

Effects of Sowing Dates on the Phenology, Seed Yield and Yield Components of Peas

A. B. Siddique, D. Wright and ¹S. M. Mahbub Ali

School of Agricultural and Forest Sciences, University of Wales, Bangor, Gwynedd, United Kingdom, ¹Planning and Training Division, Bangladesh Jute Research Institute, Manikmia Avenue, Dhaka-1207, Bangladesh

Abstract: This experiment was conducted to test a range of sowing dates, between 01.03.99 and 07.06.99 and in this way covering a wide range of environmental situations. Seed yield, yield component and different development periods of peas were measured. It was found that seed yield generally decreased in delayed sowing. Decrease of yield in delayed sowing was due to decreases in all yield components. The effects were significant for number of seeds per m², number of seeds per plant and number of seeds per pod but not for number of pods per m² and per plant.

Key words: Peas, seed, sowing date, yield

Introduction

The farmers of third world countries usually do not grow particular crops for seed purposes only, so they do not apply physiological and agronomic crop husbandry techniques which are necessary for a seed crop rather than a commercial crop for grain. These include use of appropriate sowing and harvest time, sowing density, fertilizer requirements, irrigation, seed processing and drying at appropriate temperature, seed cleaning and storing in good storage environments. Adjustment of sowing date plays an important role in increasing the seed yield. Pea is a large seeded grain legume with high protein content. The majority of pea crops in Europe and North America are spring sown. Most sowing date field trials have, therefore, concentrated on spring sowings and excluded autumn sowings (Boswell, 1926; Milbourn and Hardvich, 1968; Vulstekeg, 1974). In principle, delay in sowing beyond an optimum date results in a progressive reduction in the potential yield of the crop (Green *et al.*, 1985; Heenan, 1994; Sangar and Singh, 1994; Varshney, 1995). Peas require a cool, moist climate. The pea seeds germinate and grow vigorously at lower temperatures than do many other pulses. High temperatures induce flowering before the plants have grown sufficiently to bear a good crop. In regions with mild winters and winter rainfall peas are sown in winter; in the summer rainfall, regions with cold winter, they are sown in the spring (Arnon, 1972). Boswell (1929) reported that as temperature during the growing season rose, the pod yield dropped off rapidly. Early sowing makes a significant contribution towards yield, indeed for each week's delay in sowing after the first week of March, the yield of combining peas falls by 125 kg ha⁻¹ (Anonymous, 1982). Seed yield is affected very much by environmental factors prevailing at the time of seed development. Even at the same location seed yield of early, mid or late maturing pea crops is different because of varying environmental conditions at the time of pod maturity (Makasheva, 1973). Therefore, this experiment was conducted to identify the effects of sowing dates on development periods, plant growth, seed yield and yield components of peas.

Materials and Methods

This experiment was conducted at the Henfaes Research Centre of the University of Wales, Bangor, United Kingdom during 1999. Important meteorological parameters i.e. mean weekly maximum and minimum temperature, sunshine, total number of rainy days and rainfall experienced by the seed crop during the growing season were recorded in a standard agrometeorological station, located less than 1 km from the experimental site. Following eight sowing (S) dates were tested:

S1 = 01.03.99; S2 = 15.03.99;
S3 = 29.03.99; S4 = 12.04.99;
S5 = 26.04.99; S6 = 10.05.99;
S7 = 24.05.99 and S8 = 07.06.99.

A randomized complete blocks design was used. The pea variety was Baccara, which is a normal leaved variety and collected from John Turner Seeds, Cambridge, UK.

Clay loam top soil (0-15cm) was collected from an agricultural field, sieved, mixed with compost (B & Q multipurpose compost, B & Q Plc, Chandlersford, Hants, SO 53 3YX), UK and used to fill thirty two pots (holding capacity of 70 litres), 44 cm diameter and 65 cm deep. Initially 24 seeds were sown in each pot, with 2 seeds at each position. When the seeds emerged the seedlings were counted and then thinned to twelve per pot, which is equivalent to 79 plants per m². Twelve plants were established in each pot, and arranged in a grid pattern, with approximately 8 cm between plants. Phosphorus and potassium fertilizer were applied as a basal dose @ 50kg P₂O₅ and 50 kg K₂O per ha before sowing in the form of a compound fertilizer (0-24-24). As soil was fertile and additional nitrogen requirements were low because of mixing compost, no nitrogenous fertilizer was applied. The plants were watered with tap water as and when required. Weeds were removed manually in all pots whenever necessary.

