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Short Communication

Response of common onion (*Allium cepa* L.) to spacing and planting time in Manipur valley of North-East India

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Common onion (*Allium cepa* L.) is a bulbous biennial herb belongs to the family *Amaryllidaceae*. It is one of the most important bulb crops of India consumed by both the rich and the poor alike. India rank second after China in onion production. In India, Maharashtra is leading in area (200.0 thousand ha) and production (3146.0 thousand tons) while Gujarat is top in productivity 24.9 t/ha (Anonymous, 2010). It is one of the important condiments being widely used either in green form or as mature bulb or both used as salad and in preparations of immeasurable number of dishes, like soups, sauces and for seasoning of foods. Onion bulb is rich in phosphorus, calcium, and carbohydrates, and other minerals. In Manipur valley of India onion grown in lesser extent as compared to other states of India. The total area, production and productivity of onion in Manipur valley is 500 ha 1100 tons and 2.2 t/ha, respectively (Anonymous, 2005). There are several biotic and abiotic factors which lowers the productivity of onion in Manipur. However, spacing and planting time are the two important factors which affect the productivity of onion in greater extent. Rabi onion is long day plant and greatly affected by the environmental condition. Therefore effect of planting time is usually more prominent. Onion is highly sensitive to temperature and photoperiod, differences in yield caused by the different planting time of the year (Derawadan *et al.,* 2002). Planting time plays a vital role for the bulb formation and spacing determines the optimum yield with quality bulbs. Keeping in view the importance of rabi crop the present studies were taken up to standardize the planting time and spacing for exploring the possibilities for achieving the higher yield of rabi onion in Manipur valley of North-East India.

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The present investigations were conducted during rabi seasons of two consecutive years in 2008 and 2010 at Horticultural Experimental Field, College of Agriculture, Central Agricultural University, Imphal (Manipur). Four different spacing (S_1=15x20 cm, S_2=10x20 cm, S_3=15x10 cm and S_4=10x10 cm) and four different planting dates (D_1= 25th Nov., D_2= 10th Dec., D_3= 25th Dec. and D_4= 10th Jan.) were tested in factorial randomized block design (FRBD) with three replication, and the plot size was 1.2 m^2 plots during both the years. The main field was prepared first by ploughing cross-wise by tractor and followed by power tiller to a depth of 25-30 cm. Breaking of clods and levelling were done before lay out of plots by manual labour. Farm yard manure at the rate of 250q/ha was incorporated into the field at the final field preparation. NPK were applied through Urea, SSP and Murate of potash, respectively. Full dose of P, K and half dose of N were applied at basal. The remaining half dose of nitrogen was top dressed at 30 days after transplanting of seedlings. The healthy and disease free seedling were transplanted in the main field with four different spacings and four planting date and standard intercultural operations such as earthing up, hoeing, weeding and irrigation was followed during the experiment. Bulbs were harvested when the neck fall of 25-50% of the whole population was occurred. The top of the remaining erect plants were pulled down manually before harvesting. The onion was harvested by hand pulling with the help of khurpi. Immediately after harvesting, the bulbs were kept under shade condition for 3-5 days. The top parts were cut off by a sharp knife leaving 3-5 cm of the top attached to the bulbs. The onion bulbs were cured by spreading them on an open cemented surface in order to reduce the infection of disease, to minimize shrinkage, development of skin colour and also to increase the shelf life. Curing process was continued till the necks were tight and the outer scales were dried and rustle. Observations like fresh weight of whole plant (g), fresh

weight of bulb (g), equatorial diameter (mm), polar diameter (cm), bulb dry matter percentage, were recorded at harvest from the selected plants. Bulb yield (q/ha) was calculated as per hectare basis. Cost of cultivation was calculated based on the prevailing market prices of the inputs during the respective crop seasons. Gross returns were calculated based on the bulb yield and their prevailing market prices during the respective crop seasons. Net returns were calculated by subtracting cost of cultivation from gross returns.

Net returns (per ha) = Gross returns (per ha) – Cost of cultivation (per ha)

Benefit: Cost (B: C) ratio was calculated by using following expression:

B: C = Net returns (per ha) / Cost of cultivation (per ha)

All the data obtained from common onion for two consecutive years of study were statistically analyzed using the F-test as per the procedure given by Gomez and Gomez (1984). Critical difference (CD) values at P=0.05 were used to determine the significance of differences between means.

