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EFFECT OF SOWING DATE AND ROW SPACING ON GREEN POD YIELD OF GARDEN PEA

M. R. H. MONDOL[1], M. A. R. SARKAR[2], A. K. HASAN[3]
M. M. KHAN[4] AND M. M. HOSSAIN[5]

Abstract

Field experiments on garden pea were conducted at the Tuber Crops Research Sub-Centre, Bangladesh Agricultural Research Institute (BARI), Bogura, during the 2015-16 and 2016–17 cropping seasons. The study aimed to evaluate the impact of sowing dates and row spacing on the yield-contributing characteristics and green pod yield of garden pea (cv. BARI Motorshuti-3). The experiment was conducted a split-plot design with three replications, assigning three sowing dates (27 October, 10 November, and 24 November) to the main plots and four row spacings (20 cm, 30 cm, 40 cm, and farmer's practice) to the sub-plots. Results from the 2015–16 season indicated that sowing on 10 November with a 20 cm row spacing achieved the maximum green pod yield (6.80 t ha^{-1}) and green stover yield (5.65 t ha^{-1}). This was statistically similar to the 24 November sowing at the same 20 cm spacing, which produced 6.71 t ha^{-1} green pod; 5.58 t ha^{-1} stover. A similar trend was observed in 2016–17, where the 10 November sowing at 20 cm spacing yielded the highest results (7.08 t ha^{-1} pod; 5.74 t ha^{-1} stover), closely followed by the 24 November sowing at 20 cm spacing (7.01 t ha^{-1} green pod; 5.72 t ha^{-1} stover). Based on these findings, a sowing window between 10 and 24 November combined with a 20 cm row spacing is recommended to optimize green pod yield of garden pea in the Bogura region.

Key words: Garden pea, *Pisum sativum,* sowing date, row spacing, green pod yield and stover yield.

Introduction

Garden pea (*Pisum sativum* L.) is one of the most important winter minor pulse crops in Bangladesh. Peas are full of nutrition because its grain is rich in protein (27.8%), complex carbohydrates (42.65%), vitamins, minerals, dietary fibers and antioxidant compounds (Dahl *et al*., 2012). Pea crop has a great impact in the rice-based cropping system to utilization of fallow land where land remains fallow about 80-90 days between *T. Aman* and *Boro* rice. In the high and medium high

[1]Senior Scientific Officer, Tuber Crops Research Sub-Centre, Bangladesh Agricultural Research Institute (BARI), Bogura, [2&3]Professor, Department of Agronomy, Bangladesh Agricultural University (BAU), Mymensingh, [4]Senior Scientific Officer, Regional Wheat and Maize Research Centre, Gazipur, and [5]Senior Scientific Officer, Regional Agricultural Research Station, BARI, Rangpur, Bangladesh.

lands of Bangladesh, *T. Aman* – Fallow - *Boro* cropping pattern is practiced by the farmers. It was found that short duration pea var. BARI Motorshuti-3 can be grown after harvest of short duration *T. Aman* var. Binadhan-7 and BRRI dhan33 in the fallow period of *T. Aman* and Boro cropping pattern. Further, this crop also plays a significant role in soil fertility restoration as a suitable rotation crop that fixes atmospheric nitrogen and also serves as rotational crop that plays great role in controlling disease epidemics and weeds (Hoorman *et al*., 2009). Pea production in Bangladesh is very low due to lack of high yielding modern varieties, lack of proper agronomic management practices such as sowing time and method, row spacing and seed rate as well as nutrient. Pea production in Bangladesh depends on many factors, of which climate is the most important one. The minimum temperature for germination is about 10°C and the optimum about 22°C. It is sensitive to high temperature and drought stress (Baloch, 1994). In plains land peas are sown from October to December; whereas in hilly areas they are planted after mid-March to the end of May. The time of sowing influences the establishment, growth and development of pea crops (Castillo *et al*., 1992). Sowing time can affect the number of days to germination and flowering, the number and weight of green pods plant^{-1} and seed yield (Gill and Ahmad, 1981). Date of sowing determines the amount of radiation and the temperature to be experienced by the crop. Growth and yield of garden peas, greatly influenced by sowing date; plants sown in late November had a higher leaf area index (LAI) and greater yield than earlier sowing in mid-November (Jamil *et al.,* 2006). An early maturing pea variety showed that seed yield, pods plant^{-1}, pod length, seeds pod^{-1} from a November sowing were all superior to October sowing (Randhir *et al*., 1996). So, climate change has been one of the greatest economic, social and environmental threats of pea cultivation. On the other hand, the yield of pea crops normally increases, with increasing plant population, until it reaches an optimum density. Moot and McNeil (1995) showed seed yield of pea doubled from 350 g m^{-2} at 9 plants m^{-2} to 675 g m^{-2} at 400 plants m^{-2} However, once the plant population exceeds the optimum it can lead to a progressive decrease in yield. Sharma (2002) reported that the highest number of pods plant^{-1} in wider row spacing. Therefore, the present study was carried out to determine optimum sowing date and row spacing of garden pea for obtaining its desirable crop characters and yield.

