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# PHENOLOGICAL RESPONSES OF FABA BEAN TO CLIMATOLOGICAL EFFECTS UNDER DIFFERENT SOWING DATES AND PLANT DISTRIBUTIONS

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## ABSTRACT

This investigation was conducted at the Agric. Exp. and Res. Center Fac. Agric., Cairo Univ., Egypt, during 1999/2000 and 2000/ 2001 seasons, to study phenological stages and yield response of faba bean to sowing dates and plant distribution patterns. The experiments were laid out in a split plot design with four replications. The main plots were allocated with the three sowing dates, early (Oct., 10), mid (Nov., 10) and late (Dec., 10). The sub-plots were occupied with the six plant distribution patterns. Three sowing dates were early (Oct10.), mid (Nov10) and late (Dec10.). Six plant distribution patterns were 60 x 10 with 2 pl./ hill on single row ridge ($D_1$), 60 x 20 with 2 pl. on double row ridge ($D_2$), 60 x30 with 3 pl./ hill on triple row ridge ($D_3$), 90 x 10 with 3 pl./ hill on single row ridge ($D_4$), 90 x 20 with 3 pl./ hill on double row ridge ($D_5$) and 90 x 30 with 3 pl./ hill on triple row ridge ($D_6$) The phenological stages were:

1- Emergence ($V_1$): 50% of the plants reached full unfolding of the 1$^{st}$ leaf.
2- Flowering bud ($V_2$): when the 1$^{st}$ flower bud was visible.
3- First flower ($V_3$): when the 1$^{st}$ flower was fully unfolded.
4- 50% flowering ($V_4$).
5- Last faded ($V_5$): when last flower of the main shoot was faded.
6- Ripening ($V_6$): when 75% of pods were black.

The results showed that number of days (ND) for $V_1$ and $V_2$, were increased as sowing was delayed. On the other hand, ND for $V_3$, $V_4$ and $V_5$ were reduced as sowing was delayed. Late sowing (Dec.10) consumed the highest total sunshine hours (TBSSH) at stages of $V_1$, $V_2$, $V_4$ and $V_5$, while mid sowing (Nov.10) consumed the highest TBSSH at $V_3$ and $V_6$.Early sowing consumed the greatest photothermal units (PTU) at $V_1$ and $V_2$, while late sowing had the greatest PTU at $V_5$ and $V_6$. Maximum LAI was recorded at 105 days in Oct. and Nov. sowings, while in Dec. sowing maximum LAI was recorded at 90 days after sowing. The best yield components i.e. number of pods one m$^2$, seed index, seed yield/ plant and number of plant/ m$^2$ as well as yields of seeds and straw/fad resulted from Nov. sowing.

Plant distribution patterns had no significant effect on ND for all growth stages. 60 x 20 x 2 pl./ hill on double row ridge consumed the highest TBSSH, PTU. The same plant distribution gave the highest LAI as well as the best yield components and the highest seed yield/ fad.

The interactions between sowing dates and distribution patterns had a significant effect on some growth attributes and seed yield per fad in both seasons. The highest seed yields/ fad 718.08 and 711.03 resulted from $D_2$ with Nov. sowing in the first and second seasons, respectively.

## INTRODUCTION

Faba bean (*Vicia faba* L.) is one of the most important legume crops in the Mediterranean basin (FAO, 1997). In Egypt, faba bean production is still limited and fails to face the increasing local consumption of seeds. So, increasing its production is one of the major targets of the agriculture policy and that can be achieved by both increasing the cultivated area and improving the productivity per faddan.

Sowing date is an important factor, which affects the timing and duration of the phenological stages i.e. emergence, vegetative, flowering and reproductive stages. Zeidan *et al* (1986) found that early sowing date (Oct.15) produced the highest values of LAI at three growth stages i. e vegetative, flowering and pod- filling.The highest seed yield was obtained by the earliest sowing (Oct.15) as compared with Nov.15 sowing in old lands (Amer 1986). El-Murabaa *et al.* (1987) at Assiut recorded that late sowing increased field emergence and reduced the number of days to flowering. Sowing on 25 Oct. gave the highest dry seed yield (1.57-1.79t/fed). Late sowing recorded yields to 0.83-1.58 t dry seeds/fed. El- Defrawy *et al* (1994) reported that delaying sowing date from the first week of November to first week of December reduced seed yield of 32 faba bean accessions. Hussein *et al* (1994) indicated that sowing faba bean at mid-October resulted in the highest seed yield (11 ardabs/ fad.).

Studying the change within the canopy with plant distribution patterns is necessary to understand plant response pattern ( Abo-EL-Zahab *et al.*, 1981). Plant distribution patterns of recommended plant density (33 plants/ $m^2$) play a major role in productivity of faba bean ( Nassib *et al* 1989 , Mohamed 1985 and Hussein *et al* 1999 ).

Ghonema and Salem (1991) found that, the distribution patterns i.e. planting one plant per hill, 10 cm apart on two sides of ridge and planting two plants per hill, 20 cm apart on two sides of ridge increased number of pods / plant, 100– seed weight as well as seed and straw yields/ fad . as compared with other distribution patterns.

Hassan and Hafiz (1998) reported that, the two-side ridge plants surpassed the one side ridge in LAI, biological, straw and seed yield / fad. Also, Mohamed (2000) reported that, the highest seed yield / fad. was obtained from planting two plants / hill, 20 cm apart on both sides of ridges spaced 50 cm apart (40 plants / $m^2$ ) followed by planting two plants in hills spaced 20 cm on both sides of ridges spaced 60 cm apart ( 33.3 plants/ $m^2$ ) .

Intera- seasonal changes in the microclimate in faba bean is a consequence of different sowing date and plant distributions (through changes of spacing without changing plant population density per square area). Therefore, the present investigation was carried out to study the effect of these two factors on phenological stages, growth and yield of faba bean.