During both the years of study, closer spacing of 10x10 cm recorded maximum dry matter percentage (13.7 and 12.9) which was statistically on par with the spacing of 10x15cm (13.2 and 12.8) during both the years, respectively (Table 1). Maximum fresh weight of whole plant was observed by wider spacing of 15x20 cm (73.6 g and 99.4 g) which was on par with the spacing of 10x20 cm (71.8 g) in the first year only. Minimum fresh weight of whole plant was exhibited by closer spacing of 10x10 cm (65.4 g and 83.58 g) in respective years. Highest productivity was concluded by closer spacing of 10x10 cm (265.5 q/ha and 241.4 q/ha) which was closely followed by the spacing of 10x15cm (162.0 q/ha and 176.6 q/ha) whereas least productivity was observed by wider spacing of 15x20 cm (135.5 q/ha and 162.9 q/ha) in respective years (Table 1). Data presented in Table 2 clearly indicates that different spacing were significantly influence the entire yield attributes and bulb yield of onion during both the years. Wider spacing of 15x20 cm (47.10 g and 65.38 g) gave

Table 1: Effect of spacing and planting time on yield and yield attributes of common onion

Treatment	DM %		FWWP (g)		Bulb yield (q/ha)	
	2008-09	2009-10	2008-09	2009-10	2008-09	2009-10
Spacing						
S_1	12.4	11.9	73.6	99.4	135.5	162.9
S_2	13.0	12.0	71.8	95.9	157.1	163.6
S_3	13.2	12.8	68.8	92.3	162.0	176.6
S_4	13.7	12.9	65.4	83.6	265.5	241.4
SEm±	0.40	0.40	1.19	1.43	22.40	23.86
CD (P=0.05)	0.82	0.82	2.43	2.93	45.74	48.71
Planting time						
D_1	13.7	13.6	88.3	104.5	262.4	272.0
D_2	13.4	13.4	73.4	96.4	216.8	201.7
D_3	12.7	11.8	64.7	94.0	136.5	143.4
D_4	12.4	10.7	53.1	76.2	104.4	127.4
SEm±	0.40	0.40	1.19	1.43	22.40	23.86
CD (P=0.05)	0.82	0.82	2.43	2.93	45.74	48.71
Interaction effect (spacing x *planting time)*						
S_1 D_1	11.9	11.5	101.0	113.7	204.0	259.2
S_1 D_2	13.3	12.4	64.1	104.5	146.0	125.0
S_1 D_3	12.6	11.9	61.9	103.9	92.0	136.5
S_1 D_4	11.8	11.8	67.4	75.5	100.0	131.0
S_2 D_1	14.1	16.4	87.2	103.7	245.1	245.5
S_2 D_2	12.9	11.9	85.5	88.5	174.3	190.7
S_2 D_3	13.1	10.8	63.9	105.9	107.4	129.7
S_2 D_4	11.7	8.9	50.7	85.4	101.7	88.5
S_3 D_1	14.1	11.3	88.7	103.0	229.5	238.2
S_3 D_2	14.2	14.3	71.9	106.1	197.2	230.0
S_3 D_3	11.8	13.6	66.5	87.5	127.5	121.0
S_3 D_4	12.7	11.8	48.3	72.7	93.7	117.0
S_4 D_1	14.8	15.4	76.5	97.9	370.9	345.0
S_4 D_2	13.0	14.9	71.9	86.4	349.6	261.2
S_4 D_3	13.3	11.0	66.8	78.7	219.3	186.2
S_4 D_4	13.5	10.4	46.3	71.3	122.2	173.0
SEm±	0.80	0.81	2.38	2.87	44.80	47.71
CD (P=0.05)	NS	1.65	4.85	5.86	NS	NS

DM=dry matter and FWWP= fresh weight of whole plant

the highest fresh weight of single bulb which was closely followed by 10x20 cm (45.75 g and 64.06 g). Significantly bigger size of bulbs was collected from wider spacing of 15x20 cm, maximum equatorial diameter (46.70 mm and 52.04 mm) and maximum polar diameter (4.51 cm and 5.07 cm). Smaller size of bulbs was obtained the closer spacing of 10x10 cm. These results are in close conformity with the findings of Kumar *et al*. (1998), Khan *et al*. (2003) and Singh *et al*. (1990).

