants may reduce light and temperature stress and thus provided favorable climate to cucumber fruit to development in terms of shape quality mentioned above. Therefore, fruits produced from intercropped cucumber would receive better acceptance of consumers and provide higher cash return than those from sole culture. Overall, results of simultaneously planted cucumber and okra tend to support alternate within-row hills cropping system.

In conclusion, a reasonable additional crop outcome could be realized by intercropping of cowpea or cucumber secondary crops with okra cv. 'Baladi' as main crop. To benefit from these added crops, it is recommended to plant them simultaneously on the same date of planting okra. It is also possibly to plant cowpea 3 weeks after planting okra.

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الإنتاج المحمل من اللوبيا والخيار (كمحاصيل ثانوية) والياميا (محصول رئيسي) ومدى تأثيره بمواعيد تحميل المحاصيل الثانوية

مجدى على أحمد موسى، محمد فؤاد محمد عبد الله، محمد حمام الدقيشي، عماد الدين فؤاد النوبى

قسم البساتين - كلية الزراعة - جامعة أسيوط

أجريت هذه الدراسة خلال موسمين صيفيين متتاليين (2004, 2005) بمزرعة الخضرة البحثية بكلية الزراعة - جامعة أسيوط، وذلك بهدف دراسة الإنتاج المحمل للوبيا والخيار (كمحاصيل ثانوية) على الياميا (كمحصول رئيسي). وقد استخدم نظام تحميل واحد وهو الزراعة في نفس الخط بالتبادل بين الجور حيث تم زراعة الياميا في 1 أبريل عام 2004 وفى 7 أبريل عام 2005 على أبعاد 40 سم. أجريت كل التجارب في هذه الدراسة في قطاعات كاملة عشوائية ذات أربعة مكررات في الموسم الزراعى 2004 وذات ثلاث مكررات في الموسم الزراعى 2005، وكانت التجارب كما يلي :

أولا - تجربة تحميل اللوبيا على الياميا :-
فيها زرعت اللوبيا كمحصول محمل على الياميا 4/1، 4/27، 6/1 عام 2004 ، وفى 4/7، 4/28، 5/16، 6/1 عام 2005، كما زرعت اللوبيا غير محملة فى 4/1 ، 4/7 فى عامى 2004 ، 2005 على التوالي، وقد أظهر التحليل الإحصائي للبيانات الآتي : لم يتأثر المحصول الإجمالي لقرون الياميا وعدد القرون/نبات، ومتوسط وزن القرن وعقدة أول قرن عند تحميل اللوبيا عليها، وذلك فى عام 2004 فيما وجدت زيادة معنوية فى محصول القرون ونقص معنوي فى متوسط وزن القرن عند زراعة اللوبيا معها فى نفس الميعاد فى العام الثاني 2005، هذا ولم يتأثر محصول الياميا ومتوسط وزن القرن بالزراعات المتأخرة عن ذلك للوبيا. بالمقارنة مع اللوبيا الغير محملة فإن تلك المحملة أعطت محصولا من البذور الجافة أقل معنويا بدرجة كبيرة فى عامي الدراسة وصاحب هذه زيادة فى عدد الأيام حتى 50% نباتات مثمرة وعقدة أول قرن ونقص فى طول القرن وعدد القرون على النبات بينما لم يتأثر متوسط وزن 1000 بذرة. أظهرت حسابات قيم معامل كفاءة استغلال الأرض (LER) دائما أعلى من الواحد الصحيح (1.0)، وذلك عند زراعة الياميا واللوبيا معا فى نفس ميعاد الزراعة أو عند زراعة اللوبيا بنحو 3 أسابيع بعد زراعة الياميا، وبلغت فى المتوسط لمعدى الزراعة وموسمى الزراعة 1.20 وبهذا فإنه لإنتاج محصول مماثل من الياميا واللوبيا يلزم مساحه أكبر من تلك التى استخدمت فى إنتاجهما كمحصولين محملين بحوالى 20%. وأوضحت تقديرات العدوانية أن الياميا تسود فى إنتاجها على اللوبيا.