## MATERIALS AND METHODS

Two experiments were conducted at the Agric. Exp. and Res. Center Fac. of Agric., Cairo Univ. Egypt in the two winter seasons of 1999/2000 and 2000/2001. The two factors (sowing dates and plant distributions) were arranged in a split-plot arrangement in a complete block design with four replicates. Sowing dates of faba bean (Giza 2 cultivar) were randomly allocated to the main plot, while sub-plots included plant distributions. Each sub plot size was 3.6 x6.0 m (21.6 $m^2$ ). Three sowing dates were: 10 $^{th}$ Oct. (Early), 10$^{th}$ Nov. (Mid.) , and 10 $^{th}$ Dec.(Late) in the two seasons. Six plant distribution patterns as combinations of row spacing ,hill spacing and number of plants per hill were:

60 cm x 10 cm x 2 pl. (single -row ridge ) ($D_1$)
60 cm x 20 cm x 2 pl. (double -row ridge) ($D_2$)
60 cm x 30 cm x 2 pl. (triple -row ridge ) ($D_3$)
90 cm x 10 cm x 3 pl. ( single - row ridge) ($D_4$)
90 cm x 20 cm x 3 pl. ( double –row ridge) ($D_5$)
90 cm x 30 cm x 3pl. ( triple - row ridge) ($D_6$)

All plant distribution gave 139,860 plants/ fad all cultural practices, i.e. hoeing, phosphate and nitrogen fertilizer and irrigation were carried out in the same way as in ordinary faba bean fields. Thinning took place before the first irrigation 3 weeks from sowing.

**Characters studied:**

**Phenological climatology:**

**I-Phenology:**

This characters represent growth / developments event in terms of number of days each stage takes (Skjelvag 1981). Identification characteristics of stages were listed in the following Table:

**Table 1: Phenological stages of faba bean:-**

| Growth stage | Description |
|---|---|
| Emergence (v1) | -Days when 50% of the plants reached full unfolding of 1 st foliage leaf. |
| Flowering buds (v2) | -Days when 1 st flower bud was plainly visible. |
| First flower (v3) | -Days when 1 st flower was fully unfolded . . |
| 50% flowering (v4) | -Days when 1 st flower to last flower /2+day sowing to 1 st flower. |
| Last faded (v5) | -Days when last flower of main shoot had faded . |
| Ripening (v6) | -Days when 75% of pods were black, and dry to touch at main shoot of 3/5 of observed plants. |

**II-Climatology:**

Climatology measuring was practical for both macro and micro climates at the exp. site. Macroclimatic variables were taken from files of Giza Agrometereological station (Lat. 30.03. Lon. 31.13 and Altitude 95 m.). Microclimatic variables measurements were determined by portable electronic (Steady State Porometer LI-1600).

Characters studied were as follows:

1-Total Bright Sunshine Hours (TBSSH)

2-Photothermal Unit (PTU) which denotes GDD x Day length (Nuttonson, 1958 and Bauer *et al.*, 1984 ).

Growing Degree Days (GDD) calculated from the formulae:

$$GDD = ? \ (T.max. + T.min.)/2 - T_b$$

Where: T. max. was the maximum daily air temperature , T. min. was the minimum daily temperature and $T_b$ was the base temperature for the lower threshold temperature where growth cases namely 5 c˙ for faba bean (Seemann *et al.* ,1979 and Skjelvag, 1981).

**III-Growth attributes:**

Six plants from the one inner row of each sub plot, denoted for growth analyses, were taken during the period of 45-120 days from sowing. Five samples on a fortnight periods were analysed for growth attributes. The different plant and fractions were dried for 48 hours at 105 c. The following traits were evaluated:

Leaf area index (LAI) was expressed as the ratio of total leaf area ($cm^2$) per plant to the area of the land ($cm^2$) covered by the plant (Watson, 1958).

**V- Yield and its components:**

At harvest time, ten guarded plants were taken from the center ridge of each plot to determine, 100- seed weight and seed yield / plant. Number of pods and number of plant at harvest were determined from $m^2$. Seed, straw and biological yields/Fad. were estimated on plot basis. Analysis of variance was carried out according to Snedecor and Cochran (1967).

## RESULTS AND DISCUSSION

**I- Phenological climatology:**

Table 2 showed the number of days (ND) for phenelogical stages of faba bean as influenced by sowing date and plant distribution pattern. ND was significantly influenced by sowing date at all stages, except at first flower stage ($V_3$) which was insignificant only in the second season. In successive growth stages from emergence ($V_1$) to flowering buds ($V_2$), ND progressively increased by delayed sowing. In further stages ($V_3$ to $V_5$), where development occurs, late sowing reduced the number of days from first flower to last faded stages. These results are in harmony with those obtained by El- Murabaa *et al.*(1987). Plant distribution patterns, failed to exert any significant effect on ND for all stages, except 50 % flowering stage ($V_4$), in both seasons, where the highest ND was obtained from plant distribution patterns 60 x 30 triple row x 2 plants ($D_3$) and 60 x20 double row x 2 plants ($D_2$) in the first season, while in the second season the highest ND for $V_4$ resulted from $D_1$ and $D_2$. Similar results were reported by El- Shaer (1985). The interactions between sowing dates and plant distribution patterns were not significant at all growth stage in both seasons, except at $V_4$ in both seasons where the highest ND resulted from early sowing with $D_3$ and $D_4$ in the 1st and 2nd season, respectively ( Table 7 and 8).

