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Research Paper

Influence of dates of planting and mulching on growth and tuber yield of potato (*Solanum tuberosum*) in rice (*Oryza sativa*) fallows of shallow lowland of Asom

B.S. SATAPATHY[1], T. SINGH[2], K.B. PUN[3], K. SAIKIA[4] AND S.K. RAUTARAY[5]

Regional Rainfed Lowland Rice Research Station, Gerua, Asom 781 102

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ABSTRACT

A field experiment was carried out during the winter (*rabi*) season of 2010–11 and 2011–12 at the research farm of Regional Rainfed Lowland Rice Research Station, Gerua, Asom, to study the effect of dates of planting and mulching on growth and yield of potato (*Solanum tubersoum* L.) in rice fallows of rainfed shallow lowland ecosystem. The treatments consisted of 6 dates of planting, viz. 30 October, 10 November, 20 November, 30 November, 10 Decemer and 20 December in main plots and with and without mulch in subplots. Growth and yield attributes like days to emergence, plant height, leaf-area index, tubers/plants, tuber yield and dry-matter content of tubers showed significant response to different dates of planting. Planting on 30 November registered higher plant population, tubers/plant and tuber dry-matter which resulted higher tuber yield (13.91 t/ha) than early or late planting. Early planting on 30 October recorded poor tuber yield of 7.92 t/ha which was due to poor crop stand. The yield components and yield of potato were positively influenced by the use of paddy straw mulch. Mulch with paddy straw recorded 24% increase in tuber yield over no mulch. Higher yield of potato under mulch might be owing to better crop stand, higher percentage of large tubers and better tuber dry matter. Common scab affected tuber percentage was significantly less in 30 November-planted plots (20%) as compared to other planting dates. Mulch with paddy straw reduced the incidence of common scab by 16% over no mulching.

Key words: Dates of planting, Emergence percentage, Mulching, Potato, Rice fallows, Tuber yield

Of the total 30 major cropping systems identified in India, rice based cropping system is the utmost important for food security and income generation. Rice–potato sequence is one of the widely adopted cropping system in rice-fallow lands of eastern India and plains of north-east India. Rice in the hot humid rainy season (May to October) followed by potato in the dry season (November to March) is a common practice in eastern and north-eastern India under both rainfed and irrigated ecosystems. Soil-moisture availability is the main limiting factor for growing the second crop in rainfed rice fallows of eastern India (Kar *et al*., 2006) but in shallow lowland areas of Asom sufficient carry-over residual soil moisture is available in rice fallow in the post-rainy season, which can be utilized for growing the second crop with the help of supplemental irrigation and soil-moisture conservation techniques. Under high-altitude conditions, monoculture of rice is prevalent but cropping sequences of rice–potato/mustard/pea/lentil/ seasonal vegetables are recommended for mid- and low-altitude of shallow lowland conditions. Rautaray (2005) reported that rice–potato cropping sequence gave the highest economic returns in the post-rainy season.

The optimum date of planting for potato is highly location-specific and every production region has an 'optimum' planting period during which conditions are most favourable for giving the higher yield (Thornton and Nolte, 2005; Kawakami *et al*., 2005). Planting date directly affects the rainwater supply and crop-water demand and thus influences tuber yield under rainfed situation. Hijmans (2003) predicted global yield losses for potato in the range of 18–32% without adaptation in production methods, and 9–18% without adaptation of right time of planting and use of heat-tolerant cultivars. Perfect timing of planting is one of the key factors which strongly affects crop production in rainfed agriculture (Wang *et al*., 2008). Optimum planting time is critical for maximum nutrient uptake of the applied fertilizer dose to the potato crop (Sandhu *et al*., 2014), which results in greater leaf-area index, crop-growth rate (Ezekiel and Bhargava, 1992) and yield.

