

## PHYSIOLOGICAL PARAMETERS AND QUALITY OF POTATO UNDER DIFFERENT PLANTING DATES

**Comment [E1]:** Physiological Parameters and Quality of Potato under Different Planting Dates

### ABSTRACT

A field experiment was conducted to study the influence of planting dates on physiological parameters and quality of potato crop during the *Rabi* seasons of 2021-22 and 2022-23. The experiment was laid out with seven different planting dates viz., 15 Sept (D1); 30 Sept (D2); 15 Oct (D3); 30 Oct (D4) (Timely planting); 14 Nov (D5); 29 Nov (D6) and 14 Dec (D7) in randomized block design (RBD) with four replications. The potato (cv. Kufri Mohan) was planted with a seed rate of 3.5 t ha<sup>-1</sup> and with a spacing of 60 cm x 20 cm. The recommended dose of chemical fertilizers viz., 180:80:120 kg ha<sup>-1</sup>N:P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O, respectively was applied to the crop. The various physiological parameters viz., crop growth rate, relative growth rate and absolute growth rate; and quality parameters (protein, starch, dry matter and true density) were recorded. The results revealed that the timely planting treatment date (30 Oct) showed significant positive effect on physiological parameters in potato crop whereas effect was at par with respect to the quality parameters under studied planting dates.

**Keywords** **EYWORDS:** CGR, RGR, AGR, Planting date, potato, true density, dry matter content, protein, starch content, quality of potato

**Comment [E2]:** Use full phrases rather than acronyms or abbreviations. Italic. Please respect the number indicated in Instructions for authors.

### INTRODUCTION

**Comment [E3]:** 1. INTRODUCTION

Potato is an important food crop having a significant contribution towards food and nutritional security, especially in the developing world (Scott *et al.*, 2019). It is considered as a balanced food due to the presence of high-quality proteins, vitamins and minerals, trace elements with lesser energy (Rana and Anwer, 2018). Potato is the staple food of almost half of the world's population (Thiele *et al.*, 2010). Potato is the fourth most important food crop in the world, after corn, rice, and wheat. It is known as a protective food because potato protein is rich in lysine, which is one of the most important amino acids. It is also the most important food crop in the world, and it contains approximately 78% water, 22% dry matter, 20.6% carbohydrates, 2.1% protein, 1.1% crude fiber, 0.9% ash, and 0.3% fat (Zhang *et al.*, 2017). In India, about 68% of potatoes are utilized for table purposes, 7.5% for processing, 8.5% for seed, and the remaining 16% of produce goes waste during pre- and post-harvest handling (Gupta *et al.*, 2009). In India, it is grown on an area of 2.14 million hectares with a production of 51.31 million tonnes and a productivity of 24.0 tonnes ha<sup>-1</sup>. Currently, Madhya Pradesh contributes about 6.96 percent of area and 6.58 percent of production of potatoes in the country. Its productivity in Madhya Pradesh is 22762 kg ha<sup>-1</sup>. The optimum growth and production of potato largely depend upon prevailing weather conditions and use of improved inputs like use of improved varieties, time of

**Comment [E4]:** Please respect Instructions for authors. I will not remind you later.

**Reference style**  
References must be listed at the end of the manuscript and numbered in the order that they appear in the text. Every reference referred in the text must also present in the reference list and vice versa. In the text, citations should be indicated by the reference number in brackets [1].

**Comment [E5]:** I recommend a new paragraph here.

**Comment [E6]:** 22,762?

**Comment [E7]:** I suggest a new paragraph here.

planting, good seed quality and other cultural practices till harvesting contribute in increasing potato yield. Among them, the optimum time of planting is major limiting factor for maximum production of potato.

The Planting of potato at optimum time result in maximum emergence, good crops growth and better utilization of light and temperature and minimum pest problem would enhance the yield. For best yields, potato crop requires long day conditions for good growth and short-day conditions for tuberization (Chadha, 2009). Optimum tuber formation takes place at 20 °C. Increase in temperature beyond 21 °C causes sharp reduction in the tuber initiation and yield and at 30 °C complete inhibition of tuber formation (Shekhawat, 2001). However, the studies related to the effect of planting dates on physiological parameters viz., crop growth rate, relative growth rate and absolute growth rate in potato are lacking. Similarly, the influence of planting dates on quality parameters such as protein content, dry matter content, true density and starch content is not clearly understood. Therefore, in order to study the effect of planting dates on physiological and quality parameters in potato was studied in a field experiment.