Significant response of planting time was observed in respective years of experimentation for yield attributes (Table 1). Planting on 25th November recorded higher dry matter percentage in respective years (13.7 and 13.6) which was statistically on par on the planting of 10th December (13.4 and 13.4). Maximum fresh weight of whole plant was recorded with the planting of 25th November (88.3 g and 104.5 g) while minimum with the planting of 10th January (53.1 g and 76.2 g) similar results were also reported by Singh and Korla (1991) and Tomar *et al*. (1988). Higher productivity was also observed by the planting of 10th November (262.4 q/ha and 272.0 q/ha) which was closely followed by the planting of 10th December (216.8 q/ha and 201.7 q/ha). Planting on 25th November recorded significantly higher fresh weight of single bulb (63.42 g and 73.55 g) and lower with the planting on 10th January (29.92 g and 50.29 g). Maximum equatorial diameter (53.30 mm and 54.02 mm) was observed by planting on 25th November and minimum (38.20 mm and 44.46 mm) by planting on 10th January. More polar diameter (4.78 cm and 5.06 cm) was exhibited by planting on 25th November and less (3.78 cm and 4.41 cm) by planting on 10th January. These results are with the close agreements with Singh *et al.* (1995) and Anisuzzaman *et al*. (2009).

Interaction effect of spacing and planting time were significantly influences the dry matter percentage, fresh weight of plant (g), and yield (q/ha) during both the years (Table 1). Spacing of 10x20 cm and planting on 25th November recorded maximum dry matter percentage (16.4) in the second year of experimentation which was closely followed by spacing of 10x10 cm

Table 2: Effect of spacing and planting time on bulb of common onion

Treatment	FWB (g)		ED (mm)		PD (cm)	
	2008-09	2009-10	2008-09	2009-10	2008-09	2009-10
Spacing						
S_1	47.10	65.38	46.70	52.04	4.51	5.07
S_2	45.75	64.06	46.10	49.79	4.28	4.64
S_3	44.80	60.68	45.60	47.09	4.06	4.57
S_4	40.25	56.72	43.40	44.00	3.98	4.48
SEm±	0.98	0.89	0.71	0.68	0.10	0.17
CD (P=0.05)	2.01	1.82	1.45	1.40	0.20	0.35
Planting time						
D_1	63.42	73.55	53.30	54.02	4.78	5.06
D_2	50.32	69.18	48.90	48.52	4.31	4.80
D_3	34.25	53.82	41.50	45.93	3.97	4.48
D_4	29.92	50.29	38.20	44.46	3.78	4.41
SEm±	0.98	0.89	0.71	0.68	0.10	0.17
CD (P=0.05)	2.01	1.82	1.45	1.40	0.20	0.35
Interaction (spacing x *planting time)*						
S_1 D_1	72.53	82.20	58.10	58.57	5.58	5.92
S_1 D_2	44.27	79.13	46.10	51.83	4.75	5.23
S_1 D_3	29.87	56.13	40.10	51.53	3.99	4.65
S_1 D_4	41.73	44.07	42.70	46.23	3.73	4.48
S_2 D_1	61.33	80.27	53.67	56.30	4.99	4.92
S_2 D_2	57.27	72.93	50.80	53.80	4.30	4.76
S_2 D_3	38.73	52.80	43.10	46.33	4.13	4.65
S_2 D_4	25.67	50.23	36.90	42.73	3.67	4.21
S_3 D_1	63.33	61.20	50.70	56.37	4.25	4.79
S_3 D_2	51.73	63.00	50.90	49.63	4.01	4.99
S_3 D_3	38.13	60.73	44.10	42.63	3.95	4.24
S_3 D_4	26.00	57.80	36.70	39.73	4.05	4.27
S_4 D_1	56.47	70.53	50.90	44.83	4.29	4.63
S_4 D_2	48.00	61.67	47.53	39.10	4.17	4.22
S_4 D_3	30.27	48.53	38.60	48.53	3.80	4.40
S_4 D_4	26.27	46.13	36.60	43.53	3.65	4.65
SEm±	1.97	1.78	1.42	1.37	0.20	0.34
CD (P=0.05)	4.02	3.64	2.90	2.79	0.40	NS

