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To find out the best planting distance on growth and tuber yield of potato (*Solanum tuberosum* L.) Variety Kufri laukar

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Abstract
Field experiment entitled "To find out the best planting distance on growth and tuber yield of potato (*Solanum tuberosum* L.)" Variety Kufri lauvkar have been conducted at the research farm of AKS University, Sherganj Satna. During rabi season of 2015-16. Experiment comprised of three level of spacing's viz.,- 60 x 10 cm, 60 x 20 cm and 60 x 30 cm. Experiment was laid out in Randomized Block Design (with factorial concept) with three replications. 60 x 20 cm plant spacing caused significant effect on growth parameters such as height of the plant, number of main stem/hill, stem diameter (mm), yield and yield attribute were also affected by plant spacing i.e. total number of tuber, number of big size tuber and total tuber yield q/ha. It was observed that the earthing up at 30 DAP showed superior performance in most of the growth and yield parameters. Therefore, 30 cm plant spacing for better growth and higher tuber yield.

Keywords: Potato (*Solanum tuberosum* L.), planting distance, growth and yield

Introduction
Potato **(***Solanum tuberosum* L.) is a tuber crop and belongs to the family Solanaceae, genus Solanum and species tuberosum. It is an herbaceous annual and edible portion of potato is modified underground stem, which is known as tuber. Potato is a nutritious food and it contains practically all the major constituents. Half quantity of the Potato produced in the world is utilized as human food. Among the root and tuber crops, potato ranks first in volume of production and consumption, followed by Cassava, sweet potato and yam. The potato is grown in 79% of the countries in the world (FAO, 2008) [2]. The total cultivated area of potato in India is about 1973.2 thousand hectares with a production of 41555.4 metric tonnes and average productivity is 21.1 metric tonnes per hectare. Spacing is an important factor for better growth and yield of plant. Optimum number of plants is required per unit area to utilize efficiently the available production factors such as water, nutrient, light and Co_2. Maximum exploitation of these factors is achieved when the plant population puts forth maximum pressure on all the factors of production. The yield of seed potato can be maximized at higher plant population by regulating the number of stems per unit area and to certain extent by removing the haulm earlier during the maturity. The absence of optimal plant spacing practices could significantly reduce total tuber yield up to 50%. Therefore, optimization of plant spacing is one of the important agronomic practices of potato production as it affects the seed cost, plant development and potato tuber yield (Gulluogh and Arioglu, 2009) [3]. It involves drawing mounds of soil up around the plant proper to prevent new tubers form growing and turning green poisonous. It also helps to prevent greening, tuber moth and blight infection. It also helps to loosen the subsoil for good aeration and to cover the tuber with sufficient layer of soil. One of the bottle neck problems of production of potato with better tuber quality is lack of information on the appropriate agronomic practices, since no research has so far been conducted for the area to determine the optimum plant spacing and time of earthing up for optimum production of potato with better tuber quality. It is well known that the plant spacing can alter above and below ground biomass accumulation of vegetable crops.

Materials and Methods

Location: instructional Farm is located 5 km away from main city of Satna district at Sherganj, Panna road, Satna, M.P. The experimental plots have uniform topography with homogenous fertility and typical soil characteristics to suit potato cultivation. The experiment was laid out in Randomized block design (with factorial concept) with three replications. Each replication consists of three plant spacing: 10, 20 and 30 cm, 20 and 30 days after plant emergence. The details of treatments are as given below;

Experimental Design			:	RBD (with factorial concept)
Plant spacing's			:	60× 10, 20 and 30cm
Number of treatment combination			:	3 × 3 = 9
Number of replications			:	3
Number of total plot			:	27
Net plot size			:	1.80×1.20 m^2
Treatment combination				
T_1	=	S_1E_0	-	10 cm spacing + No earthing up
T_2	=	S_1E_1	-	10 cm spacing + 20 Days after planting
T_3	=	S_1E_2	-	10 cm spacing + 30 Days after planting
T_4	=	S_2E_0	-	20 cm spacing + No earthing up
T_5	=	S_2E_1	-	20 cm spacing + 20 Days after planting
T_6	=	S_2E_2	-	20 cm spacing + 30 Days after planting
T_7	=	S_3E_0	-	30 cm spacing + No earthing up
T_8	=	S_3E_1	-	30 cm spacing + 20 Days after planting
T_9	=	S_3E_2	-	30 m spacing + 30 Days after planting