[1]Corresponding author Email: bsatapathy65@gmail.com

[1]Scientist (Agronomy), [2]Senior Scientist (Agronomy), [3]Principal Scientist (Pathology), [4]Senior Scientist (Entomology); Regional Rainfed Lowland Rice Research Institute, Gerua, Asom 781 102; [5]Principal Scientist (Agronomy), Indian Institute of Water Management, Bhubneswar, Odisha 751 023

Further, planting followed by mulch with organic waste materials also plays a major role in growth and development of plants by extending life-span and moderation of soil temperature, which results in higher yield. Beneficial effects of mulch on moisture conservation, weed control, soil physico-chemical and biological conditions in the dry season have been well established (Kathmale *et al*., 2000; Mishra *et al*., 2000). Mulching of potato crop with organic waste increases potato tuber yield owing to better soil and plant water status and more roots (Acharya and Kapur, 2001). Mulch with dried water hyacinth or paddy straw significantly increases the potato tuber yield and reduces the incidence of diseases (Sanigrahi *et al*., 2000; Rautaray, 2010; Ferdoushi *et al*., 2010; Kumari, 2012). Mulch with black polythene significantly increases the potato tuber yield due to better emergence, plant height and number of shoots per hill (Singh and Ahmed, 2008). However, information on relative response of mulch under different date of planting on potato yield is meager, especially under shallow lowland ecosystem of Asom. Considering this, an attempt was made to find out the suitable planting date of potato with mulching for higher system productivity.

MATERIALS AND METHODS

A field experiment was carried out during the winter (*rabi*) season of 2010–11 and 2011–12 at the research farm of Regional Rainfed Lowland Rice Research Station, Gerua, Kamrup, (26° 14' 59" N, 90° 33' 44" E, 49 m above mean sea-level), Asom and characterized as subtropical monsoon type climate with annual average rainfall of 1500 mm. The soil was clay loam texture, having *p*H of 5.2, high in organic carbon (1.02%), medium in available nitrogen (276 kg/ha), high in available P (37 kg/ha) and high in available K (320 kg/ha). The experiment was conducted in the harvested rice field in split-plot design. The treatments consisted of 6 dates of planting (30 October, 10 November, 20 November, 30 November, 10 December and 20 December) in main plot and no mulch and mulch with paddy straw in subplots and replicated thrice. After harvesting of rainy (*kharif*) season rice (*sali*), the field was prepared by disking and harrowing. Tubers of potato variety 'Kufri Jyoti' (20–25 g) were planted with seed rate of 20.0 q/ha on ridges at a spacing of 50 cm × 20 cm. Fertilizer dose of 100, 60, 100 kg/ha of N, P_2O_5 and K_2O were applied to potato in 2 split doses. Mulching with dried paddy straw @ 2 t/ha was done immediately after planting of potato. The crop was raised with recommended package of practices. Soil-moisture status was recorded at time of planting and at different growth stages. Weather parameters like maximum and minimum temperature, rainfall, and pan evaporation were recorded throughout the crop. The mean minimum, maximum and daily mean air temperature during the study period ranged from 8.3 to 17.0° C, 22.7 to 34.7° C and 15.5 to 24.6° C respectively. Days to first emergence of potato and emergence percentage was recorded at 20, 30, 40 and 50 days after planting. Five plants were selected randomly from each plot and uprooted at 60 days of planting for calculating leaf-area index (LAI), dry-matter accumulation and crop-growth rate. Ten plants from each plot were selected at random and marked for height measurement. Height of the tallest shoot was measured from the soil surface to the base of last leaf unfolded at 60 days after planting. Leaf-area index was calculated by using graph-paper method.

At maturity, potato was harvested by using spade. At harvesting shoots/hill, tubers/plant, biomass yield were recorded by taking sample of 10 plants/plot. Tuber yield were recorded on whole plot basis. Fresh tubers (100 g) were dried in oven to obtain final dry weight of tuber. Similarly from each plot, 100 tubers were randomly taken for calculating percentage of common scab disease. Plot-wise tubers were graded and tubers weighing more than 50 g and less than 50 g were calculated. Economics of production was computed based on prevailing market price. Production efficiency (kg/ha/day) was calculated as the ratio of tuber yield and duration of the crop. Data were subjected to analysis of variance (ANOVA) for split-plot design. The results were presented at 5% level of significance (P=0.05) and critical difference (CD) values were calculated to compare the treatments.

