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Effect of Different Planting Dates on Yield and Yield Components of Potato (*Solanum tuberosum)* in Foot Hills of Arunachal Pradesh

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Abstract

Field experiment was conducted for determination of most suitable planting date for cultivation of potato during *rabi* of 2009-10. Experimental design was split-plot on the basis of randomized complete blocks with two factors in four replications that main plots had five planting dates (October 1, 10, 20, 30 and November 11, 2009) and the sub-plots had four cultivars (Kufri Chandramukhi, Kufri Ashoka, Kufri Phukraj and Kufri Pushkar). Plant emergence (%), plant height (cm), number of shoots/plants, number of leaves/plant, yield of tubers (0-25g), (25—50g), (50—75g), (>75g) t/ha, total tuber yield (t/ha), numbers of tubers (0—25g), (25—50g), (50—75 g), (>75g) /ha, total number of tubers/ha and economics and net return were measured. Analysis of complete variance showed that there were significant effect of planting date on plant emergence, plant height, yield of tubers (0—25g), (25—50g), (50—75 g), (>75 g) t/ha and total numbers of tubers/ha. Significant effect of cultivars observed on yield of tubers (0—25 g), (50—75g), total tuber yield, number of tubers (0—25g), and number of tubers (>75g)/ha. The maximum tuber yield belonged to 20 October planting date. Cultivar Kufri Pushkar had higher total tuber yield.
Key words : Planting dates, Yield, Potato, Yield components.

Potato (*Solanum tuberosum*) is a solanaceous plant cultivated for its edible starchy tubers. Potato is consumed either boiled or fried. Despite the progress made in increasing potato production in India but there are still problems that must be given some attention for potato production in foot hills of eastern Himalayas of Arunachal Pradesh. The major production constraint in Arunachal Pradesh include among others, lack of improved varieties, diseases, pest and unfavorable environmental conditions. In view of these, a field study was undertaken to investigate on the performance of four varieties of potato and five planting dates on the growth and tuber yield of the crop.

Table 1. Average monthly temperature, relative humidity and precipitation during growing season.

Month	Temp (0 C) 2009-10) Min.	Max.	RH (%) 2009-10 Min	Max.	Precipitation (mm) (2009-10)
Oct	21.3	30.8	74.2	86.0	177.6
Nov	16.7	26.2	72.3	85.1	143.1
Dec	14.4	24.0	72.7	85.7	22.4
Jan	12.0	25.1	64.3	82.4	0.3
Feb	14.8	24.1	69.9	82.1	39.3

Methods

This research was done to determine the best planting date for potato varieties to receive higher

Table 2. Effect of date of planting on plant emergence (%). F_1 = Date of planting, F_2 = Varieties.

Treatments	Plant emergence (%) F_2 (K. Chandramukhi)	F_2 (K. Ashoka)	F_2 (K. Pukhraj)	F_2 (K. Pushkar)	Means
F_1 (Oct 1)	88.75	87.50	88.00	89.25	88.38
F_1 (Oct 10)	87.50	86.50	90.50	86.00	87.63
F_1 (Oct 20)	91.00	90.25	90.00	88.25	89.88
F_1 (Oct 30)	86.25	86.75	87.00	90.75	87.69
F_1 (Nov 11)	83.75	81.25	79.50	84.25	82.19
Means	87.45	86.45	87.00	87.70	87.15
CD F_1 (5%)			1.65		
CD F_2 (5%)			1.48		
CD F_1F_2 (5%)			3.30		
CV (%)			2.67		

Table 3. Effect of dates planting on plant height (cm). F_1 = Date of planting, F_2 = Varieties.

	Plant height (cm)				
Treat-ments	F_2 (K. Chandra-mukhi)	F_2 (K. Ashoka)	F_2 (K. Pukhraj)	F_2 (K. Pushkar)	Means
F_1 (Oct 1)	34.50	33.00	32.75	34.50	33.69
F_1 (Oct 10)	35.50	34.75	34.75	36.00	35.25
F_1 (Oct 20)	40.75	41.50	45.25	42.75	42.56
F_1 (Oct 30)	36.75	36.25	36.75	35.00	36.19
F_1 (Nov 11)	37.75	36.75	37.00	35.25	36.69
Means	37.05	36.45	37.30	36.70	36.88
CD F_1 (5%)			1.05		
CD F_2 (5%)			0.10		
CD F_1 F_2 (5%)			2.1		
CV (%)			4.01		

Table 4. Effect of dates of planting on number of shoots. F_1 = Date of planting. F_2 = Vartieties.