Observations assessments

(A) Growth Attributes

(i) Plant height (cm): Five plants were selected randomly from each plot, tagged permanently and measured in centimeter with the help of measuring tape from the base of the sprout to the growing point and their average length represent the plant height in centimeters. Observations were recorded at each growth stage (30, 45, 60DAP and at harvesting time)

(ii) No. of main stem: The number of main stem per hill was counted on each of the five selected plant on each treatment at progressive growth stage 30, 45, 60 DAP and at harvesting time.

(iii) Stem diameter (MM.) Stem diameter was measured with the help of Vernier calipers at progressive growth stage 30, 45, 60 DAP and at harvest time.

(B)Yield Attribute

(i) Total Number of tuber per plot: The total numbers of tubers obtained from each plot were sorted out into different grades based on the weight viz. less then 20 g, 20-50g and more then 50g then the total number of tubers of each grade was recorded separately and worked out to find the number of tuber yield per plot count per plot on each plot.

(ii) Big size tuber per plot The total numbers of tubers obtained from each plot were sorted out into tuber grade more then 50 g and count the tubers per plot.

(iii) Total yield (q)/ha: Total tuber yield per hectare in quintals weight total tuber yield in quintal per hectare.

Results: Plant height

Effect of plant spacing: Data portrayed in above table marked out that spacing caused beautiful response on height of the plant in potato when tubers were planted at 20 cm apart. Maximum plant height was received i.e. 20.24cm, 25.69 cm, & 31.51 cm at 30, 45, 60 DAP.

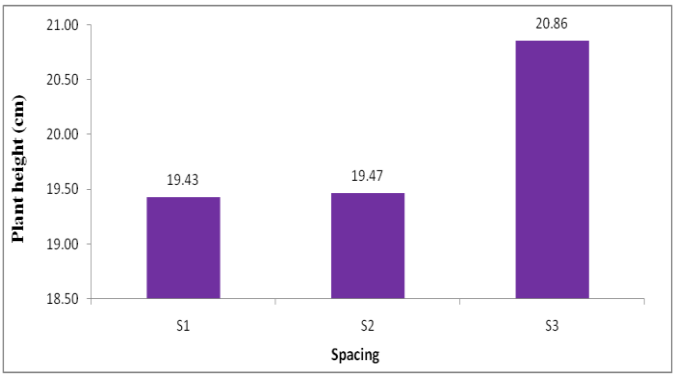

Fig 1: Plant height (cm) as affected by different level of plant spacing at 30 day

Table 1: Table showing the number of main stems/hill as affected by different plant spacing.

Treatments	Number of main stem/hill
Plant spacing	
E_0	3.22
E_1	3.37
E_2	3.81
SEm±	0.08
CD (P=0.05)	0.23

Table 2: Table showing the number of main stems/hill as affected by different plant spacing.

Treatments	Number of main stem/hill
	45 DAP
Plant spacing	
S_1	3.33
S_2	3.60
S_3	3.57
SEm±	0.07
CD (P=0.05)	0.20

Stem diameter (mm) Effect of plant spacing: Data present in above table indicated out that plant spacing caused beautiful response on stem diameter in potato when tuber were planted at 20 cm apart. Maximum diameter of stem was received 4.30 mm, 5.07 mm. & 5.66 mm at 30, 45 and 60 DAP respectively and minimum diameter of stem was received when tuber were planted at 10 cm apart.

Yield attribute: Total number of tuber/plot

Effect of plant spacing: Data portrayed in above table marked out that spacing caused beautiful response on total number of tuber in potato when tubers were planted at 10 cm apart maximum number of tubers i.e. 144.00 was received and minimum tubers were received when tubers were planted at 30 cm apart.

