

## Effects of intra-row spacing on growth and yield of potato (*Solanum tuberosum* L.) variety local Jabal Marra under North Darfur, Sudan conditions

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### ABSTRACT

This study was executed at Elfasher Research Station Farm for two successive winter seasons (2019/2020 and 2020/2021) to study the effect of intra-row spacing on growth and yield of local potato cultivar, Jabel mrara. The treatment consisted of three intra- rows spacing, viz., 25, 35 and 40 cm applied on the local potato cultivar, Jabel mrara. The results of two seasons showed highly significant differences for the total yield among the different intra-row spacing the interaction between the two seasons was significant. The highest yield was recoded at the intra-row spacing of 25 cm, which produced 16.49 tha<sup>-1</sup>. Moreover, there were significant differences in plant height and number of leaves /plant, and highly significant differences in number of leaves per plant among the intra-row spacings. Based on the above results, intra-row spacing of 25 cm suitable for potato growth and production in North Darfur State.

**Key words:** Potato yield; intra-row spacing and Sudan.

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### INTRODUCTION

Potato (*Solanum tuberosum* L.) belongs to the family Solanaceae. It is one of the most important food crops in the world and become third crop behind rice and

wheat (Birch et al., 2012; Hancock et al., 2014). The production in Sudan is steadily increasing, and total production has tripled during the last ten years. Moreover, it is currently considered as one of the cash crops for the farmers and one of the important components of the diet, especially in urban areas. Khartoum state is regarded as an area for potato production; with an average yield of approximately 12 tons/ha (Khalafalla, 2001). Potato is a moderate source of iron and its high vitamin C content which promotes iron absorption, also it contain a good source of vitamins B1,B3 and B6 and minerals such as K,P,and Mg also include dietary antioxidants, which may play a part in preventing diseases related to aging and dietary fiber (Mulatu *et al*; 2005). Potato yield and quality are affected by cultivar, soil type, weather conditions, water management, fertilization, plant population, seed piece size, pests, and disease control (Khalafallah, 2001). Jabal Mrra, located in West Sudan height of ten thousand feet above sea level, with a semi-Mediterranean climate Sea, potato grown during autumn and winter; it has the highest fertility soil, and fruits of the Middle East are successfully grown. Yield increases are ascribable to more tubers produced at the large plant population per hectare, although average tuber size is decreased because of increased inter-plant competitiveness with closer spacing (Rex *et al.*, 1987). The cost of tuber seeds is very high and it increase the total cost of production thus making farmers look for other choices to obtained local tuber seeds with affordable prices. Seed size and intra-row spacing describe plant density, which is given as number of stems/unit area since the plant could consist of two, three or more stems. Nelson (1976) in North Dakota reported that he found increased plant populations reduced average tuber weight but increased yields due to more tubers being harvested. Rex *et al.* (1987) found closer seed piece spacing of Shepody increased yields particularly during early harvest. Ahmed (1989) found that closer spacing (20 cm) gave higher yields than wider spacing (30 cm). Closer spacing and big seed size gave less tuber weight but more numbers of

tubers/plant. Sharpe and Dent (1968), Thompson and Taylor (1974), Collins (1977) and Allen (1978) reported similar results. Khalafallah, 2001 recommended the use medium size tubers cut into two halves and plant at a spacing of 15 - 25 cm to obtain acceptable yield and good quality tubers. Plant spacing is one of the most importantly known management practices in potato production (Binalfew *et al.*, 2015). Regasa *et al.* (2022) stated that variety Jalenie gave highest total yields of tuber (24.84 ton/ha) at intra-row spacing 25cm.

The objective of this study was; aiming to study the effect of intra-row spacing on the growth and yield of potato during the winter season.