Materials and Methods

The experiment was conducted at the Tuber Crops Research Sub-Center, Bangladesh Agricultural Research Institute (BARI), Bogura, Bangladesh during *rabi* season 2015-16 and 2016-17. It was located at 24.51^0 N latitude and 89.18^0 E longitudes which is 17 m above the sea level (UNDP and FAO, 1988) and belongs to the Barind Level Tract "AEZ 25". The experimental site was associated with a medium high land with sandy-loam soil texture and the soil was slightly acidic in reaction. The experimental area is under the sub-tropical climatic zone

characterized by relatively scanty rainfall, low humidity and temperature, short day and long clear sunshine period during October to March. The temperature during winter season December to February remains fairly low and goes up during the summer season (March to October). The average (10 years) annual rainfall is 1525 mm, most of which fell during May-September. The warmest and coldest months are April (35^0 C maximum) and January (11.6^0 C minimum), respectively. Bangladesh's overall mean temperature in summer ranges between 25 and 33^0 C, and in winter remains between 11 to 26^0 C (Hossain 2007). The meteorological data of the experimental site during crop period (October-February) are presented in Table 1. The weather data were taken from the Meteorological Department, Khander, Bogura.

Table 1. The meteorological data of the experimental site during crop period (October 2015-February 2017).

Months	Temperature (^{0}C)				Relative Humidity (%)		Rainfall (mm)	
	2015-2016		2016-2017		2015-2016	2016-2017	2015-2016	2016-2017
	Maximum (Mean)	Minimum (Mean)	Maximum (Mean)	Minimum (Mean)				
October	29.15	25.10	28.12	26.56	78	77	40	270
November	26.1	20.22	26.33	24.19	75	75	-	-
December	21.2	15.13	21.88	16.01	77	76	-	-
January	19.29	15.03	19.08	15.32	77	76	-	-
February	22.10	20.11	24.13	20.01	72	68	15	-

The experiment was laid out in a spilt plot design with three replications. The experiment consisted of three sowing dates *viz.*, (i) 27 October (D_1), (ii) 10 November (D_2) and (iii) 24 November (D_3) in the main plots and row spacings *viz*., (i) 20 cm (S_1), (ii) 30 cm (S_2), (iii) 40 cm (S_3) and (iv) Farmer practice or broadcast (S_4) in the sub-plots. The unit plot size was 3.0 m x 4.0 m. The garden pea var. BARI Motorshuti-3 was used as a test crop. The land was uniformly fertilized with PKSB @ 14-20-20-10-7 kg ha^{-1} PKSB (BARC, 2012) through Urea, Triple Super Phosphate (TSP), Muriate of Potash (MP), Gypsum and Boric Acid, respectively. Total amount of all the fertilizers was applied during the final land preparation. Seeds were sown with recommended seed rate of 200 kg ha^{-1}. The seeds were sown in furrows and in case of farmer practice or broadcast, seeds were scattered in the plot and covered with soil by leveler for the best germination. Finally, approximately 5 cm plant to plant distance along with row was maintained through gap filling and thinning to have uniform population. Different intercultural operations such as weeding, thinning, gap filling, pesticide spray and irrigation

