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VV Mali
M. Sc. Student, Department of Horticulture, College of Agriculture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Ratnagiri, Maharashtra, India

SB Thorat
Assistant Professor, Department of Horticulture, College of Agriculture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Ratnagiri, Maharashtra, India

AP Pawar
M.Sc. Student, Department of Horticulture, College of Agriculture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Ratnagiri, Maharashtra, India

YR Parulekar
Assistant Professor, Department of Horticulture, College of Agriculture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Ratnagiri, Maharashtra, India

PV Shelke
B. Sc. Student, Department of Horticulture, College of Agriculture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Ratnagiri, Maharashtra, India

Correspondence
VV Mali
M. Sc. Student, Department of Horticulture, College of Agriculture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Ratnagiri, Maharashtra, India

Effect of spacing and potash levels on physical and chemical parameters of yam bean (*Pachyrhizus erosus* L.) tubers under Konkan agro-climatic conditions

VV Mali, SB Thorat, AP Pawar, YR Parulekar and PV Shelke

Abstract
Yam bean is a plant which produces both starch and proteins in quite high level. Thus, yam bean can be used as an alternative source of starch with high protein content. A field research was conducted to study the effect of spacing and potash levels on physical and chemical parameters of Yam bean (*Pachyrhizus erosus* L.) tubers under agro-climatic conditions of Konkan region. The field experiment was carried out in Split Plot Design with three replications. There were two factors studied in experiment *viz.*, a) four spacing levels and b) four potash levels. Effect of interaction on chemical parameters of yam bean tubers was significant except protein content of the tubers. Highest dry matter content (16.50%) was recorded in S_4F_2. Highest crude fibre (0.79%) was recorded in S_1F_2. S_4F_4 recorded highest starch content (6.53%) whereas S_2F_2 recorded highest moisture content of tubers (90.10%).

Keywords: Yam bean, spacing, fertilizer, physical and chemical parameters

Introduction
Among several tuber crops yam bean (*Pachyrizhus* spp.) is one which is tuberous belonging to family leguminosae. Yam bean is a plant which produces both starch and proteins in quite high level. Thus, yam bean can be used as an alternative source of starch with high protein content. Yam bean (*Pachyrhizus erosus* L. Greek words *pachys* = thick ened, and *rhiza* =root) indigenously known as *Mishrikand*. Yam bean is a native of Mexico and Central America. The genus *Pachyrhizus* comprises five species within family Leguminosae and sub family fabaceae. All *Pachyrhizus* spp. species are diploid plants with chromosome number n = 11. Cultivated species are *Pachyrhizus erosus*, *P. ahipa*, and *P. tuberosus*. Whereas two wild species are *P.panamensis* and *P. ferrugineus*. Among the species *P. eroses* is most widely cultivated throughout the world. The white flesh tuber having conical or turnip shape are consumed as raw or in cooked form. (Anon. 2013) [1]. In India, it is mostly grown in North Bihar, extending parts of West Bengal, Assam, Orissa and eastern Uttar Pradesh. Large area under yam bean is in Bihar state of India from where it is marketed all over the country. It is also a popular crop in the Gangetic alluvial tract of West Bengal (Naskar, 2009) [5]. Yam bean will thrive best in light, rich, sandy-loam or alluvial soils in zones with a moderate precipitation rate, i.e. approximately 1500 mm m.a.p.r. (mean annual precipitation rate) (Srivastava *et al.* 1973) [7].
Hot and humid Konkan agro-climatic conditions are ideal for cultivation. In Konkan it can be grown during Kharif as well as rabi season. Considering its taste and acceptability as salad as well as its nutritional importance in diet, the crop is having tremendous potential for commercial cultivation in Konkan. Therefore, the aims of this experiment were to find the best spacing and potash levels and to formulate an economic nutrient management schedule for yam bean in Konkan agro-climatic conditions.

Material and Methods
The present investigation was conducted at Educational Research Farm, Department of Horticulture, College of Agriculture Dapoli, Dist. Ratnagiri during *kharif* season of 2016. The experiment was laid out in Split Plot Design with four main treatments i.e. spacing S_1 (60 x 20 cm), S_2 (60 x 30 cm), S_3 (60 x 60 cm), S_4 (45 x 30 cm) and four sub treatments i.e. Potash levels F_1 – 80:40:40 NPK Kg/ha, F_2 – 80:40:60 NPK Kg/ha, F_3 – 80:40:80 NPK Kg/ha, F_4 – 80:40:100 NPK Kg/ha. Thus, in all 16 treatment combinations replicated thrice. The spot application of required fertilizer doses as per treatment details was done. Crop was sown directly by seeds on well prepared ridges.

