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Growth and Vegetable Pod Yield of Edible Podded Pea as Influenced by Sowing Time and Plant Density

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Abstract: An experiment was carried out to study the growth and vegetable pod yield of edible podded pea as influenced by sowing time and spacing. The experiment consisted of two factors, which were three sowing times and six plant spacings. The results revealed that Nov. 23 sown plants showed higher leaf area index, leaf, stem and pod dry matter, plant height and vegetable pod yield than those of Nov. 8 and Dec. 8 sowing. Closest spacing produced the highest LAI, leaf, stem and pod dry matter, crop growth rate, plant height and vegetable pod yield. However, relative growth rate and net assimilation rate were the highest in widest spacing. Regardless of variation in sowing time and spacing, LAI, leaf and stem dry matter, CGR, RGR and NAR increased sharply up to 60 DAE and then declined but pod dry matter increased thereafter. Moreover, plant height increased rapidly up to 60 DAE and then slowly. The highest vegetable pod yield (10.26 t ha^{-1}) was recorded from the Nov. 23 sowing with 30x20 cm^2 spacing.

Key words: Pea, sowing time, plant density, growth, pod yield

Introduction

Edible podded pea is a short duration crop and can be grown successfully during winter season in Bangladesh. Sowing of peas beyond or before its optimum period causes reduction in grain yield (Ram *et al.*, 1973). Pea can be grown well at 10-18°C and after 20°C the yield is reduced and above 30°C, pea cultivation is impossible. Time of sowing determines the flowering time and also has great influence on dry matter accumulation, pod formation, seed setting and seed yield (Saran and Giri, 1987). A short cool season prevails in Bangladesh, which starts with the fall of temperature and humidity and ends with sudden rise in temperature. For that, planting time of edible pea is therefore, very critical and planting should be done carefully so that the crop can take the best advantage of the entire cool period. On the other hand, plant density is another important factor affecting the growth and yield of crops which can be manipulated to maximize yield (Babu and Mitra, 1989). Dry matter production of crops depends on the amount of intercepting solar radiation and its conversion to chemical energy. The efficiency of crop in intercepting and converting solar energy is dependent on the distribution and posture of the leaves in the canopy (Misa *et al.*, 1994). Population density modifies the canopy structure and influence light interception, dry matter production and yield of crop (Fukai *et al.*, 1990). Since edible podded pea is a newly introduced crop, the information regarding the influence of sowing time and plant density on its growth and yield is limited (Hoque *et al.*, 1994; Kaul and Gowda, 1982). Hence, the study was undertaken to evaluate the effect of different planting time and plant density on growth, dry matter production and yield performance of edible podded pea.

Materials and Methods

The experiment was conducted at the experimental field and Horticulture Laboratories of the Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Salna, Gazipur during October 1999 to March 2000. The treatments included 3 planting times viz., Nov. 8, 23 and Dec. 8, 1999 and the six spacings viz., 30x20 (144 plants $plot^{-1}$), 40x20 (120 plants $plot^{-1}$), 50x20 (96 plants $plot^{-1}$), 40x30 (80 plants $plot^{-1}$), 50x30 (64 plants $plot^{-1}$), and 50x40 cm^2 (48 plants $plot^{-1}$). The experiment was laid out in a factorial randomized complete block design (RCBD). Edible podded pea variety, BARI Motorshuti-2 was used in this experiment. The land was fertilized with cowdung, urea, TSP, muriate of potash (MP) and gypsum @ 10000, 50, 200, 200 and 120 kg ha^{-1}. The entire quantity of cowdung, TSP, MP and gypsum were applied as a basal during final land preparation and urea was top dressed in two equal splits at 15 and 30 days after emergence (DAE). Seeds were sown @ 2-3 seeds $hill^{-1}$ at 15 days interval on Nov. 8, 23 and Dec. 8, 1999 in furrows, keeping the row and plant spacing according to the treatments. The seedling emerged within 5-7 days after sowing. Finally one plant was kept per hill to avoid competition and to maintain desired planting density. Weeding and irrigation were done as and when needed. Ten plants were randomly selected from each plot and three successive harvesting of pods at five days interval were done for vegetable pod yield. First harvesting of vegetable pod was done on Jan. 23, Feb. 10 and 20, 2000 for Nov. 8, 23 and Dec. 8 sowing, respectively. Plant samples from 1 m^2 area were harvested from each plot at an interval of 15 days starting from 30 up to 90 DAE. The leaves and pods were separated from the stem of each plant sample. Then the different plant parts were put into polythene bag separately and taken into the laboratory to determine the leaf area index and dry matter accumulation of different plant parts. The leaf areas were measured by an automatic leaf area meter. Then the plant parts were sun dried separately for several days. The sun dried plant parts were then dried in an oven at 70°C for 72 h until the weight became constant. Then the weight of different plant parts separately and also the total weight of each sample were taken. The leaf area index (LAI), crop growth rate (CGR), relative growth rate (RGR) and net assimilation rate (NAR) were calculated. The data on the number of branches $plant^{-1}$, days to 50% flowering and vegetable pod yield were recorded from 10 randomly selected plant in each plot. The heights were taken at 5 dates at 15 days interval starting from 30 up to 90 DAE. The recorded data on different parameters were statistically analyzed by using MSTAT software to find out the significance of varience and the treatment means were compared by using least significant difference (LSD) test.

