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Performance of some Mungbean (*Vigna radiata* (L.) Wilczek) Genotypes as a Forage Crop under Different Sowing Dates and Plant Population Densities

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FOUR MUNGBEAN genotypes were evaluated as forage plants under three plant population densities, two sowing dates and their interactions at Mariout Research Station, Desert Research Center throughout 2002 and 2003 summer seasons. The experiments were laid out in a split split plot design with three replications. The following results could be summarized as follows:

1. Most of growth parameters studied were significantly decreased by delaying sowing date. Fresh and dry forage yields followed closely the same trend of growth parameters. Although crude protein percent of mungbean herbage was significantly increased by delaying sowing date, crude fiber percent take an opposite trend. However, total ash percent did not affect by sowing date. Mungbean seed yield and its attributes produced from May planting surpassed those of June planting.
2. Kawmy-1 genotype exceeded the other three mungbean genotypes, *i.e.*, L 263, V 2010 and L 107 in all growth, forage and grain yield parameters. Whereas, chemical constituents of their forage material did not significantly differ.
3. Increasing plant population density tended to increase plant height and specific leaf weight of mungbean plants while, No. of branches / plant and leaf area were decreased. The highest fresh and dry forage yields were achieved by the lowest plant density. There was a progressive and significant reduction in crude protein and total ash percentages by widening plant spacing while, crude fiber percent was insignificantly increased. Higher values of all parameters associated with mungbean fruiting and seed filling were obtained when mungbean plants were spaced 20 cm.
4. Most of seed yield and its contributing characters were significantly affected by the first and second order interactions between main factors under study. But growth, chemical and forage yield parameters were unaffected by the interactions.

Keywords : Mungbean, Vigna radiata, Forage, Sowing date, Genotypes and plant density.

In Egypt summer annual grasses are commonly grown to provide forage especially in the new reclaimed soils as in Mariout region. Annual species that are commonly used include various sorghum and pearl millet species. Although these crops are usually productive, they have inferior forage quality in comparison other forage legumes. When annual grasses are fed to livestock, they must usually be supplemented with protein source to maintain animal performance at acceptable levels. It is believed that using new forage legume crops with high nutritive value such as mungbean may increase forage production and enhance its quality in these areas.

Mungbean or greengram (*Vigna radiate* (L.) Wilczek) is widely cultivated in many arid and semi-arid regions of the world particularly in Pakistan and Sri lanka and originated to India (Ram & Singh, 1994). The crop is grown principally for its protein-rich edible seeds that are used as human food, while its herbage is used as a fodder and green manure (Allen & Allen, 1981 and Provorov *et al.*, 1998). Producing leguminous crops such as mungbean for forage is considered an alternative method to provide supplemental protein with annual grasses (Twidwell *et al.*, 1992). In addition, legumes are typically higher than grasses in concentrations of N, Ca and Mg (Smith, 1975). For increasing mungbean forage productivity, it can achieve through agricultural practices such as sowing date and plant population density.

Sharma *et al.* (1989) studied the response of four greengram varieties (ML 131, GMC 73, GMC 74 and Pusa Baisakhi) to sowing dates of July, 13,July, 23 August, 2 and August, 12 They stated that the highest grain yield was recorded with early date of sowing (July, 13) and there was significant reduction in grain yield in successive dates. They found also that cultivar ML 131 gave significantly higher yield over other cultivars. They confirmed the results of Jaiswal (1995) that sowing at 5 March gave the highest grain yield of two genotypes of each greengram and blackgram and he mentioned also that further delay in sowing significantly reduced the yield. Moreover, the greatest yield of greengram was obtained with sowing on March , 30 followed by April, 9 (Ram and Dixit, 2000). Patra *et al.* (2000) conducted a field experiment during winter season to study the response of greengram varieties to date of sowing. Variety "Nayagarh Local" gave the maximum seed yield when sowing was done on 10 September. They pointed out that a delay of 10 and 20 days in sowing reduced the seed yield by 14.2 and 30.0 %, respectively. Under middle Egypt conditions, the highest mungbean seed yield was obtained by Kawmy-1 followed by T-44 and Vc-1000. These genotypes also are differed in their chemical composition (Selim, 1995). On the other hand, mungbean forage yield for the July planting was higher than that of the May planting by 2.2 t/ha (Twidwell *et al.*,1992). Also, El-Houssini (1996) mentioned that higher values of pigeon pea forage and seed yields, number of pods/plant, pod length, number of seeds /pod, seed/ husk ratio and seed index were obtained at May, 15 planting followed by 1st May, 1st June and June, 15 respectively. He showed also that May planting produced higher crude fiber and total ash percentages of pigeon pea leaves, stems, and seeds and these contents were decreased with delaying cultivation.