**Comment [E8]:** Therefore, in order to study the effect of planting dates on physiological and quality parameters in potato a experiment has been carried out.

## 2. MATERIALS AND METHODS

### The field experiment

**Comment [E9]:** 2.1. The experiment setup

The present experiment was carried out at the Research Farm of ICAR-Central Potato Research Institute (Regional Station), Gwalior (M.P.) during the *Rabi* seasons of 2021-22 and 2022-23. Geographically, Gwalior is located at 26°13' North latitude and 78°14' East longitude and 206 meters above mean sea level (AMSL) which lies in the North tract of M.P. enjoying subtropical climate, with extreme hot up to 48°C in summer and minimum temperature as low as 4.0°C during winter season. The annual rainfall ranges between 750 to 800 mm, most of which received from end of June to end of September, with few showers in winter months.

**Comment [E10]:** The present experiment was carried out at the Research Farm of Central Potato Research Institute (ICAR), Regional Station, Gwalior (Madhya Pradesh)(MP), India, during....

The experiment was laid out with seven different planting dates viz., D1- 15/09/2021; D2- 30/09/2021; D3- 15/10/2021; D4- 30/10/2021 (Timely planting); D5- 14/11/2021; D6- 29/11/2021 and D7-14/12/2021 in randomized block design (RBD) with four replications. The potato (cv. Kufri Mohan) was planted with a seed rate of 3.5 t ha<sup>-1</sup> and with a spacing of 60 cm x 20 cm. The recommended dose of chemical fertilizers viz., 180:80:120 kg ha<sup>-1</sup>N:P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O, respectively was applied before planting. Seed treatment was done with 3.0 % boric acid solution by dipping tubers for 30 minutes for controlling soil and tuber born diseases before keeping seed tubers in cold store. Seed treatment was performed at shady place and immediate after treatment, tuber were treated and covered with soil to protect the tubers from sun light. Seed tubers were planted manually at a uniform distance of 60 cm between row to row and 20 cm between plant to plant. The planting was done as per the designed treatments during first and second years. A uniform seed rate of 35 q ha<sup>-1</sup> was used for planting. Weed was managed using Metribuzin 70%WP as a pre-emergence herbicide (one day after planting) @ 500g a.i. ha<sup>-1</sup> in all treatments. Imidachloprid (17.8% SL) insecticide was used for controlling pest population at the 45 days after planting (DAP). The first irrigation was given immediately after planting since planting was done under dry soil condition. It ensures proper establishment of potato plant.

**Comment [E11]:** Why now q? and not tons?

Subsequent irrigations were given at about 10-15 days interval using ridge - furrow irrigation method as per crop requirement.

**Observations recorded**

The physiological parameters viz., absolute growth rate, crop growth rate and relative growth rate were computed following standard methods as depicted under:

*Absolute growth rate (AGR)*

Radford (1967) suggested AGR. It expresses the increase in the dry weight per unit time and is expressed in  $g\text{plant}^{-1}\text{day}^{-1}$ . It gives Absolute values of biomass between two intervals.

$$AGR = \frac{W_2 - W_1}{t_2 - t_1}$$

Where,

$W_1$  and  $W_2$  are the total dry weight per plant at time  $t_1$  and  $t_2$ , respectively.

*Crop growth rate (CGR)*

It is the dry weight gain by a unit area of crop in a given time. The CGR is expressed in  $gm^{-2}\text{day}^{-1}$ .

$$CGR = \frac{W_2 - W_1}{(t_2 - t_1) S}$$

Where,

$W_1$  and  $W_2$  are the total dry weight per plant at time  $t_1$  and  $t_2$ , respectively.

$S$  = Land area ( $m^2$ ) over which dry matter recorded.