Results and Discussion

Effect of sowing time and plant density

Leaf area index: Leaf area index was significantly influenced by

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Table 1: Effect of sowing time and spacing on leaf area index of edible podded pea at different growth stages

Treatments	Leaf area index at different DAE 30	45	60	75	90
Sowing time					
Nov. 8	0.94b	1.97a	2.93a	2.71a	2.22b
Nov. 23	1.09a	1.81b	3.05a	2.74a	2.39a
Dec. 8	0.89b	1.64c	2.73b	2.40b	1.89c
Spacing (cm^2)					
30x20	1.24a	2.16a	3.50a	3.19a	2.65a
40x20	1.10b	2.01b	3.37ab	3.07ab	2.48ab
50x20	1.03b	1.92b	3.25b	2.94b	2.32b
40x30	0.90c	1.68c	2.67c	2.37c	1.99c
50x30	0.83cd	1.57cd	2.44d	2.18d	1.88c
50x40	0.75d	1.48d	2.17e	1.97e	1.67d

Table 2: Total dry matter (g cm^{-2}) of edible podded pea as influenced by sowing time and spacing at different growth stages

Treatments	Total dry matter (g m^{-2}) at DAE 30	45	60	75	90
Sowing time					
Nov. 8	92.53a	149.57a	299.85b	367.19b	403.03b
Nov. 23	98.16a	158.27a	325.75a	393.63a	427.77a
Dec. 8	74.08b	126.81b	259.30c	303.16c	345.98c
LSD (0.01)	9.61	9.97	16.03	16.23	15.06
CV (%)	11.97	7.57	5.97	5.03	4.22
Spacing (cm^2)					
30x20	106.35a	167.18a	342.93a	416.23a	459.66a
40x20	96.24ab	156.37ab	320.06b	387.59b	429.92b
50x20	90.99bc	148.98bc	304.32bc	364.98b	408.89b
40x30	83.53b-d	141.18cd	288.60cd	340.76c	372.56c
50x30	77.96cd	130.55de	266.13de	317.41d	350.46d
50x40	74.50d	125.03e	247.77e	301.34d	332.06d

DAE= days after emergence, Means in a column under the same factor followed by the same letter (s) are not significantly different at $P \leq 0.01$

sowing time and planting density (Table 1). In case of sowing time, the higher leaf area index was observed in Nov. 23 sowing and lower in Dec. 8 sowing. This might be due to that Dec. 8 sowing produced smaller leaf with few numbers of leaflets due to less time received for vegetative growth. In case of planting density, the highest LAI was obtained by the highest densities. The LAI was decreased with the decrease in plant density at all the dates of observation. The increase in LAI at closer plant spacing might be due to the more number of leaves per unit area. There was an increasing trend in LAI from 30 to 60 DAE then showed a decline trend irrespective of sowing time and planting density. The decreased LAI was due to leaf senescence and abscission of leaves from 60 DAE to maturity.