	No. of shoots/plant				
Treat-ments	F_2 (K. Chandra-mukhi)	F_2 (K. Ahoka)	F_2 (K. Pukhraj)	F_2 (K. Pushkar)	Means
F_1 (Oct 1)	3.75	3.75	4.50	3.50	3.88
F_1 (Oct 10)	4.75	4.50	4.00	4.75	4.50
F_1 (Oct 20)	5.00	4.50	4.50	5.25	4.81
F_1 (Oct 30)	4.50	4.00	4.50	3.50	4.13
F_1 (Nov 11)	4.50	4.75	4.75	4.25	4.56
Means	4.50	4.30	4.45	4.25	4.38
CD F_1 (5%)			0.76		
CD F_2 (5%)			0.68		
CD F_1 F_2 (5%)			1.51		
CV (%)			24.40		

tuber yield and better quality in foot hills of eastern Himalayas of Arunachal Pradesh during rabi 2009-10. The experiment was conducted according to split plot design based on the randomized complete blocks with two factors in four replication at vegetable farm of College of Horticulture and Forestry, Central Agricultural University, Pasighat, Arunachal Pradesh. Main plots included five planting dates (October 1, 10, 20, 30 and November 11, 2009). Sub-plots included four varieties (Kufri Chandramukhi, Kufri Ashoka, Kufri Phukraj and Kufri Pushkar). Treatments were planted in 3.6 × 3.6 m^2 plots that had 60 cm distance between the rows and 20 cm distance between plants. Half dose of nitrogen with full dose of P and K were given as basal dose and rest half dose of nitrogen mixed around the plantlets to make mound. Standard practices were followed for weed, diseases and pest control . Plant emergence (%), plant height (cm), number of shoots/plants, number of leaves/plant, tubers yield (0—25g), (25—50g), (50—75g), (>75g), total tuber yield (t/ha), numbers of tubers (0—25g), (25—50g), (50—75g), (>75g)/ha, total number of tubers/ha and economics and net return of different treatments were measured during growth period and after harvest, analysis of complete variance and comparison of means was done according to LSD test by MSTAT-C software.

Results and Discussion

The meteorological conditions during the growth period of potato are presented in Table 1 showing the

Table 5. Effect of planting dates on no. of leaves/plant, F_1 = Date of planting, F_2 = Varieties.

	No. of leaves/plant				
Treat-ments	F_2 (K. Chandra-mukhi)	F_2 (K. Ashoka)	F_2 (K. Pukhraj)	F_2 (K. Pushkar)	Means
F_1 (Oct 1)	50.75	49.25	46.25	47.00	48.31
F_1 (Oct 10)	41.75	43.25	42.50	43.50	42.75
F_1 (Oct 20)	41.50	49.50	49.75	51.25	48.00
F_1 (Oct 30)	48.00	47.25	45.25	44.25	46.19
F_1 (Nov 11)	37.25	35.75	34.25	34.25	35.38
Means	43.85	45.00	43.60	44.05	44.13
CD F_1 (5%)			1.54		
CD F_2 (5%)			1.38		
CD F_1F_2 (5%)			3.09		
CV (%)			4.94		

Table 6. Effect of planting dates on tuber yield of (0—25g)t/ha. F_1 = Date of Planting, F_2 = Varieties.