*Relative growth rate (RGR)*

It is the increase of material per unit weight per unit time. It is expressed in  $gg^{-1}\text{day}^{-1}$ . It was suggested by Blackman, (1919).

$$RGR = \frac{\ln W_2 - \ln W_1}{t_2 - t_1}$$

Where,

$W_1$  and  $W_2$  are the total dry weight per plant at time  $t_1$  and  $t_2$ , respectively.

The quality parameters viz., true density, dry matter content, protein content and starch content were also determined by adopting following standard methods:

*True density of potato*

**Comment [E12]: 2.2. Recorded parameters**  
**2.2.1. Physiological parameters**  
 Absolute growth rate (AGR)  
 .....  
 Crop growth rate (CGR)  
 .....

**Comment [E13]: 2.2.2. The quality parameters**  
 True density of potato  
 .....

It was determined by water displacement method as reported by Mohsenin (1986) as:

$$\text{True density of potato (g cc}^{-1}\text{)} = \frac{W}{V}$$

Where,

W- Mass of potato tuber (g)

V- Volume of water displaced by tuber (cm<sup>3</sup>)

#### *Tuber dry matter content*

The tuber dry matter was calculated by the following formula:

Tuber dry matter content (%) = 100 x Dry weight of tuber / Fresh weight of tuber

#### *Protein content*

Protein content in tuber was worked out by multiplying the nitrogen content in tuber with the factor 6.25, as suggested by (AOAC, 1970).

#### *Starch content*

Starch content in potato has been determined by water wash method as described by Miernik and Jakubowski (2021).

All data related to the study were collected, compiled, and statistically analyzed by using the analysis of variance technique (Fisher, 1958). Data so computed were as subjected to Fisher's analysis of variance for judging the effect of various treatments.

### **3. RESULTS AND DISCUSSION**

#### **Crop growth rate**

The crop growth rate (CGR) of potato under various planting date treatments determined at 0-30 DAP during 2021-22, 2022-23 and pooled of two years ranged between 0.686-1.891 g m<sup>-2</sup> d<sup>-1</sup>, 0.990-1.570 g m<sup>-2</sup> d<sup>-1</sup> and 0.838-2.231 g m<sup>-2</sup> d<sup>-1</sup>, respectively (Table 1). The CGR determined at 0-30 DAP in 2021-22 showed that the timely planting treatment found superior over rest other treatments studied except the treatment D5 where it was found at par. Further, the treatments D1, D2 and D7 were also found at par with respect to the CGR in potato crop. The treatment D3 and D5 were also found statistically at par with each other. In 2022-23, the CGR found highest in timely planting treatment (D4) followed by the treatment D5 (1.968 g m<sup>-2</sup> d<sup>-1</sup>). The treatments D2, D3 and D5 were found statistically at par. Further, D1, D6 and D7 were also found statistically at par.

Table 1. Effect of planting dates on crop growth rate (CGR) in potato

**Comment [E14]:** Statistical analysis

**Formatted:** Indent: First line: 0"

**Comment [E15]:** Now, please follow the same structure as in materials and methods section.

For example:  
3.1. Physiological parameters  
3.1.1. Crop growth rate

And so on,

**Comment [E16]:** 1.570 ?

or  
2.570? as we can see in Table 1.

**Comment [E17]:** Bold

**Comment [E18]:** Please, inside the Table the explanations should be done for the abbreviations, or, otherwise, below the Table a Legend is necessary. The observation is valuable for each Table.

Treatment	Crop growth rate ( $\text{g m}^{-2} \text{d}^{-1}$ )					
	0-30 DAP			30-60 DAP		
	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled
D1	1.129	1.255	1.192	6.761	8.457	7.609
D2	1.166	1.612	1.389	7.097	8.712	7.904
D3	1.556	1.830	1.693	10.200	11.038	10.619
D4	1.891	2.570	2.231	11.612	12.475	12.043
D5	1.616	1.968	1.792	10.339	11.095	10.717
D6	0.994	1.303	1.149	8.312	9.373	8.842
D7	0.686	0.990	0.838	7.699	8.848	8.274
SEm $\pm$	0.094	0.147	0.094	0.423	0.477	0.316
CD at 5%	0.281	0.439	0.279	1.263	1.422	0.943