RESULTS AND DISCUSSION

Plant emergence

Dates of planting exhibited significant effect on days to first emergence and percentage of emergence of potato crop after planting (Table 1). The early planting (30 October) took more number of days (17 days) for first emergence than late-planted tubers. Tubers used in early planting had lesser sprouts while tubers planted in later dates had more sprouts, which finally resulted in fast emergence in late plantings. These results are in conformity with findings of Haile *et al.* (2015). This might be due to difference in physiological age of the seed tuber used for planting. The physiological age of seed potato tuber modifies several morphological, physiological and agronomic characteristics of the crop (Caldiz *et al*., 1996). Also the poor plant stand of early-planted crop was due to unfavourable soil moisture and temperature during early stage of crop growth. Planting on 30 November registered first emergence in 8 days, whereas early or late planting took 10 to 17 days. This may be owing to prevailing favourable weather condition at the time of planting. Planting on 30 November recorded the highest percentage of emerged

plants per unit area 97.7%, followed by 20 November (96.9%) and 10 December (93.0%). Mulch with paddy straw exerted positive influence on days to first emergence, emergence percentage as compared to no mulch. Mulch advances days to first emergence rate by 2 days over no-mulch.

Crop growth

Plant height, number of shoots/hill, leaf-area index, dry-matter accumulation and days to maturity were significantly influenced by planting dates and mulching treatment (Table 2). Planting on 30 November resulted in the highest plant height (56.0 cm) followed by 10 December and 20 November. Late planting on 20 December resulted in lowest plant height. The highest plant height, shoots/hill and leaf area were noted at 30 November, which can be attributed to the favourable environment for crop growth. The lowest plant height recorded at 20 December was due to the exposure of plants to very low temperature (8.3° C) experienced after emergence, which might have reduced allocation of assimilates for growth. Ezekiel and Bhargava (1992) and Singh and Khurana (1997) also reported similar findings. However, planting on 30 October recorded reduction in plant height due to delay in emergence. Plant height and shoots/hill with mulch resulted in 8 and 25% increase over no mulch respectively. Planting on 30 November exhibited the highest leaf-area index (LAI) (3.04), followed by 10 and 20 December. The LAI in 30 October planting was the lowest due to unfavorable soil moisture and temperature at initial period of growth. The LAI re-

Table 1. Effect of dates of planting and mulch on emergence of potato plants (pooled data of 2 years)

Treatment	Days to first emergence (days)	Percentage emergence			
		20 days after planting	30 days after planting	40 days after planting	50 days after planting
Date of planting					
30 October	17.0	26.3	39.0	56.6	69.9
10 November	14.5	51.4	79.4	86.9	88.3
20 November	11.8	72.3	92.7	96.6	96.9
30 November	7.7	94.0	95.5	97.7	97.7
10 December	10.3	88.8	90.8	93.3	93.0
20 December	11.7	76.2	84.4	89.2	90.6
SEm±	0.28	0.75	0.98	0.54	0.83
CD (P=0.05)	0.83	2.36	3.09	1.70	2.63
Mulch					
No mulch	13.1	66.1	78.2	85.2	88.2
Mulch	11.3	70.2	82.4	88.2	90.8
SEm±	0.12	0.22	0.16	0.23	0.22
CD (P=0.05)	0.38	0.61	0.50	0.74	0.67

Table 2. Effect of dates of planting and mulch on growth parameters of potato (pooled data of 2 years)

Treatment	Plant height (cm)	Shoots/plant	Leaf-area index (60 DAP)	Dry matter (g)/ plant (60 DAP)	Days to maturity (days)
Date of planting					
30 October	50.3	1.6	1.67	12.9	104
10 November	52.8	2.0	2.25	16.9	102
20 November	54.1	2.4	2.70	22.2	101
30 November	56.0	3.2	3.04	30.7	97
10 December	54.6	2.5	2.94	26.4	95
20 December	49.0	2.2	2.94	18.8	94
SEm±	0.64	0.09	0.04	0.60	0.60
CD (P=0.05)	2.002	0.276	0.129	1.876	1.734
Mulch					
No mulch	50.7	2.0	2.18	18.7	99.6
Mulch	54.9	2.5	2.80	18.7	98.1
SEm±	0.32	0.05	0.03	0.26	0.16
CD (P=0.05)	0.720	0.148	0.083	0.796	0.479

DAP, days after planting

corded with mulch was 28% higher than no mulch. Planting on 30 November resulted high accumulation of dry weight/plant (30.7 g) than early or late planting. Mulching with paddy straw recorded 27.8% increase in plant dry weight than no mulch. Crop planted on 30 October matured at 104 days and thereafter reduction in days to maturity. Delay in planting shortens the duration of the crop due to physiological maturity of seed tuber and prevailing temperature during the crop-growth period. Mulch hastened the maturity of the crop by about 2 days.

