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Impact of different sowing dates and mulching practices on economics of potato (K. Himalini) crop

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Abstract
The economic suitability of potato crop depends upon the management practices particularly the by maintaining the cost of inputs. Because the potato seed (tubers) alone cost more than 60% of the total cost of cultivation. The application of different management practices like sowing dates and mulching practices are very mulch needed to improve in cropping intensity and productivity of rice fallow lands under valley land of Meghalaya. Timely sowing of crop is most important to get higher yield and to utilize natural resources in a sustainable way by utilizing the available natural resources through application of various straw and biomass mulches. All these practices finally lead to higher monetary returns. Significantly higher economics suitability of potato crop under rice fallows was recorded under S_1 (5th November) sowing dates in comparison to others. From this experimental finding we can suggest that potato crop sown under November sowing dates along with mulch could be the better option for farmers under rice fallows of valley land of Meghalaya.

Keywords: sowing dates, mulching practices, economics, potato

1. Introduction
Crop production under rice fallow lands become the need of present time due to lack of land resources in the country and at global level to feed the rising world population. Rice fallows accounts around 11.70 m ha across the country specially easter parts and north east India (Kumar *et al.,* 2019) [1]. The cropping system adopted under rice fallows needs the careful planning and management strategies to gey higher crop yield by utilizing the locally available natural resources in eco-friendly way without compromising the future resources or soil fertility and productivity. The proper production technique and sowing under optimum environmental conditions are the prerequisite for higher tuber yield and, significantly higher and profitable outcomes (Jamro *et al.,* 2015) [2]. The higher profit from the potato crop under rice fallows not only depends on the management practices, but it also depends on soil moisture content and temperature conditions. Because potato crop is very sensitive to lack of soil moisture and temperature which affects the growth and developmental process, and finally leads to higher and lower tuber yield. As per the previous findings on rice-based farming systems reported by Pandiaraj *et al.* (2017) [5] that the higher net income was recorded where rice-potato-maize system was adopted. Also, the similar findings were reported by Biswas *et al.* (2017) [4] and said that the higher income was recorded where potato crop was added to the rice -based farming systems.
The aim of conducting this experiment was to see the effects of different sowing dates and mulching practices on economic suitability based on the experimental findings under rice-fallow of valley land. Because the application of economically viable techniques and introduction of such technique of crop production which is suitable for farmers as per their economic standards so they can easily adopt and get something out of nothing from rice fallows. That's why we have introduced sowing date which is non-monetary input. Moreover, the application of organic mulch also another reason because added organic mulches not only maintains the suitable soil moisture content during various growth stages of potato crop but also upon decomposition improve in the soil fertility status by increasing soil available nutrients through improving in soil chemical and biological pools. Finally, all these practices lead to higher tuber yield and more income per unit area in per unit time.

2. Materials and Methods

2.1 experimental site

The potato crop was grown under rice fallow land of valley land of Ri-Bhoi district of Meghalaya during the years of 2018-19 and 2019-20. The experimental farm which is situated at 24.41^0 N latitude and 91.54^0 E longitudes at an elevation of 950 m above mean sea level (MSL). This region comes under sub-tropical climatic conditions.

2.2 Economic analysis

The various aspects of economics including cost of cultivation, gross income, net income and benefit to cost ratio were calculated using the following formula.

2.2.1 Cost of cultivation (₹ ha^{-1})

The cost of cultivation was calculated on per hectare basis for every treatment by taking into account the inputs, labours and operational cost.