were accomplished time to time for better growth and development of the crop. The crop was harvested plot-wise at maturity stages. Five plants were uprooted each time randomly from the sampling area of each plot. Data were recorded on plant population m^{-2}, plant height, number of pods $plant^{-1}$, pod length, weight of 100 fresh pods, green pod yield $plot^{-1}$and green stover yield $plot^{-1}$. The plot yield was then converted into t ha^{-1}. The collected data of different parameters were statistically analyzed with the help of STATISTIX 10 software and differences among the treatment means were adjudged by Duncan's Multiple Range Test (DMRT) at 5% level of profanity.

Results and Discussion

Interaction effect on plant population m^{-2}

Plant population m^{-2} of garden pea was significantly influenced by the combination of sowing date and row spacing. In 2015-16 (Table 2), the maximum plant population m^{-2} (91.66) was recorded from 27 October sowing at 20 cm row spacing followed by 10 November sowing of same row spacing (90.00), while the minimum in 27 October sowing at 40 cm row spacing (58.33). It might be due to more plant population $unit^{-1}$ area. Similar results have been reported by Rops (1997). In 2016-17, the maximum plant population m^{-2} (91.00) was recorded from 10 November sowing at 20 cm row spacing followed by 24 November sowing at 20 cm row spacing (89.33) and 27 October sowing at 20 cm row spacing (81.00), while the minimum in 27 October sowing at 40 cm row spacing (47.33).

Interaction effect on plant height

Sowing date coupled with row spacing had significant effect on plant height in both the years (Table 2). In 2015-2016, the maximum plant height (44.63 cm) was recorded from the crops sown on 10 November at 20 cm row spacing followed by 24 November sown at 20 cm row spacing (42.99 cm), while the lowest plant height was recorded in 27 October sowing at broadcast method (31.90 cm) followed by 27 October sowing at 30 cm row spacing (33.34 cm). It might be due to relatively cool temperature and sufficient time available for the growth and development to these seeds before low temperatures creep in, which could have promoted the growth of the plants. Similar results have been reported by Baloch (1994). The result indicated that closer row spacing (20 cm) enhanced to produce taller plant than other spacing. It might be due to space for plant spread was less and hence plant height increased significantly. It was also reported that the tallest plants from closer row spacing (Sharma 2002). Almost Similar trend was observed in 2016-17. The maximum plant height (45.13 cm) was recorded from the crops sown 10 November at 20 cm row spacing followed by 10 November sown at 20 cm row

spacing (43.15 cm) and 24 November sowing at 20 cm row spacing (42.49 cm), while the lowest plant height was obtained in 27 October sowing at 30 cm row spacing (32.83 cm).

Interaction effect on number of pods plant^{-1}

Dates of sowing and row spacing had a significant interaction effect on number of pods plant^{-1} in both the years (Table 2). In 2015-16, the maximum number of pods plant^{-1} (3.94) was found in 24 November sowing at 40 cm row spacing followed by 10 November sowing at 20 cm row spacing (3.55), 10 November sowing at 30 cm row spacing (3.62), 10 November sowing at 40 cm row spacing (3.72), 10 November sowing at broadcast method (3.48), 24 November sowing at 20 cm row spacing (3.35) 24 November sowing at 30 cm row spacing (3.37) and 24 November sowing at broadcast method (3.26), while the minimum was found in 27 October sowing at broadcast method (2.20). Sowing time can affect the number of pods plant^{-1} and seed yield (Gill and Ahmad, 1981). Similar results have been reported by Randhir *et al*. (1996). Increase in number of pods plant^{-1} in wider row spacing (40 cm) might be due to vigorous plants, as in wider space, plant grew vigorously and produce more branches which resulted in high number of pods plant^{-1}. These results are in consonance with the results of Sharma (2002) who reported the highest number of pods plant^{-1} in wider row spacing. With decrease in row spacing, the plant growth was also decreased which resulted in low pods production. Almost similar trend was found in 2016-17. The maximum number of pods plant^{-1} (3.97) was found in 24 November sowing at 40 cm row spacing followed by 10 November sowing at 20 cm row spacing (3.61), 10 November sowing at 30 cm row spacing (3.68), 10 November sowing at 40 cm row spacing (3.76), 10 November sowing at broadcast method (3.54), 24 November sowing at 20 cm row spacing (3.42), 24 November sowing at 30 cm row spacing (3.44) and 24 November sowing at broadcast method (3.33), while the minimum was found in 27 October sowing at broadcast method (1.95).