Table 3 showed the total bright sunshine hours (TBSSH) for phenological stages as influenced by sowing date and plant distribution pattern. The data indicated that, TBSSH was significantly influenced by sowing date at all stages of growth in both seasons. Where, late sowing date (Dec.10) significantly consumed the greatest TBSSH at stages $V_1$ , $V_2$ $V_4$ and $V_5$ in both seasons, while mid sowing ( Nov. 10) consumed the highest TBSSH at $V_3$ and $V_6$ in both seasons. This results are in accordance with these obtained by Rady (1986). On the other hand, Oct. sowing almost consumed the lowest TBSSH at all growth stages in both seasons. Plant distribution patterns, exhibited significant differences in TBSSH at $V_4$ and $V_5$ (50% flowering and last faded stages), TBSSH was greatest with 60 x 20 x double row x 2 plants ($D_2$), at $V_4$ stage in both seasons and at $V_5$ in the second season. Only, the interaction between sowing date and plant

**Table 2: No. of days (ND) for phonological stages of faba bean as influenced by sowing date and plant distribution pattern in 1999 / 2000 and 2000 / 2001 seasons .**

| Factors | | Phonological stages | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1999 / 2000 | | | | | | 2000 / 2001 | | | | | |
| | | V1 | V2 | V3 | V4 | V5 | V6 | V1 | V2 | V3 | V4 | V5 | V6 |
| Sowing date | Oct. 10 (Early) | 14.89 | 35.22 | 54.83 | 89.37 | 144.22 | 156.33 | 16.28 | 35.44 | 52.50 | 90.33 | 147.67 | 155.67 |
| | Nov.10 (Mid) | 20.78 | 40.50 | 52.78 | 89.28 | 147.94 | 163.22 | 21.00 | 40.61 | 52.94 | 89.50 | 147.87 | 158.72 |
| | Dec.10 (Late) | 23.33 | 42.83 | 47.67 | 84.06 | 144.06 | 153.17 | 23.67 | 42.61 | 52.11 | 86.22 | 145.63 | 154.28 |
| LSD at 5% | | 0.41 | 1.59 | 1.16 | 0.48 | 1.78 | 2.11 | 0.58 | 1.30 | NS | 0.64 | 0.82 | 1.44 |
| Distribution | 60 x 10 S.R x 2 pl. ($D_1$) | 20.11 | 40.00 | 51.70 | 87.67 | 145.80 | 158.67 | 20.67 | 40.00 | 53.00 | 89.27 | 147.33 | 156.44 |
| | 60 x 20 D.R x 2 pl.($D_2$) | 19.56 | 39.33 | 52.01 | 88.17 | 145.76 | 158.22 | 20.56 | 39.89 | 52.67 | 89.35 | 147.22 | 156.33 |
| | 60 x 30 T.R. x 2 pl.($D_3$) | 20.11 | 39.89 | 51.65 | 88.23 | 145.92 | 158.11 | 20.33 | 39.56 | 52.44 | 88.29 | 147.44 | 156.67 |
| | 90 x 10 S.R.x3 pl. ($D_4$) | 19.56 | 39.44 | 51.78 | 87.39 | 145.00 | 157.11 | 20.22 | 39.36 | 52.30 | 88.80 | 147.11 | 156.00 |
| | 90 x 20 D.R.x3 pl. ($D_5$) | 19.00 | 39.11 | 51.85 | 86.83 | 144.86 | 157.00 | 19.89 | 39.30 | 52.35 | 88.60 | 146.67 | 155.89 |
| | 90 x 30 T.R.x3 pl. ($D_6$) | 19.67 | 39.33 | 51.57 | 87.11 | 145.11 | 156.33 | 20.22 | 39.22 | 52.34 | 87.77 | 146.56 | 156.00 |
| LSD at 5% | | NS | NS | NS | 0.76 | NS | NS | NS | NS | NS | 0.42 | NS | NS |
| A x B | | NS | NS | NS | * | NS | NS | NS | NS | NS | * | NS | NS |

NS and * indicate to insignificant and significant at 0.05 level of probability, respectively.

Table 3: Total bright sunshine hours (TBSSH) for phenological stages of faba bean as influenced by sowing date and plant distribution pattern in 1999 / 2000 and 2000 / 2001 seasons .

| Factors | | Phenological stages | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1999 / 2000 | | | | | | 2000 / 2001 | | | | | |
| | | V1 | V2 | V3 | V4 | V5 | V6 | V1 | V2 | V3 | V4 | V5 | V6 |
| Sowing date | Oct. 10 (Early) | 131.74 | 289.27 | 393.66 | 651.84 | 1116.83 | 1210.96 | 141.16 | 294.19 | 404.85 | 672.53 | 1151.37 | 1229.80 |
| | Nov.10 (Mid) | 154.87 | 285.17 | 401.62 | 654.01 | 1195.45 | 1366.03 | 165.67 | 298.54 | 410.38 | 671.25 | 1188.00 | 1316.47 |
| | Dec.10 (Late) | 173.50 | 300.22 | 384.48 | 676.69 | 1206.78 | 1292.27 | 173.41 | 308.16 | 400.31 | 686.53 | 1228.93 | 1295.93 |
| LSD at 5% | | 2.71 | 8.91 | 10.50 | 7.39 | 15.57 | 19.44 | 6.22 | 3.83 | 6.34 | 4.90 | 6.62 | 11.77 |
| Distribution | 60 x 10 S.R x 2 pl. ($D_1$) | 156.21 | 300.78 | 397.28 | 662.79 | 1171.93 | 1291.12 | 163.70 | 309.20 | 406.90 | 680.87 | 1193.27 | 1282.53 |
| | 60 x 20 D.R x 2 pl.($D_2$) | 152.61 | 299.96 | 393.67 | 667.11 | 1176.60 | 1295.46 | 163.19 | 308.41 | 408.24 | 685.19 | 1194.30 | 1284.40 |
| | 60 x 30 T.R. x 2 pl.($D_3$) | 156.29 | 262.51 | 394.62 | 666.39 | 1180.03 | 1294.77 | 160.11 | 272.62 | 404.67 | 675.78 | 1191.54 | 1281.60 |
| | 90 x 10 S.R.x3 pl. ($D_4$) | 152.53 | 296.88 | 394.24 | 658.74 | 1171.13 | 1285.24 | 157.50 | 304.16 | 403.76 | 676.63 | 1191.52 | 1278.87 |
| | 90 x 20 D.R.x3 pl. ($D_5$) | 148.69 | 293.27 | 389.13 | 655.53 | 1169.14 | 1284.53 | 156.37 | 304.16 | 403.78 | 671.93 | 1187.90 | 1278.07 |
| | 90 x 30 T.R.x3 pl. ($D_6$) | 153.89 | 295.92 | 390.57 | 654.51 | 1169.28 | 1287.46 | 159.60 | 303.23 | 403.74 | 670.23 | 1178.07 | 1278.93 |
| LSD at 5% | | NS | NS | NS | 6.15 | 9.71 | NS | NS | NS | NS | 3.20 | 10.54 | NS |
| A x B | | NS | NS | NS | * | * | NS | NS | NS | NS | * | * | NS |

