Effect of spacing, and size of seed-tubers on the growth parameters of potato (*Solanum tuberosum)* cv Kufri chipsona-1

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Abstract: A field experiment was carried out during 2019-20 and 2020-2021 on light-textured soil at R.B.S. College ,Bichpuri Agra on potato, variety KUFRI Chipsona to ascertain the effects of three intra row planting spacing's, i.e. S_1-15cm ,S_2-20cm and S_3-25 cm (at fixed ridge spacing 45 cm)and tree size (weight)of potato seed tubers viz. P_1 - 20g, P_2-30g and P_3 -40g in factorial R.B.D with tree replication. Plant spacing and seed tuber size are important agronomic management practices in the production of potato. However, potato farmers in India often use disorganized plant spacing and seed tuber sizes, which contribute to the low yield of the crop. A study was designed to elucidating the effect of varied plant spacing and seed tuber sizes on growth and quality of potato. Average fresh weight tuber plant^{-1} was significantly affected by combined effects of plant spacing and seed tuber sizes. The highest average fresh weight tuber pant^{-1} 411.496 g) was obtained from 30 gram seed tuber sizes and at 45 × 25 cm plant spacing treatment combination S_3P_2. The highest haulms pant^{-1} (318.50g) was obtained from 40 gram seed tuber sizes and at 45 × 25 cm plant spacing treatment combination S_3P_3. The highest no. of the leaves pant^{-1} (13.91) was obtained from 20 gram seed tuber sizes and at 45 × 20 cm plant spacing treatment combination S_2P_1. The highest length of the longest stolon pant^{-1} (20.33cm) was obtained from 40 gram seed tuber sizes and at 45 × 20 cm plant spacing treatment combination S_2P_3. The highest no of stolon pant^{-1} (20.33) was obtained from 40 gram seed tuber sizes and at 45 × 20 cm plant spacing treatment combination S_2P_3. The highest no of tubers pant^{-1} (12.91) was obtained from 20 gram seed tuber sizes and at 45 × 20 cm plant spacing treatment combination S_2P_1. The highest average weight per tuber (59.36g) was obtained from 30 gram seed tuber sizes and at 45 × 25 cm plant spacing treatment combination S_3P_2 .The use of high plant spacing 45 × 25 cm under seed tubers size of 30-40 gram are recommended for potato production over than other seed tubers size and plant spacing combinations, farmers can use to get maximum yield.

Keywords*:* Seed-sized tubers, planting Spacing, stolon. Potato, haulms, weight of tuber

I. Introduction

The potato is the most important vegetable which is used surrounding the world. the potato is used as a vegetable and also making of chips and a variety of sweets it is primarily an energy food containing on an average about 74.7% water, 1.6% protein 0.6 % ash, 22.6% starch, and a minor quantity of vitamin A B C and D (**14)** Potato) are a high potential food security and cash crop because of its ability to provide a high yield of high-quality product per unit input with a shorter crop cycle mostly **(1, 2).** The country has about 2117000 hectares of available agricultural land suitable for potato production and production of 4341700 tons **[3]** a major production problem of potato that accounts for such low yields could be the unavailability and high cost of seed tubers, lack of well-adapted cultivars, inappropriate agronomic practices management, diseases, insect pests and proper storage **[4].** Optimizing plant density is one of the most important agronomic practices of potato production because it affects plant development, seed cost, yield, and quality of the crop [**5].**

Farmers who grow potatoes frequently give less regard to the optimum plant population. The possibility of securing a high yield depends on the proper consideration of the optimum number of plants per unit area **[11**]. Narrow spacing increased the hectare yield and decreased the yield per plant. According to Rajadrai [**6]** the highest yield was obtained with large-sized tubers planted in narrow spacing. However, the combination of large-size seed tubers and narrow spacing produced many small-size tubers of low market value.

In all areas of India, there is no separate plot and management for ware and seed potato production. Mostly, potato tubers are sorted into ware and seed immediately after harvest. For most potato producers seed potato is usually considered as the by-product of ware potato **[2].** Potato tubers are planted by marginal, small, and medium landholder farmers at narrow and erratic spacing, with very small tuber sizes resulting in a non-optimum plant population and seed tuber size that may result in low tuber yields and quality of tubers. Production of maximum no. of tubers should be the main component of potato production program .but Available seed production technology produce (**11)** the objective of this research study was to determine optimum tuber seed size and plantation distance for maximum yield production and tuber quality