2.2.2 Gross income (₹ ha^{-1})

The total monetary value of the grain and straw of rice, and tuber yield of potato as economic produce obtained from the crop and it was calculated on the basis of prevailing local market price of the produce and expressed on unit area (ha^{-1}). Using the following formula:

Gross income (₹ ha^{-1}) = Price per kg of potato tubers (based on local market)

2.2.3 Net income (₹ ha^{-1})

The cost of cultivation for each treatment was subtracted from the gross income to get net income in rupees per hectare (₹ ha^{-1}). Using the following formula:

Net income (₹ ha^{-1}) = gross income – total cost of cultivation

2.2.4 Benefit to cost (B:C) ratio

The benefit to cost ratio of rice-potato cropping system was worked out using the following formula:

$$\text{Benefit cost ratio} = \frac{\text{Net income (Rs.ha}-1)}{\text{Cost of cultivation (Rs.ha}-1)}$$

2.3 Statistical analysis

A standard method of analysis of variance was used for analysing data. The 'F' test of significance was used for testing the standard error of mean ($SE_{(m)\pm}$) for each treatment and where the treatment effects was significant, the critical difference (C.D.) at 5% probability level worked out for testing the significance of treatment difference. The interpretation was based on the method given by Gomez and Gomez (1984) [3].

3. Experimental findings

Experimental findings of potato crop regarding to various economic aspects is given in the Table 1. The different sowing dates and mulching practices were showed the significant effect on various economic aspects of potato crop during both the years of 2018-19 and 2019-20, as well as in pooled analysed data during experimentation.

3.1 Effect of sowing dates

Sowing dates found significant effects on cost of cultivation, gross monetary returns, net monetary returns and on benefit to cost (B:C ratio) ratio during both the years of potato crop experimentation. The cost of cultivation was recorded non-significant under various sowing dates from S_1 (5^{th} November) to S_5 (4^{th} January). The cost of cultivation was recorded same during first year under various sowing dates also, similar resulted were recorded during second year of potato crop experimentation. However, the cost of cultivation during second year of crop experimentation was recorded lower in comparison to first year under various sowing dates. The cost of cultivation during both the years under various sowing dates was found on par to each other. The pooled analysed data also showed the similar results. Gross monetary return was significantly influenced by various sowing dates. The maximum gross monetary returns were recorded under S_1 (5^{th} November) sowing date during both the years of crop experimentation as well as in the pooled analysed data too. However, the significantly lower gross monetary returns were recorded under S_5 (4^{th} January) sowing date during both the years and in pooled analysed data too. Net monetary returns were significantly affected by various sowing dates during both the years of crop experimentation and in pooled analysed data too. The significantly higher net monetary return was recorded under S_1 (5^{th} November) sowing date in comparison to others during both the years and in the pooled analysed data too. Moreover, its lower net monetary returns were recorded under S_4 (20^{th} December) sowing date. furthermore, the negative net returns were recorded under S_5 (4^{th} January) sowing date during both the years as well in the pooled analysed data too. The sowing dates were significantly influenced the benefit to cost ratio of potato crop. The significantly higher benefit to cost ratio was recorded where potato crop was sown under S_1 (5^{th} November) sowing date and lowest under S_3 (5^{th} December) sowing date during both the years of crop experimentation and as per the pooled analysed data too. Moreover, the negative benefit to cost ratio was recorded under S_5 (4^{th} January) sowing date.

3.2 Effect of mulching practices

Mulching practices were found significant effects on cost of cultivation, gross monetary returns, net monetary returns and on benefit to cost (B:C ratio) ratio during both the years of potato crop experimentation. Mulching practices significantly influenced the economic parameters of potato crop. The significantly higher cost of cultivation, gross monetary returns, net monetary returns and benefit cost ratio was recorded under M_1 (Rice straw mulch) mulch in comparison to others and lower recorded under M_0 (No mulch) mulch during both the years of crop experimentation and in pooled analysed data too, respectively. Moreover, the higher cost of cultivation under various mulching was recorded during first year (2018-19) in comparison to second year (2019-20) of potato crop experimentation.