Formatted: Font: Bold, Superscript

Formatted: Font: Bold

Formatted: Font: Bold

Formatted: Font: Bold

Formatted: Font: Bold

The pooled data revealed that the timely planting treatment (D4) showed higher CGR followed by D5 ( $1.968 \text{ g m}^{-2} \text{d}^{-1}$ ) and D3 ( $1.693 \text{ g m}^{-2} \text{d}^{-1}$ ). The treatments D1, D2 and D6 were found statistically at par. The lowest CGR found in the treatment D7 ( $0.838 \text{ g m}^{-2} \text{d}^{-1}$ ). The CGR of potato under various planting date treatments determined at 30-60 DAP during 2021-22, 2022-23 and pooled of two years ranged between  $6.761-11.612 \text{ g m}^{-2} \text{d}^{-1}$ ,  $8.457-12.745 \text{ g m}^{-2} \text{d}^{-1}$  and  $7.609-12.043 \text{ g m}^{-2} \text{d}^{-1}$ , respectively (Table 1).

Comment [E19]: 12.745 ? or 12.475?

The CGR determined at 30-60 DAP in 2021-22 showed that the timely planting treatment found superior over rest other treatments studied. Further, the treatments D3 and D5 were found at par with respect to the CGR in potato crop. The treatment D2, D6 and D7 were also found statistically at par with each other. In 2022-23, the CGR found highest in timely planting treatment (D4  $12.745 \text{ g m}^{-2} \text{d}^{-1}$ ) followed by the treatment D5 ( $11.095 \text{ g m}^{-2} \text{d}^{-1}$ ). The treatments D3 and D5 were found statistically at par. Further, D1, D2, D6 and D7 were also found statistically at par. The pooled data revealed that the timely planting treatment (D4) showed higher CGR at 30-60 DAP followed by D5 ( $10.717 \text{ g m}^{-2} \text{d}^{-1}$ ) and D3 ( $10.619 \text{ g m}^{-2} \text{d}^{-1}$ ). The treatments D1, D2 and D7 were found statistically at par. The lowest CGR found in the treatment D1 ( $7.609 \text{ g m}^{-2} \text{d}^{-1}$ ).

### Relative growth rate

The relative growth rate (RGR) of potato under various planting date treatments determined at 0-30 DAP during 2021-22, 2022-23 and pooled of two years ranged  $0.014-0.029 \text{ g g}^{-1} \text{d}^{-1}$ ,  $0.020-0.034 \text{ g g}^{-1} \text{d}^{-1}$  and  $0.017-0.029 \text{ g g}^{-1} \text{d}^{-1}$ , respectively (Table 2). The RGR determined at 0-30 DAP in 2021-22 showed that the treatment D4 (timely planting), treatment D3 and D5 found at par with each other and superior over rest other treatments studied. Further, the treatments D1, D2 and D6 were found at par with respect to the RGR in potato crop. The treatment D7 showed significantly lower RGR among all the treatments studied. In 2022-23, the RGR found statistically significant and highest in timely planting treatment (D4) followed by the treatment D5 ( $0.030 \text{ g g}^{-1} \text{d}^{-1}$ ). The treatments D1, D2 and D6 were found statistically at par. Further, D1, D6 and D7 were also found statistically at par. The pooled data revealed that the timely planting treatment (D4) showed highest RGR followed by D5 ( $0.028 \text{ g g}^{-1} \text{d}^{-1}$ ) and D3 ( $0.027 \text{ g g}^{-1} \text{d}^{-1}$ ). The treatments D3 and D5 were found statistically at par. Similarly, the treatments D1 and D6 were

also found statistically at par. The lowest RGR was found in the treatment D7 (0.020 g g<sup>-1</sup> d<sup>-1</sup>). In the Table 2 is g g<sup>-1</sup> day<sup>-1</sup>. So, please use the same expression unit inside the text.