Interaction effect on pod length

Sowing date and row spacing had significant interaction effect on pod length in both the years (Table 2). In 2015-16, the maximum pod length (6.66 cm) was recorded from 10 November sowing at 30 cm row spacing followed by 10 November sowing at 20 cm row spacing (6.39 cm), 10 November sowing at 40 cm row spacing (6.43 cm), 10 November sowing at broadcast method (6.44 cm), 24 November sowing at 20 cm row spacing (6.23 cm), 24 November sowing at 30 cm row spacing (6.23 cm) 24 November sowing at 40 cm row spacing (6.06 cm) and 24 November sowing at broadcast method (6.29 cm), while the minimum was found in 27 October sowing at 20 cm row spacing (4.67 cm). It might be due to the

prevailing of optimum temperature (average 23.16-25.26^0 c) for the plants sown on 10 and 24 November and as such there was best vegetative and reproductive growth, as a result maximum pod length was recorded for this sowing date. During the period of 27 October, temperature (average 27.34^0 c) was high that resulted in small size production of pods. Results showed that pod length from a November sowing was all superior to an October sowing. These results are in agreement with the findings of Randhir *et al.* (1996). Almost the similar result was found in 2016-17. The maximum pod length (6.79 cm) was recorded from 10 November sowing at 30 cm row spacing followed by 10 November sowing at 20 cm row spacing (6.45 cm), 10 November sowing at 40 cm row spacing (6.44 cm), 10 November sowing at broadcast method (6.40 cm), 24 November sowing at 20 cm row spacing (6.25 cm), 24 November sowing at 30 cm row spacing (6.25 cm) 24 November sowing at 40 cm row spacing (6.31 cm) and 24 November sowing at broadcast method (6.08 cm), while the minimum was found in 27 October sowing at 20 cm row spacing (4.79 cm).

Table 2. Effect of interaction of sowing date and row spacingon crop characters, yield attributes and yield of garden pea

Interaction (D×S)	Plant population m^{-2}		Plant height (cm)		Number of Pods $plant^{-1}$		Pod length (cm)	
	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2
D_1 x S_1	91.66a	81.00ab	35.18d	36.68efg	2.41c	2.16b	4.67b	4.79b
D_1 x S_2	75.33c	59.33cd	33.00de	34.50gh	2.53bc	2.28b	4.89b	5.01b
D_1 x S_3	58.33f	47.33d	33.34de	32.83h	2.55bc	2.30b	5.31b	5.21b
D_1 x S_4	65.67f	65.66bc	31.90e	35.40fgh	2.20c	1.95b	5.11b	4.57b
D_2 x S_1	90.00a	91.00a	44.63a	45.13a	3.55a	3.61a	6.39a	6.45a
D_2 x S_2	74.00d	78.00bc	42.05b	43.15ab	3.62a	3.68a	6.66a	6.79a
D_2 x S_3	64.66f	55.53d	40.74b	41.24bcd	3.72a	3.76a	6.43a	6.44a
D_2 x S_4	68.66e	73.00bc	38.06c	38.56def	3.48a	3.54a	6.44a	6.40a
D_3 x S_1	87.33b	89.33a	42.99ab	42.49abc	3.35a	3.42a	6.23a	6.25a
D_3 x S_2	76.66c	77.33bc	39.88bc	41.38bcd	3.37a	3.44a	6.23a	6.25a
D_3 x S_3	65.33f	56.33d	38.29c	39.79cde	3.94a	3.97a	6.06a	6.31a
D_3 x S_4	66.00f	75.00bc	38.11c	39.61cde	3.26ab	3.33a	6.29a	6.08a
CV (%)	7.82	9.20	4.12	3.58	13.61	13.97	6.11	5.62

