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Effect of spacing on growth and green pod yield of pea (*Pisum sativum* L. subsp. Hortense) local cultivar *Makhyatmubi*

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Abstract
A field experiment was conducted to find out the "Effect of spacing on growth and green pod yield of pea (*Pisum sativum* L. subsp. hortense) local cultivar *Makhyatmubi*" during the *rabi* season of 2012-2013 at the Research farm of Agronomy, College of Agriculture, Central Agricultural University, Imphal, Manipur. The experiment consists of eight treatments (T_1 - 30 × 10 cm, T_2 - 30 × 15 cm, T_3 - 30 × 20 cm, T_4 - 30 × 25 cm, T_5 - 30 × 30 cm, T_6 - 35× 30 cm, T_7 - 40 × 30 cm and T_8 – 45 × 30 cm,) which were laid out in a Randomized Block Design and replicated thrice. Observation on plant height, number of leaves/plant, days to 50% flowering, number of branches/plant, pod lenght, pods/plant, seeds/pod, green pod yield/plant, green pod yield/ha, stover yield/plant and stover yield/ha were recorded. The results revealed that treatment T_2 was recorded higher plant height (77.27cm) over other treatments. However maximum number of leaves/plant at harvest and higher number of branches were recorded under the treatment (T_8 -1.63). Days to 50% flowering was not differed significantly due to spacing in pea. Pod length (8.22cm), number of pods/plant (8.93) and number of seeds/pod (7.37) respectively and maximum green pod yield/plant (47.50g) and stover yield/plant (15.39g) were recorded under the treatment T_8 which was found to be at par under the treatment T_7. However, significantly maximum green pod yield (83.15q/ha) was recorded under the treatment T_2 and maximum stover yield (24.96q/ha) was recorded under the tratment T_1.

Keywords: Spacing, pea, *Makhyatmubi*, growth, yield

Introduction
Pea (*Pisum sativum* L.) is a popular pulse crop of India and belongs to family Leguminoseae. It is a native of Southern Asia, was among the first crop cultivated by man. Pea is a cold season crop in many parts of the world. There are two types of cultivated pea, the garden pea and the field pea. Garden pea is harvested in an immature conditions to be cooked as agreen pea delicious dish or uncooked vegetable. It is also used for dehydration (or sun dried), canning and freezing. Pulses are good sources of proteins for a majority of the population in India. Pulses contribute 11% of the total intake of proteins in India (Reddy, 2010) [10]. About 89% consume pulses at least once a week (IIPS, ORC Macro, 2007) [4]. Pulses are not only rich in protein but also have essential amino acid compared to cereal protein. They provide energy to the tune of 372K cal/100g. They also contain other nutrients such as C,Fe and vitamins *viz*.,β-carotene, thiamine, riboflavin and niacin.

In Manipur, various types of peas are grown and each type has its unique character and taste. Among them, *Makhyatmubi* is one of the most popular local cultivar under Garden pea (*Pisum sativum* L. subsp. hortense). It is consumed as green pod as well as grain for preparation of different curry along with potato, tomato or other some other vegetables and meats. Tender shoot are nipped for the preparation of salad and boil. *Singju* is another Manipuri (Meitei) famous item; it's a snack for us. *Singju* is more like a vegetable salads made for mixing of various vegetables indigenous to Manipur like *hawai maton* (tender shoot), roasted pea seed, ' tunik khok ' (buck wheat) and other vegetables.The dry seed is harvested for the purpose of seed production. After harvesting the remaining stovers are burnt and collected the ash. The ash is diluted in water and then, its filtered in a strainer. The filtrate is used for the preparation of special traditional dish known as "*utti*" (Manipuri ethnic cuisine). Nowadays, people started using Sodium Bicarbonate (baking soda) instead of pea plant ash. In addition, it is also grown both in hills and parts of the plain areas of Manipur.

Optimum spacing is necessary to obtain maximum yield in any crop by reducing the competition among the plants for light, nutrient, moisture, etc. It depends on size of plant, elasticity, nature of the plant, capacity to reach optimum leaf area at an early date and seed rate used. Optimum spacing for any crop varies considerably due to environment under which it is grown.