II. Experimental treatments and design

The treatments consisted of here tuber seed sizes in gram(gm)P_1 P_2 & P_3 (20g, 30g & 40g) and three plantings spacing S_1,S_2& S_3 (45 × 15 cm, 45 × 20 cm,& 45 × 25 cm). . The experiment was laid out as a factorial randomized block design (FRBD) arrangement nine treatment combination, three replication, and twenty-seven total treatments

III. Experimental site

The study was conducted under irrigation during the year 2019-20 to 2020- 21cropping season in on season at R.B.S. College horticulture research farm, Bichpuri, Agra. The location of the experiment remained unaltered in both years. The research farm is situated about 1 km near Bichpuri railway station in Uttar Pradesh India. Bichpuri Agra is located latitude of 27.2° North and a longitude of 77.9° east with an altitude of 163.4 meters above means sea level. Agra has a semi-arid and subtropical climate with hot and dry summers and severely cold. The average annual maximum and minimum temperature is 36 C° and 4 C° respectively. The soil type in the area is light-textured sandy loam.

IV. Data collection and analysis

Data on growth and yield, yield components, and quality variables were collected and subjected to analysis of variance (ANOVA) using the General Linear Model of the SAS statistical package (SAS, 2007). All significant pairs of treatment means were compared using the critical difference (CD) at a 5% level of significance, coefficient of variation (C.V.), and standard error of the mean (SEM)

V. Results and Discussion

1.haulms (gram)

From the analysis of the variance, seed tuber sizes and plant spacing showed a highly significant difference in average **haulms** weight**(gram)** (**Table 1& fig.1**). The highest average haulms weight (318.18 gram) was recorded for plants grown from 40 Gram seed tuber sizes and at 45 × 25 cm plant spacing treatment combinations this might be due to highest seed tuber sizes produced by an optimum number of stems (haulms) and wider plant spacing had fewer resource competitions they get the high potential of resources whereas lowest average haulms weight (247.22 gram) was obtained at 45 × 15 cm plant spacing and 20-gram seed tuber sizes treatment combinations. The present result agreed with the finding of **[17]** that average haulms weight decreased with an increase in mother tuber size. Similarly,**[18]** reported that an increase in density probably causes the increase in competition between and within plants and hence, leads to a decrease in the availability of nutrients to each plant and consequently, results in a decline of mean haulms weight. The production of higher average tuber weight at wider plant spacing as compared to closer plant spacing was also reported by other authors **[5, 9,].**

Fig.1 Haulms (g)

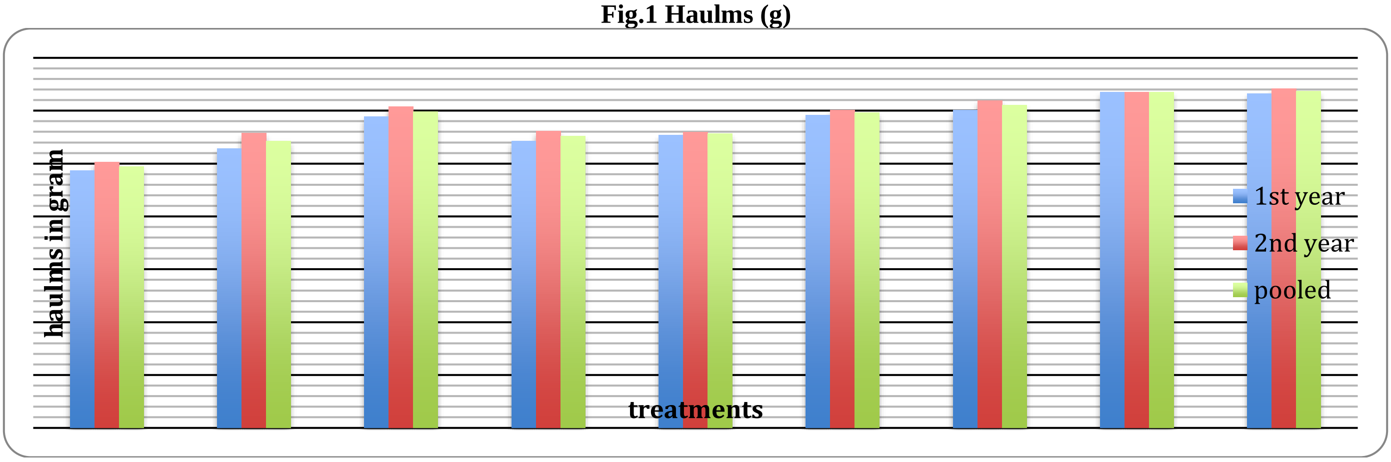


Table: 1 Effect of spacing and size of seed tubers on following numbers – (1) Fresh weight of haulms per plant (Gram), (2) No. of the leaves on the main shoot (3) The length of the longest stolon (cm), (4) No. of stolon per plant, (5) No. of tubers per plant, (6) Weight per tuber (gram) and (7) Fresh weight of tubers per plant (gram)

