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# Effect of the machine parameters on agronomical parameters of Potato crop

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**Abstract**

*Agriculture mechanization plays very important role for horticulture crops. To reduce the labour scarcity, labour drudgery, time consumption in manual planting of potatoes, a prototype was designed, fabricated and evaluated in the field. The present study was carried out at IGKV, Raipur in the year 2019-20. The developed planter consists of seed metering device, seed tube, seed tuber covering duct, fertilizer tube, seed and fertilizer hopper. There were three levels of each machine parameters i.e., shoe type furrow opener angles ($S_1$ or 45°, $S_2$ or 90°, $S_3$ or 120°), drive wheel sizes ($W_1$ or 38cm, $W_2$ or 42cm, $W_3$ or 52cm) and the machine was operated at three speeds ($V_1$ or 1.5 km/h, $V_2$ or 2.0 km/h, $V_3$ or 2.5 km/h). Combination of these parameters in terms of various treatments ($T_1$, $T_2$ and $T_3$) with three replications were observed for agronomical properties of potato tubers. The weight of tubers per plant was highest in case of treatment $T_2$ (352.07 ± 15.47g) followed by $T_3$ (352.04 ± 17.74) and $T_1$ (349.18 ± 23.94) respectively. The highest number of tubers and weight of tubers was obtained from treatment $T_2$ (5057.9 ± 714.33g) followed by $T_1$ (5052.9 ± 798.7g) then $T_3$ (4657.1 ± 702.8g). Total yield of potato was maximum in treatment $T_2$ (50.57 t/ha) followed by $T_1$ (50.52 t/ha) and $T_3$ (46.57 t/ha) respectively.*

**Keywords:** Shovel angle, drive wheel size, stem diameter, leaf area index, potato planter, DAP

## Introduction

Potato (*Solanum tuberosum* L. Family-Solanaceae) popularly known as 'The king of vegetables' is the most important food crop in the world and has emerged as fourth most important food crop in India after rice, wheat and maize. Indian vegetable basket is incomplete without potato. It is a starchy tuberous food crop containing many vitamins and minerals. Potato is temperate crop grown under subtropical conditions in India. The fleshy part of the root (potato) is commonly eaten as a vegetable. Potato is efficient food crop and alluded as helpless man companion. It is rich wellspring of starch and nutrients. Planting of potato is considered as quite possibly the main activity that includes factors like correct seed rate, fitting profundity of seed arrangement and required seed dispersing. For planting of potato crop land is furrowed immediately and develop double cross with roto cultivator at a profundity of 24-25 cm. Potatoes are grown in almost every state in India. India's major potato-growing states include Uttar Pradesh, West Bengal, Punjab, Karnataka, Assam, Bihar, Madhya Pradesh, Jharkhand, and Chhattisgarh. The Ministry of Agriculture has estimated that, the production of potato at record during the current crop year (July 2020-June 2021) as the planting of the staples were higher. The production of potato is projected at a record 53.11 million tonnes during 2020-21 against the final estimates of 26.09 million tonnes in 2019-20. This has been driven by an increase in acreage at 22.47 lakh hectares compared with 20.51 lakh ha in the previous season.

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## Materials and Methods

The present study was carried out at research farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur during the year 2019-20. In which an attempt has been made to develop a single row automatic feeding type

potato planter cum fertilizer applicator with best suited seed metering mechanism to achieve uniform planting of potato as well as proper distribution of fertilizer in field. It also performs the function of furrow opening and covering of the seed tuber there by making ridges. In view of the aforesaid facts research work has been planned and conducted at instructional farm of IGKV, Raipur. This arrangement study was a complete randomized design with a factorial arrangement consisting of three levels of speed ($V_1$ or 1.5 km/h, $V_2$ or 2.0 km/h, $V_3$ or 2.5 km/h), three levels of ground wheel ($W_1$ or 38cm, $W_2$ or 42cm, $W_3$ or 52cm), three levels of furrow opener ($S_1$ or 45°, $S_2$ or 90°, $S_3$ or 120°), and three levels of seed size with three replications. Combination of these parameters in terms of various treatments ($T_1$, $T_2$ and $T_3$) with three replications were observed for agronomical properties of potato tubers. The matured potato tubers were harvested manually with manually operated digging equipment and spade when haulms start yellowing and falling on the ground. At this stage haulm should be removed at ground level. The following observations were recorded from the day of planting to crop maturing;

*Agronomical observations*

*Pre harvest observation*

*a) Plant population*

The plant population in one-meter square from randomly selected five plots were counted in planted area after 30 DAP and average population was worked out for one square meter area by considering row spacing.