Table 2. Cont'd

Interaction (DXS)	Weight of 100 fresh pods (g)		Number of seeds pod^{-1}		Green pod yield (t ha^{-1})		Green stover yield (t ha^{-1})	
	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2
D_1 x S_1	273.30h	270.93i	3.54c	3.72cd	5.90b	5.75b	4.95b	4.85b
D_1 x S_2	274.54h	271.20h	3.87bc	3.89cd	4.12ef	3.97g	3.62d	3.51e
D_1 x S_3	310.70c	305.10c	4.36b	4.21c	3.15g	2.95h	2.95f	2.80f
D_1 x S_4	263.92k	266.91k	4.02bc	3.39d	4.35de	4.20f	3.68d	3.72d
D_2 x S_1	276.93f	284.29d	5.63a	5.89ab	6.80a	7.08a	5.65a	5.74a
D_2 x S_2	281.29d	278.8e	5.90a	6.07a	5.21c	5.51c	4.30c	4.55c
D_2 x S_3	349.11a	351.80a	5.82a	6.19a	3.89ef	4.10fg	3.35e	3.50e
D_2 x S_4	269.80i	271.35h	5.72a	5.60ab	5.11c	5.25d	4.54c	4.64c
D_3 x S_1	275.21g	277.2g	5.62a	5.64ab	6.71a	7.01a	5.58a	5.72a
D_3 x S_2	278.32e	278.3f	5.94a	5.90ab	5.14c	5.44c	4.30c	4.55c
D_3 x S_3	346.96b	349.3b	5.54a	5.53ab	3.70fg	3.99g	3.19ef	3.35e
D_3 x S_4	266.80j	268.5j	5.33a	5.28b	4.65cd	4.85e	4.42c	4.57c
CV (%)	3.33	4.80	7.13	6.99	6.93	6.26	3.45	5.32

Mean values in a column having the same letters do not differ significantly while those with dissimilar letters differ significantly as per DMRT (P≤0.05).

Note: D_1 = 27 October, D_2 = 10 November, D_3 = 24 November.

S_1 = Row spacing 20 cm, S_2 = Row spacing 30 cm, S_3 = Row spacing 40 cm, S_4 = Broadcast sowing; Y_1 = 2015-16 and Y_2 = 2016-17

Interaction effect on number of seeds pod^{-1}

Date of sowing in combination with row spacing had a significant effect on number of seeds pod^{-1} in both the years (Table 2). In the first year, the maximum number of seeds pod^{-1} (5.94) was found in 24 November sowing at 30 cm row spacing followed by 10 November sowing at 20 cm row spacing (5.63), 10 November sowing at 30 cm row spacing (5.90), 10 November sowing at 40 cm row spacing (5.82), 10 November sowing at broadcast method (5.72), 24 November sowing at 20 cm row spacing (5.62), 10 November sowing at 40 cm row spacing (5.54) and 24 November sowing at broadcast method (5.33), while the lowest in 27 October sowing at 20 cm row spacing (3.54). These results corroborate the findings of Rai and Gupta (2003). Seed number pod^{-1} is correlated with pod growth in particular with early pod elongation (Jeuffroy and Chabanet, 1994. Almost similar trend was found in 2016-17. The highest number of seeds pod^{-1} (6.19) was found in 10 November sowing at 40 cm row spacing followed by 10 November sowing at 20

cm row spacing (5.89), 10 November sowing at 30 cm row spacing (6.07), 10 November sowing at broadcast method (5.60), 24 November sowing at 20 cm row spacing (5.64), 24 November sowing at 30 cm row spacing (5.90), 24 November sowing at 40 cm row spacing (5.53) and 24 November sowing at broadcast method (5.28), while the lowest in 27 October sowing at broadcast method (3.39).