Total dry matter: Total dry matter (TDM) of edible podded pea influenced significantly by different sowing times and planting density. The highest dry matter was obtained in plants sowing at Nov. 23 (427.77g m^{-2}) and the lowest dry matter was found from the sowing at Dec. 8 sowing (345.98 g m^{-2}) at 90 DAE (Table 2). Similar trend was found in all growth stages. The highest dry matter at Nov. 23 sowing might be due to that plant received maximum favourable environmental condition at this sowing which perhaps help formation of higher photosynthetic products and thus resulted in higher dry matter. Regarding spacing, the TDM per unit area increased with increasing population density (Table 2). The highest TDM was recorded in the plant at closest density at all the growth stages and the lowest at the widest plant density. In both cases dry matter production showed an increasing trend from 45 up to 90 DAE. The rate of dry matter accumulation was higher from 30 to 60 DAE but afterwards it was comparatively lower.

Dry matter partitioning: Both sowing time and spacing showed significant variation in leaf, stem and pod dry weight (Fig. 1). Leaf, stem and pod dry weight was the highest in plants of Nov. 23 sowing at all growth stages and the lowest in that of Dec. 8. Nov. 8 sowing was intermediate. Higher leaf, stem and pod dry weight in plants of Nov. 23 sowing probably, the temperature prevailed during this period was perhaps favourable for maximum vegetative growth of plant and thus produced higher leaf, stem and pod dry weight. In respect of plant density, higher the population density higher was the dry matter accumulation in leaf, stem and pod per unit area (Fig. 2). Regardless time of sowing and plant density, the leaf and stem dry weight continued to increase till 60 DAE and then decreased till maturity but pod dry matter production continued till 90 DAE. The decrease in leaf and stem dry matter after 60 DAE might be attributed to remobilization of stored assimilates from vegetative organs to reproductive ones. Similar result was reported by Lodhi *et al.* (1979).

Crop growth rate: The highest crop growth rate (CGR) was obtained in Nov. 23 sowing followed by Nov. 8 (Table 3). This might be due to that LAI and TDM were higher in Nov. 23 sowing. The highest CGR was recorded in the closest spacing (30x20 cm^{-2}) (11.72 g m^{-2} day^{-1}) and decreased with the increasing of spacing (Table 3). The maximum CGR was obtained at 45-60 DAE irrespective of sowing time and spacing. A similar result of higher crop growth rate with higher planting density was recorded by Miah (1988) in cowpea and mungbean.

Relative growth rate and net assimilation rate: Both RGR and NAR were not significantly influenced by sowing time and spacing (Table 3). However, RGR obtained in Dec. 8 sowing (0.048 g^{-1} day^{-1}) at 45-60 DAE and the lowest was obtained in Nov. 8 sowing (0.05 g^{-1} day^{-1}) at 75-90 DAE. The RGR values were apparently higher at lower population density (Table 3). Irrespective of sowing time and population density RGR increased in 45-60 DAE and then declined till 90 DAE. Yadav *et al.* (1990) reported that in pea RGR increased significantly at wider row spacing. Irrespective of sowing time and planting density the highest net assimilation rate (NAR) was recorded in 45-60 DAE and then declined (Table 3). The declined in NAR might be due to leaf falling and leaf senescence. The highest NAR (4.60 g m^{-2} day^{-1}) was found in the widest spacing (40x30 cm^2) and the lowest NAR was found in the closest spacing (30x20 cm^2) (1.03 g m^{-2} day^{-1}) (Table 3). NAR decreased with increasing population density with the advancement of crop age (Pandey *et al.*, 1978).