It is not possible to recommend a generalized optimum spacing since the crop is grown in different seasons with different management practices in different soil type. So, optimum spacing differs depending on the environmental conditions and plant type. But till date no research work is conducted in this regard for the said variety. Therefore, keeping in view the above aspects the present investigation "Effect of spacing on growth and green pod yield of pea (*Pisum sativum* L. subsp. hortense) local cultivar *Makhyatmubi*" is done.

Methodology

A field experiment was conducted to study the "Effect of spacing on growth and green pod yield of pea (*Pisum sativum* L. subsp. hortense) local cultivar *Makhyatmubi*" was conducted in 2012-2013 during the *rabi* season at the Research Farm, College of Agriculture, Central Agricultural University, Imphal. The experimental field was situated at 24^0 51"N latitude and 93^0 56"E longitude at an altitude of 790m above mean sea level. The treatments comprised eight (T_1, T_2, T_3, T_4, T_5, T_6, T_7 and T_8). The experiment was laid out in randomized block design with three replications. The seeds of pea local cultivar *Makhyatmubi* were sown on 29th November, 2012 and harvested on 18th March, 2013 as 1st picking and 25th March, 2013 as 2nd picking. Seeds were sown manually with different spacing as per treatment with a depth of 4-5 cm and then covered with a thin layer of soil. The crop recieved a rainfall of 34.2 mm during the cropping period. But there was no rain during December, 2012 and January, 2013.

Results and Discussion

Growth parameters

The data can be recorded and analyzed for growth attributing characters of pea (Table 1). Among the different treatment taller plant height (77.27 cm) was observed under treatment T_2 at harvest which was found to be at par withs T_1, T_3 and T_4. However, significantly shorter plant height (67.48 cm) was recorded under treatment T_8. The increased in plant height due to crowding might be explained from the fact that higher plant population density decreased penetration of light that might have increased endogenous auxin formation which enhanced the growth of the dormant bud. These results were conformity with the findings of (Willey and Hearth, 1969) [18]. In pea, closer plant to plant as well as closer row spacing increased plant height. Similar results were also obtained by Saharia and Thakuria, (1988) [11], Singh *et al.* (2001) [17] in field pea, Yadav (2003) [19] in cowpea and Sen *et al*. (2005) [13] in dwarf field pea.

Table 1: Effect of spacing on plant height (cm) at different stages of pea

Treatments	30 DAS	45DAS	60 DAS	75 DAS	90 DAS	At Harvest
T_1	10.83	22.73	32.55	56.47	74.89	76.14
T_2	10.98	22.87	32.99	56.62	75.08	77.27
T_3	10.56	21.27	32.20	55.53	74.22	76.40
T_4	10.13	21.20	31.34	54.86	72.94	75.39
T_5	9.34	20.35	30.01	51.92	71.04	72.40
T_6	9.18	20.18	29.35	51.45	69.85	71.75
T_7	8.84	19.90	27.90	50.92	67.07	68.89
T_8	8.68	19.55	26.34	49.17	66.05	67.48
S.Em(±)	0.21	0.40	0.53	0.95	1.21	1.27
CD(0.05)	0.64	1.22	1.62	2.87	3.66	3.86

Data on number of leaves per plant were recorded at different stages of the plant growth (Table 2). It was observed that spacing showed non-significant effect at early stage (30 DAS) but at later stage spacing showed significant effect in respect to the leaves per plant. At harvest, significantly effect in respect to the leaves per plant (28.10) was observed under ttreatment (T_8) while treatment T_5, T_6 and T_7 found to be at par. However, significantly minimum number of leaves/ plant (22.27) was showed under treatment T_4. In contrast to plant height, studied showed that increasing plant population decreased the number of leaves /plant. Similar results were also obtained by. (Lazim, 1972) in haricot bean.