Interaction effect on weight of 100 fresh pods

Sowing date and row spacing had significant interaction effect on weight of 100 fresh pods in both the years (Table 2). In 2015-16, the highest weight of 100 fresh pods (349.11g) was recorded from 10 November sowing at 40 cm row spacing, while the minimum in 27 October sowing at farmer practices or broadcast method (263.92g). It might be due to prevailing of high temperatures during pod and seed formation in early sowing on 27 October, as a result photosynthates from source to sink were not translocated properly. Similar results have been reported by Duke (1981). Almost similar trend was found in 2016-17. The highest weight of 100 fresh pods (351.80g) was recorded from 10 November sowing at 40 cm row spacing, while the minimum in 27 October sowing at 20 cm row spacing (266.91g).

Interaction effect on greed pod yield

Date of sowing and row spacing had a significant effect on seed yield in both the years (table 2). In 2015-16, the maximum green pod yield (6.80 t ha^{-1}) was obtained from 10 November sowing at 20 cm row spacing followed by 24 November sowing at 20 cm row spacing (6.71 t ha^{-1}), while the lowest in 27 October sowing at 40 cm row spacing (3.15 t ha^{-1}) followed by 24 November sowing at 40 cm row spacing (3.70 t ha^{-1}). It might be due to improvement of yield contributing characters *viz.,* number of pods $plant^{-1}$, pod length and number of seeds pod^{-1}. Similar results have been reported by Jamil *et al.* (2006). In closer row spacing, the number of pods $plant^{-1}$ were less as compared to wider row spacing but the number of plants population $unit^{-1}$ area was more that resulted in higher green pods yield. Similar results have been reported by Sajid *et al.* (2012) and Rops (1997). Almost similar trend was found in 2016-2017. The highest green pod yield (7.08 t ha^{-1}) was obtained from 10 November sowing at 20 cm row spacing followed by 24 November sowing at 20 cm row spacing (7.01 t ha^{-1}), while the lowest in 27 October sowing at 40 cm row spacing (2.95 t ha^{-1}).

Interaction effect on green stover yield

Date of sowing coupled with row spacing had significant effect on green stover yield in both the years (Table 2). In 2015-16, the maximum green stover yield (5.65 t ha^{-1}) was obtained from 10 November sowing at 20 cm row spacing followed by 24 November sowing at 20 cm row spacing (5.58 t ha^{-1}), while the lowest in 27 October sowing at 40 cm row spacing (2.95 t ha^{-1}) followed by 24 November

sowing at 40 cm row spacing (3.19 t ha^{-1}). It might be due to improvement of yield contributing characters *viz*., plant height and more plant population unit^{-1} area. These results agree with the findings of by Rops (1997), Rai and Gupta (2003). Almost similar trend was found in 2016-2017. The maximum green stover yield (5.74 t ha^{-1}) was obtained from 10 November sowing at 20 cm row spacing followed by 24 November sowing at 20 cm row spacing (5.72 t ha^{-1}), while the lowest in 27 October sowing at 40 cm row spacing (2.80 t ha^{-1}).

Relationship between plant population and green pod yield

In, 2015-16, the green pod yield showed a linear response with the increasing population per square meter (Fig. 1). The linear relationship as estimated was: y = 0.1016x -2.5286, R^2 = 0.9336, r = 0.97**. The positive relationship indicated that green pod yield (t ha^{-1}) increased with the increasing plant population. The linear equation stated that for every increased population of 1 per square meter, about 101.6 kg green pod yield was increased per hectare of land. The R^2 value indicated that 93% increase in green pod yield was attributed to plant population Almost similar trend was also observed in 2016-17 under correlation (y = 0.0789x-0.4675, R^2 =0.9085, 0.95r= 0.95**) (Fig. 2). In this year, the linear equation stated that for every increased population of 1 per square meter, about 78.9 kg green pod yield was increased per hectare of land. The R^2 value indicated that 90% increase in green pod yield was attributed to plant population.