Plant height: Plant height was significantly influenced by sowing time at all the growth stages expect 90 DAE (Table 4). Nov. 23 sowing produced the tallest plant at all the growth stages, except 75 DAE at which the first sowing (Nov. 8) produced the tallest plants (74.27 cm^2) and was statistically similar to that of Nov. 23 sowing at all growth stages. Plant height also significantly influenced by spacing throughout the growth period (Table 4). Plant height increased with the decrease of spacing in all growth stages. The increase in plant height due to cowdung might be explained from the fact that higher population density decreased penetration of light that might have increased endogenous auxin formation which enhanced the growth of the dormant bud (Willey and Hearth, 1969). In pea, closer plant to plant spacing as well as closer row spacing increased plant height (Saharia and Thakuria, 1988).

Vegetative pod yield: Significant variation was observed among the sowing time and spacing in respect of vegetable pod yield per hectare (Table 4). The best performance was exhibited by Nov. 23 sown plants with the highest yield (8.26 t ha^{-1}) followed by Nov. 8 sowing (7.44 t ha^{-1}). The lowest yield (5.16 t ha^{-1}) was given by Dec. 8 sowing which was also statistically lower than that of other treatments. The result of the study is similar to the findings of (Anonymous, 1996) where Nov. 20 sown plants produced the highest yield per hectare. In respect of spacing, the highest green pod yield (8.79 t ha^{-1}) was obtained from closest spacing (30x20 cm^2) and it was decreased with the increase of spacing (Table 4). The lowest green pod yield (5.11 t ha^{-1}) was found in the widest

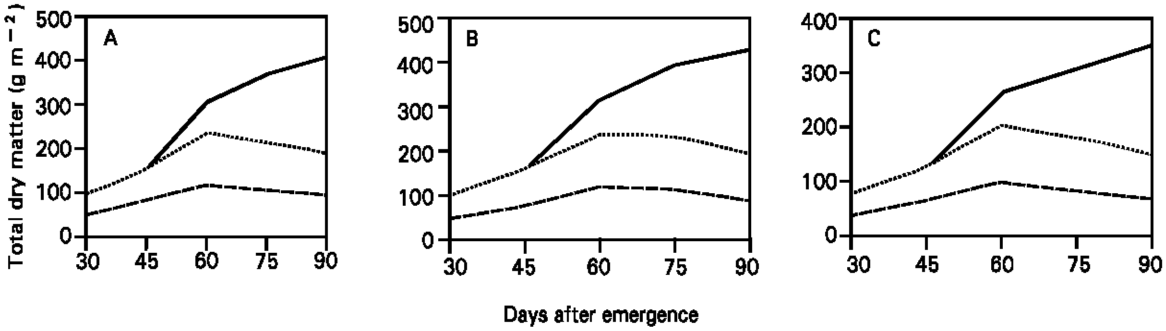

Fig. 1: Dry matter accumulation in different components of edible podded pea plants over time as influenced by sowing time, A) Nov. 8 sowing, B) Nov. 23 sowing and C) Dec. 8 sowing

