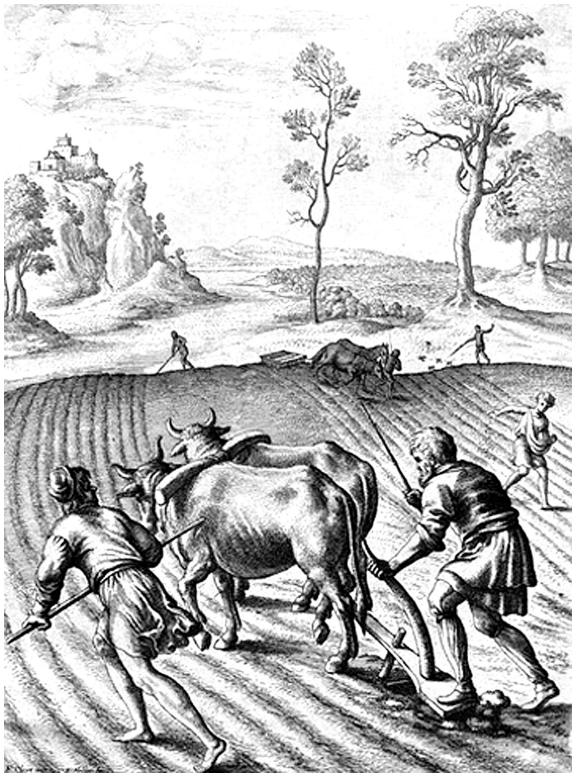
ISSN : 1812-5379 (Print)
ISSN : 1812-5417 (Online)
http://ansijournals.com/ja

JOURNAL OF AGRONOMY



ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Journal of Agronomy 13 (3): 127-130, 2014
ISSN 1812-5379 / DOI: 10.3923/ja.2014.127.130

Effect of Inter and Intra Row Spacing on Potato (*Solanum tuberosum* L.) Seed and Ware Tuber Seedling Emergence and Establishment at Bako, Western Ethiopia

[1]Bikila Akassa, [2]Derbew Belew and [2]Adugna Debela
[1]Bako Agricultural Research Center, Bako, Ethiopia
[2]Department of Horticulture and Plant Sciences, College of Agriculture and Veterinary Medicine, Jimma University, Jimma, Ethiopia

Abstract: A study was conducted to determine the effect of inter and intra row spacing on potato (*Solanum tuberosum* L.) seed and ware tuber emergence and subsequent growth in 2011/12 production season. The experiment was laid out in a 6×3 factorial combination arranged in a randomized complete block design with three replications (Six levels of inter: 60, 65, 70, 75, 80 and 85 cm and three levels of intra row spacings: 20, 30 and 40 cm). Most of the variables collected in this experiment were significantly affected by inter, intra and/or their interactions except the number of main stem which did not show any change as the result to change of these treatments. Though most of the variables considered require wider spacing, it was observed that an indefinite increase in the space between plants and rows did not result to an increase in any of the variables apart from extending days to flowering and maturity. For the optimum emergence and successful growth of potato tubers for both seed and ware, spacing of 70-75 and 20-30 cm between plants and rows, respectively were identified as the best combination to be used in the study area.

Key words: Potato seed, ware, inter row, intra row, emergence

INTRODUCTION

Potato (*Solanum tuberosum* L.) belongs to the family Solanceae or the night shade family and the genes Solanum. The major species grown worldwide is S*olanum tuberosum* a tetraploid with chromosome number of 12 and with the genomic formula of 2n = 4x = 48 (Girma *et al*., 2004). It is an herbaceous annual crop that grows up to 100 cm tall and produces a tuber in which edible food materials are stored. Potato propagated asexually through tubers and grows as erect or semi erect with stems as single or branched (FAO, 2008).

The utilization of potato in Ethiopia is very popular from consumption of boiled potato, it is now extensively used in the wide arrays of traditional stew (wet) preparations in both rural and urban areas (Girma *et al*., 2004). It is a major source of inexpensive energy and produces more food per unit of time than any other major crops and the crop is mainly produced on fertile soils but also grown on sandy soils both under irrigation and rain fed conditions (Sadowska *et al*., 2004).

The total area under potato production in Ethiopia was about 51,000 ha with an average productivity of 8 t ha^{-1}. Currently the total area under production reached 69,784 ha and the production estimated to be 5,723.33 t. The productivity of the crop in the country is low as compared to the world average of 17 and 11 t ha^{-1} in Africa (Hirpa *et al*., 2010).