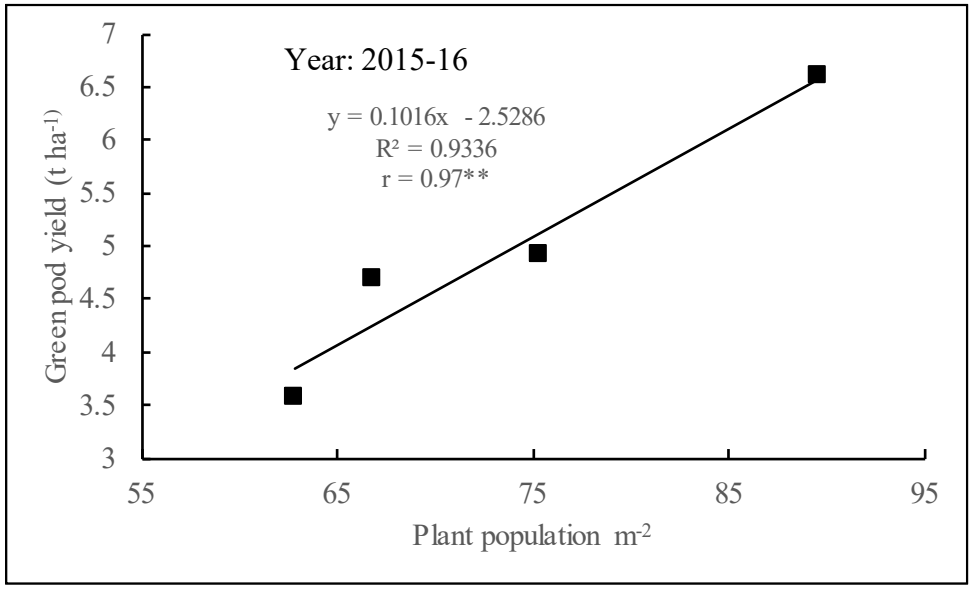

Fig. 1. Relationship between plant population and green pod yield of pea during 2015-16.

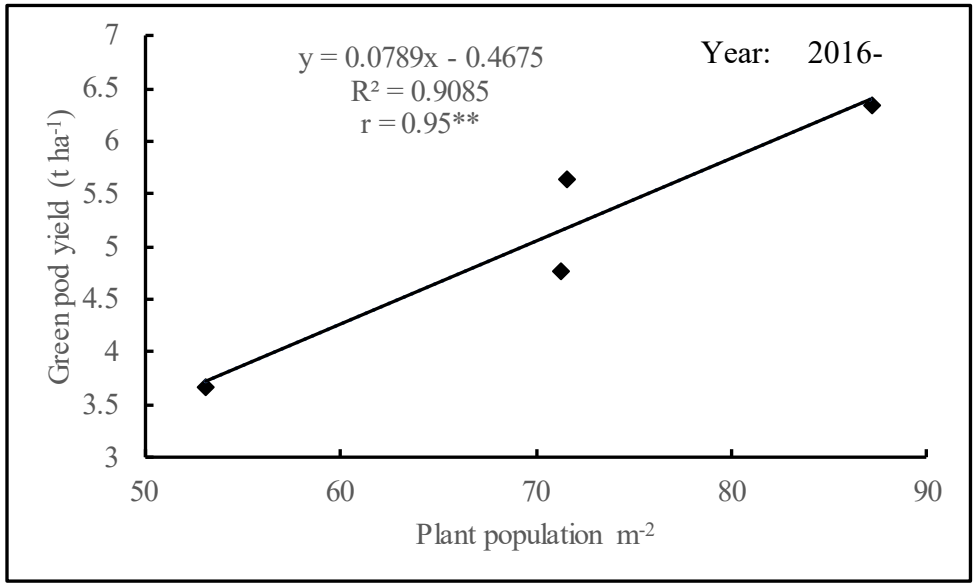

Fig. 2. Relationship between plant population and green pod yield of pea during 2016-17.

Conclusion

Based on this study, the BARI Motorshuti-3 Garden pea variety performs best when sown between November 10 and 24. This sowing time optimizes the number of pods per plant, as well as green pod and stover yields. Furthermore, using a 20 cm row-to-row spacing significantly outperforms broadcasting or farmer practices in all key yield attributes, especially number of pods per plant, green pod yield and stove yield.

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