	1 haulms (g)			2 No. of the leaves			3 length of the longest stolon (cm)			4 No. of stolon per plant			5 No. of tubers Per plant			6 Weight per tuber (g)			7 Fresh weight of tubers /plant (g)		
	Year 1	Year 2	Pooled	Year 1	Year 2	Pooled	Year 1	Year 2	Pooled	Year 1	Year 2	Pooled	Year 1	Year 2	Pooled	Year 1	Year 2	Pooled	Year 1	Year 2	Pooled
$S_1 P_1$	243.23	251.22	**247.22**	11.56	12	**11.56**	16.77	17.86	**17.315**	17.5	18.09	**17.795**	7.68	8.83	**8.255**	52.03	52.22	**52.125**	335.44	336.37	**335.905**

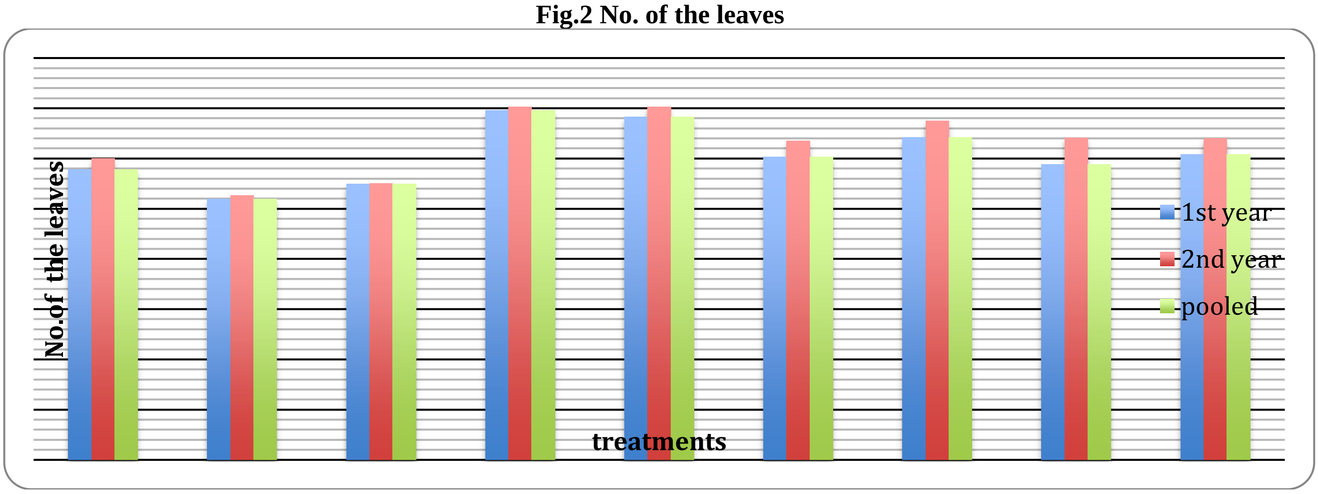
$S_1 P_2$	264.31	278.65	**271.48**	10.38	10.53	**10.38**	18.76	18.99	**18.875**	15.88	16.95	**16.415**	7.29	8.3	**7.795**	51.5	51.69	**51.595**	313.16	314.13	**313.645**
$S_1 P_3$	294.37	303.89	**299.13**	10.99	11	**10.99**	15.09	16.1	**15.595**	15.56	16.41	**15.985**	8.68	9.59	**9.135**	42.08	42.34	**42.21**	228.66	329.56	**279.11**
$S_2 P_1$	271.44	280.56	**276**	13.91	14.06	**13.91**	15.83	17	**16.415**	18.29	19.44	**18.865**	11.57	12.65	**12.11**	33.63	33.81	**33.72**	304.66	305.09	**304.875**
$S_2 P_2$	276.79	279.56	**278.17**	13.65	14.06	**13.65**	15.7	16/69	**15.7**	14.57	15.52	**15.045**	8.21	10.16	**9.185**	44	44.31	**44.155**	312	313.15	**312.575**
$S_2 P_3$	295.91	300.41	**298.16**	12.06	12.7	**12.06**	14.76	15.88	**15.32**	14.88	25.78	**20.33**	9.4	10.44	**9.92**	34.57	35.45	**35.01**	277.31	278.41	**277.86**
$S_3 P_1$	300.5	309.76	**305.13**	12.85	13.5	**12.85**	12.87	14.1	**13.485**	15.94	16.89	**16.415**	8.66	9.76	**9.21**	45.74	46.33	**46.035**	360.69	362.35	**361.52**
$S_3 P_2$	317.42	317.58	**317.5**	11.76	12.83	**11.76**	14.86	15.96	**15.41**	13.5	14.53	**14.015**	7.18	8.26	**7.72**	59.1	59.63	**59.365**	411.5	411.49	**411.495**
$S_3 P_3$	316.33	320.68	**318.50**	12.17	12.8	**12.17**	15.39	16.66	**16.025**	15.86	16.88	**16.37**	10.33	11.33	**10.83**	43.82	44.4	**44.11**	407.58	407.3	**407.44**
C.V.	0.68	0.53	**0.605**	2.93	2.66	**2.93**	2.44	0.81	**1.625**	0.71	1.23	**0.97**	1.12	0.6	**0.86**	0.68	0.41	**0.545**	0.12	0.16	**0.14**
S.Em+/-	1.13	0.9	**1.015**	0.2	0.19	**0.2**	0.22	0.078	**0.149**	0.06	0.119	**0.0895**	0.05	0.034	**0.042**	0.17	0.1	**0.135**	0.23	0.31	**0.27**
CD at 5%	3.41	2.72	**2.14**	0.61	0.58	**0.43**	0.9	0.23	**0.39**	0.26	0.35	**0.21**	0.017	0.1	**0.040**	0.53	0.32	**0.29**	0.7	0.95	**0.57**