*b) Plant height*

The plant height was measured from the base of the plant to the base of the fully opened top leaf until tuber emergence. Later the plant height was measured from the bases of the plant to the collar of flag leaf and expressed in centimeters.

*c) Number of branches/stems per plants*

Total number of branches per plants were counted from five tagged plants of each plot of one square meter area at 30, 60, 90 DAP and at the time of harvest. For one square meter area it was recorded during the initial growth stage and till before harvesting.

*d) Stem diameter*

Twenty plants from the per plot were evaluated at 30 and 60 days after planting by choosing the highest stem and measuring it from its base to the apical bud with a ruler.

*e) Leaf area*

It was calculated when sampling 20 plants randomly selected from the linear measurements of its leaves (length, width and their product) at 30, 60 and 90 DAP, estimating leaf surface from the previously obtained regression equation as (Almeida *et al.* 2016);

$Y = 0.89X + 2.75$; Where x represents the product of length by width values withing the function, the linear equation parameters, its slope and the intercept with y axis.

*Post-harvest observation*

*a) Number of tubers per plant*

Tuber obtained from each crop from sampled plants were weighted on pan balance in g/plant and average tuber yield/plant was calculated.

*b) Tuber weight and total yield*

Tuber weight per square meter was measured by the harvested potato in selected one-meter square plots. Harvested potato was manually digging and initially weighted it and multiplies it with 10000 for kg per hectare measurements. Manually harvested samples of each one $m^2$ were taken from each plot. The digging tubers were weighed and yield per hectare was calculated (Hegazy and Dhaliwal, 2013). For one square meter area it can be obtained by taking a total tuber sample from five different location of each treatment. After taking the samples, it was initially weighted with digital balance and reported tuber mass in grams or kilogram. Total obtained yield was estimated.

## Results and Discussion

*Plant population per $m^2$*

The plant population in one-meter square from randomly selected plots were counted in planted area after all passes of potato planter and average population was worked out for one square meter area by considering row spacing. The analysis of variance was observed in the combination of various parameters of machines in terms of treatment as $T_1$ ($V_1S_2W_1$), $T_2$ ($V_2S_1W_2$) and $T_3$ ($V_3S_3W_3$). The data pertaining to plant population per square meter are given in Table. 1. The highest plant population was found in $T_1$ (17.94 ± 3.22) followed by $T_3$ (17.55 ± 3.82) and $T_2$ (17.51 ± 3.46) respectively.

*Plant height (cm)*

Height of five tagged plants in each plot was recorded in cm at an interval of 30, 60, 90 DAP and at harvest summation with five and then average was worked out and used for statistical analysis. Plant height was measured in cm from ground surface to uppermost leaf top (Fig. 4). The plant height was measured from

Table 1: Data pertaining to mean values of pre-harvest observations

| Particulars | $T_1$ | | $T_2$ | | $T_3$ | |
|---|---|---|---|---|---|---|
| | Mean (x) | SD (ó) | Mean (x) | SD (ó) | Mean (x) | SD (ó) |
| Plant population (25 DAP), Nos | 17.23 | 0.62 | 16.38 | 1.00 | 16.45 | 1.07 |
| Plant height (30 DAP), cm | 33.54 | 0.30 | 33.62 | 2.29 | 34.53 | 0.48 |
| Plant height (60 DAP), cm | 48.60 | 0.83 | 48.32 | 1.46 | 47.16 | 1.44 |
| Plant height (90 DAP), cm | 51.83 | 1.40 | 52.76 | 2.14 | 52.93 | 1.61 |
| Branches per plant (30 DAP) in Nos | 4.32 | 0.28 | 4.17 | 0.21 | 4.06 | 0.11 |
| No. of branches per plant (60 DAP) | 5.15 | 0.12 | 5.22 | 0.42 | 4.59 | 0.26 |
| Plant stem diameter (45 DAP), mm | 4.93 | 0.23 | 5.11 | 0.22 | 4.93 | 0.34 |
| Plant stem diameter (90 DAP), mm | 7.16 | 0.03 | 6.82 | 0.01 | 6.29 | 0.44 |
| No. of stems in $m^2$ (30 DAP) | 36.33 | 1.50 | 32.20 | 0.95 | 32.31 | 0.94 |
| Leaf area (30 DAP), mm2 | 11.43 | 0.26 | 11.54 | 0.34 | 11.38 | 0.31 |