Concerning the effect of plant population density, Abd El-Gawad *et al.* (1991a) revealed that widening inter-plant spacing tended to increase plant height and number of branches / plant of pigeon pea plants. They also mentioned that fresh and dry forage yields / unite area significantly decreased by increasing hill spacing. Increasing spacing between pigeon pea plants increased leaf area / plant whereas, crude protein percentage of leaves and stems were not influenced with distance between plants (Abd El-Gawad *et al.*,1991 b). Furthermore, Peres *et al.* (1990) studied the effect of spacing on yield and quality of utilizable forage of two cultivars of pigeon pea and reported that averaged over cultivars, total dry matter yield and crude protein content were lower with the largest inter-plant spacing. Roy (2000) on mungbean plants found that the highest yield was obtained when the crop was sown at the highest seeding rate of 14 kg / ha. In Egypt, Ashour *et al.* (1995) concluded that the greatest mungbean seed yield (1.98-2.05 ton / ha) was obtained when Kawmy-1 or Vc 1000 genotypes were planted at the medium plant density of 4.4×10^5 plants / ha.

Therefore, the main target of the current study was to evaluate the effect of genotype, sowing time and plant population density on mungbean forage yield under Mariout district conditions.

Material and Methods

The present investigation was conducted during the two successive summer seasons of 2002 and 2003 in Mariout Research Station, Desert Research Center at Mariout region, 35 km west Alexandria. The soil of the experimental site was sandy clay loam in texture with pH 8.4 and EC 2.97 mmhos/cm. The soil was ploughed twice and ridged at 50 cm apart and divided into plots. The area of each experimental unit was 10.5 m^2 (1/400 feddan) and consisted of 6 ridges 2.5 m in length and 50 cm apart three of them were used for growth and forage production determinations and the others were left intact for seed production determinations. Calcium super phosphate (15.5 % P_2O_5) with rate of 150 kg/fed. was applied during soil preparation.

The treatments comprising three distances between plants of 10, 20 and 30 cm were employed to secure population densities of 60000, 30000 and 20000 plants/fed. ,respectively and four mungbean genotypes (Kawmy-1, L 265, V 2010 and L 107) as well as two dates of sowing (1^{st} May and 1^{st} June) were evaluated in split split plot design having three replications. The main plots were devoted to sowing time, while the sub plots were allocated to genotypes whereas, the sub sub plots occupied with inter-plant spacing.

Seeds of four mungbean genotypes were sown on 1^{st} May and 1^{st} June in both seasons of experimentation. After full germination, the plants were thinned to secure one plant per hill to attain the predetermined planting densities. Plots were hand-weeded throughout the growing season to minimize weed competition.

Growth parameters, *i.e.*, plant height, number of branches/plant, leaf area and specific leaf weight (SLW) as well as forage yield were determined when vegetative growth reached its maximum. While, the plants that devoted to seed yield determinations were harvested at maturity stage (100 days after sowing). Grain yield and its components, *i.e.*, number of pods/plant, number of seeds/pod, seed/husk ratio, pod length and seed index were measured.

Vegetative samples were collected when the plants were harvested for forage to determine the following chemical constituents:

1- Crude protein content: total nitrogen was determined by using micro-kjelahl method as described by Peach and Tracey (1956). Crude protein was calculated by multiplying total nitrogen by 6.25 (Tripath *et al*., 1971).

2- Crude fiber and total ash were determined by using the method outlined by A.O.A.C. (1960).

Data of growth, forage yield, chemical contents, grain yield and grain yield attributes were subjected to the proper statistical analysis by the technique of analysis of variance of split split plot design as mentioned by Gomez & Gomez (1984). The combined analysis of variance was performed for the data of the two seasons. Treatment means were compared by the least significant differences (L.S.D.) test at 5% level of probability.