Spacing used between ridges and plants for the production of ware and seed potato tuber was one of the most important among the magnitude of the constraints contributing to low yield of potato especially in the western parts of the country. Plant spacing affects seed cost, plant development, yield and quality of the crop. In practice plant spacing in potato crop is manipulated through the number and size of tuber planted (Allen and Warr, 1992). This of course resulted to increased total yield but decreased the percentage of large potato tubers to be produced. The possibility of securing high yield depends much upon maintenance of optimum number of plants per unit area and their spatial arrangement in the field (Gebremedhin *et al*., 2008). This therefore requires the establishing optimal combination of seed size and planting distance.

Farmers in western parts of Ethiopia are using similar spacing for seed and ware potato production system which finally resulted to poor quality and different sized tuber seeds. Since, quality of potato seed is a key factor in profitable potato production, it is imperative to identify appropriate spacing for seed and ware potato productions

Corresponding Author: Bikila Akassa, Bako Agricultural Research Center, Bako, Ethiopia

as the two are distinct commodities that need to be treated differently from planting to storage. The objective of this research study was therefore to identify optimum inter and intra row spacing combinations that support early emergence and subsequent growth of seed and ware potato tuber seedlings.

MATERIALS AND METHODS

Description of the study area: The study was conducted at Bako Agricultural Research Center (BARC) during 2011/12 main cropping season. The center located in the western parts of Ethiopia at a distance of 260 km away from Addis Ababa at a latitude of 9°6'N, longitude 37°9'E and altitude of 1650 m above sea level. The area has a humid climate with annual mean minimum and maximum temperature of 13.5 and 26.9°C, respectively. It receives average annual rainfall of 1424 mm extending from May to November with the maximum precipitation in the months of June to August (OARI, 2002). The soil of the area is characteristically reddish brown Nitosols, with a pH of 4.8-5.0.

Experimental design and treatments: The experiment consisted of six levels of inter row spacing (60, 65, 70, 75, 80 and 85 cm) and three levels of intra row spacing (20, 30 and 40 cm) and was set up in a 6×3 factorial design arranged in RCBD with three replications. Potato varieties called 'Jalene' was used in this experiment as it is growing widely in the area and has got acceptance by farmers due to its high yielding and resistance to disease and pest as well as acceptability by consumers.

Data collection and analysis: Data on growth and yield attributes were collected and subjected to analysis of variance (ANOVA) using SAS computer software version 9.2 (SAS, 2008). When ANOVA showed significant differences, mean separation was carried out using LSD (least significant difference) test at 5% level of significance.

RESULTS AND DISCUSSION

Days to emergence: From the analysis of variance, interaction effect of inter and intra row spacing showed very highly significant differences ($p<0.0001$) with respect to days to emergence (Table 1). Treatment combination of inter and intra row spacing of 60×40 cm and 70×30 cm took longer days (16 days) for emergence and treatment combination 70×20, 75×30, 75×40, 80×30 and 85×40 cm on the other hand emerged within 12 days after planting. As can be observed here, seedlings emerged at relatively faster rate in a wider spacing than in space containing greater number of plants per plot.

Table 1: Interaction effect of inter and intra row spacing on days to emergence

Treatments (cm)	Days to emergency
60×20	15.00^{b}
60×30	13.66^{c}
60×40	16.00^{a}
65×20	15.00^{b}
65×30	13.00^{d}
65×40	14.00^{c}
70×20	12.00^{e}
70×30	16.00^{a}
70×40	15.00^{b}
75×20	13.00^{d}
75×30	12.00^{e}
75×40	12.00^{e}
80×20	14.00^{c}
80×30	12.00^{e}
80×40	13.00^{d}
85×20	14.00^{c}
85×30	13.00^{c}
85×40	12.00^{e}
LSD (5%)	0.49
CV (%)	2.20

Means followed by the same letter(s) within the same column are not significantly different at a probability level of 0.05

Days to 50% flowering: The analyses of variance for the effects of inter row spacing showed significant ($p<0.05$) difference with respect to days to 50% flowering. The inter row spacing 80 cm took 58 days to reach its 50% flowering whereas inter row spacing 60 cm took relatively shorter period of time, 51.55 days to reach this flowering stage (Table 2). Intra row spacing as a main effect or interaction with inter row spacing did not show any significant effect on days to 50% flowering at all. This is probably seedlings in a wider space got sufficient light that promote the transition of vegetative stage to the reproductive stage than those planted in a closer spacing. Plants in a closer spacing may compete for the available light and may remain in a vegetative sage for longer period than plants grown in a wider spacing.