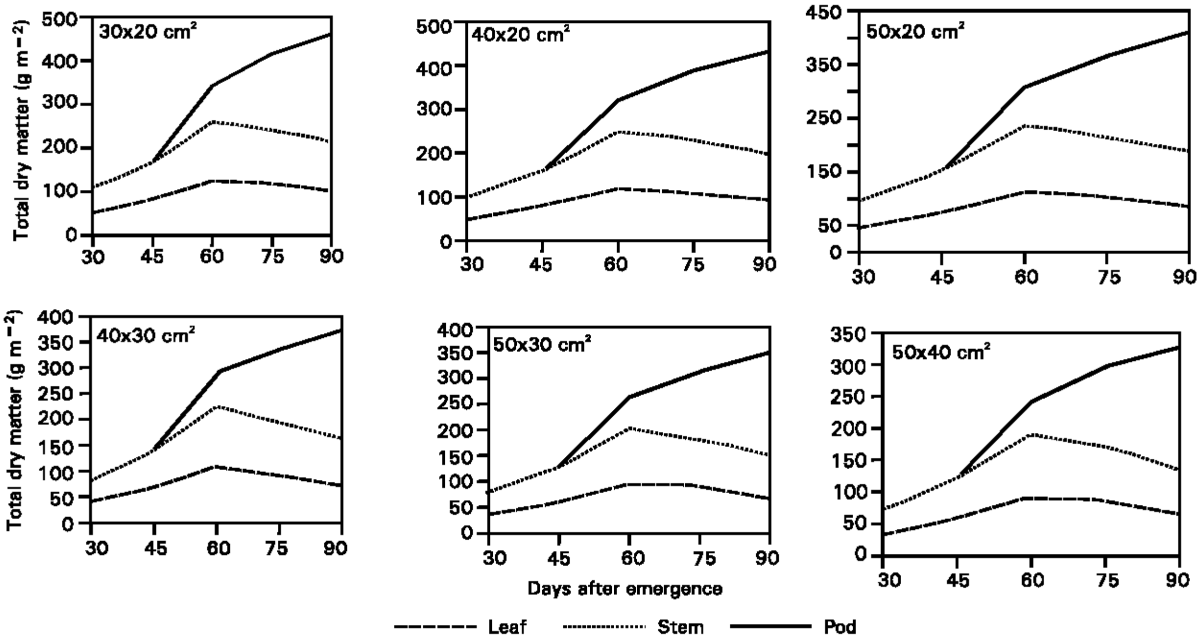

Fig. 2: Dry matter accumulation in different components of edible podded pea plants over time as influenced by spacing

Table 3: crop growth rate (CGR), relative growth rate (RGR) and net assimilation rate (NAR) of edible podded pea as influenced by sowing time and spacing at different growth stages

	Crop growth rate (g m^{-2} day^{-1}) at DAE				Relative growth rate (g m^{-2} day^{-1}) at DAE				Net assimilation rate (g m^{-2} day^{-1}) at DAE			
Treatments	30-45	45-60	60-75	75-90	30-45	45-60	60-75	75-90	30-45	45-60	60-75	75-90
Sowing time												
Nov. 8	3.80	10.02ab	4.49a	2.39	0.031	0.046	0.012	0.005	2.80	4.22	1.61	0.97
Nov.23	4.01	11.17a	4.51a	2.29	0.032	0.047	0.013	0.006	2.85	4.73	1.57	0.91
Dec. 8	3.52	8.83b	2.95b	2.83	0.037	0.048	0.013	0.009	2.93	4.17	1.17	1.11
Spacing (cm^2)												
30x20	4.06	11.72a	4.89	2.90	0.030	0.046	0.012	0.006	2.46	4.15	1.41	1.03
40x20	4.01	10.91ab	4.50	2.82	0.033	0.047	0.013	0.006	2.72	4.16	1.41	1.04
50x20	3.87	10.36a-c	4.04	2.93	0.033	0.047	0.012	0.008	2.70	4.12	1.29	1.13
40x30	3.84	9.83b-d	3.48	2.12	0.035	0.048	0.011	0.007	3.06	4.60	1.38	0.97
50x30	3.52	9.04cd	3.42	2.20	0.035	0.048	0.012	0.007	3.06	4.58	1.48	1.10
50x40	3.67	8.18d	3.57	2.05	0.036	0.048	0.013	0.008	3.13	4.56	1.72	1.14

DAE= days after emergence, Means in a column under the same factor followed by the same letter (s) are not significantly different at $P \leq 0.01$

spacing (50x40 cm^2). The other spacing levels produced medium pod yield per hectare. The results agreed well with the findings of (Anonymous, 1995) where the closer spacing (30x10 cm^2) was better for a higher vegetable pod yield in edible podded pea. The highest marketable yield in the closest spacing (30x20 cm^2) might be due to the higher plant density.