NS and * indicate to insignificant and significant at 0.05 level of probability, respectively.

distribution pattern was significant for TBSSH at $V_4$ and $V_5$ (50% flowering and last faded stages) in both seasons. Where, late sowing x $D_1$ or $D_2$ at $V_4$ in both seasons and late sowing x $D_1$ or $D_3$ at $V_5$ consumed the greatest TBSSH in both seasons, respectively (Tables 7 and 8)

Results in Table 4 showed the effect of sowing date and plant distribution pattern on photothermal units at different growth stages in both seasons. The data indicate that, the photothermal units (PTU) was significantly influenced by sowing date at all stages of growth in both seasons, where, early sowing (Oct. 10) consumed the greatest values of PTU at stages of $V_1$, $V_2$, $V_3$, and $V_4$ (from emergence to 50 % flowering), while late sowing (Dec. 10) had the greatest PTU at $V_5$ and $V_6$ (last faded and ripening stages) in both seasons. Keatinge, et al. (1998) found that the warmest temperature combined with the shortest photoperiod hastened flowering and fruit maturity in annual legume as faba bean. As for plant distribution pattern, PTU was significantly affected only at $V_4$ (50 % flowering stage) in both seasons. Where, 60 x 20 double row x 2 plant distribution pattern ($D_2$) consumed the greatest PTU, while 90 x 30 triple row x 3 plants ($D_6$) consumed the smallest PTU in both seasons.

The interaction between sowing date and plant distribution pattern was significant for PTU at $V_4$ in both seasons and at $V_1$ in the second season. Where, the highest PTU was consumed with early sowing x $D_2$ at $V_4$ in both seasons and at $V_1$ in the second season ( Tables 7 and 8).

**II- Growth attribute:**

The effect of sowing date and plant distribution pattern on leaf area index (LAI) at different growth stages in both seasons is presented in Table 5. Sowing date had significant effects on LAI at all growth stages in both seasons. However, the peak of LAI was gained at 105 days in early and mid-season sowing but in the later date of sowing the peak of LAI was gained earlier at 90 days, as plants tended to develop earlier. This result may be due to the temperature prevailing during the growth of late sown faba bean account for the decease of LAI values as plants tend to shortest the cycle of growth earlier. Shalaby and Mohamed (1978 ) found that LAI was decreased by delaying sowing date. Also, Zeidan, *et al* (1986) found that early sowing date (Oct. 15) produced the highest values of LAI at the three growth stages (vegetative, flowering and pod- filling stages) during the two seasons. As for plant distribution pattern, the data showed that LAI was insignificantly affected except at 60 and 75 days in first seasons and at 60 days in second season. Where, 60 x 20 double row x 2 plant distribution gave the highest LAI This result also was recorded by Hassan and Hafiz (1998). The interaction between sowing date and plant distribution pattern was significant for LAI only at 60 days in both seasons and at 75 days in the first season. Where, mid- sowing date x $D_2$ gave higher LAI value than other combinations. (Tables 7 and 8).

Table 4: Photothermal units (PTU) for phenological stages in faba bean as influenced by sowing date and plant distribution pattern in 1999 / 2000 and 2000 / 2001 seasons .