Results and Discussion

Effect of sowing date

Results recorded in Table 1 showed that most of growth parameters studied, *i.e.*, plant height, number of branches per plant and specific leaf weight were significantly decreased by delaying sowing date from 1st May and 1st June however, such decrement in leaf area was not great enough to reach the significance level. These decrements which occurred in growth characters of mungbean plants as planting date was delayed might be due to the fact that longer growth period of May planting was favorable for mungbean vegetative growth. These findings are in general accordance with those obtained by El-Houssini (1996) on pigeon pea plants. Fresh and dry forage yields of mungbean plants followed closely the same trend of growth parameters in their responses to sowing time which fresh and dry yields were increased by about 228.7 and 219 %, respectively by earliness in sowing date. This may be due mainly to high accumulated heat could obtained throughout the longer growth period of May planting. Also, late planting in June under the higher air temperature caused in more respiration rate than assimilating rate which in turn could result in less dry matter as a result of both processes. In this connection, El-Houssini (1996) concluded that higher pigeon pea forage yield was obtained at 15 May planting followed by 1st May, 1st June and 15 June ,respectively. However, Twidwell *et al.* (1992) pointed out that mungbean forage yield for the June planting was higher than that of the May planting.

Although crude protein percent of mungbean herbage was significantly increased by delaying sowing date from 1st May to 1st June, crude fiber percent take an opposite trend which it decreased from 17.94 to 15.05 %, whereas the total ash percentage was not affected due to sowing date. In this respect, El-Houssini (1996) revealed that May planting produced higher crude fiber and total ash percentages of pigeon pea leaves, stems and seeds. He also found that such chemical contents were decreased with delaying cultivation.

On the other side, mungbean seed yield and its attributes, *i.e.*, number of pods/plant, number of seeds / pod, seed / husk ratio, pod length and seed index produced from May planting surpassed those of June planting (Table 2). It seems that the prevailing weather during the growing period may play a role for growth enhancement (Table 1) and acceleration of both fruit setting and seed filling, which may in turn was reflected on seed yield. Many investigators came to similar conclusion among whom Sharma *et al.* (1989); Jaiswal (1995); Ram & Dixit (2000) and Patra *et al.* (2000).

TABLE 1. Effect of sowing time (T) and plant population density (D) on growth, forage yield and some chemical constituents of four mungbean cultivars (V) (Combined analysis of 2002 & 2003).

Traits / Treat.	Plant height (cm)	No. of branches per plant	Leaf area (cm^2)	SLW (mg/cm^2)	FFY (ton/fed)	DFY (ton/fed)	CP (%)	CF (%)	TA (%)
T1	44.0	14	141.6	4.98	1.121	0.252	9.02	17.94	17.16
T2	26.0	5	134.5	3.42	0.341	0.079	10.61	15.5	17.60
LSD 0.05	8.9	4	N.S	1.40	0.115	0.085	1.00	2.89	N.S
V1	38.0	11	164.2	5.07	1.446	0.389	9.89	17.16	18.07
V2	37.0	10	138.4	3.65	0.416	0.096	10.86	15.97	17.29
V3	34.0	9	136.5	3.50	0.546	0.144	9.05	17.69	17.44
V4	30.0	8	133.0	3.69	0.516	0.132	9.47	16.86	16.73
LSD 0.05	8.0	3	24.5	N.S	NS	0.278	N.S	N.S	N.S
D1	36.0	8	125.8	4.73	0.556	0.122	10.81	16.79	18.26
D2	34.0	9	139.1	4.00	0.667	0.153	10.10	15.97	16.70
D3	34.0	10	149.3	3.20	0.885	0.198	8.64	17.00	17.17
LSD 0.05	N.S	2	13.5	0.98	0.329	0.073	1.94	N.S	1.55

T1= 1st May T2 = 1st June V1= Kawmy 1 V2= L 263 V3 = V 20.10
V4= L 107 D1= 10 cm D2= 20 cm D3= 30 cm SLW= Specific leaf weight
FFY= Fresh Forage Yield DFY= Dry Forage Yield CP= Crude protein
CF= crude Fiber TA= Total Ash