Data was statistically analyzed for the effect of spacing and potash levels on physical and chemical parameters of yam bean tubers as per the methods prescribed by Panse and Sukhatme (1985) [6].

Results and Discussion

Physical parameters

The physical parameters like tuber length and tuber diameter were recorded and the results obtained are summarized below:

Effect of spacing on Physical parameters

The highest tuber length was recorded in S_2 (21.33 cm) and lowest in S_4 (16.69 cm) with mean of 19.01 cm and the difference was significant. Similarly, highest tuber diameter was recorded in S_2 (11.06 cm) whereas it was lowest in S_3 (10.02 cm) with mean of 10.54 cm but the difference was non-significant.

From the present study it is revealed that closer spacing promoted tuber physical parameters.

Effect of potash levels on Physical parameters

The highest tuber length was recorded in F_2 (19.42 cm) and lowest in F_4 (17.49 cm) with mean of 18.45 cm however the difference was non-significant. Similarly, highest tuber diameter was recorded in F_4 (11.85 cm) and lowest in F_1 (9.69 cm) with mean of 10.77 cm and the difference was significant. Thus it is revealed from the data that spacing does not have much effect in tuber diameter. Similar effect was also recorded by Cisneros and Herrera (1987) [2] in potato and Takyi (1972) [8] in cassava.

Effect of interaction on Physical parameters

The highest tuber length was recorded in S_2F_2 (23.70 cm) and lowest in S_4F_1 (15.75 cm) with mean of 19.72 cm but the difference among them was non-significant. Similarly, highest tuber diameter was recorded in S_4F_4 (12.54 cm) whereas it was lowest in S_1F_1 (8.49 cm) with mean of 10.51 cm but the difference was significant.

Chemical parameters

Chemical analysis of the tubers was done to analyze the protein, fiber, starch, dry matter and moisture content of the tubers. And the results obtained are as following:

Effect of spacing on Chemical parameters

Among the various chemical parameters the effect of spacing on crude fiber, starch, dry matter and moisture was significant whereas it was non-significant on protein. The highest protein content was noticed in S_4 (1.50%) and lowest was in S_3 (1.24%) with mean 1.37%. The crude fiber content was highest in S_1 (0.69%) and lowest in S_3 (0.50%) with mean 0.59%. Moisture content was also observed highest in S_2 (88.10%) and lowest in S_4 (85.19%) with mean 86.64%. The highest dry matter content was noticed in S_4 (14.81%) and lowest was in S_2 (11.90%) with mean 13.35%. The starch content was highest in S_1 (6.18%) and lowest in S_2 (5.73%) with mean 5.95%.

Effect of potash on Chemical parameters

Among the various chemical parameters the effect of potash on crude fiber, starch, dry matter and moisture was significant whereas it was non-significant on protein. The highest protein content was noticed in F_2 and F_4 (1.44%) and lowest was in F_1 and F_3 (1.25%) with mean 1.34%. The fiber content was highest in F_2 (0.67%) and lowest in F_4 (0.55%) with mean 0.61%. Moisture content was also observed highest in F_1 (87.30%) and lowest in F_4 (85.40%) with mean 86.35%. The highest dry matter content was noticed in F_4 (14.60%) and lowest was in F_1 (12.70%) with mean 13.65%. The starch content was highest in F_4 (6.30%) and lowest in F_3 (5.57%) with mean 5.93%. Effect of graded levels of potash were significantly influenced on quality parameters. Same results was also reported by Pushpalatha *et al.*, (2017) [4]

Effect of interaction on Chemical parameters

Among the various chemical parameters the effect of interaction on crude fiber, starch, dry matter and moisture was significant whereas it was non-significant on protein. The highest protein content was recorded in S_4F_2 (1.92%) and lowest was seen in S_2F_3 (1.05%) with mean 1.48%. The fiber content was analyzed highest in S_1F_2 (0.79%) and lowest was seen in S_3F_1 (0.38%) with mean 0.58%. The highest moisture content was recorded in S_2F_2 (90.10%) and lowest was seen in S_4F_2 (83.50%) with mean 86.80%. The highest dry matter content was recorded in S_4F_2 (16.50%) and lowest was seen in S_2F_2 (9.90%) with mean 13.20%. The starch content was analyzed highest in S_4F_4 (6.53%) and lowest was seen in S_2F_3 (5.27%) with mean 5.9%.

The above results revealed that various spacing as well as fertilizer levels does not have any role in deciding the protein content of the tubers, either alone or when they are in combination. Similar results were also obtained by Kareem (2013) [3] in sweet potato.

Keeping Quality

Effect of spacing on keeping quality

The highest keeping quality was observed in S_4 (33.67days) and lowest was in S_2 (29.17 days) with mean 31.17 days and the difference was found significant.

