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Research Paper

Effect of root tuber weight and spacing on *Kala zeera* (*Bunium persicum*) in Gurez valley of Kashmir

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ABSTRACT

A field experiment was conducted at *Zeera* Research Sub Station Izmarg Gurez, (78^0 20 N longitude and 31^0 20 E Latitude and 2,393 m amsl) of Sher-e- Kashmir University of Agricultural Sciences and Technology of Kashmir during 2006-07 and 2007-08 on a flat narrow valley land to determine the influence of plant geometry and planting tuber weight on *kala zeera* (*Bunium persicum* Bioss). The treatments comprised of three categories of tuber weights *viz* small (<2g), medium (2-5g) and large (>5g) and four planting spacings *viz* 20 cm × 20 cm, 20 cm × 25 cm, 25 cm × 25 cm and 25 × 30 cm, which were laid out in a factorial randomized block design with three replication. Significant variations in growth and yield attributes were observed under influence of spacings and planting tuber weights. Numbers of umbels/plant appears to be least stable components in *kala zeera* and are influenced with crop management practices like spacing and planting tuber weight. Subsequent increase in planting tuber weight from small to medium size caused increase in seed yield and straw yield by 79% and 74%, respectively. The net returns and net returns per rupee invested varied from ₹10,37,000 to ₹ 27,17,000 and 1.94 to 8.71 in different treatments combinations. Among all the treatment combinations, seed tubers of *kala zeera* weighing 2 to <5 gm (medium sized) and planted at spacing of 25 cm × 25 cm resulted maximum seed and straw yield with a net return of ₹27,17,000.

Key words : *Kala zeera*, Response analysis, Spacings, Tuber weight

As a phytogeographic entity Kashmir Himalayan region is by far one of the most enriched natural ecosystem, where a large number of highly valued medicinal and aromatic plants grow. Kala zeera (*Bunium persicum* L) is an important culinary spice and had immence potential in Gurez valley of Kashmir. It grows as a wild plant in forests and grassy slopes at elevations between 1850 to 3100 m amsl. High altitude regions of Kinnaur, Lahaul Spiti, Pangi and Bharmour in Himachal Pardesh and Gurez, Kargil and Padder of Jammu and Kashmir are the potential areas of production of *kala zeera* in India. It is highly priced (Rs 2000-3000 /kg), low volume, non-perishable commodity. Straw and seeds of *kala zeera* yield cumin oil 1-1.25% and 5.5-14.3%, respectively, which is rich in cuminaldehyde and P- menthadiennals. *Kala zeera* seeds are used in Ayurveda system of medicines as stimulants, carminatives and in the treatment of diarrhea and dyspepsia (Thappa *et al*. 1991; Abdugnaiew, *et al.* 1997). The extracts of *kala zeera* has hypoglycemic activity and can prevent diabetes and obesity (Giancarlo, *et al.* 2006). Since the crop usually grows wild in scattered pockets, the yields are lower *i.e* 129 kg/ha in Jummu and Kashmir and 179 kg/ha in Himachal Pradesh as compared to 350-400 kg/ha in case of caraway (Carum carway) (Anonymous, 2004). The lower crop productivity is mainly due to poor crop management practices such as inadequate planting density and nutrition, high weed infestation, incidence of diseases and insect pests. Agronomic information of *kala zeera* is meager (Panwar, 1992). Inter and intra row spacing is one of the important components of systematic cultivation and manipulation, that could enhance productivity of this important crop. Root tubers are commonly used for planting *kala zeera*, however information regarding their appropriate weight size is not avialable. Keeping this in view, the present study was made for determining optimum spacing and tuber weight of planting material of *kala zeera.*