FWB= fresh weight of bulb, ED= equatorial diameter and PD= polar diameter

Table 3: Effect of spacing and planting time on economics of common onion

Treatment	Gross returns (ha^{-1})		COC (ha^{-1})	Net returns (ha^{-1})		B:C ratio	
	2008-09	2009-10		2008-09	2009-10	2008-09	2009-10
Spacing							
S_1	135500.0	162940.0	65652.9	69847.0	97287.0	1:1.1	1:1.5
S_2	157140.0	163630.0		91487.0	97977.0	1:1.4	1:1.5
S_3	162000.0	176560.0		96347.0	110907.0	1:1.5	1:1.7
S_4	265500.0	241380.0		199847.0	175727.0	1:3.0	1:2.7
Planting time							
D_1	262390.0	272000.0		196737.0	206347.0	1:3.0	1:3.1
D_2	216790.0	201750.0		151137.0	136097.0	1:2.3	1:2.1
D_3	136550.0	143380.0		70897.0	77727.0	1:1.1	1:1.2
D_4	104410.0	127380.0		38757.0	61727.0	1:0.6	1:0.9
Interaction effect (spacing x planting time)							
S_1 D_1	204000.0	259250.0		138347.0	193597.0	1:2.1	1:2.9
S_1 D_2	146000.0	125000.0		80347.0	59347.0	1:1.2	1:0.9
S_1 D_3	92000.0	136500.0		26347.0	70847.0	1:0.4	1:1.1
S_1 D_4	100000.0	131000.0		34347.0	65347.0	1:0.5	1:1.0
S_2 D_1	245140.0	245500.0		179487.0	179847.0	1:2.7	1:2.7
S_2 D_2	174290.0	190750.0		108637.0	125097.0	1:1.7	1:1.9
S_2 D_3	107430.0	129750.0		41777.0	64097.0	1:0.6	1:1.0
S_2 D_4	101710.0	88500.0		36057.0	22847.0	1:0.5	1:0.3
S_3 D_1	229500.0	238250.0		163847.0	172597.0	1:2.5	1:2.6
S_3 D_2	197250.0	230000.0		131597.0	164347.0	1:2.0	1:2.5
S_3 D_3	127500.0	121000.0		61847.0	55347.0	1:0.9	1:0.8
S_3 D_4	93750.0	117000.0		28097.0	51347.0	1:0.4	1:0.8
S4 D_1	370910.0	345000.0		305257.0	279347.0	1:4.6	1:4.3
S4 D_2	349640.0	261250.0		283987.0	195597.0	1:4.3	1:3.0
S4 D_3	219270.0	186250.0		153617.0	120597.0	1:2.3	1:1.8
S4 D_4	122180.0	173000.0		56527.0	107347.0	1:0.9	1:1.6

COC= Cost of Cultivation

and planting on 25th November (15.4). However, during first year it was non-significant. Fresh weight of whole plant was significantly higher (101.0 g and 113.7 g) with the spacing 0f 15x20 cm and planting on 25th November and lower fresh weight of whole plant (46.3 g and 71.3 g) was observed with the spacing of 10x10 cm and planting on 10th January. Such results with wider spacing and early planting might be due to plants getting more space and time then rest levels of spacing and planting time for their growth and development while productivity was less with wider spacing as closer spacing exhibits more number of plants/unit area than wider spacing. Highest yield (q/ha) was observed by closer spacing of 10x10 cm and planting on 25th November. Nagre *et al.* (1985) drew the similar conclusions. Interaction effect of spacing and planting time reveals significant effect on bulb quality (Table 2). Higher productivity was observed with closer spacing and early planting in both the years of experimentation. Fresh weight of bulb (72.53 g and 82.20 g) was significantly higher with the interaction of wider spacing of 15x20 cm and planting on 25th November which was closely followed by the spacing of 10x20 cm and planting on 25th November (61.33 g and 80.27 g). Equatorial and polar diameter was also observed similar results as fresh weight of bulb. Maximum equatorial and polar diameter (58.10 mm and 58.57 mm) and (5.58 cm and 5.92 cm) were observed with the spacing of 15x20 cm and planting on 25th November. Lowest equatorial (36.60 mm) and polar (3.65 cm) diameter was recorded by closer spacing 10x10 cm and planting on 10th January in the first year of study however, in the second year, lowest equatorial (39.10 mm) and polar (4.20 cm) diameter was recorded by 10x10 cm spacing and planting on 10th December where polar diameter was non significant. Such results might be due to fluctuation in temperature, rainfall and relative humidity during the course of study.

Data pertaining to economics is presented in Table 3. Perusal of data indicates, that net returns and B:C ratio were higher under closer spacing of 10x10 cm 199847.$0^{-1}$and 1:3.0 and 175727.0^{-1} and 1:2.70) in respective years. Highest B:C ratio (1:3.0 and 1:3.1) was found with the planting on 25th November while lowest B:C ratio (1:0.6 and 1: 0.9) was observed with the planting on 10th January. Interaction of closer spacing and early planting resulted in highest net return and B:C ratio which was 305257.0^{-1} and 1:4.6 and 279347.0^{-1} and1:4.3, respectively in respective years. Higher net returns and B:C ratio was closely followed by spacing of 10x10 cm and planting on 10th December (283987.0^{-1} and 1:4.3 and 195597.$0^{-1}$and 1:3.0 in respective years).

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