3.3 Interaction effect

The significantly higher gross returns were recorded under S_1M_1 (5^{th} November sowing date and rice straw mulch) during both the years and in pooled analysed data, while the lower gross returns were recorded under S_4M_0 (20^{th} December sowing date and No mulch) during first year, and under S_5M_0 (4^{th} January sowing date and No mulch) during second year, and in the pooled analysed data, respectively. Net returns were significantly higher recorded under S_1M_1 (5^{th} November sowing date and rice straw mulch) during both the years and in pooled data. Likewise, the net returns were significantly recorded under S_1M_1 (5^{th} November sowing date and rice

straw mulch) during 2018-19, and S_5M_0 (4th January sowing date and No mulch) during 2019-20 and in pooled analysed data, respectively. Benefit to cost ratio was significantly higher recorded under S_1M_1 (5th November sowing date and rice straw mulch) during 2018-19, 2019-20 and in pooled data. However, its lower ratio was recorded in the S_4M_0 (20th December sowing date and No mulch) during 2018-19 and in pooled data, and S_5M_0 (4th January sowing date and No mulch) during 2019-20, respectively. Moreover, superiorly higher benefit to cost ratio was recorded under S_1M_1 (5th November sowing date and rice straw mulch) during second year of crop experimentation in comparison to others with respect to various practices of potato crop production.

Table 1: Effect of different sowing dates and mulching practices on economic parameters of potato crop (K. Himalini)

Treatments	Cost of cultivation (₹)			Gross income (₹)			Net income (₹)			B:C ratio		
Sowing dates	**2018**	**2019**	**Pooled**	**2018**	**2019**	**Pooled**	**2018**	**2019**	**Pooled**	**2018**	**2019**	**Pooled**
S_1	104037	100327	102182	272278	286783	279530	168241	186457	177349	2.57	2.75	2.66
S_2	104037	100327	102182	208972	199850	204411	104936	99524	102230	1.95	1.93	1.94
S_3	104037	100327	102182	202111	211337	206724	98075	111010	104542	1.89	2.00	1.95
S_4	104037	100327	102182	104806	106580	105693	769	6253	3511	0.99	1.01	1.00
S_5	104037	100327	102182	93917	86592	90255	-10120	-13734	-11927	0.91	0.83	0.87
S.E(m)±	*	*	*	7820	7748	4494	7820	7748	4494	0.08	0.07	0.04
CD (p=0.05)	*	*	*	25499	25265	13472	25499	25265	13472	0.26	0.23	0.13
Mulching practices												
M_0	88596	84886	86741	117700	86111	101906	29104	1225	15165	1.33	1.01	1.17
M_1	117746	114036	115891	237983	281288	259635	120237	167252	143745	2.02	2.47	2.24
M_2	105768	102058	103913	173567	167287	170427	67799	65229	66514	1.64	1.64	1.64
S.E(m)±	*	*	*	5446	6136	3745	5446	6136	3745	0.05	0.06	0.04
CD (p=0.05)	*	*	*	16063	18098	10702	16063	18098	10702	0.15	0.17	0.10
Interaction	*	*	*	S	S	S	S	S	S	S	S	S

* Is showing the non-significance

4. Discussion

The significant higher gross income, net income and benefit to cost ratio was recorded under S_1 (5th November) sowing date during 2018-19, 2019-20 and in pooled analysed data. The significance of various economic aspects of potato crop is due to suitable growing conditions during potato crop sowing in the November month along with mulching practices. These practices lead to higher production of tubers and higher profitability (Gao *et al.*, 2019; Zhou *et al.*, 2017) [6, 10]. The Sharma *et al.* (2015) [11] also reported the higher net returns under the same cropping system. The similar findings were reported by Saha and Gosh (2010) [7]; Barman *et al.* (2008) [8]; Rahaman *et al.* (2004) [9].

5. Conclusion

These experimental findings showed the significant and higher economics returns under S_1 (5th November sowing date) and M_1 (rice straw mulch) during 2018-19, 2019-20 as well as under pooled analysed data. The interaction effect on economic returns was significant recorded under S_1M_1 (5th November sowing date and rice straw mulch). So, from this experiment it can be concluded that potato crop sown under S_1 along with M_1 could be the better option to farmers to grow potato crop under rice-based farming system in the rice fallows of valley land. Because the application of rice straw mulch along with November sowing date is an economically viable practice for farming community.

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