Table 3: Table showing the total number of tuber as affected by different level of plant spacing.

Treatments	No. of total tuber/plot
Plant spacing	
S_1	144.00
S_2	139.11
S_3	133.78
SEm±	**2.38**
CD (P=0.05)	**7.13**

Number of big size tuber per plot Effect of plant spacing: Data presented in above table indicated out that spacing caused excellent response on number of big size tuber in potato when tubers were planted at 30 cm apart. Maximum big size tubers 32.60 were received and minimum big size tubers when tubers were planted at 10 cm apart.

Total tuber yield q/ha Effect of plant spacing: Data portrayed in above table marked out that spacing caused beautiful response on total tuber yield q/ha in potato when tubers were planted at 20 cm apart maximum tuber yield 203.27 q/ha was received and minimum tuber yield was recorded when tubers were planted at 10 cm apart.

Discussion

The present investigation has been carried out during 2015-16 to find out the effect plant spacing on different plant characters and yield of potato.

Plant height: The highest plant height recorded when planting was done at 20 cm apart. The shortest plant height was observed at 10 and 30 cm plant spacing (4.1.1). This might be due to the presence of higher competition for sunlight among plants grown at the closer intra row spacing.

Number of main stem: Qadir *et al*. (1999) [4] also concluded that the number of stems per plant was significantly higher for plants earthed up 30 days after planting.

Stem diameter: The largest stem diameter was observed at the wider intra row spacing of 20 cm whereas the smallest stem diameter was found at the narrowest intra row spacing of 10 cm (4.1.3). Wider plant spacing resulted in less competition among plants, availability of resources; high light interception and large quantity of photo assimilate production as well as assimilation and thus increased plant growth and development which ultimately increased the diameter of stem.

Total number of tuber/plot: Significantly the highest number of tubers per plot was recorded at the 10 cm plant spacing whereas the lowest number of tubers per plant was obtained at the plant spacing of 30 cm.

Number of big size tubers: The highest number of big size tuber was found when wider plant spacing of 30 cm at 30 days after planting (4.2.2). This could be due to the fact that early spacing during the active growth period of the plant improved the soil conditions for nutrient absorption and also at the wider plant spacing due the presence of minimum competition. The result is in consistency with the work of Gulluoglu and Arioglu (2009) [3] who confirmed that, the percentage of big size tuber in total tuber yield was increased with widening plant spacing.

Total tuber yield (hac): The highest tuber yield per hectare was obtained at the 20 cm plant spacing of 10 cm whereas the lowest was obtained at the plant spacing of 30 cm (4.2.7).This is due to the compensation effect of closer plant spaced per hectare than the wider plant spacing which resulted in higher yield of tubers per plot.

Summary

The experiment was carried out at the Horticulture field, AKS University, Satna during 2015-16 to study the effect of three plant spacing *viz*., 60×10 cm, 60×20 cm and 60×30 cm on potato. The experiment was laid out in a Randomized Block Design (with factorial concept) with three replications. The plot size was 2.16m^2 (1.20m × 1.80m). Altogether 9 treatment combinations were there in the experiment. Harvesting was done when crop was matured. The data on different plant characters, yield and yield atributing characters were taken from the harvested crop. Plant spacing 60×20 cm gave highest plant height i.e. 20.24 cm, 25.69 cm, 31.51 cm and 33.92 cm at 30, 45 and 60 days after planting. Maximum main stem/hill (3.57 stem/hill during at 30 DAP stem/hill at 45 and 60 DAP) when plant spacing 60×20 cm kept apart.Plant spacing 60×20 cm gave highest stem diameter i.e, 4.30 mm, 5.07 mm, 5.66 mm and 6.02 mm at 30, 45 and 60 days after planting. Maximum total number of tuber per hectare (666666.67) was recorded when 60×20 cm planting distance was kept evaluation. Plant spacing 30 cm apart gave highest number of big size tuber per hectare (150925.93. Maximum total tuber yield i.e. 203.27 q/ha was recorded when plant spacing 60×20 cm was evaluted.

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