Cultivars performance

The results presented in Tables 1 & 2 indicate that mungbean genotypes were significantly varied in their forage and grain yields as well as their components. Whereas, chemical constituents of their forage material, *i.e.*, crude protein, crude fiber and total ash percentages did not significantly differ. It is clear that, Kawmy 1 (V1) exceeded the other three mungbean genotypes, *i.e.,* L 263 (V2), V 2010 (V3) and L 107 (V4) in all growth and forage yield parameters (Table 1). Kawmy 1 genotype surpassed L 263, V 2010 and L 107 in fresh forage yield by 1.330, 0.900 and 0.930 ton / fed while, such increments were 0.293, 0.245 and 0.257 ton / fed for dry forage yield, respectively. Regarding fresh and dry forage yields, investigated genotypes could be arranged in descending order as Kawmy 1, V 2010, L 107 and L 263. The differences in growth and forage yield criteria of mungbean genotypes under study may be due to the differences in response of their genetic make up to environmental factors prevailing in Mariout region and affecting developmental processes and ability to thrive and benefit from the available nutrients which led to an increase in dry matter production.

Concerning seed yield and its attributes, the obtained results indicated clearly that studied mungbean genotypes were significantly differed in No. of pods / plant, No. of seeds / pod, seed / husk ratio, pod length, seed index and seed yield (Table 2). In general, Kawmy 1 significantly outyielded the rest of other genotypes tested in seed yield and its components. These differences which noticed between the investigated mungbean genotypes may be due to the difference in the genetic potentiality between genotypes which would play an important role with regard to the utilization of all climatic and edaphic factors by these genotypes in the photosynthesis process which could have a sensible impact on grain filling consequently, seed yield. Furthermore, the superiority of Kawmy 1 genotype might be due to its vigorous growth and taller plants (Table 1) that develop more pods with higher No. of seeds / pod and heavier 100-seed weight resulting in higher seed yield. In this connection, Ashour *et al.* (1995) and Selim (1995) in Egypt concluded that Kawmy 1 gave the highest seed yield compared with other mungbean genotypes.

TABLE 2. Effect of sowing time (T) plant population density (D) on seed yield and its attributes of four mungbean cultivars (V) (Combined analysis of 2002& 2003) .

Traits / Treat.	No. of pods / plant	No. of Seeds/ pod	Seed / husk ratio	Pod length (cm)	Seed Index	Seed yield (ton/fed)
T1	18.0	10	1.91	9	3.70	0.177
T2	10.0	9	1.74	8	3.50	0.139
LSD 0.05	3.50	N.S	N.S	N.S	N.S	0.034
V1	15.0	11	2.09	11	3.94	0.202
V2	19.0	9	1.92	7	3.52	0.191
V3	10.0	9	1.72	9	3.20	0.074
V4	12.0	10	1.56	9	3.73	0.105
LSD 0.05	6.00	1	0.49	2	0.45	0.081
D1	11.0	9	1.79	9	3.64	0.160
D2	19.0	10	1.92	9	3.53	0.176
D3	11.0	10	1.77	9	3.63	0.138
LSD 0.05	2.00	1	N.S	N.S	N.S	N.S

Effect of plant population density

Data recorded in Table 1 show means of some growth, chemical and forage yield parameters of mungbean plants as affected by population density. There was a tendency to increase in plant height and specific leaf weight with increasing plant density. Whereas, increasing plant spacing from 10, 20 to 30 cm between plants caused a significant increase in the No. of branches/plant and leaf area. It could be concluded that the maximum number of branches/plant and the greatest values of leaf area were obtained at the lowest plant density. These increments in number of branches/plant and leaf area which accompanied thin planting my be due to low competition among plants for growth elements and well utilization of above ground environmental conditions. Similar results were reported by Abd El-Gawad *et al.* (1991 a & b). The highest fresh and dry forage yields of mungbean plants were achieved by the lowest plant density, *i.e.*, planting at 30 cm hill space (20000 plants/fed). Widening inter-plant spacing led to significant increase in fresh and dry forage yield of mungbean plants. This is not surprising since plants at wider spaces suffered less from competition for edaphic and climatic factors. In this respect, Abd El-Gawad *et al.* (1991 a); Peres *et al.* (1990) on pigeon pea plants and Roy (2000) on mungbean plants stated that total dry matter yields were lower with the widest inter-plant spacing. Concerning chemical contents, there was a progressive and significant reduction in both of crude protein and total ash percentages of mungbean shoots by widening plant spacing while, crude fiber percent was insignificantly increased (Table 1). Peres *et al.* (1990) came to similar results for crude protein whereas, Abd El-Gawad *et al.* (1991 a) revealed that crude protein percentage of pigeon pea leaves and stems were not affected by distance between plants.