the base of the plant to the base of the fully opened top leaf until tuber emergence. Later the plant height was measured from the bases of the plant to the collar of flag leaf and expressed in centimeters. Mean values and analysis of variance from the means of plant height at 30 DAP, 60 DAP and 90 DAP are depicted in Table. 1. Highest plant recorded at 30 DAP was highest in treatment $T_3$ (34.53 ± 4.17cm) followed by $T_2$ (33.62 ± 4.49cm) and $T_1$ (33.53 ± 3.72cm) respectively. The values of the plant height recorded at 60 DAP was slightly higher than the recorded values of plant height at 30 DAP. Plant height observed at 60 DAP was maximum in case of $T_1$ (48.60 ± 4.90cm) $T_2$ (48.32 ± 5.79cm) and $T_3$ (47.16 ± 5.46cm) respectively. Plant height at 90 DAP was somewhat higher than plant height at 60 DAP and moreover higher than 30 DAP. At the 90 DAP the plant height observed was maximum in $T_3$ (52.93 ± 5.77cm) followed by $T_2$ (52.76 ± 4.82cm) and $T_1$ (51.83 ± 4.92cm) respectively.

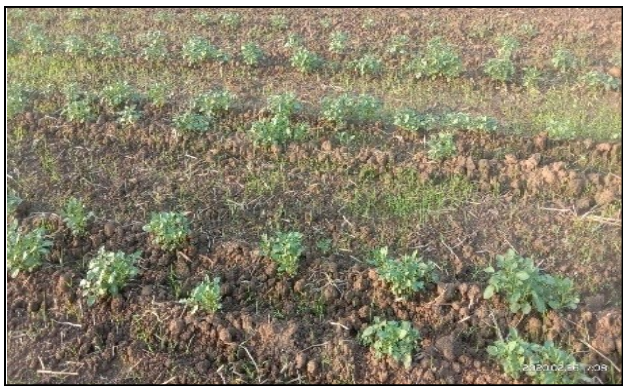

Fig. 1. View of crop at 20 DAP

Fig. 2. Measurement of plant row spacing

*Number of branches per plants*

Number of tillering per plant was calculated by the counting of tillers generated at the root of each plant from randomly selected five plots with all treatments (Fig. 3). It was observed 30 DAP and 60 DAP respectively. The maximum number of branches per plant was recorded in case of treatment $T_1$ (4.32 ± 0.78) followed by $T_2$ (4.17 ± 0.68) and $T_3$ (4.06 ± 0.86) correspondingly. The number of stem/plants was gradually increased during potato plant development period and the values observed at 60 DAP was significantly higher as compared to 30 DAP measurements and that was an indication of satisfactory development period. The highest number of branches per plant at 60 DAP was maximum in $T_2$ (5.23±0.76), $T_1$ (5.14 ± 0.95) followed by $T_3$ (4.59 ± 0.98) respectively. Total number of branches per plants were counted from five tagged plants of each plot at 30, 60 DAS. It was recorded during the initial growth stage (20 DAS) and before harvesting with the help of measuring scale. Meter scale was placed in three rows of each plot randomly and then plants were

Table 2: Data pertaining to mean values of post-harvest observations

| Particulars | $T_1$ | | $T_2$ | | $T_3$ | |
|---|---|---|---|---|---|---|
| | Mean (x) | SD (ó) | Mean (x) | SD (ó) | Mean (x) | SD (ó) |
| Tuber weight per plant (gm) | 349.2 | 2.1 | 352.1 | 7.7 | 352.0 | 5.8 |
| Tuber weight in square meter (gm) | 5053.0 | 124.8 | 5057.9 | 252.4 | 4657.1 | 153.9 |
| Total yield,(t/ha) | 50.5 | 1.2 | 50.6 | 2.5 | 46.6 | 1.5 |