Table 2. Effect of planting dates on relative growth rate (RGR) in potato

Treatment	Relative growth rate (g g <sup>-1</sup> day <sup>-1</sup> )					
	0-30 DAP			30-60 DAP		
	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled
D1	0.022	0.023	0.022	0.047	0.051	0.049
D2	0.022	0.027	0.024	0.048	0.051	0.050
D3	0.026	0.028	0.027	0.053	0.055	0.054
D4	0.029	0.034	0.031	0.055	0.056	0.056
D5	0.027	0.030	0.028	0.054	0.055	0.054
D6	0.020	0.023	0.022	0.050	0.052	0.051
D7	0.014	0.020	0.017	0.049	0.051	0.050
SEm±	0.001	0.001	0.001	0.001	0.001	0.001
CD at 5%	0.003	0.004	0.002	0.002	0.002	0.002

Comment [E20]: bold

Formatted: Font: Bold

Formatted: Font: Bold

Formatted: Font: Bold

The RGR of potato under various planting date treatments determined at 30-60 DAP during 2021-22, 2022-23 and pooled of two years ranged 0.047-0.055 g g<sup>-1</sup> d<sup>-1</sup>, 0.051-0.055 g g<sup>-1</sup> d<sup>-1</sup> and 0.049-0.056 g g<sup>-1</sup> d<sup>-1</sup>, respectively (Table 2). The RGR determined at 30-60 DAP in 2021-22 showed that the treatment D4 (timely planting), treatment D3 (0.053 g g<sup>-1</sup> d<sup>-1</sup>) and D5 found at par with each other but found superior over rest other treatments studied. Further, the treatments D1 and D2 were found at par with respect to the RGR in potato crop. The treatment D7 showed significantly lower RGR among all the treatments studied. In 2022-23, the RGR found statistically significant and highest in timely planting treatment (D4) followed by the treatment D5 and D3. The treatments D1, D2, D6 and D7 were found statistically at par. The pooled data revealed that the timely planting treatment (D4) showed highest RGR followed by D5 (0.028 g g<sup>-1</sup> d<sup>-1</sup>) and D3 (0.027 g g<sup>-1</sup> d<sup>-1</sup>). The treatments D2, D6 and D7 were found statistically at par. Similarly, the treatments D1, D2 and D7 were also found statistically at par. The lowest RGR was found in the treatment D1 (0.049 g g<sup>-1</sup> d<sup>-1</sup>).

Comment [E21]: d or day?

#### Absolute growth rate

The absolute growth rate (AGR) of potato under various planting date treatments determined at 0-30 DAP during 2021-22, 2022-23 and pooled of two years ranged 0.091-0.249 g d<sup>-1</sup>, 0.131-0.339 g d<sup>-1</sup> and 0.111-0.294 g d<sup>-1</sup>, respectively (Table 3). The pooled data revealed that the timely planting treatment (D4) showed significantly higher AGR among the treatments studied. Further the treatments D3 and D5 were found statistically at par and superior over D1, D2, D6 and D7. The treatments D1, D2 and D6 were found statistically at par. The lowest RGR determined at 30-60 DAP was found in the treatment D7 (0.111g d<sup>-1</sup>). The absolute growth rate (AGR) of potato under various planting date treatments determined at 30-60 DAP during 2021-22, 2022-23 and pooled of two years ranged 0.892-1.532 g d<sup>-1</sup>, 1.116-1.645 g d<sup>-1</sup> and 1.004-1.589 g d<sup>-1</sup>, respectively (Table 3). The AGR in potato crop was found highest in the treatment D4 (timely planting) followed by the treatments D5 and D1. The treatment D4 showed statistically significant AGR as compared to all the treatments under study. Similarly, the treatments D3 and D5 were found at par but statistically superior over the treatments D1, D2, D6 and D7. The

treatments D1, D2 and D7 were also found statistically at par. The lowest AGR was observed under the treatment D1 (1.004 g day<sup>-1</sup>).