| Factors | | Phenological stages | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1999 / 2000 | | | | | | 2000 / 2001 | | | | | |
| | | V1 | V2 | V3 | V4 | V5 | V6 | V1 | V2 | V3 | V4 | V5 | V6 |
| Sowing date | Oct. 10 (Early) | 3419.2 | 7194.9 | 8528.2 | 13213.9 | 20566.8 | 22886.0 | 3057.9 | 6034.4 | 7569.5 | 10315.6 | 16281.2 | 17834.1 |
| | Nov.10 (Mid) | 3272.7 | 5611.8 | 6956.3 | 10674.5 | 20909.6 | 24876.4 | 2416.4 | 3850.0 | 4780.5 | 7854.2 | 16028.3 | 17836.6 |
| | Dec.10 (Late) | 2430.3 | 3919.3 | 5825.1 | 10805.7 | 23730.1 | 25980.2 | 1745.7 | 3240.4 | 4171.3 | 8042.4 | 19117.2 | 21300.7 |
| LSD at 5% | | 65.5 | 248.9 | 172.9 | 269.62 | 392.84 | 482.28 | 48.02 | 105.87 | 81.62 | 62.53 | 996.20 | 157.33 |
| Distribution | 60 x 10 S.R x 2 pl. ($D_1$) | 3094.8 | 5656.2 | 7145.2 | 11681.7 | 21820.5 | 24607.6 | 2446.0 | 4408.6 | 5559.0 | 8765.8 | 17320.9 | 19037.1 |
| | 60 x 20 D.R x 2 pl.($D_2$) | 3024.6 | 5529.4 | 7140.2 | 11763.2 | 21845.5 | 24738.7 | 2449.3 | 4406.2 | 5524.0 | 8791.6 | 17331.3 | 19094.3 |
| | 60 x 30 T.R. x 2 pl.($D_3$) | 3088.8 | 5627.2 | 7141.8 | 11621.9 | 21851.1 | 24706.6 | 2397.0 | 4391.0 | 5496.7 | 8725.4 | 16486.6 | 19001.1 |
| | 90 x 10 S.R.x3 pl. ($D_4$) | 3032.5 | 5559.6 | 7112.1 | 11509.7 | 21625.5 | 24453.8 | 2389.1 | 4316.8 | 5490.2 | 8732.7 | 17303.2 | 18936.3 |
| | 90 x 20 D.R.x3 pl. ($D_5$) | 2953.4 | 5529.9 | 7019.7 | 11414.9 | 21609.1 | 24457.6 | 2357.2 | 4372.3 | 5486.4 | 8714.6 | 17215.9 | 18925.2 |
| | 90 x 30 T.R.x3 pl. ($D_6$) | 3050.5 | 5549.5 | 7060.1 | 11397.0 | 21661.6 | 24520.9 | 2401.6 | 4354.8 | 5486.3 | 8694.3 | 17195.6 | 18948.9 |
| LSD at 5% | | NS | NS | NS | 311.3 | NS | NS | 85.70 | NS | NS | 39.10 | NS | NS |
| A x B | | NS | NS | NS | * | NS | NS | * | NS | NS | * | NS | NS |

NS and * indicate to insignificant and significant at 0.05 level of probability, respectively.

**Table 5: Leaf Area Index (LAI) in different growth stages of faba bean as influenced by sowing date and plant distribution pattern in 1999 / 2000 and 2000 / 2001 seasons .**

| | Factors | Growth periods ( days after planting) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1999 / 2000 | | | | | | 2000 / 2001 | | | | | |
| | | 45 | 60 | 75 | 90 | 105 | 120 | 45 | 60 | 75 | 90 | 105 | 120 |
| Sowing date | Oct. 10 (Early) | 2.13 | 3.02 | 4.09 | 5.76 | 6.69 | 5.78 | 1.91 | 2.96 | 4.01 | 5.06 | 5.63 | 5.23 |
| | Nov.10 (Mid) | 2.39 | 3.25 | 4.51 | 6.16 | 6.65 | 6.38 | 2.21 | 3.24 | 4.23 | 5.57 | 5.59 | 5.53 |
| | Dec.10 (Late) | 1.54 | 2.81 | 3.79 | 5.27 | 5.18 | 4.39 | 1.69 | 2.59 | 3.56 | 4.94 | 4.23 | 4.06 |
| LSD at 5% | | 0.12 | 0.16 | 0.25 | 0.31 | NS | 0.48 | 0.10 | 0.28 | 0.23 | 0.50 | 0.32 | 0.33 |
| Distribution | 60 x 10 S.R x 2 pl. ($D_1$) | 1.96 | 3.08 | 4.19 | 5.88 | 6.06 | 5.48 | 1.92 | 2.94 | 3.91 | 5.21 | 5.11 | 4.92 |
| | 60 x 20 D.R x 2 pl.($D_2$) | 2.01 | 3.25 | 4.30 | 6.91 | 6.26 | 5.63 | 1.98 | 3.07 | 3.97 | 5.22 | 5.21 | 4.98 |
| | 60 x 30 T.R. x 2 pl.($D_3$) | 2.03 | 2.90 | 4.15 | 5.63 | 6.17 | 5.56 | 1.91 | 2.98 | 3.92 | 5.21 | 5.18 | 4.96 |
| | 90 x 10 S.R.x3 pl. ($D_4$) | 2.02 | 3.03 | 4.16 | 5.48 | 6.12 | 5.42 | 1.96 | 2.87 | 3.96 | 5.17 | 5.12 | 4.94 |
| | 90 x 20 D.R.x3 pl. ($D_5$) | 2.06 | 3.05 | 4.12 | 5.77 | 6.23 | 5.46 | 1.93 | 2.87 | 3.90 | 5.18 | 5.16 | 4.90 |
| | 90 x 30 T.R.x3 pl. ($D_6$) | 2.05 | 2.87 | 3.85 | 5.71 | 6.19 | 5.58 | 1.94 | 2.85 | 3.93 | 5.14 | 5.13 | 4.91 |
| LSD at 5% | | NS | 0.08 | 0.09 | NS | NS | NS | NS | 0.12 | NS | NS | NS | NS |
| A x B | | NS | * | * | NS | NS | NS | NS | * | NS | NS | NS | NS |

NS and * indicate to insignificant and significant at 0.05 level of probability, respectively.

**III- Yield and its components:**

The effect of sowing date and plant distribution pattern on yield and its components is presented in Table 6 in which sowing date had a significant effect on No. of pods/ $m^2$ , 100- seed weight , seed yield / plant, straw yield / fad. seed yield / fad. and biological yield/ fad. in both seasons. Stand at harvest (number of plants/ $m^2$) was significantly affected by sowing date in the second season only. Where mid- sowing gave higher number of plants/$m^2$ at harvest than other sowing dates. Data in Table 6 showed that mid- sowing (Nov. 10) gave best results of seed yields per plant and per faddan as well as straw yield per faddan. This also led to better biological yield per faddan. Minor yield components i.e. No. of pods/$m^2$ and 100- seed weight were also higher in Nov. 10 sowing date. This results are in harmony those obtained EL- Defrawy *et al.* (1994). On the other hand, Amer, (1986) And Hussien, *et al* (1994) found that sowing faba bean at mid- October resulted in the highest seed yield/ fad.