Date of emergence (when the first shoot appeared above the ground surface), date of first flowering, date of average flowering (when flowers were visible and open at most of the nodes and the first pods were visible on the plants), last date of visible flowers and date of harvest were recorded. Flowering period was calculated from the difference between first flowering date and last date of visible flowers. The plants in each pot were harvested by hand as they matured. All plants were removed by hand pulling and counted. All pods were removed, counted and threshed by hand. The seeds were counted using an automatic seed counter, dried in trays in the air in an unheated glasshouse and then weighed. The empty pods were collected, put with the straw and dried in an oven at 80°C for 48 hours to determine the straw dry weight. These data were then used to calculate number of pods per plant, number of seeds per plant, number of seeds per pod, seed weight per plant, straw dry weight per plant and 1000 seed weight.

All data were analyzed by the analysis of variance (ANOVA) method, using Minitab statistical package version -12. Tests of differences between means were made at the 5% probability level when a significant F value was obtained for sowing date effect. Different treatment means were compared by calculating a Least Significance Difference (LSD) as follows:

$$LSD = \sqrt{(2EMS/n) \times t (0.05), df.}$$

Where EMS = error mean square; from analysis of variance table n = number of replications (4); t = (0.05), df = value from the t distribution table at 5% probability level and appropriate error degrees of freedom (df).

Results

The effects of sowing date on all development periods were significant (Fig. 1). As the sowings were made at two weeks

Table 1: Mean weekly maximum and minimum temperature, sunshine and total number of rainy days and rainfall recorded during the growing season of peas and flax in 1999 (sowing started on 1st March, 1999)

Dates	Weeks after first sowing	Temperature (°C)		No. of rainy days	Rainfall/day (mm)	Sunshine/day (h)
		Max.	Min.			
1-7 March	1	7.6	4.4	7	8.2	0.0
8-14 March	2	9.5	3.5	3	0.4	4.0
15-21 March	3	11.8	7.0	3	1.5	5.0
22-28 March	4	10.0	5.3	6	2.5	2.2
29 March-4 April	5	15.9	8.9	5	1.5	6.3
5-11 April	6	13.4	9.3	4	3.3	4.1
12-18 April	7	8.1	2.4	6	3.3	5.1
19-25 April	8	12.2	6.3	6	3.9	4.7
26 April-2 May	9	12.3	7.3	1	0.3	8.1
3-9 May	10	17.4	9.2	4	2.8	5.3
10-16 May	11	14.5	10.3	5	2.7	6.7
17-23 May	12	15.1	9.6	3	0.5	6.2
24-30 May	13	15.7	10.5	6	1.3	4.5
31 May-6 June	14	14.8	10.0	6	3.9	5.3
7-13 June	15	14.1	8.7	2	0.4	6.0
14-20 June	16	18.7	11.6	2	2.6	8.8
21-27 June	17	18.5	10.6	4	5.0	6.2
S28 June-4 July	18	18.9	12.4	4	1.0	6.0
5-11 July	19	21.5	14.6	1	0.5	8.2
12-18 July	20	19.2	12.9	3	0.3	7.1
19-25 July	21	19.4	13.2	2	1.0	5.8
26 July-1 August	22	22.1	12.1	0	0.0	12.4
2-8 August	23	19.7	15.0	6	6.8	2.5
9-15 August	24	17.3	12.6	4	2.2	6.0
16-22 August	25	18.0	10.8	4	1.1	8.8
23-29 August	26	19.5	13.1	4	2.3	3.9
30 Aug-5 Sept.	27	21.0	13.0	0	0.0	5.5
6-12 September	28	20.6	11.5	4	7.5	7.4
13-19 September	29	17.6	10.5	3	9.7	6.3

Table 2: Effects of date of sowing on emergence percentage, development periods, yield and yield components of peas