As for seed yield-contributing characters and seed yield, changing hill spacing from 10 to 30 cm had significant effect on No. of pods/plant and No. of seeds/pod whereas, seed/husk ratio, pod length and seed index were not significantly affected. Generally, higher values of most parameters associated with mungbean fruiting and seed filling, *i.e.*, No. of pods/plant, No. of seeds/pod, seed/husk ratio, pod length and seed index were obtained when mungbean plants were spaced 20 cm. Consequently, the maximum seed yield of o.176 ton/fed was achieved with the middle distance between plants (20 cm). This in a close agreement with the findings of Ashour *et al.* (1995) who concluded that the greatest mungbean seed yield was obtained at the medium plant density of 4.4×10^5 plants/ha.

Significant interaction effects

The interaction effects between the main factors under this study can be divided into significant and insignificant effects. In this concern, it has to be mentioned that the insignificant interactions were excluded. The significant interactions will only be presented and discussed.

Interaction between sowing date and genotypes

The interaction between sowing date (T) and genotypes (V) had significant effect on No. of pods / plant and seed yield, as illustrated graphically in Fig. 1 a & b. It is clear from the data that the maximum No. of pods/plant (30 pods/ plant) was obtained when genotype L 263 (V_2) was cultivated at the early date of sowing (1^{st} May). Meanwhile, the lowest mean of aforementioned character was observed. When sowing date of the same genotype (L 263) was delayed to 1^{st} June. Also, seed yield was markedly affected by that interaction. The greatest seed yield of 0.327 ton/fed was recorded when mungbean genotype L 107 (V_4) was planted on 1^{st} June.

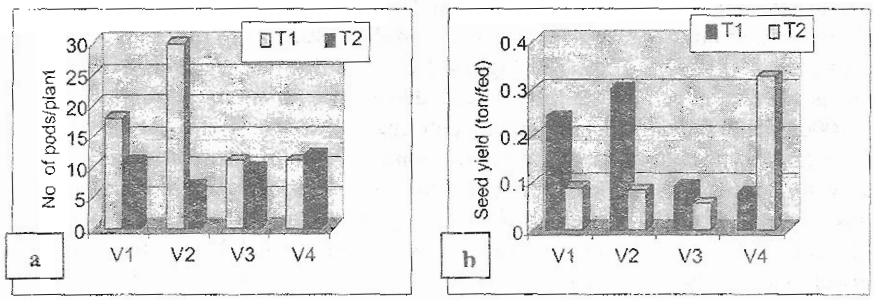

Fig. 1 a & b. Number of pods/plant and seed yield as affected by the interaction between sowing date and genotypes.

Interaction between sowing date and plant population density

Data illustrated graphically in Fig. 2 a , b and c referred that the interaction between sowing date (T) and plant population density (D) had significant effect on No. of pods/plant, seed/husk ratio and seed yield. The highest No. of pods/plant was obtained with planting at 20 cm between hills and when the crop was sown on 1^{st} May. However, seed/husk ratio was markedly affected by that interaction in favour of dense planting (10 cm between hills) and earliness in cultivation (1^{st}May) which the highest value of seed/husk ratio (2.18) was produced. At the same time, sowing date and plant population density were interacted together to produce the greatest value of mungbean seed yield of 0.269 ton/fed in favour of earliness in sowing and planting at the medium distance between plants (20 cm). So, it may be concluded that planting mungbean plants at 20 cm between hills when combined with earliness in cultivation gave the maximum record of seed yield.

Interaction between genotypes and plant population density

Results of No. of pods/plant and seed yield as affected by the interaction between different mungbean genotypes and plant population density are illustrated in Fig. 3 a & b. Both of No. of pods/plant and seed yield of mungbean plants were significantly responded to that interaction. The highest values of No. of pods/plant (42) and seed yield (0.417 ton/fed) were achieved when L 263 genotype (V_2) was planted at the medium plant population density (30000 plants/fed). While, the lower value of seed yield was obtained by increasing the distance between plants of L 263 (V_2) genotype to 30 cm.