Table 1: Average shoot height, tuber weight, and yield. Percentage and grade of tuber A, B & C as influenced by the interaction factors of plant spacing and size of seed-tuber. Means followed by the same letter(s) within a row and column are not significantly different at a 5% level of significance. CD= critical difference, CV= coefficient of variation

2. No.of the leaves

Plant spacing and seed tuber size significantly affected No. of the leaves, but the two factors interact with the parameter (**Table 1 & fig.2**). The results showed that the maximum No. of the leaves (13.91) was obtained at 20 g tuber size and plant spacing of 45 × 20 cm whereas the lowest (11.56) was obtained at 20-gram tuber size and 45 × 15 cm. Plants grown at plant spacing of 45 × 25 cm produced higher total tuber yield higher than plants spaced at 45 × 15cm and 45 × 20 cm by about 9.53 and 10.30%, respectively. In this study, plants spaced at 45 × 15 cm and 45 × 20 cm produced total tuber yields that exhibited statistically non-significant differences. The maximum No. of the leaves was obtained at medium plant spacing than wider and lower plant spacing except for plants spaced 45 × 15 cm. This might be attributed to the efficient use of available soil nutrients and other growth factors in plants grown at medium plant spacing than wider and closer plant spacing. This result consistent with [**13,16,17]** indicated that increased No. of the leaves at medium densities might be due to the ground being covered with green leaves earlier , fewer lateral branches are being formed and tuber growth starting earlier. In other words, increased plant population increased No. of the leaves due to more No. of the leaves being counting per plant.