	Yield of (0—25 g) t/ha)				
Treat-ments	F_2 (K. Chandra mukhi)	F_2 (K. Ashoka)	F_2 (K Pukhraj)	F_2 (K. Pushkar)	Means
F_1 (Oct 1)	3.28	3.46	3.36	3.19	3.32
F_1 (Oct 10)	3.44	2.91	3.20	3.26	3.20
F_1 (Oct 20)	3.92	3.90	4.09	4.81	4.18
F_1 (Oct 30)	3.98	3.90	4.03	4.02	3.98
F_1 (Nov 11)	4.01	4.94	4.32	4.90	4.54
Means	3.72	3.80	3.80	4.03	3.85
CD F_1 (5%)			0.14		
CD F_2 (5%)			0.13		
CD F_1 F_2 (5%)			0.29		
CV (%)			5.31		

Table 7. Effect of planting dates on tuber yield of (25—50 g) (t/ha). F_1 = Date of planting, F_2 = Varieties.

Treatments	Yield of (25—50 g) (t/ha) F_2 (K. Chandramukhi)	F_2 (K. Ashoka)	F_2 (K. Pukhraj)	F_2 (K. Pushkar)	Means
F_1 (Oct 1)	3.53	3.70	3.88	3.55	3.67
F_1 (Oct 10)	3.40	3.47	3.98	3.80	3.66
F_1 (Oct 20)	3.67	3.86	3.72	3.42	3.67
F_1 (Oct 30)	2.84	2.84	3.09	3.20	2.99
F_1 (Nov 11)	3.24	3.36	4.53	5.13	4.07
Means	3.34	3.45	3.84	3.82	3.61
CD F_1 (5%)			0.19		
CD F_2 (5%)			0.17		
CD F_1 F_2 (5%)			0.38		
CV (%)			7.47		

Table 8. Effect of planting dates on tuber yield (50—75g) (t/ha). F_1 = Date of planting, F_2 = Varieties.

Treatments	Yield of (50—75g) t/ha F_2 (K. Chandramukhi)	F_2 (K. Ashoka)	F_2 (K. Pukhraj)	F_2 (K. Pushkar)	Means
F_1 (Oct 1)	4.42	5.61	5.23	6.41	5.42
F_1 (Oct 10)	5.50	5.85	5.54	6.56	5.86
F_1 (Oct 20)	7.86	7.33	7.47	8.10	7.69
F_1 (Oct 30)	4.44	5.08	5.37	5.67	5.14
F_1 (Nov 11)	3.45	3.98	4.75	4.75	4.23
Means	5.13	5.57	5.67	6.30	5.67
CD F_1 (5%)			0.24		
CD F_1(5%)			0.22		
CD F_1 F_2 (5%)			0.49		
CV (%)			6.09		

average air temperature and monthly rainfall from October, 2009 to February, 2010. The weather conditions during the growing period varied. The highest monthly precipitation during the growing period of potato occurred in October (177.6 mm).

Plant Emergence (%)

The effect of date of planting on plant emergence (%) was significant at the 5% level. The lowest plant emergence was recorded in fifth treatment i.e. 11 November date of planting and highest plant emergence was recorded in third treatment i.e. 20 of October. There was non-significant of cultivars on plant emergence. The interaction of date of planting × cultivar on plant emergence was significant at the 5% level. The highest plant emergence was obtained on third date of planting i. e. 20 October in cultivar Kufri Chandramukhi (Table 2).

Plant Height (cm)

A significant difference among the dates of planting was found on the plant height. The highest plant height was recorded at thirds date of planting (20 October). Cultivars had also significant effect at the 5% level. The interactions of dates of planting × cultivar on plant height were significant at the 5% level. The highest plant height was obtained at third date of planting (20 October) for Kufri Pukhraj (45.25) and lowest was recorded at first date of planting (i.e.1 October) for cultivar Kufri Pukhraj. (Table 3).

Table 9. Effect of planting dates on Yield of (>75 g) (t/ha). F_1 = Date of planting, F_2 = Varieties.