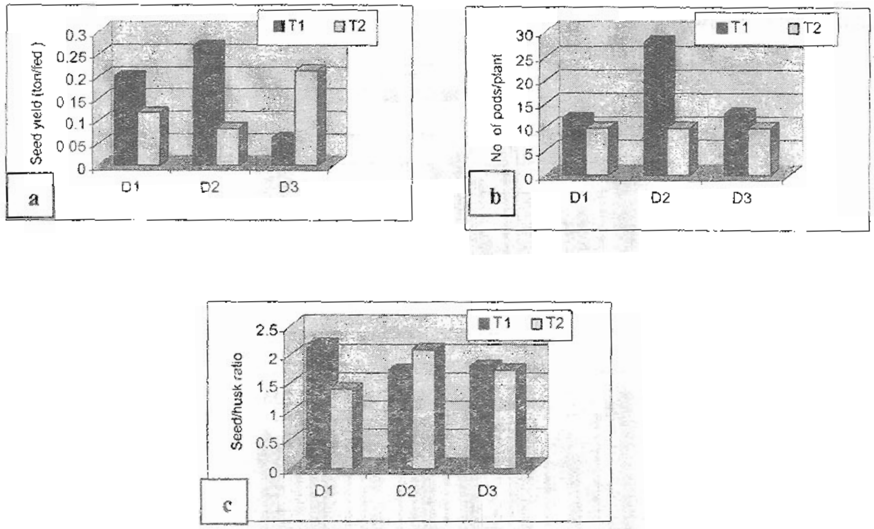

Fig. 2 a , b & c. Number of pods/plant, seed yield and seed/husk ratio as affected by the interaction between sowing date and plant density.

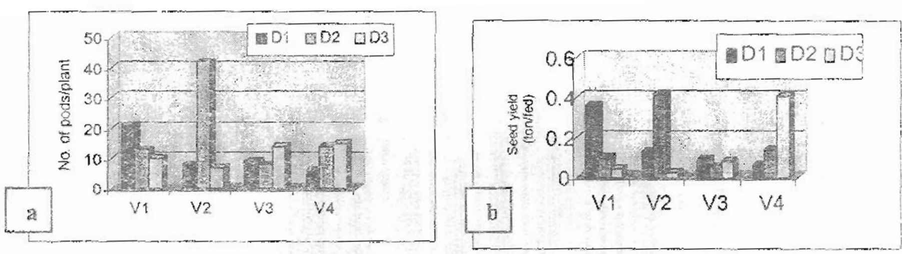

Fig. 3 a & b. Number of pods/plant and seed yield as affected by the interaction between plant density and genotypes.

Interaction between sowing date, plant population density and genotypes

The second order interaction between three main factors under this study, *i.e.*, sowing date, plant population density and mungbean genotypes was demonstrated in Fig. 4 a, b, c and d. Seed yield and most of its contributing characters i.e. No. of pods / plant, pod length and seed index were significantly affected by that interaction. Greatest No. of pods / plant (28) and longest pod length (12) were produced when Kawmy-1 genotype was sown at early sowing date (1^{st} May) with dense planting (60000 plants / fed). However, V 2010 genotype (V_3) with thin planting when sown on May 1 produced the highest value of seed index (4.80). In addition, planting L 263 mungbean genotype (V_2) at medium population density, *i.e.*, 30000 plants / fed on 1^{st} May maximized seed yield to 0.810 ton / fed. Meanwhile, lowest seed yield / fed was obtained by planting the former genotype at lower density of 20000 plants / fed on early date of sowing.