## MATERIALS AND METHODS

The study was conducted at Elfasher Research Station farm, North Darfur State (latitude 13° 66'N, longitude 25° 35'E) for two successive winter seasons (2019/2020 and 2020/2021), aiming at studying the effect of intra-row spacing on growth and yield of potato during winter season. The experiment included three intra-rows spacing 25, 35 and 40 cm. Randomized complete block design (RCBD) was used with three replications. The land was prepared by disk ploughing, leveling, ridging at 70 cm apart, the area of the experimental unit was 3×2 m (6 m<sup>2</sup>). Local potato tubers (Jabal marra) were used. Urea fertilizer was applied in two equal doses. Seed tubers were brought in by vegetables traders upon request, size of tuber was suitable. The data recorded were plant height (cm), number of leaves/plant, tuber diameter (mm), tuber length (mm) and total yield tonsha<sup>-1</sup>. The data were statistically analyzed using GENSTAT software. Soil of the experimental plot at Elfasher research Station was classified as Arenosol with high sand content 69%, clay 6%, silt 25%, organic carbon at range (0.1-0.8) %, pH range (7.2-8.0), total nitrogen at range (0.77-2.95) and available phosphorus P<sub>2</sub>O<sub>5</sub> (2.0-4.0) ppm (Mahmoud Hashim and El-Abbas Doka, 2016).

## RESULTS AND DISCUSSION

The results showed significant differences among total yield during the season 2019/2020 ( $P \leq 0.05$ ), with the highest yield of  $16.2 \text{ t/ha}^1$  recorder by the narrower intra row spacing of 25cm compared to other wider spacings. However, there was no significant difference in tuber length due to spacing (Table 1). Moreover, there were no significant differences between plant height, number of leaves/plant and tuber diameter due to intra row spacing (Table 2). For the second season, 2020/2021, there were highly significant differences in total potato yield, with the closer intra row spacing of 25 cm producing  $16.78 \text{ t/ha}^1$  compared to wider spacing ( $P \leq 0.05$ , Table 3). On the other hand, there were no significant differences in tuber length due to intra row spacing (Table 3). Contrarily, significant differences were recorded for plant height and number of leaves/plant ( $P \leq 0.05$ ). Nevertheless, there were no significant differences in tuber diameter due to intra row spacing (Table 4). The results of the combined analysis showed highly significant differences among total yield, with narrow intra-row spacing of 25 cm produced  $16.49 \text{ t/ha}^1$  compared to wider intra row spacing and there significant differences for interaction of yield between the two seasons ( $P \leq 0.05$ ), but no significant differences for tuber length (Table 5). Moreover, there were significant differences for plant height and number of leaves /plants, and the interaction was highly significant for number of leaves/plant. Nonetheless, there were no significant differences in tuber diameters (Table 6). The results of the combined analysis, recorded highly significant differences among the intra row spacing, with narrow spacing of 25cm exhibited the highest value as compared to broader spacing this result was similar to that obtained by Regasa *et al*, (2022) who stated that variety Jalenie gave highest total yields of tuber ( $24.84 \text{ ton/ha}$ ) at intra-row spacing 25cm. Furthermore there were significant by  $\text{Int s} \times \text{sp}$ , when reduced intra-row spacing increase the plant population per hectare without competition of plants them themselves lead to increase tuber per plant furthermore

increase tuber per hectare and gave good quality similar to that obtained by Ahmed (1989) who found that closer spacing (20 cm) gave higher yields than wider spacing (30 cm). Also (Khalafallah, 2001) advise to cut medium size tubers into two halves and plant at a spacing of 15 - 25 cm to obtain acceptable yield and good quality tubers. Similarly, Rex *et al.* (1987) found closer seed piece spacing of Shepody increased yields particularly during early harvest. Moreover, there were significant differences for plant height and number of leaves /plant. Furthermore highly significant for interaction was recorded for the number of leaves/plant, when the plants founded available nutrients, have a good cultural practice, diseases, pests control suitable irrigation and weather continuously in growth and produced high yield agree with that says by (Khalafallah, 2001) who said the factors affecting on potato yield and quality include cultivar, soil type, weather conditions, water management, fertilization, plant population, seed piece size, pests and diseases control (Khalafallah, 2001)