Table 2: Effect of spacing on number of leaves per plant at different stages of pea

Treatments	30 DAS	45DAS	60 DAS	75 DAS	90 DAS	At Harvest
T_1	3.57	8.23	14.57	17.53	21.10	22.50
T_2	3.80	8.90	14.67	17.93	21.70	23.13
T_3	3.53	8.47	14.40	17.47	20.80	22.47
T_4	3.33	8.87	14.33	17.20	20.67	22.27
T_5	3.30	8.07	17.13	21.60	25.97	27.10
T_6	3.20	7.97	17.40	22.20	26.13	27.47
T_7	3.17	7.93	17.63	22.57	26.20	27.60
T_8	3.10	7.77	15.70	22.63	26.57	28.1
S.Em(±)	0.11	0.15	0.28	0.40	0.41	0.43
CD(0.05)	NS	0.45	0.86	1.22	1.25	1.31

The results on days to 50 percent flowering in pea crop did not differed significantly between the treatments due to spacing is presented in Table 3. However, 50 percent flowering was early (66.33 days) under treatment T_2 as

compared to other treatments while the treatment T_1 recorded the delayed flowering (69.33 days). It might be related to vegetative growth, plant canopy area and efficient photosynthetic activity which might have enhanced the reproductive phase in wider spacing compared to narrow spacing. These results are in agreement with the finding of Mazumder *et al.* (2007) in hyacinth bean and Shaukat *et al.* (2012) [15].

Table 3: Effect of spacing on days to 50% flowering and number of branches per plant at harvest, pod length, number of pods per plant and number of seeds per pod of pea

Treatments	Days to 50% flowering	No. of branches/plant at harvest	Length of the pod (cm)	No. of pods/plant	No. of seeds/pod
T_1	69.33	1.03	6.83	6.00	5.93
T_2	66.33	1.21	7.10	7.40	6.13
T_3	68.00	1.30	7.27	7.47	6.27
T_4	67.00	1.40	7.48	7.57	6.47
T_5	67.67	1.45	7.51	8.37	6.63
T_6	68.67	1.47	7.88	8.57	6.90
T_7	68.33	1.53	8.10	8.67	7.20
T_8	68.00	1.63	8.22	8.93	7.37
S.Em(±)	1.19	0.05	0.13	0.19	0.14
CD(0.05)	NS	0.14	0.39	0.58	0.41

The experimental results revealed that maximum number of branches/plant (1.63) was observed under treatment T_8 which was at par with T_7 Table 3. However, significantly minimum number of branches/ plant (1.03) was observed under treatment T_1. The increased in number of branches/ plant in wider row spacing may be due to more space availability to plants to spread more rather to grow straight due to less plant population density and competition resulted in more horizontal growth ad plant canopy area compared to those other narrow spacing. It is the reason that plant height in wider spacing was less and hence produced more branches while plant height in closer spacing was high and produced less branches. Our results are supported by investigations that the closer spacing produced lowest number of branches per plant by Monsoor *et al.* (2010) [9] in mungbean, Sajid *et al.* (2012) [12] in pea and Shaukat *et al.* (2012) [15] in pea.

Yield and yield parameters

The data can be recorded and analyzed for yield attributing characters in pea (Table 4). Significantly maximum pod length (8.22 cm) was observed under treatment T_8 which was at par with T_6 and T_7. However, minimum pod length (6.83 cm) was measured under treatment T_1. Pod length increased with decreased in plant population. In wider spacing, increased in pod length may be due to more vegetative growth of the plants. In closer spacing vegetative growth was less which obviously affected the reproductive growth of plants due to which minimum pod length was measured under treatment T_1. The results are also in line with the findings obtained by Alizai *et al.*, (2005), Singh *et al.* (2010) in pea and Shaukat *et al.* (2012) [15] in pea.