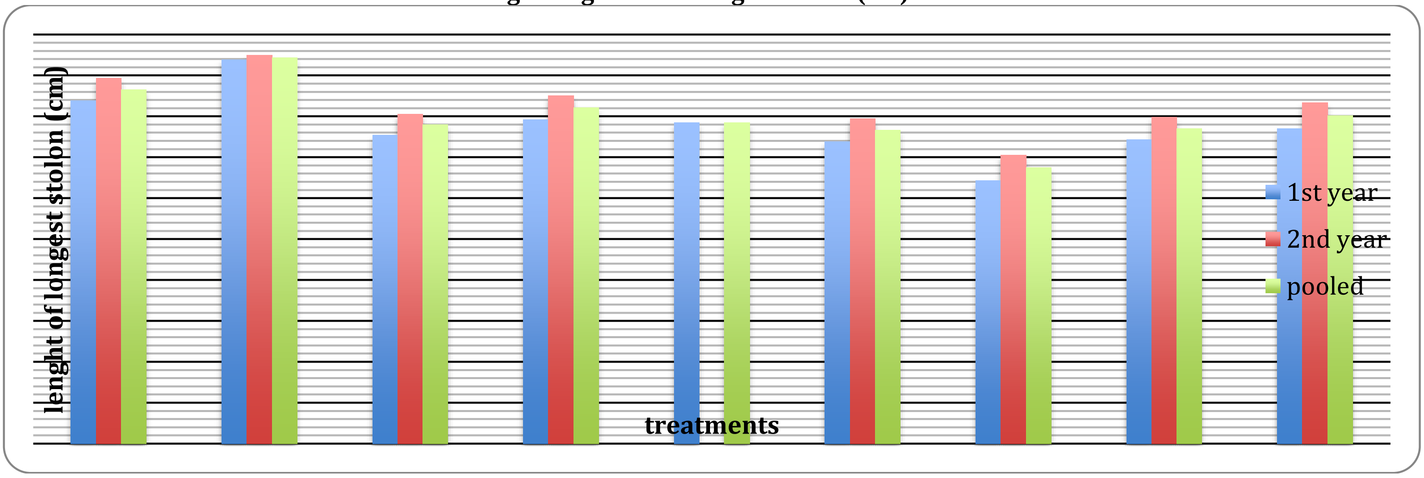
Fig.2 No. of the leaves



3. Length of the longest stolon (cm)

From the analysis of the variance, seed tuber sizes and plant spacing showed a highly significant difference in average length of the longest stolon **(cm)** (**Table 1 & fig.3**). The highest average length of the longest stolon (18.87 cm) was recorded for plants grown from 30 Gram seed tuber sizes and at 45 × 15 cm plant spacing treatment combinations this might be due to medium seed tuber sizes produced by an optimum length of the longest stolon and medium plant spacing and medium size tuber had fewer resource competitions they get the high potential of resources whereas lowest average length of the longest stolon (13.48 cm) was obtained at 45 × 25 cm plant spacing and 20-gram seed tuber sizes treatment combinations. The present result agreed with the finding of **[15]** that average length of the longest stolon decreased with an increase in mother tuber size. Similarly, **[16]** reported that an increase in density probably causes the increase in competition between and within plants and hence, leads to a decrease in the availability of nutrients to each plant and consequently, results in a decline of mean length of the longest stolon. The production of higher average length of the longest stolon at medium plant spacing as compared to closer and wider plant spacing was also reported by other authors **[15, 18].**

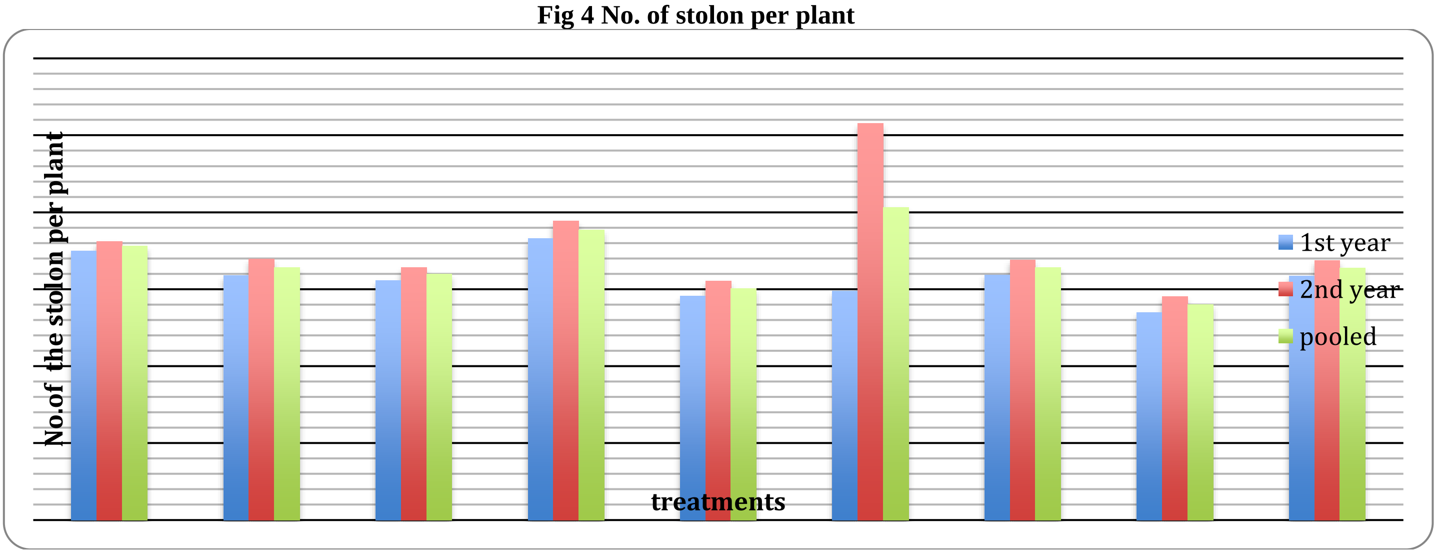
Fig 3.length of the longest stolon (cm)