Days to maturity: The result of analysis indicated that interaction effects of inter and intra row spacing showed significant differences ($p<0.05$) with respect to potato days to maturity (Table 3). Treatment combination inter to intra row spacing of 70×30 and 75×20 cm matured earlier (81 days) as compared to potato planted at the other spacing combinations. A treatment combination of 80×40 cm and 85×40 cm on the other hand were found to mature 91 days after planting. The results of this experiment is in line with the findings of Mengistu and Yamoah (2010) who reported that increasing plant density fastened days to maturity. As the number of plant per unit area is reduced by increasing the inter and intra row spacing there is a chance of availability of nutrients, light and space that the plants may find to grow more vegetative which extends maturity. The days to reach

Table 2: Inter and intra row spacing (cm) effect on potato days to 50% flowering

Treatments	Days to 50% flowering
Inter row (cm)	
60	51.55^{c}
65	53.33^{bc}
70	54.44^{abc}
75	56.22^{abc}
80	58.22^{a}
85	57.55^{ab}
LSD (5%)	4.47
Intra row (cm)	
20	53.83 ^{a}
30	56.16 ^{a}
40	55.66^{a}
LSD (5%)	3.35
CV (%)	8.97

Means followed by the same letter(s) within the same column are not significantly different at a probability level of 0.05

maturity are relevant parameter for potato producers in order to develop planning for production season, marketing etc.

Plant height (cm): The analysis of variance of plant height showed significant differences ($p<0.05$) for the interaction effects of inter and intra row spacing (Table 3). The tallest plant height (82.66 cm) was observed in the combination of 80 cm inter row spacing and 40 cm intra row spacing, whereas, relatively shorter plant height (57.33 cm) was obtained in the treatment combination of 60×30 cm inter row and intra row spacing.

The increase in height may be due to better availability of nutrients, water and sun light since plants in wider spacing have less competition and grow more shoots. But, densely populated plants show intensive competition which leads to decrease in plant height. The result of the experiment was in line with the findings of Zamil *et al.* (2010) who reported that the widest spacing enhances growth and height of the plant which was significantly different from narrow spacing. This current finding is also supported by a study made by Gebre and Giorgis (2001). They reported that significant effect of spacing on plant height, as a result of availability of wider inter row spacing for growth factor.

Plant canopy (cm): The analysis of variance for the inter and intra row spacing measurement of plant canopy showed that there was significant statistical differences ($p<0.05$), between the treatments (Table 4). Potato plants planted at an inter row spacing of 65 and 85 cm and those planted at an intra-row spacing of 40 cm developed wider canopy 48.55, 47 and 46.94 cm, respectively. The treatment combinations between inter and intra row spacing on the other hand did not show any significant differences ($p>0.05$) with respect to this variable. This indicate that if there is wider space for plant growth, plants grow both horizontally vertically to explore the available resources like light and nutrients. As the plant increases in their canopy, they have the chance to intercept more light and convert that to dry matter for better growth and yield than those grown in closer spacing.

Table 3: Interaction effect of inter and intra row spacing on days to maturity and plant height

Treatments	Maturity (days)	Plant height (cm)
60×20	81.66^{fg}	60.66^{def}
60×30	83.33^{d-g}	57.33^{f}
60×40	88.33^{a-d}	61.66^{def}
65×20	88.00^{a-e}	67.33^{bcd}
65×30	88.33^{a-d}	66.33^{b-e}
65×40	84.66^{c-g}	66.00^{b-e}
70×20	85.66^{b-g}	58.66^{ef}
70×30	80.66^{g}	66.00^{b-e}
70×40	84.66^{c-g}	72.33^{b}
75×20	81.00^{g}	64.33^{c-f}
75×30	87.00^{a-f}	64.00^{c-f}
75×40	84.33^{c-g}	64.00^{c-f}
80×20	84.66^{c-g}	66.00^{b-e}
80×30	89.33^{a-c}	70.00^{bc}
80×40	90.66^{ab}	82.66^{a}
85×20	82.66^{efg}	67.00^{bcd}
85×30	89.33^{abc}	64.66^{b-f}
85×40	91.33^{a}	70.00^{bc}
LSD (5%)	5.39	7.95
CV (%)	8.97	7.25

Means followed by the same or no letter(s) within the same column are not significantly different at a probability level of 0.05

Table 4: Inter and intra row spacing effect on main stem number

Treatments	Plant canopy (cm)	Main stem number
Inter row (cm)		
60	42.88^{b}	3.0^{ab}
65	48.55^{a}	3.0^{ab}
70	41.77^{b}	2.8^{ab}
75	43.66^{b}	3.11^{a}
80	46.33^{b}	3.0^{ab}
85	47.00^{ab}	3.0^{ab}
LSD (5%)	4.75	0.18
CV (%)	10.93	6.31
Intra row (cm)		
20	43.27^{b}	3.0^{a}
30	45.88^{ab}	2.94^{a}
40	46.94^{a}	3.0^{a}
LSD (5%)	3.36	0.12
CV (%)	10.93	6.31

Means followed by the same or no letter(s) within the same column are not significantly different at a probability level of 0.05

Number of main stem (branches): The analysis of variance for the number of main (primary) stem or branches showed that there were no statistical differences ($p>0.05$) with the combination of row and plant spacing (Table 4). Number of main stem or branch per plant were not influenced by plant spacing as reported by different workers Beukema and van der Zaag (1990) but stem number increased as a result of either by planting smaller tuber size or more tuber number per unit area pre plant (Sturz *et al*., 2003). It is a function of seed pieces type as their production was not affected by plant density nor

excess application of fertilizers but, can significantly be affected by altering the planting date (Entz and LaCroix, 1984).