Treatments	Yield of (>75g) t/ha F_2 (K. Chandramukhi)	F_2 (K. Ashoka)	F_2 (K. Pukhraj)	F_2 (K. Pushkar)	Means
F_1 (Oct 1)	5.04	5.36	5.69	5.64	5.43
F_1 (Oct 10)	6.24	6.50	6.44	6.52	6.43
F_1 (Oct 20)	7.33	8.11	8.49	8.40	8.08
F_1 (Oct 30)	7.14	7.03	7.08	7.11	7.09
F_1 (Nov 11)	5.11	4.36	4.69	4.63	4.70
Means	6.17	6.27	6.48	6.46	6.35
CD F_1 (5%)			0.19		
CD F_2 (5%)			0.17		
CD F_1 F_2 (5%)			0.38		
CV (%)			4.22		

Table 10. Effect of planting dates on total yield of tuber (t/ha). F_1 = Date of Planting, F_2 = Varieties.

Treatments	Total yield (t/ha) F_2 (K. Chandramukhi)	F_2 (K. Ashoka)	F_2 (K. Pukhraj)	F_2 (K. Pushkar)	Means
F_1 (Oct 1)	16.27	18.14	18.16	18.78	17.84
F_1 (Oct 10)	18.57	18.74	19.17	20.15	19.16
F_1 (Oct 20)	22.78	23.20	23.78	24.72	23.62
F_1 (Oct 30)	18.39	18.84	19.57	20.00	19.20
F_1 (Nov 11)	15.83	16.64	18.30	19.42	17.54
Means	18.37	19.11	19.79	20.61	19.47
CD F_1 (5%)			0.42		
CD F2 (5%)			0.38		
CD F_1 F_2 (5%)			0.85		
CV (%)			3.07		

Table 11. Effect of planting dates on number of tubers/ha (0—25g). F_1 = Date of Planting, F_2 = Varieties.

Treatments	Number of tubers/ha (0—25g) F_2 (K. Chandramukhi)	F_2 (K. Ashoka)	F_2 (K. Pukhraj)	F_2 (K. Pushkar)	Means
F_1 (Oct 1)	151427.50	152970.75	179398.00	168595.50	163097.94
F_1 (Oct 10)	237269.00	246528.00	255594.50	240162.25	244888.44
F_1 (Oct 20)	147183.50	149498.50	143711.50	148341.00	147183.63
F_1 (Oct 30)	161265.50	165123.50	165702.00	164544.50	164158.88
F_1 (Nov 11)	167245.25	169753.25	177083.25	181327.25	173852.88
Means	172878.15	176774.80	184297.85	180594.10	178636.22
CD F_1 (5%)			3737.20		
CD F_2 (5%)			3342.65		
CD F_1 F_2 (5%)			7474.40		
CV (%)			2.96		

Number of Shoots/Plant

A non-significant difference among the dates of planting treatment was found on the number of shoots/plant at the 5% level. The effect of cultivar was non-significant on number of shoots/plant. The interaction of date of planting × cultivar on number of shoots/ plant was also non-significant (Table 4).

Number of Leaves/Plant

A significant difference among the dates of planting treatment was found on the number of leaves/ plant. While non-significant effect of cultivars were recorded on number of leaves/plant. The interaction of date of planting × cultivar on number of leaves/ plant was significant. Maximum number of leaves/ plant were recorded at 3rd date of planting (i.e. 20th October) for cultivar Kufri Pushkar (Table 5).

Tuber Yield (0—25g) (t/ha)

A significant difference among the dates of planting treatment was found on the tuber yield (0—25g). Cultivars had also significant effect on tuber yield (0—25g). The interaction of date of planting × cultivar had significant effect on tuber yield (0—25g). Maximum tuber yield (0—25g) were observed on fifth date of planting(i.e. 11 November) for cultivar kufri Ashoka (Table 6).

Tubers Yield (25—50g) (t/ha)

A significant difference among the date of planting treatments was recorded on the tuber yield (25—50g) at the 5% level (Table 7). Cultivars had significant effect on tuber yield (25—50g) at the 5% level. The interaction of date of planting × cultivar had significant effect. Maximum tuber yield (25—50 g) were

Table 12. Effect of planting dates on number of tubers/ha (25—50g) F_1 = Date of planting, F_2 = Varieties.