Parameters	Date of sowing								SED	LSD
	1.3.99	15.3.99	29.3.99	12.4.99	26.4.99	10.5.99	24.5.99	7.6.99		
Emergence % (original data)	95.5	94.6	97.3	97.3	94.6	96.4	95.5	91.0	4.78	NS
Emergence % (transformed data)	9.7	9.7	9.8	9.8	9.7	9.8	9.7	9.5	0.25NS	
Flowering period	27.2	24.5	22.0	18.5	15.7	13.0	14.5	18.0	0.62	1.28 ***
Days from 1 st flowering to harvest	53.2	50.2	49.0	47.0	43.0	44.2	46.0	47.7	0.74	1.54 ***
Number of pods/m ²	567.0	627.0	616.0	570.0	523.0	577.0	575.0	567.0	35.46	NS
Number of seeds/ m ²	2732.0	3006.0	2972.0	2970.0	2834.0	3019.0	3026.0	2342.0	163.98	338.45 **
Seed weight/ m ² (g)	894.0	918.0	904.0	890.0	844.0	863.0	863.0	70.18	144.86 **	
Straw dry weight/ m ² (g)	599.0	610.0	596.0	616.0	551.0	565.0	569.0	395.0	51.27	105.82 **
1000 seed weight (g)	326.0	306.0	305.0	300.0	298.0	284.0	284.0	269.0	15.39	31.77*
Number of pods/plant	6.2	6.8	6.7	6.2	5.7	6.2	6.3	6.2	0.39	NS
Number of seeds/plant	29.7	32.7	32.3	32.3	30.8	32.8	32.9	25.4	1.78	3.68 **
Number of seeds/pod	4.8	4.8	4.8	5.2	5.4	5.2	5.3	4.1	0.21	0.43 ***
Seed weight/plant (g)	9.71	9.97	9.83	9.68	9.17	9.37	9.37	6.83	0.762	1.572 **
Straw dry weight/plant (g)	6.50	6.63	6.47	6.69	5.99	6.14	6.18	4.29	0.557	1.149 **
Harvest index %	59.9	60.0	60.3	59.1	60.5	60.6	60.3	61.4	1.13	NS

* = Significant level at 5 %, ** = Significant level at 1 %, *** = Significant level at 0.1 % NS = Non Significant

Table 3: Values of the linear correlation coefficient (r) of seed yield/m² between pods/plant, seeds/pod and 1000 seed weight of peas (n=8).

Parameters	Peas
Pods/plant	r = 0.324
Seeds/pod	r = 0.664
1000 seed weight	r = 0.733
	(P < 0.05)

Values within brackets are the corresponding probability levels

intervals the differences between consecutive sowings were generally small and sometimes not significant.

Days from sowing to emergence: As sowing date was delayed then days from sowing to emergence {D (S-E)} decreased. Days

from sowing to emergence decreased markedly as sowing was delayed from 01.03.99 to 29.03.99. Days from sowing to emergence for sowing 4 was slightly greater than expected due to very cold and wet weather during week 7 (Table 1). Days from sowing to emergence for sowings 5 to 8 were similar.

Duration of different development periods: As sowing was delayed the number of days from sowing to first flowering, emergence to first flowering, sowing to average flowering and sowing to harvest all decreased (Fig. 1). The effects of date of sowing on the number of days from sowing to first flowering decreased as sowing was delayed. The decrease was large in between sowings 1 to 5 and relatively smaller from sowings 5 to 8. The number of days from emergence to first flowering decreased as sowing was delayed. This decrease was relatively