MATERIALS AND METHODS

The field experiment was conducted at *Zeera* Research

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Sub-Station Gurez (78°, 20' N Longitude and 31° 20' E Latitude and at 2393 m amsl) of Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Jammu & Kashmir during *rabi* seasons of 2007-08 and 2008-09 on a flat narrow valley land. The soil was sandy loam, highly acidic (pH 5.45) and high in organic carbon (1.2%). Available N, P and K in soil were 251, 27 and 235 kg/ha, respectively. Planting material consisting of root tubers collected during July - August, from natural populations, were sorted visually by hands into three size classes *viz.* large (>5g), medium (2-5g) and small (<2g). These root tubers were planted in 6 m^2 raised plots area at four different spacing of 20 cm × 20 cm, 20 cm × 25 cm, 25 cm × 25 cm and 25 cm × 30 cm, respectively. The treatments were 12 combinations of 3 root sizes and 4 spacings. The experiment was laid out in a factorial randomized block design with three replications. The space between two adjacent plots and blocks was 0.25 m and 0.75 m, respectively. Before planting root tubers were treated with fungicide carbendazim (50% W.P) for ten minutes. Tubers were planted at different spacings as per treatment in month of October during both the season. The FYM @ 20 t/ha was mixed with soil at the time of land preparation. Twenty kg N, 40 kg P_2O_5 and 20 kg K_2O were applied as basal and rest 25 kg N/ha was applied in April. All recommended agronomic practices were adopted for raising and maintaining a healthy crop. Ten randomly selected samples from each plots were studied for growth, yield attributes, yield and oil content. Data was also collected on plant stand percentage, and expressed at harvest as percentage of tubers planted. The crop was grown under rainfed conditions and was harvested on 25th July and 29 July of 2008 and 2009, respectively. The collected data were analyzed statistically by using analysis of variance (ANOVA) technique. After harvesting kala zeera crop was sun dried until its moisture content was reduced to 14%. The mean differences among the treatments were compared by Duncan's Multiple Range Test (DMRT). Correlation and regression analysis were performed to determine the relationship between different parameters, the prediction equation used was $Y= a+b_1X_1 + b_2X_2$; where Y = Seed yield; a = intercept; b_1-b_2 = regression coefficients; X_1 = Plant height; X_2= Number of umbelets/plant. Relative economics was also worked out under Gurez valley conditions.

RESULTS AND DISCUSSION

Weather

The climate of Gurez valley is temperate. The study area remains snow covered for about five months (November to March) and has an annual rainfall of 550 to 620 mm, temperature ranges from -5 in January to 28.5 ^{0}C in summer and relative humidity varies from 55 to 80% respectively. The ambient temperature varies between a minimum of -25°C during last week of December to the first week of January to a maximum of 32^{0}C in the month of May during active growth period. The mean daily temperature varied from 14-30°C and mean daily radiations from 10-25 MJ/m^2. These ranges of variation define the limits of applicability of the study.

Growth and yield attributes

All the growth and yield attributes except test weight and oil content were significantly influenced by the size of planting tubers and plant geometry, elucidating importance of agronomic factors under study (Table 1). Planting geometry and seed tuber weight has a highly significant effect on plant stand. Planting at 25 cm × 25 cm spacing led to a significantly higher plant population. High planting density seems to favour early full canopy development and increased the interception of light, but this advantage outweighed by mutual shading and increased lodging due to weaker stem. Numbers of umbelets/plant appears to be least stable components in *kala zeera* and are influenced with crop management practices like spacing and tuber weight. Maximum number of umbels/plant might be attributed to wider row spacing and less inter or intra plant competition in the community. Spacing of 25 cm × 25 cm and 25 cm × 30 cm were at par in registering growth and yield attributes except secondary branches/plant. Secondary branches/plant has immense importance from yield point of view as these are mainly responsible for formation of umbels, umbelets and finally seeds. Although subsequent increase in spacing's increases formation of growth and yield attributes of *kala zeera*, but overall crop stand decreases tremendously. Due to proper spacing plant can gain sufficient sunlight, water and nutrition from soil, which can influence healthy yield and yield attributes (Miah, 1990). Sofi, *et al.* (2008) further reported that narrow spacing of 20 cm × 20 cm gave lower number of umbels/plant in *kala zeera*. Subsequent increase in size of planting tubers increases growth and yield attributes, but percent increase was at decreasing order. However, seed yield/plant shows decreasing trend, when size of planting tubers is increased. The increase in size of planting tubers decreases its viability of germination, which results in poor crop stand and finally yield and yield attributes. Small tubers (<2g) although having high crop stand but endosperm of the tuber is not fully supportive for vigorous and healthy *kala zeera* crop, which resulted weak growth and yield attributes of *kala zeera*.

Seed, straw and oil yields and harvest index

Planting tuber weight and geometry significantly influ-

Table 1. Planting tuber weight and spacing influence on growth and yield parameters of *kala zeera* (Data pooled over years)