**Table 1. Tuber length (mm) and Total yield tons/ha<sup>-1</sup> of local potato grown during winter, 2019-2020**

| Entries      | TL (mm) | TY t/ha <sup>-1</sup> |
|--------------|---------|-----------------------|
| 25           | 63.12   | 16.20                 |
| 35           | 73.33   | 14.52                 |
| 40           | 79.14   | 13.84                 |
| Overall Mean | 71.9    | 14.85                 |
| C.V. (%)     | 15.76   | 3.5                   |
| SE±          | 6.54    | 0.30                  |
| LSD          | 25.7    | 1.17                  |
| Sig. level   | ns      | *                     |

\*, ns = significant at  $p \leq 0.05$  and not significant, respectively. LSD = Least significant difference at probability level of 5%. CV%= Coefficient of variation. SE ±=Standard error. TL= Tuber length. TY=Total yield.

**Table 2. Plant height (cm), Number of leaves/plant and Tuber Diameter (mm) of local potato grown during winter, 2019-2020**

| Spacing (cm) | PH    | NL    | TD    |
|--------------|-------|-------|-------|
| 25           | 40.22 | 14.56 | 58.4  |
| 35           | 38.89 | 14.78 | 57.9  |
| 40           | 35.78 | 17.33 | 58.4  |
| Grand Mean   | 38.3  | 15.56 | 58.23 |
| C.V. (%)     | 10.84 | 17.82 | 19.9  |
| SE±          | 2.4   | 1.60  | 6.7   |
| LSD          | 9.4   | 6.28  | 26.3  |
| Sig. level   | ns    | ns    | ns    |

ns = not significant at  $p \leq 0.05$ . LSD = Least significant difference at probability level of 5%

CV%= Coefficient of variation. SE ±=Standard error. PH= Plant height.

NL= Number of leaves /plants. TD= Tuber diameter

**Table 3. Tuber length (mm) and Total yield tons/ ha<sup>-1</sup> of local potato grown during winter season, 2020-2021**

| Entries    | TL (mm) | TY t/ha <sup>-1</sup> |
|------------|---------|-----------------------|
| 25         | 65.42   | 16.78                 |
| 35         | 66.50   | 15.80                 |
| 40         | 73.51   | 12.90                 |
| Grand Mean | 68.48   | 15.16                 |
| C.V. (%)   | 9.42    | 3.47                  |
| SE±        | 3.72    | 0.30                  |
| LSD        | 14.61   | 1.19                  |
| Sig. level | ns      | **                    |

\*\*, ns = significant at  $p \leq 0.05$  and not significant, respectively. LSD = Least significant difference at probability level of 5%. CV%= Coefficient of variation. SE ±=Standard error. TL= Tuber length. TY= Total yield (ton/ha).

**Table4. Plant height (cm), Number of leaves/plant and Tuber Diameter (mm) of local potato grown during winter season, 2020-2021**

| Spacing (cm) | PH    | NL    | TD    |
|--------------|-------|-------|-------|
| 25           | 48.78 | 21.75 | 51.40 |
| 35           | 51.94 | 25.85 | 53.51 |
| 40           | 43.48 | 15.69 | 48.77 |
| Grand Mean   | 48.07 | 21.09 | 51.23 |
| C.V. (%)     | 3     | 5.0   | 8.70  |
| SE±          | 0.83  | 0.61  | 2.57  |
| LSD          | 3.24  | 2.38  | 10.09 |
| Sig. level   | **    | **    | ns    |

\*\*, ns = significant at  $p \leq 0.05$  and not significant, respectively. LSD = Least significant difference at probability level of 5%. CV%= Coefficient of variation. SE ±=Standard error. PH= Plant height, NL= Number of leaves per plant. TD= Tuber diameter.