4. No. of stolon per plant

From the analysis of the variance, seed tuber sizes and plant spacing showed a highly significant difference in average No. of stolon per plant (**Table 1 & fig. 4**). The highest average No. of stolon per plant (20.33) was recorded for plants grown from 40 Gram seed tuber sizes and at 45 × 20 cm plant spacing treatment combinations this might be due to medium seed tuber sizes produced by an optimum number of stolon and wider plant spacing had fewer resource competitions they get the high potential of resources whereas lowest average No. of stolon per plant (14.01) was obtained at 45 × 25 cm plant spacing and 30-gram seed tuber sizes treatment combinations. The present result agreed with the finding of **[16]** that average tuber weight decreased with an increase in mother tuber size. Similarly, **[14]** reported that an increase in density probably causes the increase in competition between and within plants and hence, leads to a decrease in the availability of nutrients to each plant and consequently, results in a decline of mean tuber weight. The production of higher average tuber weight at wider plant spacing as compared to closer plant spacing was also reported by other authors **[17, 14].**

Fig 4 No. of stolon per plant

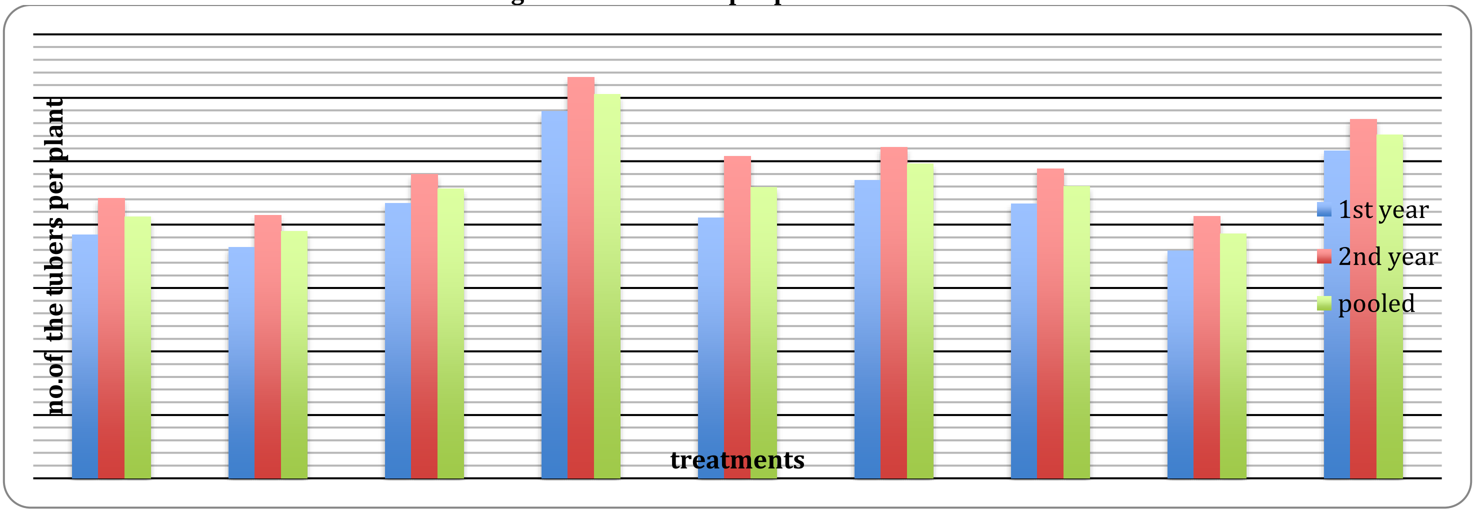


5 .No. of tubers of per plant

From the analysis of the variance, seed tuber sizes and plant spacing showed a highly significant difference in average No. of tubers per plant (**Table 1 & fig. 5**). The highest average No. of tubers per plant (12.11) was recorded for plants grown from 20 Gram seed tuber sizes and at 45 × 20 cm plant spacing treatment combinations this might be due to medium seed tuber sizes produced by an optimum number No. of tubers per plant and medium plant spacing and tuber size had fewer resource competitions they get the high potential of resources whereas lowest average No. of tubers per plant (7.72) was obtained at 45 × 25 cm plant spacing and 30-

gram seed tuber sizes treatment combinations. The present result agreed with the finding of **[13]** that average No. of tubers per plant decreased with an increase in mother tuber size. Similarly, **[14]** reported that an increase in density probably causes the increase in competition between and within plants and hence, leads to a decrease in the availability of nutrients to each plant and consequently, results in a decline of mean tuber weight. The production of higher average No. of tubers per plant at wider plant spacing as compared to closer plant spacing was also reported by other authors **[12,16,].**