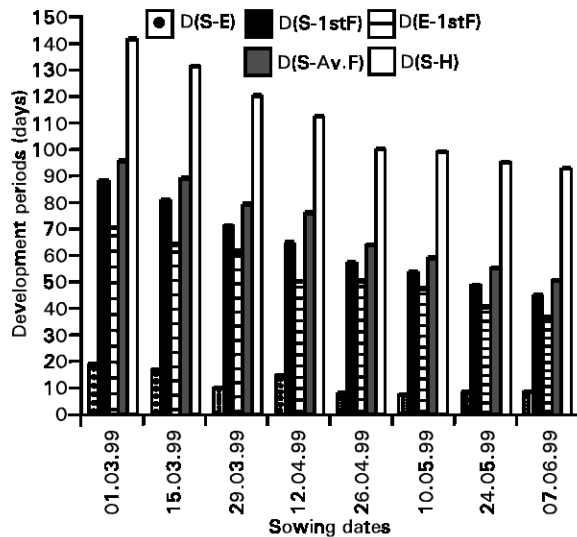


Fig. 1: The effect of data of sowing on the length of different development periods (days) of flax plants between sowing (S), emergence (E), first flowering (1stF), Average flowering (Av.F) and harvest (H) (vertical bars are \pm SE of the means)

constant over all the sowing dates, except 29.03.99 to 12.04.99. The number of days from sowing to average flowering decreased significantly as sowing was delayed. There was a significant effect of sowing date on the number of days from sowing to harvest. The number of days from sowing to harvest decreased as sowing was delayed. This decrease was large up to sowing 5 and relatively smaller from sowing 6 to 8. Days from first flowering to harvest and the duration of the flowering period also generally decreased as sowing was delayed (Table 2).

Emergence percentage: The effect of time of sowing on emergence percentage was not significant. The range of emergence percentage was 97.3 to 91% (Table 2). After thinning there were 12 plants in each pot and they all survived throughout the maturity, so, at harvest the number of plants were identical in all the sowings.

Yield and yield components: Seed weight per plant and seed weight per m² were not significantly affected by the date of sowing over the range of sowing dates from 01.03.99 to 24.05.99 (Table 2). However, at the last sowing date seed weight per plant and seed weight per m² were significantly decreased. There was no significant effect of sowing date on number of pods per plant and number of pods per m² but the effect was significant on number of seeds per plant and seeds per m². Sowings 1 to 7 all had similar number of seeds per plant, but sowing 8 had a significantly lower number. The lower seed weight per plant at the final sowing was due to significant decreases in the number of seeds per pod and 1000 seed weight. The effect of sowing date on straw dry weight was also significant. Sowings 1 to 7 had similar weight but sowing 8 had a significantly lower weight. Finally the effect of sowing date on harvest index percentage was not significant.

Discussion

The environment during seed development is a major determinant of seed yield (Delouche, 1980). Sowing dates exhibit their effects on plants by affecting various physiological process. In this experiment sowing dates had a significant effect on most of the studied characters including duration from sowing to emergence,

the length of different development periods, seed yield and yield components. In peas apart from emergence percentage, number of pods per plant and m² and harvest index, all variables were significantly affected.

Effects of sowing date on plant development: As sowing date was delayed then due to rising temperatures (Table 1) and longer photoperiods, vegetative growth was very rapid and hence pea plants matured quickly. The harvest dates of each sowing were much closer together than the sowing dates. The first sowing took 141 days from sowing to harvest whereas the final sowing took 92 days only. This was also observed with different crop species by other workers (Friend *et al.*, 1962; Wall and Cartwright, 1974; Stern and Kirby, 1979). Examination of the records for the time when individual sowings became ready for harvest showed them to have a strong relation with date of sowing.

March sowings tended to be ready for harvest before the end of July while mid April to mid May sowings tended to become ready in the second week in August and late May and first week of June sowings in the last week of August and first week of September. Delaying sowing decreased the length of all development periods. Comparing the first and final sowing dates, corresponding decreases were 10, 34 and 5 days. Hence delay sowing had its greatest effect on the duration of the period between emergence and first flowering. The shorter duration of the seed filling period was reflected in lower average seed weight (Table 2).

The faster development of later sowings is probably due to the fact that they experienced higher temperatures and longer photoperiods. Other investigators have obtained similar results with other species (Peterson and Loomis, 1949; Gardner and Loomis, 1953; Lindsey and Peterson, 1964).

Effects of sowing date on yield and yield components: The results show a clear yield trend in favour of early sowing. From these experiments it may be concluded that peas are best drilled as soon after the middle of March as soil conditions allow. Comparison of the sowing dates (Tables 2) show that the later sowings suffered a much more severe yield drop. The earliest sowings are likely to have suffered some yield loss in comparison with the second sowings, as early sowings experienced more cold and wet weather condition. The yield decrease was mainly due to a decrease in 1000 seed weight and number of seeds per pod but number of pods per plant was not affected.