CONCLUSION

Inter and intra row spacing and their interaction had significant effect on the emergence and successful seedling growth for both seed and ware potatoes except that the number of main stem are not affected by the number of plant population per plot of land. Potato seedlings require wider spacing for better and early emergence, maturity as well as for most of the growth variables. However, indefinite increases in spacing between plants and rows do not result to further change in these variables rather result to prolonged days to flowering and maturity. Therefore, for proper emergence and growth of potato for both seed and ware according to this research an inter row spacing of 70-75 and intra row spacing of 20-30 cm can be considered as the best combinations of spacing for potato seedling emergence and establishment provided that tubers meant for seed and ware are planted separately in space or time.

ACKNOWLEDGEMENTS

We are very much pleased to thank Jimma University College of Agriculture and Veterinary Medicine for the financial support and Bako Agricultural Research Centre for materials and experimental site where this research was done.

REFERENCES

Allen, E.J. and D.C.E. Warr, 1992. Plant Density. In: The Potato Crop, Harris, P. (Ed.). 2nd Edn., Chapman and Hall, London, pp: 292-330.

Beukema, H.P. and D.E. van der Zaag, 1990. Introduction to Potato Production. 2nd Edn., Centre for Agricultural Publishing and Documentation (PUDOC), Wageningen, The Netherlands, ISBN: 9789022009635, Pages: 208.

Entz, M.H. and L.J. LaCroix, 1984. The effect of in-row spacing and seedtype on the yield and quality of a potato cultivar. Am. Potato J., 61: 93-105.

FAO, 2008. International year of the potato. Food and Agricultural Organization, USA. http://www.fao.org/agriculture/crops/thematic-sitemap/theme/hort-indust-crops/international-year-of-the-potato/en/

Gebre, E. and G.W. Giorgis, 2001. Effects of spatial arrangement on tuber yields of some potato cultivars. Afr. Crop Sci. J., 9: 67-76.

Gebremedhin W., E. Gebre and B. Lemaga, 2008. Potato Variety Development. In: Root and Tuber Crops: The Untapped Resources, Gebremedhin W., E. Gebre and B. Lemaga (Eds.). Ethiopian Institute of Agricultural Research, Addis Ababa, Ethiopia, pp: 51-84.

Girma, A., B. Mathewos, D. Shimellis, G. Hailu and W.G. Geberemedhin, 2004. Enhancing food security through farmers based seed system, the case of improved potato production technology, transfer in western Ethiopia. Research Report, Oromia Agricultural Research Institute (OARI), Bako Agricultural Research Center, Oromia, Ethiopia.

Hirpa, A., M.P.M. Meuwissen, A. Tesfaye, W.J.M. Lommen, A.O. Lansink, A. Tsegaye and P.C. Struik, 2010. Analysis of seed potato systems in Ethiopia. Am. J. Potato Res., 87: 537-552.

Mengistu, T. and C. Yamoah, 2010. Effect of sowing date and planting density on seed production of carrot (Daucus carota var. sativa) in Ethiopia. Afr. J. Plant Sci., 4: 270-279.

OARI, 2002. Recommended research results for improving crop livestock and natural research productivity in Western Oromia: User's manual. Oromia Agricultural Research Institute, Bako Agricultural Research Center, Oromia, Ethiopia.

SAS, 2008. Statistical Analysis Software Version 9.2. SAS Institute Inc., USA.

Sadowska, J., J. Fornal, J. Vacek, T. Jelinski and B. Flis, 2004. Characteristics of physical properties of genetically modified potatoes. I. Mass and geometric properties of tubers. Int. Agrophysics, 18: 269-276.

Sturz, A.V., W. Arsenault and B.R. Christie, 2003. Red clover-potato cultivar combinations for improved potato yield. Agron. J., 95: 1089-1092.

Zamil, M.F., M.M. Rahman, M.G. Robbani and T. Khatun, 2010. Combined effect of nitrogen and plant spacing on the growth and yield of potato with economic performance. Bangladesh Res. Publ. J., 3: 1062-1070.