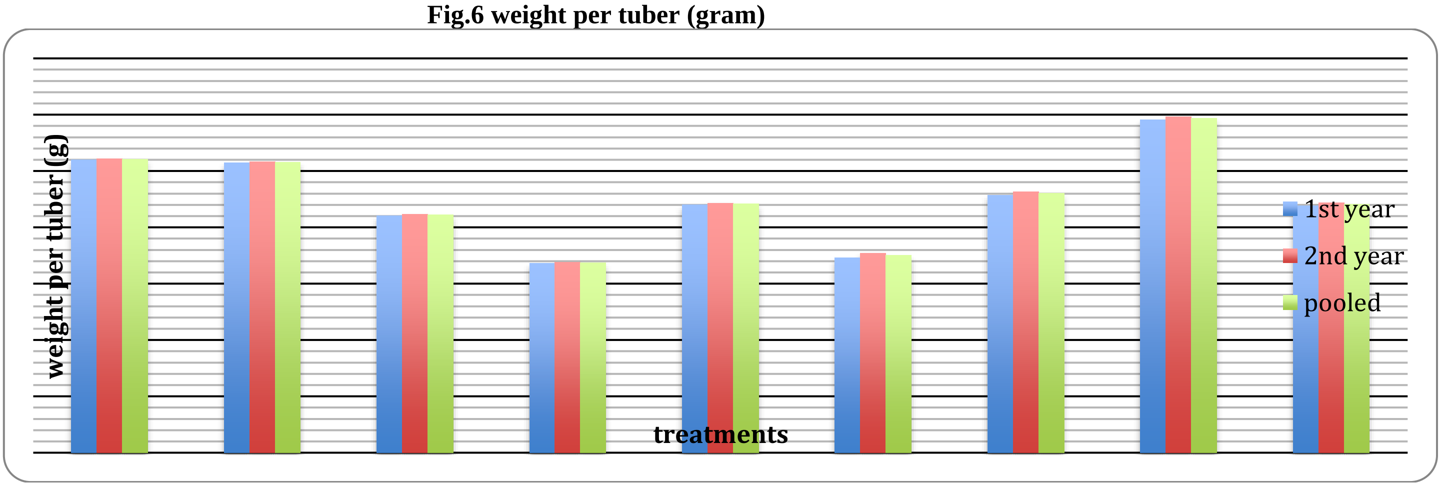
Fig.5 no. of tubers of per plant



6. Weight per tuber (gram)

From the analysis of the variance, seed tuber sizes and plant spacing showed a highly significant difference in average weight per tuber **(gram)** (**Table 1 & fig.6**). The highest average weight per tuber (59.36 gram) was recorded for plants grown from 30 Gram seed tuber sizes and at 45 × 25 cm plant spacing treatment combinations this might be due to medium seed tuber sizes produced by an optimum number of stems and wider plant spacing had fewer resource competitions they get the high potential of resources whereas lowest average weight per tuber (33.72 gram) was obtained at 45 × 20 cm plant spacing and 20-gram seed tuber sizes treatment combinations. The present result agreed with the finding of **[13, 12]** that average weight per tuber decreased with an increase in mother tuber size. Similarly, **[14]** reported that an increase in density probably causes the increase in competition between and within plants and hence, leads to a decrease in the availability of nutrients to each plant and consequently, results in a decline of mean weight per tuber. The production of higher average weight per tuber at wider plant spacing as compared to closer plant spacing was also reported by other authors **[15, 16,].**