**Table5. Combined of Tuber length (mm) and Total yield tons/ha<sup>-1</sup> of local potato grown during winter seasons, 2019/2020 - 2020/2021**

| Spacing               | TL (mm) | TY t/ha <sup>-1</sup> |
|-----------------------|---------|-----------------------|
| 25                    | 64.95   | 16.49                 |
| 35                    | 72.51   | 15.16                 |
| 40                    | 73.06   | 13.37                 |
| Grand Mean            | 70.17   | 15.01                 |
| C.V. (%)              | 13.13   | 3.47                  |
| SE±                   | 3.76    | 0.21                  |
| LSD                   | 17.34   | 0.27                  |
| Sig. level            | ns      | **                    |
| Sig. level Int s × sp | ns      | *                     |

\*\*, ns = significant at  $p \leq 0.05$  and not significant, respectively. LSD = Least significant difference at probability level of 5%. Int s × sp = Interaction season by spacing. CV%= Coefficient of variation. SE ± =Standard error. TL = Tuber length. TY= Total yield. Interaction s × sp = \*

**Table6. Combined of Plant height (cm), Number of leaves/plant and Tuber Diameter (mm) of local potato grown during winter seasons, 2019/2020 - 2020/2021**

| Spacing (cm)          | PH    | NL    | TD    |
|-----------------------|-------|-------|-------|
| 25                    | 44.50 | 18.15 | 54.88 |
| 35                    | 45.41 | 20.31 | 55.70 |
| 40                    | 39.63 | 16.51 | 53.60 |
| Grand Mean            | 43.18 | 18.32 | 54.73 |
| C.V. (%)              | 7.19  | 11.44 | 16.04 |
| SE±                   | 1.23  | 0.86  | 3.58  |
| LSD                   | 4.84  | 3.55  | 14.17 |
| Sig. level            | ns    | *     | ns    |
| Sig. level Int s × sp | ns    | ***   | ns    |

\*, ns = significant at  $p \leq 0.05$  and not significant, respectively. LSD = Least significant difference at probability level of 5%. Int s × sp = Interaction season by spacing. CV% = Coefficient of variation. SE ± = Standard error. PH= Plant height. NL = Number of leaves per plant. TD= Tuber Diameter. Interaction s × sp = \*\*\*

## CONCLUSION

According to the results of this study, intra-row spacing of 25 cm produced highest yield of 16.49 tons per hectare, and thus it is the most suitable intra-row spacing for potato growth and production in North Darfur.

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## أثر مسافات الزراعة بين الصفوف على نمو وإنتاجية البطاطس (*Solanum tuberosum* L.) صنف

جبل مرة تحت ظروف ولاية شمال دارفور، السودان

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### الملخص

أجريت هذه التجربة بمزرعة محطة بحوث الفاشر لمؤسمين متتاليين خلال مؤسمى الشتاء 2019 / 2020 و 2020 / 2021 م لدراسة أثر المسافات الزراعية داخل الصفوف على نمو وإنتاجية صنف البطاطس المحلي جبل مرة. المعاملات يتضمن ثلاثة مسافات زراعية وهي 25، 35 و 40 سم بين النباتات داخل الصفوف. أظهرت النتائج خلال المؤسمين وجود فروقات معنوية عالية في الانتاج الكلي خلال المسافات الزراعية المختلفة بين الصفوف والتفاعل بين المؤسمين كانت معنوية. حيث سجلت أعلى إنتاج في المسافة 25 سم بمقدار 16.49 طن للهكتار. علاوة على ذلك توجد فروقات معنوية في طول النبات وعدد الاوراق للنبات ، وفروقات معنوية عالية في عدد الاوراق للنبات خلال المسافات بين النباتات داخل الصفوف. بناء على ما ذكر من النتائج فإن المسافة 25 سم بين النباتات هي المناسبة لنمو وإنتاجية البطاطس بولاية شمال دارفور .

الكلمات المفتاحية: إنتاج البطاطس؛ المسافات بين النباتات و السودان

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