Treatment	Plant height (cm)	Plant stand (%)	Number of branches			Umbels/ plant (No.)	Umbelets/ plant (No.)	Test weight (g)	Oil content (%)	Harvest Index (%)
			Primary	Secondary	Tertiary					
Planting Tuber Weight										
Small (<2g)	35.6	96.4	3.65	4.92	1.49	8.3	60.4	1.62	7.04	8.01
Medium (2-5g)	48.2	90.6	4.34	6.04	2.14	11.3	73.3	1.63	7.44	13.92
Large (>5g)	51.8	75.4	4.46	5.86	2.10	11.2	68.1	1.64	7.36	11.93
SEm±	1.43	1.9	0.063	0.08	0.027	0.015	1.5	0.0004	0.002	0.18
CD (P=0.05)	3.10	5.6	0.183	0.25	0.085	0.032	4.4	NS	NS	0.51
Planting Spacing										
20 cm × 20 cm	40.5	79.3	3.76	5.05	1.68	9.09	60.2	1.63	7.13	10.71
20 cm × 25 cm	42.4	80.8	4.17	5.42	2.00	10.3	72.3	1.63	7.24	10.91
25 cm × 25 cm	43.7	95.8	4.81	5.94	1.98	11.2	78.4	1.63	7.34	12.10
25 cm× 30 cm	49.2	95.8	3.85	6.33	1.98	10. 4	69.2	1.64	7.44	11.40
SEm±	0.71	1.16	0.069	0.09	0.29	0.18	1.23	0.0004	0.005	0.19
CD (P=0.05)	2.34	3.50	0.212	0.28	0.09	0.53	3.68	NS	NS	0.59

Table 2. Interaction effect of planting tuber size and plant spacing on seed yield, straw yield, harvest index and oil yield (kg) of *kala zeera*

Treatment	Planting spacing (cm)				
	20 cm × 20 cm	20 cm × 25 cm	25 cm × 25 cm	25 cm × 30 cm	Mean
Planting tuber weight		*Kala zeera seed yield (kg/ha)*			
Small (<2g)	265	269	291	286	277
Medium (2-5g)	468	490	568	458	496
Large (>5g)	465	487	563	453	492
Mean	399	415	474	399	
	Tuber weight SEm± = 9.50		Spacing SEm ± = 10.90	Tuber weight × spacing SEm± = 17.02	
	CD (P=0.05) = 19.1		CD (P=0.05) = 22.1	CD (P=0.05) = 38.2	
		Kala zeera straw yield (kg/ha)			
Small (<2g)	786	781	812	822	800
Medium (2-5g)	1357	1372	1536	1303	1392
Large (>5g)	1070	1122	1284	1296	1193
Mean	1071	1091	1211	1140	
	Tuber weight SEm± = 20.13		Spacing SEm± = 20.8	Tuber weight × Spacing SEm± = 36	
	CD (P=0.05) = 51.1		CD (P=0.05) = 59.0	CD (P=0.05) = 102	
		Kala zeera essential oil yield (kg/ha)			
Small (<2g)	27.69	27.96	30.73	30.54	29.23
Medium (2-5g)	50.49	53.04	60.86	50.17	53.64
Large (>5g)	46.37	49.21	56.73	49.80	50.52
Mean	41.51	43.4	49.44	43.5	
Tuber weight SEm± = 6.40		Spacing SEm± = 4.42		Tuber weight × Spacing SEm ± = 3.12	
	CD (P=0.05) = 2.19		CD (P=0.05) = 1.19	CD (P=0.05) = 1.03	

enced seed, straw and oil yields of *kala zeera*. Influence on harvest index was insignificant. Small planted tubers (<2g) failed to establish *kala zeera* crop properly, which resulted tremendous reduction in growth and yield attributes and finally yield. Planting geometry of 25 cm × 25 cm was found ideal in registering higher seed and straw yields irrespective of weight of tubers planted. This was mainly due to sufficient space for the crop canopy, less infestation of weeds and sufficient plant population and easier intercultural operations. Further wide spacing resulted reduction in plant population and ultimately yield. Among all the treatments combinations of seed tubers of *kala zeera* weighing 2 to <5 gm and spacing, medium sized tubers and at spacing of 25 cm × 25 cm resulted maximum seed and straw yields. Subsequent increase in planting tuber weight from small to medium size caused increase in seed yield and straw yield by 79% and 74%, respectively. Further increase in planting tuber weight, large sized (weighing >5gm), reduces seed and straw yields significantly. In densely populated *kala zeera*, the

intra-spacific competition between the plants is high resulting in lower seed yield. On the contrary, sparsely populated fields with wider spacing could lead to uneconomic utilization of space, profuse growth of weeds and pests and reduction of yield per unit area. There was insignificant influence of treatments on oil content of *kala zeera* but overall oil yield was significantly influenced by planting spacing and size of tubers planted, respectively.