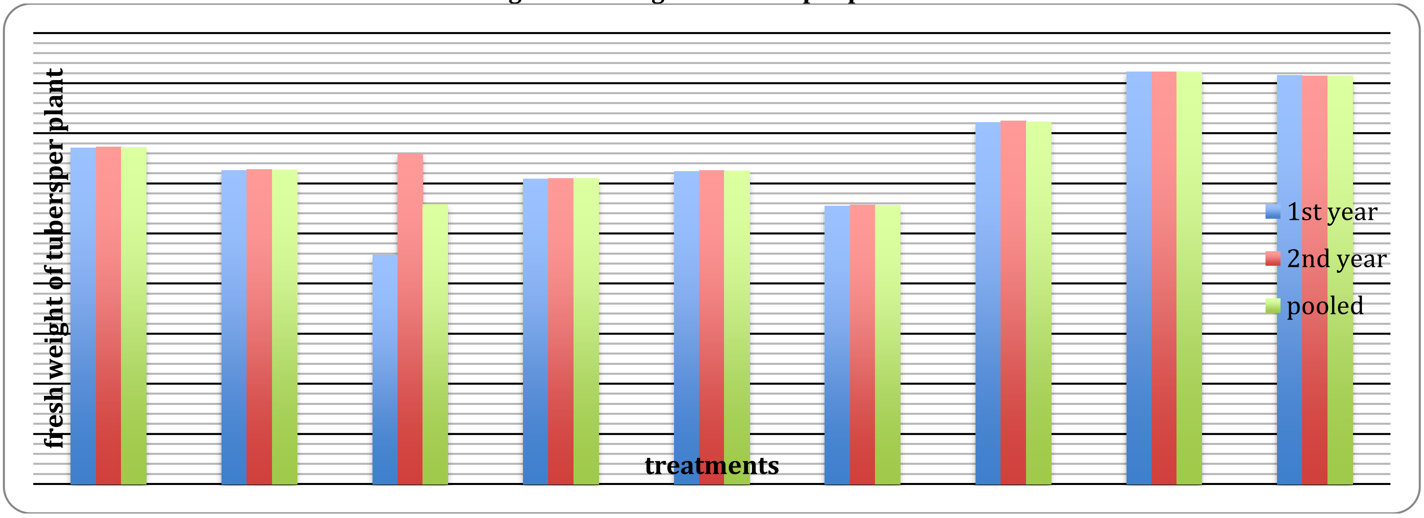
Fig.6 weight per tuber (gram)



7. Fresh weight of tubers per plant

From the analysis of the variance, seed tuber sizes and plant spacing showed a highly significant difference in average fresh weight of tubers per plant (gram) (**Table 1 & fig 7**). The highest average fresh weight of tubers per plant (411.49 gram) was recorded for plants grown from 30 Gram seed tuber sizes and at 45 × 25 cm plant spacing treatment combinations this might be due to medium seed tuber sizes produced by an optimum number of stems and wider plant spacing had fewer resource competitions they get the high potential of resources whereas lowest average fresh weight of tubers per plant (277.86 gram) was obtained at 45 × 20 cm plant spacing and 40-gram seed tuber sizes treatment combinations. The present result agreed with the finding of **[14]** that average fresh weight of tubers per plant decreased with an increase in mother tuber size. Similarly, **[13,16]** reported that an increase in density probably causes the increase in competition between and within plants and hence, leads to a decrease in the availability of nutrients to each plant and consequently, results in a decline of mean fresh weight of tubers per plant. The production of higher average fresh weight of tubers per plant at wider plant spacing and big sizetuber as compared to closer plant spacing was also reported by other authors **[15].**

Fig.7 fresh weight of tubers per plant



wer~ recorded. The number of tubers weighing less than 40 g was considered as seed and above as large-sized tubers. The interaction between spacing, farmyard manure, and de-hauling time on different plant parameters in trial I was non-significant. Hence main effects of the treatments are reported (Table 1). The crop emergence (%) was higher when the tubers were planted at 50 em x ! 0 em than 50 COl xl 5 cm spacing, The differences in the emergence count might be attributed to the improved soil moisture maintained by closer ridging due to reduced exposure of soil surface to evaporation. Farmyard manure did not affect crop emergence. The plant height was not influenced by any treatment. However, stems/plants increased with closer intra-row spacing (10 cm) compared with 15 cm spacing. Farmyard manure tended to decrease stem number although the effect was non-significant. Delay in haulm cutting decreased the numbtube~s along with good health standards and optimum physiological maturity of seed. Therefore the investigation was undertaken to study the influence of different factors on the seed tuber yield (both in number and yield)

VI. Conclusion and Suggestion

field experiment was carried out during 2019-20 to 2020-21 on light-textured soil at R.B.S. College, Bichpuri Agra on potato, variety KUFRI Chipsona to ascertain the effects of three Intra row planting spacing, i.e. S_1-15cm, S_2-20cm and S_3-25 cm (at fixed ridge spacing 45 cm)and tree size (weight)of potato seed tubers viz. P_1 - 20g, P_2-30gand P_3 -40g in factorial R.B.D with tree replication. The yield data of this experiment are suggestive of growing Kufri chipsona at 45×25 cm spacing by planting the seed tuber weight 30g each Making recommendations of both aspects of agro–practices, the experiment should be conducted at least once again

VII. Reference

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