Concerning the influence of plant distribution patterns on yield and its components, the results revealed significant differences in No. of pods/ $m^2$ , seed yield/ plant and per faddan in both seasons and biological yield per faddan in the second season . 60 x 20 x double row x 2 plants distribution gave the highest yield and its components in both seasons. These results are in agreement with those obtained by Ghonema and Salama (1991), Hassan and Hafiz (1998) and Mohamed (2000).

The interaction between sowing date and plant distribution pattern was significant for number of pods/ $m^2$, seed yield/ plant and seed yield/ fad. in both seasons. Where the highest values were obtained from mid- sowing x $D_2$ in both seasons (Tables 7 and 8 ).

In general, the mid- sowing date ( Nov. 10 ) was greater than early ( Oct. 10 ) and late ( Dec. 10 ) sowing dates in seed, straw and biological yields. It is apparent that, mid- sowing consumed greater climatic variables as number of days and total bright sunshine hours during growth period which was reflected in greater leaf area index than other sowing dates (early and late) especially during vegetative growth period and flowering stages. While late sowing consumed less climatic variables during vegetative growth period and flowering stages.

**Table 6: Yield and its components in faba bean as influenced by sowing date and plant distribution pattern in 1999 / 2000 and 2000 / 2001 seasons.**

| | Factors | Traits | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1999 / 2000 | | | | | | | 2000 / 2001 | | | | | | |
| | | No. of pods/ m2 | 100-seed weight | Seed yield/ plant (gm) | Straw yield/ fed. (kg) | Seed yield/ fed. (Kg) | Biol. yield/ fed. (Kg) | Stand at harvest plant/$m^2$ | No. of pods/ $m^2$ | 100-seed weight | Seed yield/ plant (gm) | Straw yield/ fed. ( kg) | Seed yield/ fed. (Kg) | Biol. yield/ fed. (Kg) | Stand at harvest plant/$m^2$ |
| Sowing date | Oct. 10 (Early) | 125.09 | 61.67 | 10.23 | 860.50 | 508.88 | 1369.38 | 24.84 | 102.69 | 58.22 | 8.95 | 683.94 | 424.06 | 1108.00 | 22.47 |
| | Nov.10 (Mid) | 134.96 | 63.05 | 11.44 | 1015.44 | 680.89 | 1696.33 | 25.98 | 119.12 | 62.74 | 11.14 | 1071.22 | 688.83 | 1760.05 | 25.24 |
| | Dec.10 (Late) | 121.21 | 60.90 | 8.97 | 715.30 | 442.06 | 1157.36 | 24.34 | 91.97 | 56.34 | 8.52 | 629.94 | 404.22 | 1034.16 | 21.94 |
| | LSD at 5% | 3.79 | 1.12 | 1.43 | 71.80 | 45.18 | 92.26 | NS | 7.29 | 2.29 | 1.38 | 79.35 | 50.55 | 117.03 | 0.98 |
| Distribution | 60 x 10 S.R x 2 pl. ($D_1$) | 128.04 | 62.03 | 10.32 | 872.50 | 544.54 | 1417.04 | 24.96 | 104.22 | 59.20 | 9.57 | 787.44 | 504.22 | 1291.66 | 22.79 |
| | 60 x 20 D.R x 2 pl.($D_2$) | 133.05 | 61.97 | 11.07 | 874.10 | 569.18 | 1443.28 | 25.09 | 109.94 | 58.81 | 10.13 | 830.56 | 548.11 | 1378.67 | 22.90 |
| | 60 x 30 T.R. x 2 pl.($D_3$) | 126.91 | 61.59 | 8.99 | 854.38 | 529.75 | 1384.13 | 24.89 | 102.41 | 59.00 | 9.32 | 784.11 | 497.11 | 1281.22 | 22.54 |
| | 90 x 10 S.R.x3 pl. ($D_4$) | 126.93 | 61.94 | 10.50 | 862.24 | 553.50 | 1415.74 | 25.03 | 104.94 | 59.30 | 9.67 | 790.44 | 506.67 | 1297.11 | 22.78 |
| | 90 x 20 D.R.x3 pl. ($D_5$) | 125.05 | 61.83 | 10.39 | 854.61 | 543.88 | 1398.49 | 25.06 | 103.74 | 59.07 | 9.42 | 789.89 | 497.22 | 1287.11 | 22.83 |
| | 90 x 30 T.R.x3 pl. ($D_6$) | 122.56 | 61.87 | 9.99 | 864.65 | 522.79 | 1387.44 | 25.30 | 102.29 | 59.23 | 9.10 | 787.78 | 480.89 | 1268.67 | 22.99 |
| | LSD at 5% | 4.07 | NS | 1.03 | NS | 32.71 | NS | NS | 4.73 | NS | 1.00 | NS | 31.72 | 47.41 | NS |
| A | x B | * | NS | * | NS | * | NS | NS | * | NS | * | NS | * | NS | NS |

NS and * indicate to insignificant and significant at 0.05 level of probability, respectively.

Table 7: Phenological climatology, growth attributes and yield and its components as affected by the interactions between sowing dates and plant distribution patterns in 1999/2000 season.