ثانيا : تجربة تحميل الخيار على الياميا :-
فيها زرع الخيار كمحصول محمل على الياميا 4/1، 4/27 عام 2004 ، وفى 4/7 ، 4/28 عام 2005، كما زرع خيار غير محمله فى 4/1 ، 4/7 فى عامى 2004 ، 2005 على التوالي. وقد درست فى الياميا نفس الصفات السابق ذكرها فى تجربة تحميل اللوبيا. وقد أظهر التحليل الإحصائي للبيانات أن زراعة الخيار فى نفس ميعاد زراعة الياميا محملا عليه إلى نقص معنوي فى محصول قرون الياميا فى عامي الدراسة ورافق هذا نقص معنوي فى عدد القرون/نبات دون تأثير على باقي الصفات عدا عدد الأيام حتى 50% نباتات مثمرة فى عام 2004 . هذا ولم تكن الفروق بين محصول قرون الياميا المحملة والغير محمل عليها الخيار معنويا عند زراعة الخيار فى المواعيد المتأخرة عن هذا . أنتج الخيار المحمل عند زراعته فى نفس ميعاد زراعة الياميا محصولا أقل معنويا مقارنة مع الخيار الغير محمل فى عام 2004 فقط، وصاحب هذا نقص معنوي أيضا فى عدد الثمار/نبات بينما لم تتأثر باقي الصفات الثمرية. أما الخيار الذي زرع فى مواعيد بعد هذا فإنه لم يثمر فى عامي الدراسة . عند حساب معامل كفاءة استغلال الأرض (LER) كمقياس لكفاءة التحميل فإن القيم كانت دائما تزيد عن الواحد الصحيح (1.0) عند زراعة الخيار فى نفس ميعاد زراعة الياميا محملا عليه، وبلغ متوسط للعامين 1.6، أى أن ما حصلنا عليه من إنتاج الياميا والخيار كان لينتج من مساحه تزيد عن المساحة التى استخدمت فى الإنتاج لمحمل لهما بمقدار 60%، وأوضحت تقديرات العدوانية أن الخيار منافس قوى للياميا لسرعة نموه واختلاف طبيعة نموه مما مكنته من النمو والإنتاج بكفاءة مع الياميا.

الاستنتاجات والفائدة التطبيقية للدراسة:
أنتجت الوبيا المحملة على الياميا فى المتوسط للموسمين 231 كجم بذور جافة/فدان عندما زرعت فى نفس ميعاد زراعة الياميا أو بعدها بثلاثة أسابيع وجدير بالذكر أن كثافة زراعة اللوبيا المحملة هى حوالى 50% من كثافة زراعة اللوبيا الغير محملة (معاملة المقارنة)، وأن إنتاج اللوبيا لم يصاحبه أى نقص فى محصول الياميا المحملة، وبذلك يمكن أن تمثل هذه الكمية عاندا إضافيا دون تكاليف إنتاج إضافية تذكر عدا تفاوتى الزراعة. ونظرا لأنه لم يتم إنتاج محصول بذور جافه من اللوبيا المحملة فى المواعيد المتأخرة فإنه ينصح بزراعة اللوبيا محملة على الياميا فى نفس وقت زراعة الياميا أو على الأكثر بعد فتره فى حدود 3 أسابيع. أما عن الخيار فقد أنتج عند زراعته فى نفس ميعاد زراعة الياميا كمتوسط للموسمين 3.1 طن/فدان، وهذا يمثل 71% من محصول الخيار الغير محمل (معاملة المقارنة) مع الوضع فى الاعتبار أن الخيار المحمل كان كثافته النباتية أقل حوالى 50% عن الغير محمل. إلا أن إنتاج الخيار المحمل جاء على حساب محصول الياميا والذي نقص فى المتوسط 1 طن/فدان وأصبح محصول الياميا المحمل كمتوسط 83% من محصول الياميا المنزرعة بدون تحميل وبالموضع فى الاعتبار أن أسعار الياميا حوالى ضعف أسعار وحدة الوزن من الخيار فى هذا الموسم، فإنه عمليا يمكن اعتبار أن نقص 1 طن باميا يساوى 2 طن خيار ويظل هناك عند إضافيا بدون تكاليف إضافية للإنتاج يساوى 1.1 طن/فدان. هذا ولم ينتج الخيار أى محصول إذا زرع متأخرا حيث ساد نمو الياميا تماما عليه، ولذلك فإنه ينصح بتحميل الخيار على الياميا وذلك بين جور الياميا فى نفس الخط على أن تتم الزراعة للخيار والياميا سويا فى نفس ميعاد الزراعة.