Treatments	No. of tubers/ha (25—50 g) F_2 (K. Chandramukhi)	F_2 (K. Ashoka)	F_2 (K. Pukhraj)	F_2 (K. Pushkar)	Means
F_1 (Oct 1)	93750.00	96065.00	114969.25	127700.50	108121.19
F_1 (Oct 10)	87770.25	76774.75	76774.75	87770.25	82272.50
F_1 (Oct 20)	91628.25	71759.25	73302.50	75617.25	78076.81
F_1 (Oct 30)	87577.25	87191.50	89699.00	92206.75	89168.63
F_1 (Nov 11)	92014.00	95100.50	99151.25	102044.75	97077.63
Means	90547.95	85378.20	90779.35	97067.90	90943.35
CD F_1 (5%)			1228.54		
CD F_2 (5%)			1098.84		
CD F_1 F_2 (5%)			2457.07		
CV (%)			1.91		

Table 13. Effect of planting dates on no. of tubers/ha (50—75g) F_1 = Date of planting, F_2 = Varieties.

	No. of tubers/ha (50—75g)				
Treatments	F_2 (K. Chandramukhi)	F_2 (K. Ashoka)	F_2 (K. Pukhraj)	F_2 (K. Pushkar)	Means
F_1 (Oct 1)	88349.50	84490.75	89120.25	74073.75	84008.44
F_1 (Oct 10)	73688.00	72530.75	73688.25	84298.25	76051.44
F_1 (Oct 20)	71759.00	71952.25	72338.00	71952.25	72000.38
F_1 (Oct 30)	86612.75	92014.00	93557.25	91435.25	90904.81
F_1 (Nov 11)	82561.75	90277.75	84683.75	89120.50	86660.94
Means	80594.10	82253.10	82677.50	82176.00	81925.17
CD F_1 (5%)			1769.31		
CD F_1 (5%)			1582.52		
CD F_1 F_2 (5%)			3538.61		
CV (%)			3.05		

recorded on fifth date of planting (i.e.11 November) in cultivar Kufri Pushkar.

Tuber Yield (50—75 g (t/ha)

A significant difference among different dates of planting treatments was observed on the tuber yield (50—75g) at the 5% level (Table 8). Cultivars had significant effect on tuber yield (50—75g). The interaction of date of planting × cultivar had significant effect on tuber yield (50—75g). Maximum tuber yield (50—75g) were recorded on third date of planting (i. e. 20 October) in cultivar Kufri Pushkar.

Tuber Yield (>75 g) (t/ha)

A significant difference was recorded among different date of planting at the 5% level (Table 9). Cultivars had significant effect on tuber yield (>75g). The interaction of date of planting × cultivar had significant effect on tuber yield (>75g). Highest tuber yield was recorded at third date of planting (i. e. 20 October in cultivar Kufri Pukhraj.

Total Tuber Yield (T/ha)

Date of planting significantly affected total tuber yield and highest tuber yield was related to the third date of planting (i.e. 20 October) while lowest was recorded on fifth date of planting (i. e. 11 November). Cultivars had also significant effect on total tuber yield. The interaction of date of planting × cultivar had significant effect on total tuber yield. The maximum total tuber yield was recorded on third date of planting (i. e. 20 October) in cultivar Kufri Pushkar. (Table 10).

Number of Tubers (0—25g) /ha

A significant of effect date of planting was observed on the number of tuber (0—25g) at the 5% level. Cultivars have significant effect on number of tuber (0—25g). The interaction of date of planting × cultivar had significant effect on number of tuber (0—25g) at the 5% level. Highest number of tuber (0—25g) were related to second date of planting (i.e.10 October) in cultivar Kufri Pushkar (Table 11).

Number of Tubers (25—50g) /ha

Date of planting had significant effect on number of tubers (25—50g) at the 5% level. Cultivars had also significant effect on number of tubers (25—50g). The interaction of date of planting × cultivar had significant effect. Highest number of tubers (25—50g) were related to first date planting (i. e. October) in cultivar Kufri Pushkar. (Table 12).

Number of Tubers (50—75g)/ha

A significant effect of date of planting was observed on the number of tuber (50—75g) were recorded at the 5% level. Cultivars had non-significant effect on number of tuber (50—75g) at the 5% level. The interaction of date of planting × cultivar had significant effect. Highest number of tuber (50—75g)

Table 14. Effect of planting dates on number of tubers (>75 g)/ha. F = Date of planting, F = Varieties.