Response analysis

In *kala zeera*, correlation analysis among important parameters (Table 3) revealed that plant height at maturity (0.896**), number of umbels/plant (0.736*), umbelets/plant (0.961**), oil content (0.782*), straw yield (0.937**), and harvest index (0.828*), showed significant association with seed yield. Amongst all, two important parameters *i.e.* Plant height and number of umbelets/plant are strongly correlated with seed yield. Their regression revealed that 82 % of total variation in seed yield can be accounted by a linear function involving plant height and number of umbelets/plant. The model for predicting seed yield on the basis of these two parameters is Y = -889.61 + 1.118 PH + 122.96 UM {Where, Y= Yield (kg); PH= Plant height (cm) and UM = umbelets/plant (no.)}. Partial regression coefficients further revealed that plant height caused only 4% influence on seed yield. However, umbelets/plant caused 83% influence. So appropriate plant geometry is prerequisite to get desired seed yield

Relative economics

Cost of cultivation and net returns analysis (Table 4) indicated that *kala zeera* cultivation provided higher returns. The net return and net return per rupee invested varied from ₹ 10, 37, 000 to ₹27, 17, 000 and 1.94 to 8.71 in different treatment combinations. Irrespective of tuber sizes, the cost of cultivation increased with reducing inter and intra row spacing. It is due to increased requirement of

Table 3. Correlation Co-efficient among growth attributes, yield attributes, yield index and oil content of *kala zeera* as influenced by seed tuber weight and spacing.

	Plant height (cm)	umbels/ plant (No.)	Umbelets/ plant	Test Weight (g)	Oil content (%)	Seed yield (q/ha)	Straw yield (q/ha)	Harvest Index (%)
Plant height (cm)	1.000	.824*	.478	.899**	.905**	.896**	.771*	.402
Umbels/plant (No.)	.824*	1.000	858	.627	.887**	.763*	.892**	.546
Umbelets/plant	.478*	.858**	1.00	.293	.721**	.961**	.700*	.343
Test Weight (g)	.899**	.627	.293	1.000	.745	.606	.545	.432
Oil content (%)	.905**	.887**	.721	.745	1.000	.782*	.862*	.190
Seed yield (q/ha)	.786*	.936**	.702	.606	.782*	1.000	.937**	.828*
Straw yield (q/ha)	.771*	.892**	.700	.545	.862*	.937**	1.000	.318
Harvest Index (%)	.402	.546	.343	.432	.190	.628	.318	1.000

* Correlation is significant at the 0.05 level (2-tailed).
**Correlation is significant at the 0.01 level (2-tailed).

Table 4. Relative economics of kala zeera cultivation under different spacings and planting tuber weight.

Treatment	Seed yield (kg)	Cost of cultivation (₹)	Gross returns (₹)	Net returns (₹)	B: C ratio
Small (<2g) at 20 cm × 20 cm	786	5,35,000	15,72,000	10, 37, 000	1.94
Small (<2g) at 20 cm × 25 cm	781	4,35,000	15,62,000	11,27,000	2.59
Small (<2g) at 25 cm × 25 cm	812	3,55,000	16,24,000	12,69,000	3.57
Small (<2g) at 25 cm × 30 cm	822	2,68,333	16,44,000	13,75,667	5.13
Medium (2-5g) at 20 cm × 20 cm	1357	5,35,000	27,14,000	21,79,000	4.07
Medium (2-5g) at 20 cm × 25 cm	1372	4,35,000	27,44,000	23,09,000	5.31
Medium (2-5g) at 25 cm × 25 cm	1536	3,55,000	30,72,000	27,17,000	7.65
Medium (2-5g) at 25 cm × 30 cm	1303	2,68,333	26,06,000	23,37,667	8.71
Large (>5g) at 20 cm × 20 cm	1070	5,35,000	21,40,000	16,05,000	3.00
Large (>5g) at 20 cm × 25 cm	1122	4,35,000	22,44,000	18,09,000	4.16
Large (>5g) at 25 cm × 25 cm	1284	3,55,000	25,68,000	22,13,000	6.23
Large (>5g) at 25 cm × 30 cm	1296	2,68,333	25,92,000	23,23,667	8.66

Planting tuber : ₹2/tuber
Bullock pair for ploughing : ₹300/ Kanal
Kala zeera seed spice : ₹2000/kg

number of tubers planted as tubers are expensive and cost ₹2/tuber. Due to non availability of tuber nurseries, still tubers are collected from forests and is a very laborious task. Comparatively higher net returns of ₹27,17,000 was obtained when medium sized tubers (2-5g) were planted at 25 cm × 25 cm spacing. However B:C ratio is higher in medium sized tubers planted at 25 cm × 30 cm spacing. It could be even more remunerative if market for dispersal of *kala zeera* seed yield could be established.

Thus it was concluded that *kala zeera* tuber weighing 2-5gm (medium sized) should be planted at spacing's of 25 cm × 25 cm to get optimum seed yield and consequently higher return under existing climatic conditions of Gurez valley of Jammu and Kashmir.

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