| Sowing date | P. dist. | ND. $V_4$ | TBSSH |  | PTU $V_4$ | LAI |  | No. of pods/ $m^2$ | Seed yield/ plant | Seed yield/ fad. |
|---|---|---|---|---|---|---|---|---|---|---|
|  |  |  | $V_4$ | $V_5$ |  | 60 days | 75 days |  |  |  |
| Early Oct. 10 | $D_1$ | 89.37 | 652.64 | 1112.32 | 13218.4 | 3.03 | 4.12 | 126.07 | 10.32 | 519.02 |
|  | $D_2$ | 89.97 | 653.11 | 1123.13 | 13224.9 | 3.15 | 4.10 | 128.13 | 10.29 | 525.03 |
|  | $D_3$ | 90.97 | 653.50 | 1135.28 | 13224.4 | 2.95 | 4.08 | 124.50 | 10.23 | 508.11 |
|  | $D_4$ | 88.86 | 651.55 | 1114.32 | 13224.2 | 3.04 | 4.10 | 124.73 | 10.25 | 505.00 |
|  | $D_5$ | 88.57 | 650.10 | 1107.97 | 13197.6 | 3.01 | 4.08 | 123.92 | 10.13 | 503.05 |
|  | $D_6$ | 88.45 | 650.17 | 1107.98 | 13193.9 | 2.94 | 4.06 | 123.19 | 10.16 | 493.03 |
| Mid. Nov.10 | $D_1$ | 88.54 | 646.73 | 1193.91 | 10651.4 | 3.29 | 4.52 | 136.76 | 11.58 | 704.17 |
|  | $D_2$ | 90.17 | 663.85 | 1198.50 | 10705.1 | 3.48 | 4.67 | 139.25 | 11.98 | 718.08 |
|  | $D_3$ | 89.88 | 660.41 | 1195.62 | 10683.1 | 3.09 | 4.43 | 133.93 | 10.69 | 635.42 |
|  | $D_4$ | 89.40 | 655.02 | 1194.71 | 10692.3 | 3.26 | 4.59 | 134.40 | 11.57 | 695.18 |
|  | $D_5$ | 89.07 | 650.15 | 1195.82 | 10653.0 | 3.24 | 4.45 | 132.55 | 11.52 | 684.12 |
|  | $D_6$ | 88.62 | 647.90 | 1194.20 | 10662.1 | 3.12 | 4.40 | 132.87 | 11.29 | 648.37 |
| Late Dec.10 | $D_1$ | 85.10 | 689.00 | 1209.61 | 11175.3 | 2.92 | 3.93 | 121.29 | 9.06 | 410.43 |
|  | $D_2$ | 84.37 | 684.37 | 1208.20 | 11359.6 | 3.10 | 4.13 | 131.77 | 10.94 | 464.43 |
|  | $D_3$ | 83.84 | 685.26 | 1209.24 | 10958.1 | 2.66 | 3.94 | 122.30 | 6.05 | 445.72 |
|  | $D_4$ | 83.91 | 669.65 | 1204.40 | 10612.6 | 2.80 | 3.79 | 121.66 | 9.68 | 460.32 |
|  | $D_5$ | 82.85 | 666.34 | 1203.71 | 10394.0 | 2.90 | 3.83 | 118.68 | 9.52 | 444.47 |
|  | $D_6$ | 84.26 | 665.46 | 1205.71 | 10335.0 | 2.55 | 3.12 | 111.62 | 8.54 | 426.97 |
| L.S.D. at 0.05 |  | 1.32 | 6.70 | 17.82 | 50.9 | 0.17 | 0.22 | 9.50 | 0.81 | 21.63 |

Table 8: Phenological climatology, growth attributes and yield and its components as affected by the interactions between sowing dates and plant distribution pattern in 2000 / 2001 season.

| Sowing date | P. dist. | ND. $V_4$ | TBSSH |  | PTU |  | LAI 60 days | No. of pods/$m^2$ | Seed yield/ plant | Seed yield/ fad. |
|---|---|---|---|---|---|---|---|---|---|---|
|  |  |  | $V_4$ | $V_5$ | $V_1$ | $V_4$ |  |  |  |  |
| Early Oct. 10 | $D_1$ | 90.41 | 670.90 | 1152.90 | 3105.6 | 10355.1 | 2.95 | 102.75 | 8.99 | 427.21 |
|  | $D_2$ | 90.84 | 675.81 | 1155.41 | 3109.1 | 10370.1 | 3.00 | 108.13 | 9.47 | 440.07 |
|  | $D_3$ | 89.95 | 669.88 | 1149.80 | 3045.3 | 10306.1 | 3.01 | 101.38 | 8.49 | 419.81 |
|  | $D_4$ | 90.92 | 672.77 | 1153.92 | 3027.2 | 10310.7 | 2.93 | 103.95 | 9.19 | 435.21 |
|  | $D_5$ | 90.38 | 674.19 | 1148.80 | 3020.2 | 10284.2 | 2.95 | 99.68 | 8.87 | 412.43 |
|  | $D_6$ | 89.48 | 671.80 | 1147.41 | 3040.1 | 10266.9 | 2.92 | 100.25 | 8.68 | 409.63 |
| Mid. Nov.10 | $D_1$ | 89.92 | 671.91 | 1193.41 | 2448.1 | 7888.5 | 3.24 | 119.13 | 11.13 | 689.37 |
|  | $D_2$ | 90.92 | 674.41 | 1195.81 | 2456.4 | 7902.1 | 3.60 | 127.05 | 11.26 | 715.07 |
|  | $D_3$ | 89.18 | 668.70 | 1187.50 | 2403.2 | 7846.7 | 3.39 | 115.22 | 11.08 | 679.00 |
|  | $D_4$ | 89.05 | 671.22 | 1186.92 | 2401.3 | 7861.1 | 3.08 | 123.10 | 11.23 | 711.03 |
|  | $D_5$ | 89.21 | 671.11 | 1183.71 | 2374.4 | 7831.2 | 3.05 | 118.05 | 11.18 | 671.08 |
|  | $D_6$ | 88.71 | 670.00 | 1180.70 | 2415.0 | 7795.7 | 3.07 | 112.17 | 10.96 | 667.45 |
| Late Dec.10 | $D_1$ | 87.47 | 699.80 | 1233.50 | 1784.3 | 8053.9 | 2.63 | 90.78 | 8.59 | 396.08 |
|  | $D_2$ | 86.30 | 705.40 | 1231.71 | 1782.4 | 8102.5 | 2.60 | 94.64 | 9.66 | 489.19 |
|  | $D_3$ | 85.75 | 688.80 | 1237.27 | 1742.5 | 8023.3 | 2.54 | 90.63 | 8.39 | 392.52 |
|  | $D_4$ | 86.44 | 685.91 | 1233.78 | 1738.8 | 8026.4 | 2.60 | 87.77 | 8.59 | 373.77 |
|  | $D_5$ | 86.23 | 670.42 | 1231.35 | 1677.0 | 8028.4 | 2.61 | 93.49 | 8.21 | 408.15 |
|  | $D_6$ | 85.13 | 668.90 | 1206.14 | 1749.7 | 8020.2 | 2.56 | 94.47 | 7.68 | 365.59 |
| L.S.D. at 0.05 |  | 1.14 | 4.03 | 13.64 | 40.4 | 52.3 | 0.19 | 6.53 | 1.42 | 26.32 |