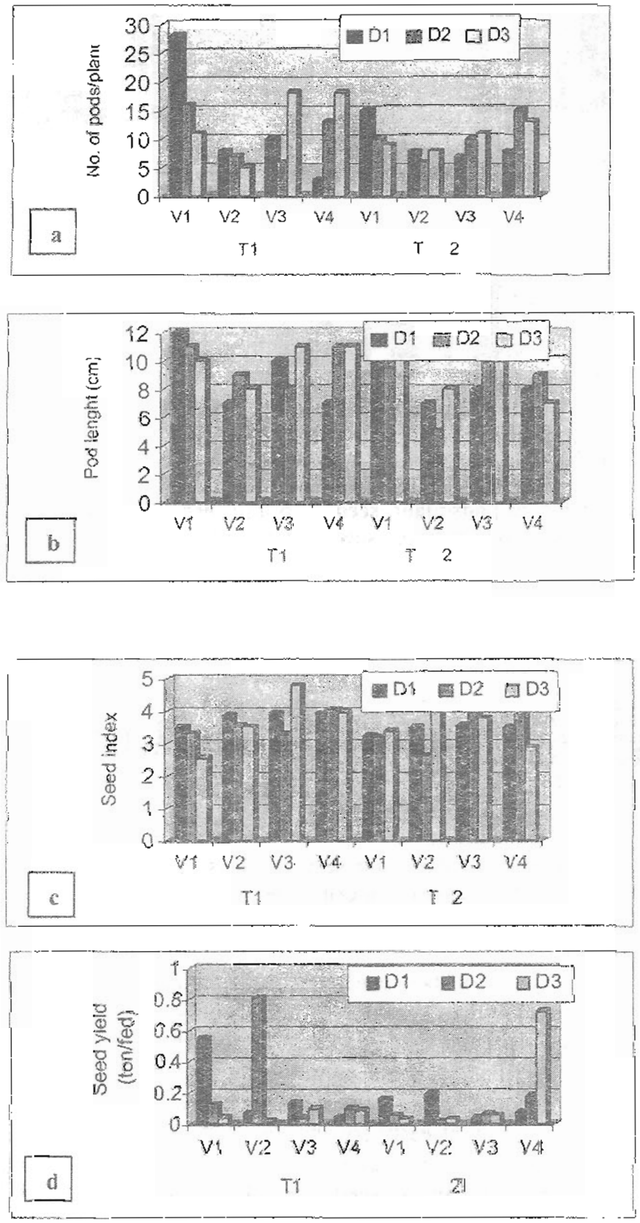

Fig. 4 a, b, c & d. Number of pods/plant, pod length, seed index and seed yield as affected by the interaction between sowing date, plant density and genotypes.

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أداء بعض أصناف فول المانج كمحصول علف تحت مواعيد زراعة وكثافات نباتية مختلفة

أحمد عهد محمد الحسيني و سيده عثمان محمد عبد الله

وحدة المراعى – مركز بحوث الصحراء – القاهرة – مصر .

تم تقييم أربعة تراكيب وراثية من فول المانج كمحصول علف متأثرة بثلاثة مسافات للزراعة هى ١٠ ، ٢٠، ٣٠ سم بين النبات والاخر وكذلك ميعادين للزراعة هما أول مايو وأول يونيه وذلك بمحطة بحوث مريوط التابعة لمركز بحوث الصحراء خلال الموسم الصيفى لعامى ٢٠٠٢ ، ٢٠٠٣ . وقد وزعت المعاملات فى التجربتين فى تصميم قطع منشقة مرتين فى ثلاث مكررات.

ويمكن تلخيص أهم النتائج كالاتى :-

١. أدى تأخير ميعاد الزراعة الى نقص معنوى فى معظم صفات النمو المدروسة كما أدى الى نقص كل من المحصول العلفى الغض والجاف. وعلى الرغم من تزايد النسبة المئوية للبروتين الخام بتاخير ميعاد الزراعة فقد أخذت النسبة المئوية للالياف الخام اتجاها عكسيا كما لم تتأثر النسبة المئوية للرماد الكلى بتاريخ الزراعة. وقد زاد محصول البذور ومكوناته بالتبكير فى ميعاد الزراعة.

٢. تفوق الصنف قومى ١ على بقية التراكيب الوراثية الاخرى فى كل صفات النمو والمحصول العلفى والبذرى فى حين لم تتأثر المكونات الكيماوية تأثرا معنويا باختلاف التراكيب الوراثية المختبرة.

٣. أدت زيادة الكثافة النباتية الى زيادة فى كل من ارتفاع النبات والوزن النوعى للورقة بينما تناقص كل من عدد الافرع للنبات ومساحة الورقة وقد امكن الحصول على أعلى محصول من العلف الاخضر والجاف بتقليل الكثافة النباتية. وقد تناقصت النسبة المئوية لكل من البروتين الخام والرماد الكلى باتساع المسافة بين النباتات بينما زادت النسبة المئوية للالياف الخام زيادة غير معنوية. وعندما زرعت نباتات فول المانج على مسافة ٢٠ سم تزايدت كل الصفات المرتبطة بمحصول البذرة.

٤. تأثرت معظم الصفات المرتبطة بمحصول البذرة تأثرا معنويا بكل من التفاعل الثنائى والثلاثى بين عوامل الدراسة بينما لم تتأثر كل من صفات النمو والمحصول العلفى وكذلك الصفات الكيماوية بالتفاعل بين عوامل الدراسة.