Table 3. Effect of planting dates on absolute growth rate (AGR) in potato

Comment [E22]: bold

Treatment	Absolute growth rate (g day <sup>-1</sup> )					
	0-30 DAP			30-60 DAP		
	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled
D1	0.149	0.166	0.157	0.892	1.116	1.004
D2	0.154	0.213	0.183	0.936	1.149	1.043
D3	0.205	0.241	0.223	1.345	1.456	1.401
D4	0.249	0.339	0.294	1.532	1.645	1.589
D5	0.213	0.260	0.236	1.364	1.464	1.414
D6	0.131	0.172	0.152	1.096	1.236	1.166
D7	0.091	0.131	0.111	1.016	1.167	1.091
SEm±	0.012	0.019	0.012	0.056	0.063	0.042
CD at 5%	0.037	0.058	0.037	0.167	0.188	0.124

In general the planting dates in potato significantly influenced the physiological parameters. The higher CGR, RGR and AGR in potato at timely planting mainly attributed to the favorable conditions for crop growth. The early and late planting of potato affected the growth of potato crop which resulted in decline in the CGR, RGR and AGR. Vishwas *et al.* (2020) also reported highest dry matter accumulation under timely planting. The timely planting ensures the better vegetative growth in potato (Singh *et al.*, 2020; Vishwas *et al.*, 2020; Yenagiet *al.*, 2005) which encourages the plant physiological parameters.

Comment [E23]: Citations will be done in a chronological order using the indicated reference style.

#### True density

Comment [E24]: 3.2. Quality parameters  
3.2.1. True density

The true density of potato in 2021-22, 2022-23 and pooled of two years ranged between 1.16-1.29 g cm<sup>-3</sup>, 1.10-1.26 g cm<sup>-3</sup> and 1.14-1.28 g cm<sup>-3</sup> with a mean value of 1.20 g cm<sup>-3</sup>, 1.17 g cm<sup>-3</sup> and 1.18 g cm<sup>-3</sup>, respectively (Table 4).

Comment [E25]: g cm<sup>-3</sup>.  
Please use the same expression unit in Materials and methods section, too.

Table 4. Effect of planting dates on true density and starch content in potato

Comment [E26]: bold

Treatment	True density of potato (g cm <sup>-3</sup> )			Starch content (%)		
	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled
D1	1.21	1.23	1.22	12.37	12.75	12.56
D2	1.20	1.10	1.15	12.80	13.45	13.12
D3	1.16	1.12	1.14	12.64	12.68	12.66
D4	1.29	1.26	1.28	12.95	12.36	12.65
D5	1.18	1.16	1.17	12.81	12.98	12.89
D6	1.16	1.15	1.16	12.76	12.54	12.65
D7	1.18	1.17	1.18	12.72	12.56	12.64
SEm±	0.05	0.04	0.03	0.17	0.18	0.09
CD at 5%	0.13	0.13	0.08	0.50	0.53	0.26

The various planting dates studied did not have significant effect on true density of potato in both the years of study whereas the same showed varied significantly in pooled data of two years. In pooled data, the true density of potato was found highest in D4 (30 Oct) whereas the lowest true density of potato was recorded in D3 (15 Oct) treatment. The true density of potato determined in the treatment D4 (timely planting) showed significant effect over rest of the treatments. The

treatment D3 showed poor true density of potato as compared to D and D4. All the treatment found statistically at par except treatments D3 and D4 (Table 4). Kaur and Aggarwal (2014) also observed the potato true density between  $1.040 \text{ g cm}^{-3}$  and  $1.097 \text{ g cm}^{-3}$ .

#### **Starch content**

**Comment [E27]:** 3.2.2. Starch content  
.....

The data pertaining to the starch content in potato is presented in Table 4. The starch content in potato determined during 2021-22, 2022-23 and pooled of two years ranged 12.37-12.95%, 12.36-13.45% and 12.56-13.12% with a mean value of 12.72%, 12.76% and 12.74%, respectively. The various planting dates studied did not have significant effect on starch content in potato during first year of study but eventually during second year the starch content significantly varied even in pooled data of two years. In 2022-23, the treatment D2 and D5 found statistically at par with respect to the starch content in potato. Similarly, the treatments D1, D3, D4, D6 and D7 also found statistically at par. The pooled data of two years followed exactly similar trends as observed during 2022-23 with respect to the starch content in potato. In general, the planting dates showed marginal but significant effect on starch content in potato (Table 4). Kumar *et al.* (2005) observed that starch content was positively correlated with specific gravity ( $r= 0.77$ ) and dry matter content ( $r= 0.79$ ). Kumlay *et al.* (2002) observed that starch content of potato increased gradually from the first sample date, but at last sampling date 11 (harvest time), the starch content of potato was almost stable. According to Feltran *et al.* (2004), the starch content had a positive correlation with specific gravity of potato. However, in present study the starch content of potato was not found influenced under various planting dates studied.