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# الاستجابة الفينولوجية للتأثيرات البيئية تحت مواعيد الزراعة وتوزيع النباتات في الفول البلدي

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أجري هذا البحث بمحطة التجارب والبحوث الزراعية بكلية الزراعة – جامعة القاهرة بالجيزة خلال موسمي ٩٩ / ٢٠٠٠ ، ٢٠٠٠ / ٢٠٠١ لدراسة استجابة المراحل الفينولوجية والمحصول في الفول البلدي لثلاث مواعيد زراعة وهي مبكر ( ١٠ أكتوبر) ومتوسط (١٠ نوفمبر) ومتأخر (١٠ ديسمبر) وسته نماذج لتوزيع النباتات وهي ٦٠ × ١٠ × ٢ نبات /جورة × ريشة واحدة ( $D_1$ ) و ٦٠ × ٢٠ × ٢ نبات / جورة × ٢ ريشة ( $D_2$ ) و ٦٠ × ٣٠ × ٣ نبات / جورة × ٣ ريشة ( $D_3$ ) و ٩٠ × ١٠ × ٣ نبات × ريشة واحدة ( $D_4$ ) و ٩٠ × ٢٠ × ٣ نبات × ٢ ريشة ( $D_5$ ) و ٩٠ × ٣٠ × ٣ نبات × ٣ ريشة ( $D_6$ ) وكل هذه التوزيعات النباتية تعطى ١٣٩,٨٦٠ نبات/فدان. وكانت مراحل النمو كالتالي :-

١- الإنبات ( $V_1$ ) وصول ٥٠ % من النباتات لاكتمال ظهور أول ورقة منبسطة.
٢- البرعم الزهري ( $V_2$ ) ظهور أول برعم زهري ٣- ظهور أول زهرة ( $V_3$ ).
٤- ٥٠ % تزهير ( $V_4$ ) ٥- تكوين آخر قرن ( $V_5$ ). ٦-النضج ( $V_6$ ): أسمرار ٧٥ % من القرون . وتوضح النتائج ما يلي :-

١-أدي تأخير ميعاد الزراعة الي زيادة عدد الأيام في المراحل من الإنبات حتي ظهور أول برعم زهري ( $V_1$ ، $V_2$ ) بينما قلت عدد الأيام في المراحل من أول زهرة و ٥٠% تزهير وحتي تكوين أخر قرن ( $V_3$ ، $V_4$ ، $V_5$ )

٢-تحصل ميعاد الزراعة المتأخر (١٠ ديسمبر) علي أكبر عدد ساعات إضاءة كلية خلال مراحل النمو من الزراعة حتي الإنبات وأول برعم زهري و ٥٠% تزهير وتكوين أخر قرن ( $V_1$ ، $V_2$ ، $V_4$ ، $V_5$ ) . أما ميعاد الزراعة المتوسط (١٠ نوفمبر) فقد تحصل علي أكبر عدد ساعات إضاءة كلية خلال مراحل أول زهرة والنضج ( $V_3$ ، $V_6$ ) .

٣-تحصلت الزراعة المبكرة علي أكبر عدد من الوحدات الضوئية الحرارية خلال مرحلة الإنبات وأول برعم زهري بينما تحصلت الزراعة المتأخرة علي أكبر عدد من الوحدات الضوئية الحرارية خلال المراحل المتأخرة وهي تكوين أخر قرن والنضج ( $V_5$ ، $V_6$ ). سجلت زراعات أكتوبر ونوفمبر أكبر قيم لدليل مساحة الأوراق عند عمر ١٠٥ يوم بينما زراعات ديسمبر سجلت أكبر قيم لدليل مساحة الأوراق عند عمر ٩٠ يوم بعد الزراعة .

٤- أعطت زراعات نوفمبر أحسن مكونات محصول وهي عدد القرون / المتر المربع ودليل البذرة ومحصول البذور / النبات وعدد النباتات / المتر المربع وكذلك محصول البذرة والقش للفدان .

٥-لم تؤثر نظم توزيع النباتات معنويا علي عدد الأيام خلال مراحل النمو المختلفة . وتحصل نظام التوزيع ٦٠ × ٢٠ × ٢ نبات علي الريشتين علي أكبر عدد ساعات إضاءة كلية ووحدات ضوئية حرارية وأعطي أكبر قيم لدليل مساحة الأوراق وكذلك مكونات المحصول ومحصول البذرة / الفدان.

٦- أثر التفاعل بين ميعاد الزراعة ونظم توزيع النباتات معنويا علي بعض صفات النمو ومحصول البذرة / الفدان في كلا الموسمين . أنتج ميعاد الزراعة ١٠ نوفمبر مع نظام توزيع النباتات ٦٠ × ٢٠ × ٢ نبات علي الريشتين أكبر محصول بذرة وكان مقداره ٧١٨,٠٨ و ٧١١,٣ كجم / الفدان للموسمين علي التوالي .