Table 4: Effect of spacing on green pod yield/ plant, green pod yield/ha, stover yield/plant and stover yield /ha

Treatments	Green pod yield/plant(g)	Green pod yield/ha (q)	Stover yield /plant (g)	Stover yield /ha (q)
T_1	24.43	81.43	7.49	24.96
T_2	37.23	83.15	9.17	21.23
T_3	43.01	71.68	9.68	16.68
T_4	45.44	60.59	10.83	14.74
T_5	45.89	51.24	12.89	15.92
T_6	46.59	44.25	14.50	13.96
T_7	46.63	38.86	14.99	12.49
T_8	47.50	35.62	15.39	11.24
S.Em(±)	0.84	1.87	0.34	0.36
CD(0.05)	2.55	5.68	1.04	1.10

It is evident from (Table 4) that spacing had significant affects on number of pods/plant. Significantly higher number of pods per plant (8.93) was recorded under treatment T_8 which was at par with T_5, T_6 and T_7. While, significantly lower number of pods per plant (6.00) was recorded under treatment T_1. The increased in number of pods per plant in wider spacing may be due to vigorous plant growth and produced more number of branches.

These results are in agreement with the results (Sajid *et al.* (2012) [12] in pea, Shaukat *et al.*, 2012 [15] in pea and Idris *et al.*, 2008 [3] in fababean) who reported highest pod number per plant in wider row spacing. With decreased in row spacing, the plant produced less number of branches which resulted in low number of pods per plant.

Number of seeds is an important parameter that directly affect yield potential of crop. Significantly higher number of seed per pod (7.37) was noticed under treatment T_8 which was found to be at par with T_7. However, significantly lower number of seeds/pod (5.93) was noticed under treatment T_1. In wider spacing plants have more space to grow vigorously and produced lengthy pods, which contained more seeds. Similar result shown that the number of seeds per pod decreased with increasing plant density Shaukat *et al.*, 2012 [15] in pea and Idris *et al.*, 2008 [3] in fababean.

Green pod yield/plant was significantly influenced by spacing in pea crop (Table 4). Significantly higher green pod yield (47.50) was observed under treatment T_8 which was found to be at par with T_7, T_6, T_5 and T_4. However, significantly lower

green pod yield /plant (24.43g) was observed under treatment T_1. The superior values of yield and its component per plant noticed under wider spacing may be attributed to be better growth and development of plants under less plant population density and it resulted into better source to sink relationship due to availability of balanced and adequate nutrients and better light, space and moisture unlike in narrow spacing. These results are in conformity with those of Ali *et al*. (2007) [1] in pea, Shah *et al*. (2007) [14] in pea and Shrikanth *et al*. (2008) in lablab bean.

Final seed yield of a crop is the expression of combined effect of various yield components. Planting density, number of branches, pod length, number of pods/ plant and number of seeds/ pod are the factors that contributing towards the crop yield. The green pod yield varied significantly due to spacing in pea (Table 4). On the contrary, significant but reciprocal trend was noticed under treatment T_2 by registering more green pod yield (83.15 q/ha) which was found to be at par with T_1 over treatment T_8. In closer spacing, the number of plants per unit land was more but vigor of the plant was poor which resulted less number of pods per plant and less seeds per pod. In respects of spacing, the highest green pod yield per hectare was obtained from closest spacing and it was decerased with increased of spacing in edible podded pea. The results obtained are in line with the findings of (Anonymous, 1995 and Islam *et al*., 2002 in pea).

Stover yield per plant differed significantly due spacing in pea (Table 4). Significantly higher stover yield/plant (15.36g) was observed under treatment T_8 which was found to be at par with T_6 and T_7. However, significanly lower stover yield/plant (7.49g) was observed under treatment T_1. The wider spacing resulted in higher stover yield/plant due to more number of branches as compared to closer spacing. On the contrary, significant but reciprocal trend was noticed at closure spacing T_1 by registering higher stover yield (24.96q/ha) over wider spacing T_8. The closer spacing resulted in higher stover yield due to taller plant height and more number of plants per unit area as compared to wider spacing. The results obtained are in line with the findings of Luikham. *et al*. (2008) [7] in broassd bean.

Conclusion

The demand of pulses is increasing day by day due to high human consumption. So, we need to enhance the productivity of pulses. This experiment reveals that at optimum spacing improves both growth and yield of pea. Thus, it enhances the productivity of the seeds.

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