#### **4.4.3 Dry matter content (%)**

**Comment [E28]:** 3.2.3. Dry matter content (%)  
.....  
Why here did you write also the expression unit and in the previous cases not? Please do the same for each parameter.

The data pertaining to the dry matter content in potato is presented in Table 5. The dry matter content in potato determined during 2021-22, 2022-23 and pooled of two years ranged 19.5-20.0%, 19.5-20.4% and 19.6-20.2% with a mean value of 19.8%, 19.9% and 19.8%, respectively. The various planting dates studied did not have significant effect on dry matter content in potato during both the years of study including pooled data of two years (Table 5). Kaur and Aggarwal (2014) also observed the dry matter content of potato ranging 14.06% to 24.31%.

#### **Protein content**

**Comment [E29]:** 3.2.4. Protein content (%)  
.....

The protein content in potato determined during 2021-22, 2022-23 and pooled of two years ranged 8.02-8.63%, 8.03-8.55% and 8.09-8.55% with a mean value of 8.39%, 8.36% and 8.37%, respectively (Table 5). The various planting dates studied did not have significant effect on protein content in potato during both the years of study. However, the pooled data showed that the protein content in potato showed significant variation. The pooled data revealed that, the treatment D4 (8.09%) and D5 (8.09%) showed lowest protein content in potato. The treatments D1, D2, D3, D6 and D7 found statistically at par with respect to the protein content in potato. Similarly, the treatments D3, D4 and D5 also found statistically at par. In general, the planting dates showed marginal but significant effect on protein content in potato (Table 5).

Table 5. Effect of planting dates on dry matter and protein content in potato

Comment [E30]: bold

Treatment	Dry matter content (%)			Protein content (%)		
	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled
D1	19.7	19.8	19.8	8.63	8.48	8.55
D2	20.0	20.4	20.2	8.44	8.55	8.49
D3	19.8	19.5	19.6	8.39	8.36	8.38
D4	20.0	19.6	19.8	8.14	8.03	8.09
D5	19.5	20.0	19.8	8.02	8.17	8.09
D6	19.8	20.0	19.9	8.52	8.55	8.53
D7	19.9	19.7	19.8	8.58	8.36	8.47
SEm±	0.19	0.21	0.19	0.166	0.205	0.111
CD at 5%	0.57	0.62	0.58	0.494	0.610	0.330

In general, the planting dates showed marginal but significant effect on protein content in potato. The lower protein in higher yield treatment is attributing to the dilution effect. Abbas *et al.* (2011) reported significant changes in quality parameters in different cultivars. Abbas *et al.* (2012) also found significant variation in quality parameter of potato. The present investigation relies on single variety hence the desired changes in quality parameters was not noticed. Singh (1995) studied the response of potato to different dates of planting and reported minimal and non-significant effect on the qualitative characters viz., dry matter starch content and specific gravity of tubers.

#### 4. CONCLUSION

The timely planting treatment (D4- 30/10/2021) showed significant positive effect on physiological parameters of potato whereas the early and late planting treatments showed poor performance. However, the planting date did not influence the quality parameters in potato.

#### REFERENCES

Abbas, G., Hafiz, I. A., Abbasi, N. A., & Hussain, A. (2012). Determination of processing and nutritional quality attributes of potato genotypes in Pakistan. *Pak J Bot*, 44, 201-208.

Abbas, G., Frooq, K., Hafiz, I. A., Hussain, A., Abbasi, N. A., & Shabbir, G. (2011). Assessment of processing and nutritional quality of potato genotypes in Pakistan. *Pak. J. Agri. Sci*, 48(3), 169-175.

AOAC International. (1970). *Official methods of analysis of the Association of Official Analytical Chemists*. Association of official analytical chemists.

Blackman, V. H. (1919). The compound interest law and plant growth. *Annals of botany*, 33(131), 353-360.

Chadha, K. L. (2009) Handbook of Horticulture, ICAR, New Delhi

Comment [E31]: Please respect Instructions for authors.