Effect of potash on keeping quality

The highest keeping quality was observed in F_1 (36.25 days) and lowest was in F_3 (29.67 days) with mean 32.96 days and the difference was significant.

Effect of interaction on keeping quality

The highest keeping quality was analyzed in S_2F_1 (37.00 days) and the lowest was seen in S_2F_3 (24.33 days) with mean 30.66 days and the difference was significant.

Conclusion

Thus from the present investigation entitled "Studies on effect of spacing and potash levels on physical and chemical parameters of Yam bean (*Pachyrhizus erosus* L.) tubers under Konkan agro-climatic conditions" variety *Rajendra Mishrikand*- 1, it was concluded that the interaction effect of spacing and fertilizer levels on physical and chemical parameters of yam bean tubers was found significant. Closer spacing promoted the chemical and physical parameters. Also graded levels of the potash promoted the chemical and physical parameters of yam bean tubers. The present investigation also revealed that either spacing or potash levels doesn't have any role in deciding the protein content of the yam bean tubers.

Table 1: Effect of spacing and potash levels on physical and chemical parameters of Yam bean (*Pachyrhizus erosus* L.) tubers

Treatments	Physical parameters of yam bean tubers (cm)		Chemical parameters of yam bean tubers (%)					Keeping quality (days)
	Tuber length	Tuber Diameter	Protein	Crude fibre	Starch	Dry matter	Moisture content	
Spacing levels :- S1 (60 cm x 20cm), S2 (60cmx 30cm), S3 (60cm x60cm), S4 (45cm x 30 cm)								
S_1	18.50	10.14	1.37	0.69	6.18	13.69	86.31	32.67
S_2	21.33	11.06	1.28	0.56	5.73	11.90	88.10	29.17
S_3	17.12	10.02	1.24	0.50	6.01	13.94	86.06	30.92
S_4	16.69	10.87	1.50	0.51	5.85	14.81	85.19	33.67
S.Em±	0.86	0.55	0.16	0.03	0.07	0.25	0.25	0.67
C.D. @ 5%	2.51	NS	NS	0.09	0.20	0.74	0.74	1.96
Potash levels :-F_1 -80:40:40, F_2 -80:40:60, F_3 -80:40:80, F_4 -80:40:100 kg NPK/ ha								
F_1	18.26	9.69	1.25	0.56	6.03	12.70	87.30	36.25
F_2	19.42	10.28	1.44	0.67	5.87	13.04	86.96	29.75
F_3	18.46	10.30	1.25	0.58	5.57	13.99	86.01	29.67
F_4	17.49	11.85	1.44	0.55	6.30	14.60	85.40	30.75
S.Em±	0.74	0.25	0.06	0.02	0.11	0.48	0.48	0.87
C.D. @ 5%	NS	0.73	NS	0.06	0.31	1.41	1.41	2.53
Interaction effect of spacing and potash levels								
S_1F_1	17.37	8.49	1.16	0.77	6.50	14.36	85.64	36.33
S_1F_2	19.09	9.68	1.28	0.79	6.30	12.03	87.97	29.00
S_1F_3	19.10	10.55	1.40	0.60	5.43	15.69	84.31	36.00
S_1F_4	18.45	11.98	1.63	0.59	6.50	12.67	87.33	29.33
S_2F_1	21.42	10.35	1.46	0.52	5.83	11.30	88.70	37.00
S_2F_2	23.70	10.35	1.40	0.51	5.37	9.90	90.10	25.00
S_2F_3	21.35	11.81	1.05	0.63	5.27	12.18	87.82	24.33
S_2F_4	18.84	11.74	1.22	0.56	6.45	14.22	85.78	30.33
S_3F_1	18.51	9.82	1.22	0.38	6.07	13.09	86.91	35.00
S_3F_2	17.12	10.41	1.16	0.64	6.20	13.74	86.26	31.33
S_3F_3	16.79	8.69	1.28	0.45	6.03	13.18	86.82	28.67
S_3F_4	16.06	11.16	1.28	0.51	5.73	15.73	84.27	28.67
S_4F_1	15.75	10.11	1.16	0.56	5.73	12.05	87.95	36.67
S_4F_2	17.78	10.66	1.92	0.72	5.60	16.50	83.50	33.67
S_4F_3	16.59	10.16	1.28	0.62	5.53	14.90	85.10	29.67
S_4F_4	16.63	12.54	1.63	0.51	6.53	15.77	84.23	34.67
S.Em±	1.48	0.50	0.11	0.04	0.21	0.97	0.97	1.74
C.D. @ 5%	NS	1.46	NS	0.12	0.62	2.83	2.83	5.07

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