Yield components and yield

Yield components, especially plant population/m^2, tubers/plant and tuber dry-matter were significantly influenced by dates of planting and mulch (Table 3). Planting on 30 November registered the highest plant population/unit area (9.78), tubers/plant (4.2) and tuber dry-matter (20.26 %) which resulted in highest tuber yield (13.91 t/ha) as compared to early or late planting. Early planting on 30 October recorded poor tuber yield (7.92 t/ha) which was due to poor crop stand. The poor yield with early planting might also be due to unfavourable soil and weather condition at the time of early growth stage of crop. Late planting on 20 December also recorded significantly low yield due to reduction in plant population, less number of tubers/plant and less percentage of large tubers as compared to other planting dates. The reduction in tuber yield under late planting was due to unfavourable temperature at the tuber-development stage of the crop. The yield components and yield of potato were positively influenced by the use of paddy straw mulch. Mulching with paddy straw recorded 24% increase in yield over no mulch. Higher yield of potato under mulch was owing to better crop stand, higher percentage of large tubers and better tuber dry matter.

Table 3. Effect of dates of planting and mulch on tuber yield and yield attributes of potato (pooled data of 2 years)

Treatment	Plant population at 50 DAP (₹/m^2)	Tubers/plant	Yield (t/ha)			Dry-matter (%)	Common scab (%)
			< 50 g tuber	> 50 g tuber	Total tuber		
Date of planting							
30 October	6.98	2.6	2.49	5.45	7.94	19.47	33.0
10 November	8.83	3.4	2.32	7.58	9.90	19.69	30.4
20 November	9.68	3.9	3.48	8.65	12.13	19.87	30.2
30 November	9.78	4.2	4.69	9.22	13.91	20.26	20.4
10 December	9.38	3.8	5.57	7.14	12.71	19.78	28.1
20 December	9.06	3.0	4.22	4.71	8.93	18.50	38.1
SEm±	0.08	0.17	0.11	0.07	0.08	0.09	0.98
CD (P=0.05)	0.26	0.53	0.32	0.24	0.27	0.29	2.95
Mulch							
No mulch	8.82	3.2	3.83	5.91	9.74	19.33	32.7
Mulch	9.09	3.7	3.88	8.22	12.10	19.85	27.4
SEm±	0.02	0.03	0.12	0.10	0.07	0.07	0.40
CD (P=0.05)	0.07	0.11	0.38	0.29	0.23	0.22	1.23

Table 4. Effect of dates of planting and mulch on economics and production efficiency of potato in rice fallow (pooled data of 2 years)

Treatment	Net returns (× 10^3₹/ha)	Benefit: cost ratio	Production efficiency (kg/ha/day)	Economic efficiency (₹/ha/day)
Date of planting				
30 October	5.4	1.09	76.3	611
10 November	21.1	1.36	97.1	776
20 November	38.9	1.67	120.1	961
30 November	53.2	1.92	143.4	1147
10 December	43.6	1.75	133.8	1070
20 December	13.3	1.23	95.0	760
Mulch				
No mulch	20.3	1.35	97.8	782
Mulch	38.2	1.65	123.3	987

Quality of tuber

Dates of planting had significant effect on quality component, especially infection of common scab of potato (Table 3). Common scab affected tuber percentage was significantly less when planted on 30 November (20%) as compared to other planting dates. Mulching with paddy straw reduced the incidence of common scab by 16% over no mulch.

Economics

Dates of planting and mulching had influenced the economics and production efficiency of potato. Planting on 30 November resulted the highest net returns, benefit: cost ratio, economic efficiency and production efficiency followed by 10 December and 20 November planting (Table 4). Mulching with paddy straw recorded increment in net returns, benefit: cost ratio, economic efficiency and production efficiency over no mulch.

It can be concluded that 30 November is the optimum planting time for growth and yield of potato in rice fallows of Asom under shallow lowland situation. Mulching with paddy straw was also useful in enhancing the growth and yield of potato crop under rainfed condition.

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