#### Reference style

References must be listed at the end of the manuscript and numbered in the order that they appear in the text. Every reference referred in the text must also present in the reference list and vice versa. In the text, citations should be indicated by the reference number in brackets [1].

Again, please respect Instructions for authors. Please carefully review the entire section.

#### Reference to a journal:

##### For Published paper:

1. Hilly M, Adams ML, Nelson SC. A study of digit fusion in the mouse embryo. *Clin Exp Allergy*. 2002;32(4):489-98.

- Feltran, J. C., Lemos, L. B., & Vieites, R. L. (2004). Technological quality and utilization of potato tubers. *Scientia Agricola*, 61, 598-603.
- Fisher, W. D. (1958). On grouping for maximum homogeneity. *Journal of the American statistical Association*, 53(284), 789-798.
- Gupta, V. K., Das, B. K., & Pandey, S. K. (2009). Performance of local potato varieties in Meghalaya hills. *Potato Journal*, 36(1-2).
- Kaur, S. and Poonam, A. (2014). Studies on Indian potato genotypes for their processing and nutritional quality attributes. *International Journal of Current Microbiology and Applied Sciences*, 3(8), 172-177.
- Kumar, D., Ezekiel, R., Singh, B., & Ahmed, I. (2005). Conversion table for specific gravity, dry matter and starch content from under water weight of potatoes grown in north-Indian plains. *Potato Journal*, 32(1-2).
- Kumlay A., Kaya C., Olgun M., Dursun A., Pehlivan M., & Dizikisa T., (2002). Comparison of seasonal change of specific gravity, dry matter accumulation and starch content of four potato (*Solanum tuberosum* L.) varieties. *Acta Horticulture*, 579, 255-258.
- Miernik, A., & Jakubowski, T. (2021, February). Selected methods for starch content determination in plant materials. In *Journal of Physics: Conference Series* (Vol. 1782, No. 1, p. 012019). IOP Publishing.
- Mohsenin, N.N., 1986. *Physical Properties of Plant and Animal Materials*, second Edn. Gordon and Breach Science Publishers, New York.
- Radford, P. J. (1967). Growth analysis formulae-their use and abuse 1. *Crop science*, 7(3), 171-175.
- Rana, R. K., & Anwer, M. D. (2018). Potato production scenario and analysis of its total factor productivity in India. *Indian Journal of Agricultural Sciences*, 88(9), 1354-61.
- Scott, G. J., Petsakos, A., & Juarez, H. (2019). Climate change, food security, and future scenarios for potato production in India to 2030. *Food security*, 11, 43-56.
- Shekhawat G S. 2001. Potato production, utilization and marketing in India. *Indian Journal of Agronomy*. 28(2-4): 185-93.
- Singh, M.V. 1995. Nitrogen needs of potato when planted on different dates. *Journal of Indian Potato Association* 22:101-104.
- Singh, N., Amandeep Singh and Kanwaljit Singh. 2020. Effect of Time of Planting on Growth and Yield Parameters of Potato Crop. *Int.J.Curr.Microbiol.App.Sci.* 9(05): 2847-2851.

Thiele G, Theisen K, Bonierbale M and Walker T (2010) Targeting the poor and hungry with potato science. *Potato J* 37: 75-86

Vishwas, U., Rathiya, P. S., Sinha, A. K., Verma, C., & Gupta, A. (2020). Response of different date of planting on growth, yield and economics of potato (*Solanum tuberosum* L) genotypes under Northern hill region of Chhattisgarh. *Journal of Pharmacognosy and Phytochemistry*, 9(3), 1203-1205.

Yenagi, B. S, Meli, S. S. and Angadi, S. S., 2005. Response of Potato to Spacing, Planting Date and Nitrogen Fertilization under Rain-fed Conditions. *Karnataka Journal of Agricultural Sciences*, 18 (2):482-493.

Zhang, H., Fen, X. U., Yu, W. U., Hu, H. H., & Dai, X. F. (2017). Progress of potato staple food research and industry development in China. *Journal of integrative agriculture*, 16(12), 2924-2932.

UNDER PEER REVIEW