Treatments	No. of tubers/ha (>75g) F_2 (K. Chandramukhi)	F_2 (K. Ashoka)	F_2 (K. Pukhraj)	F_2 (K. Pushkar)	Means
F_1 (Oct 1)	78704.00	74652.75	71180.50	74074.00	74652.81
F_1 (Oct 10)	72916.75	73495.50	74074.00	80440.00	75231.56
F_1 (Oct 20)	88734.50	94328.75	97608.00	104552.50	96305.94
F_1 (Oct 30)	74459.75	72338.00	74267.00	73302.50	73591.81
F_1 (Nov 11)	74845.50	80826.00	83719.25	88927.50	82079.56
Means	77932.10	79128.20	80169.75	84259.30	80372.34
CD F_1 (5%)			1650.05		
CD F_2 (5%)			1475.85		
CD F_1 F_2 (5%)			3300.00		
CV (%)			2.90		

were recorded to fourth date of planting (i.e. 30 October) in cultivar Kufri Pushkar (Table 13).

Number of Tubers (>75 g)/ha

The treatment date of planting had significant effect on the number of tubers at the 5% level. Cultivars had also significant effect on number of tuber (>75g) at the 5% level. The interaction of date of planting × cultivar had statistically significant effect on number of tuber (>75g). The maximum number of tuber (>75g) were recorded to third date of planting (i. e. 20 October) in cultivar Kufri Pushkar (Table 14).

Total Number of Tubers/ha

Significant effects of date of planting on total number of tuber/ha were recorded at the 5% level (Table 15). Cultivar had also significant effect on total number of tuber/ha. The interaction of date of planting × cultivar had significant effect. Highest total number of tuber were recorded at second date of planting (i. e. 10 October) in cultivar Kufri Pushkar.

Economics and Net Return

Maximum net return Rs (193,800) were recorded in the interaction of third date of planting (i. e. 20 October) in cultivar Kufri Pukhraj. Also in other studies, the planting delay decreased the yield (1,2). Balali et al. (3) used three planting dates on minituber production of potato. November 18 was the best date of planting under studied conditions and delay in date reduced mini-tuber production.

Allen et al. (4) reported that percentage hopper burn development was reduced by deferring the planting date with both early and late varieties of potato. Shailbala and Pundhir (5) also recorded decrease tuber yield with delay in planting. Early planting was given more tuber yield as compared to normal and

Table 15. Effect of planting dates on total no. of tubers/ha. F_1 = Date of Planting, F_2 = Varieties.

Treatments	Total no. of tubers/ha F_2 (K. Chandramukhi)	F_2 (K. Ashoka)	F_2 (K. Pukhraj)	F_2 (K. Pushkar)	Means
F_1 (Oct 1)	412230.00	408179.00	454668.50	444444.50	429880.50
F_1 (Oct 10)	471643.50	469328.75	480131.25	492669.75	478443.31
F_1 (Oct 20)	399305.75	387538.75	386959.75	400463.00	393566.81
F_1 (Oct 30)	409915.25	416666.75	423225.25	421489.25	417824.13
F_1 (Nov 11)	416666.50	435957.00	444637.25	461419.75	439670.13
Means	421952.00	423534.05	437924.40	444097.25	431877.00
CD F_1 (5%)			4117.09		
CD F_2 (5%)			3682.44		
CD F_1 F_2 (5%)			8234.19		
CV (%)			1.35		

late planted crops. However, it seems that early planting could increase tuber yield if amount of radiation for growth is sufficient and clearly the trends are too imprecise for forecast planting dates with confidence, but earlier planting dates are likely to be justified as time progress. Regarding the planting dates, it is essential that tuberization and tuber bulking do not coincide with unsuitable environmental conditions (heat, drought) with attention to the growth period. In conclusion, 20 October is the optimum date of planting for potato under foot hills of Eastern Himalayas of Arunachal Pradesh.

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