Relationship between sowing date, yield components and yield: The results (Table 3) show the values of the linear correlation coefficient of yield components with yield per m². In peas yield per m² was significantly correlated with 1000 seed weight only. The correlation of yield per m² was not significant with pods per plant or seeds per pod.

This study indicated that delay sowing after mid April resulted in yield reductions, which is in agreement with the findings of other workers (Bosswell, 1926; Kruger, 1973; Silim *et al.*, 1985).

References

- Arnon, I., 1972. Crop Production in Dry Regions. Vol. 2 (ed. Leonard Hill), pp: 233. London.
- Anonymous, 1982. In Notes on Growing Combining Peas, pp: 11. Processors and Growers Research Organization, Peterborough, England.
- Boswell, V.R., 1929. Factors influencing yield and quality of peas. Biophysical and Biochem. Studies, pp: 306.
- Boswell, V.R., 1926. The influence of temperature upon the growth and yield of garden peas. Proceedings of the American Soc. Hort. Sci., 23: 162-168.
- Delouche, J.C., 1980. Environmental effects on seed development and seed quality. Hort. Sci., 15: 775-780.

Siddique *et al.*: Peas, seed, sowing date, yield

- Friend, D.J.C., V.A. Helson and J.E. Fisher, 1962. Leaf growth in marquis wheat, as regulated by temperature, light intensity and day length. *Canadian J. Bot.*, 40: 1299-1310.
- Gardner, F.P. and W.E. Loomis, 1953. Floral induction and development in orchardgrass. *Pl. Physiol.*, 28: 201-217.
- Green, C.F., G.A. Paulson and J.D. Ivins, 1985. Time of sowing and the development of winter wheat. *J. Agric. Sci.*, 105: 217-221.
- Heenan, D.P., 1994. Effect of sowing time on growth and grain yield of lupin and field pea in south eastern New South Wales. *Australian J. Exp. Agric.*, 34: 1137-1142.
- Kruger, S.N., 1973. Effect of time of planting on the seasonal yield of *Pisum sativum* L. *Queensland J. Agric. Ani. Sci.*, 30: 25-38.
- Lindsey, K.E. and M.L. Peterson, 1964. Floral induction and development in *Poa pratensis* L. *Crop. Sci.*, 4: 540-544.
- Makasheva, R.K., 1973. The Pea. New Delhi, pp: 78-85. Oxonian Press Pvt. Ltd.
- Milbourn, G.M. and R.C. Hardwick, 1968. The growth of vining peas. I. The effect of time of sowing. *J. Agric. Sci.*, 70, 393-402.
- Peterson, M.L. and W.E. Loomis, 1949. Effects of photoperiod and temperature on growth and flowering of Kentucky bluegrass. *Pl. Physiol.*, 24: 31-43.
- Sangar, R.B.S. and V.K. Singh, 1994. Effect of sowing dates and pea varieties on the severity of rust, powdery mildew and yield. *Indian J. Pulses Res.*, 7, 88-89.
- Silim, S.N., P.D. Hebblethwaite and M.C. Heath, 1985. Comparison of the effects of autumn and spring sowing date on growth and yield of combining peas (*Pisum sativum* L.). *J. Agric. Sci.*, 104: 35-46.
- Stern, W.R. and E.J.M. Kirby, 1979. Primordium initiation at the shoot apex in four contrasting varieties of spring wheat in response to sowing date. *J. Agric. Sci.*, 93: 203-215.
- Varshney, J.G., 1995. Response of dwarf pea cultivars to dates of sowing and row spacings. *Indian J. Pulses Res.*, 8: 33-35.
- Vulstekeg, G., 1974. The importance of sowing date in peas for harvesting dry. *Field Crop Abst.*, 1975. 28: 6506.
- Wall, P.C. and P.M. Cartwright, 1974. Effects of Photoperiod, temperature and vernalization on the phenology and spikelet numbers of spring wheats. *Ann. Appl. Biol.*, 76: 299-309.