Interaction effect of sowing time and spacing: The interaction effect of sowing time and spacing on all the parameters except leaf area index and green pod yield per hectare was found not significant (Table 5). The interaction effect of sowing time and spacing on the LAI at 75 DAE was found statistically significant (Table 5). The treatment combination of Nov. 23 sowing with

Table 4: Effect of sowing time and spacing on growth and yield of edible podded pea

	Plant height (cm^2) at DAE						
Treatments	30	45	60	75	90	Days to 50% flowering	Vegetable pod yield (t ha^{-1})
Sowing time							
Nov.8	25.68ab	45.40a	69.04a	74.27a	74.29	52.72a	7.44b
Nov.23	27.17a	46.40a	70.48a	73.85a	74.98	49.56b	8.26a
Dec.8	22.87b	40.79b	59.79b	65.23b	71.21	44.83c	5.16c
Spacing (cm^2)							
30x20	28.94a	49.30a	74.18a	81.11a	81.94a	48.67	8.79a
40x20	27.00ab	47.40ab	70.27ab	78.94ab	80.22ab	48.67	8.03a
50x20	25.98a-c	44.50a-c	67.82a-c	72.59bc	77.92ab	49.00	7.17b
40x30	24.40a-c	42.72bc	65.25b-d	68.22cd	71.84bc	49.33	6.64bc
50x30	23.09bc	40.53c	62.82cd	64.61d	66.29c	49.56	6.00c
50x40	22.01c	40.73c	58.29d	61.23d	62.93c	49.00	5.11d

Table 5: Interaction effect of sowing time and spacing on the leaf area index at different growth stages and yield per hectare of edible podded pea

		Leaf area index at DAE					
Sowing time	Spacing (cm^2)	30	45	60	75	90	Vegetable pod yield (t ha^{-1})
Nov.8	30x20	1.23	2.45	3.57	3.28ab	2.62	9.31ab
	40x20	1.10	2.25	3.40	3.18ab	2.51	9.06b
	50x20	1.00	2.13	3.28	3.08bc	2.44	7.85c
	40x30	0.80	1.77	2.70	2.48fg	2.05	7.15cd
	50x30	0.80	1.67	2.40	2.32gh	2.00	6.02ef
	50x40	0.73	1.54	2.22	1.98ij	1.68	5.25fg
Nov.23	30x20	1.37	2.13	3.69	3.38a	3.05	10.26a
	40x20	1.23	1.97	3.55	3.30ab	2.81	9.38ab
	50x20	1.13	1.93	3.40	3.12bc	2.51	8.89b
	40x30	1.03	1.73	2.75	2.43fg	2.12	7.89c
	50x30	0.93	1.58	2.54	2.14hi	2.00	7.25cd
	50x40	0.87	1.48	2.38	2.07hi	1.87	6.89ef
Dec.8	30x20	1.13	1.90	3.26	2.90cd	2.27	6.78df
	40x20	0.97	1.80	3.15	2.73de	2.13	5.65fg
	50x20	0.97	1.70	3.08	2.61ef	2.02	4.77gh
	40x30	0.87	1.57	2.57	2.22ghi	1.81	4.88gh
	50x30	0.76	1.46	2.37	2.07hi	1.64	4.72gh
	50x40	0.67	1.43	1.93	1.87j	1.46	4.20h

DAE= Days after emergence, Means in a column under the same factor followed by the same letter (s) are not significantly different at $P \leq 0.01$

closest spacing (30x20 cm^2) gave the highest LAI (3.38) and was comparable to Nov. 23 sowing with 40x20 cm^2 (3.30), Nov. 8 sowing with 30x20 cm^2 (3.28) and Nov. 8 sowing with 40x20 cm^2 spacing (3.18) but differed significantly with the rest of the treatment combination. The lowest LAI was recorded from the treatment combination of Dec. 8 sowing with highest plant spacing (50x40 cm^2) (1.87) which was statistically similar to Nov. 8 sowing with 50x40 cm^2 spacing (1.98) but differed significantly to all other treatment combinations. In case of green pod yield, the highest yield per hectare (10.16 t ha^{-1}) obtained from Nov. 23 sowing with 30x20 cm^2 spacing and the lowest pod yield per hectare (4.20 t ha^{-1}) was obtained from Dec. 8 sowing with 50x40 cm^2 spacing. The other treatment combination produced intermediate pod yield per hectare. This indicates that dominance of Nov. 23 sowing time in respect of green pod yield per hectare over other sowing times irrespective of plant spacing.

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