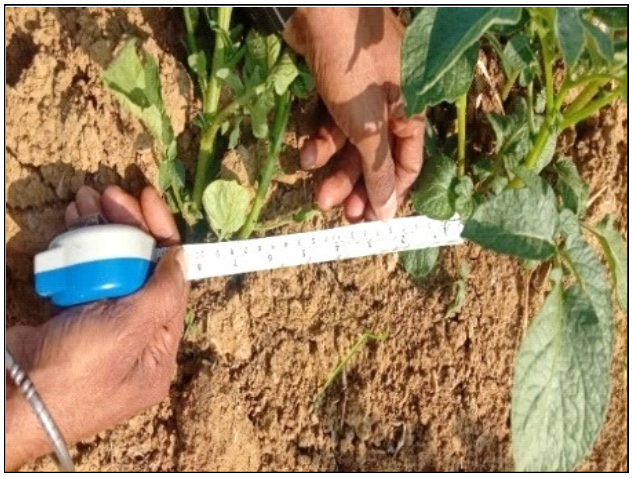

Fig. 3. Measurement of plant to plant distance

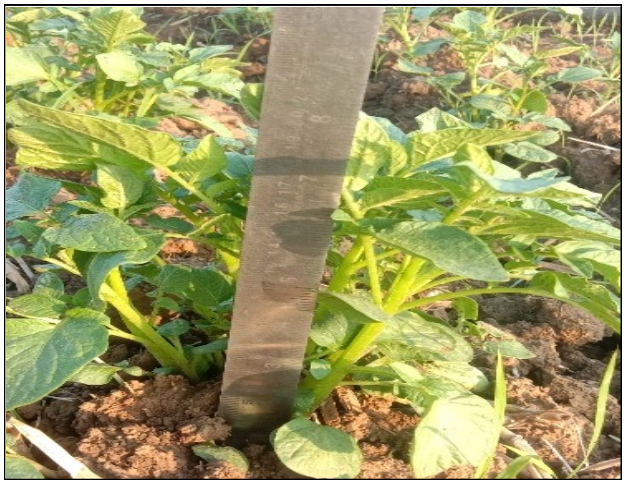

Fig. 4. Measurement of plant height

counted in running meter row length. Thereafter, the plant population per ha was worked out.

*Stem diameter*

The most important parameter regarding the plant quality measurements is stem and root development. Stem/branch diameter of plants was recorded at 45 DAP and 90 days after planting. The difference between the 45 DAP and 90 DAP are known as stem development. Maximum stem/branch diameter at 45 days after planting was observed in treatment $T_2$ (5.11 ± 1.34 mm) followed by $T_1$ (4.92 ± 0.89mm) and $T_3$ (4.92 ± 1.0mm). CV of the above digits was 26.39, 20.40 and 18.14 per cent respectively. Recorded stem diameter at 90 days after planting was significantly higher from the stem diameter recorded at 45 DAP that was maturity period of the plant. The stem developed data observed at 90 DAP was maximum in case of treatment $T_1$ (7.16 ± 1.66 mm) followed by $T_2$ (6.82 ± 1.13 mm) then $T_3$ (6.29 ± 0.68 mm) with a CV of 23.14, 16.62 and 10.67 per cent respectively.

*Stem number per square meter*

Mark the five selected plots of one-meter square area with all treatments. Count the number of plants in one row and visually count the number of stem/ branches per plant from each selected one-meter plot. Highest number of stem/branches in one square meter was recorded in case of treatment $T_1$ (36.33±3.70) followed by $T_3$ (32.31±2.71) and $T_2$ (32.20±3.02) respectively.

*Leaf area*

Leaf area was measured with a metering tape or scale. The highest leaf area was recorded in treatment $T_2$ (11.54 ± 1.09) followed by $T_1$ (11.43 ± 0.98) then $T_3$ (11.38 ± 1.25) respectively with a CV of 9.40, 8.61 and 10.97 per cent correspondingly.

*Post-harvest observation*

The weight of tuber per plant used to determine the tubers weight in one square meter plot. Weight of tubers was highest in case of treatment $T_2$ (352.07 ± 7.7 g) followed by $T_3$ (352.04 ± 5.8) and $T_1$ (349.18 ± 2.1) respectively with a CV per cent of 4.38, 5.03 and 6.86. Table 2 shows the mean values of the tubers weight per plant. The highest number of tubers and weight of tubers was obtained from treatment $T_2$ (5057.9 ± 252.4 g) followed by $T_1$ (5052.9 ± 124.8 g) then $T_3$ (4657.1 ± 153.9 g). Tubers obtained from treatment $T_3$ was a bit low due to the higher speed increase the spacing between the tubers that also affects the spacing between the plants and branches.

Total tubers obtained from the one square meter area was recorded according to combination of row spacing, different drive wheels and furrow openers at the harvesting time. Tuber weight per square meter was measured by the harvested potato in selected one-meter square plots. Harvested potato was manually digging and initially weighted it and multiplies it with 10000 for kg-per hectare measurements. Tuber yield was estimated by harvesting an area of one square meter from plot. Manually harvested samples of each one $m^2$ were taken from each plot. The weight of each was taken. The digging tubers were weighed and yield per hectare was calculated (Hegazy and Dhaliwal, 2013). Total tuber yield obtained from different treatment was found significant and the yield of potato tuber was maximum in treatment $T_2$ (50.57 ± 2.5 t/ha) followed by $T_1$ (50.52 ± 1.2 t/ha) and $T_3$ (46.57 ± 1.5 t/ha) respectively.

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