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Evaluation of cabbage (*Brassica oleracea*) hybrids for round the year production in low hill conditions of Himachal Pradesh

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ABSTRACT

The present study was carried out during summer, rainy (*kharif*), winter (*rabi*) seasons of 2022–23 at Dr Yashwant Singh Parmar University of Horticulture and Forestry Regional Horticultural Research and Training Station, Jachh, Nurpur, Kangra, Himachal Pradesh to evaluate the cabbage (*Brassica oleracea* var. *capitata* L.) hybrids for round the year production in low hill conditions of Himachal Pradesh. The experiment was laid out in a factorial randomized complete block design (RCBD-Factorial) in three replications. Five commercial hybrids of cabbage viz. Pusa Cabbage-1 (V_1), Pusa Hybrid-81 (V_2), Pusa Hybrid-82 (V_3), Glorious (V_4) and Field Rocket Plus (V_5) were tested for their suitability for growing in three seasons, viz. rainy (*kharif*) season (S_1), winter (*rabi*) season (S_2) and summer season (S_3). Among the hybrids, Pusa Hybrid-82 (V_3) performed best over other hybrids, while among seasons; *rabi* (S_2) was found most suitable for cabbage cultivation in the low hill areas of Himachal Pradesh. In overall, Pusa Hybrid-82 (V_3) recorded highest yield (454.52 q/ha and 398.57 q/ha) during the *rabi* (S_2) and summer season (S_3), respectively. On the other hand, highest yield (159.35 q/ha) during the rainy season was observed in Pusa Hybrid-81 (V_2) and this hybrid was also found to have highest 'vitamin C' content during all three seasons of study (*kharif*, 12.23 mg/100 g; *rabi*, 17.97 mg/100 g and Summer, 14.27 mg/100 g). Therefore, based on the present studies 'Pusa Hybrid-82 (*rabi* and summer seasons) and Pusa Hybrid-81 (*kharif*) can be recommended for round the year production of cabbage in low hill conditions of Himachal Pradesh.

Keywords: Cabbage, Hybrids, Low hill, Quality, Season, Yield

Cabbage (*Brassica oleracea* var. *capitata* L.) is grown worldwide including India due to its excellent nutritional value, production and adaptability (Moniruzzaman 2011). It can withstand severe handling and long-distance travel, resulting in a better return. Due to consumer's preferences, widespread availability in local markets, affordability and year-round accessibility, cabbage serves as a source of phytonutrients in human diets. In India, cabbage occupies an area of about 397 thousand hectares with annual production of 9207 million tonnes and productivity is 23.19 metric tonnes/ha (Anonymous 2019).

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It is a cool season crop that thrives well in cool and humid weather conditions (Thompson 2002). Cabbage is a versatile crop plant that thrives in diverse soil types and climatic conditions (Smith 1995). Cultivation of cabbage hybrids is becoming increasingly popular nowadays. It is cultivated across various regions of the country, ranging from the plains to high hills, although the planting times may vary. It can be grown round the year with the right selection of varieties and planting techniques. Several factors including variety, planting time, environmental conditions, and market demands, influence cabbage yield and characteristics. Days to maturity, is primarily determined by the variety chosen and is essential when shorter growth cycles are needed to meet market needs (Cervenski *et al.* 2012). Crop hybrids can be diversified in accordance with the prevailing climatic conditions and the fertility of the soil. Crops planted in June and July typically yield smaller and lighter heads compared to those planted in May, resulting in lower marketable yield. Till date no information is available in the literature pertaining to the evaluation of varieties/hybrids of cabbage for round the year production. Therefore, keeping in view

these facts in mind, the present research was carried out to evaluate the cabbage hybrids for round the year production in low hill conditions of Himachal Pradesh.

MATERIALS AND METHODS

The present study was carried out during summer, rainy (*kharif*), winter (*rabi*) seasons of 2022–23 at Dr. Yashwant Singh Parmar University of Horticulture and Forestry Regional Horticultural Research and Training Station, Jachh, Nurpur, Kangra, Himachal Pradesh. Research station experiences low hill sub-tropical agro-climatic conditions with mild climate during summers and low temperature in winters. The temperature goes as high as 43.50°C in summers and as low as -0.1°C during winter months. The mean annual rainfall experienced in area is 1500 mm. However, the mean summer and winter temperatures average at 29.30°C and 13.60 °C, respectively.

In the present studies, three hybrids of cabbage from ICAR-Indian Agriculture Research Institute Regional Station, Katrain, Kullu, Himachal Pradesh. viz. Pusa Cabbage-1 (V_1), Pusa Hybrid-81 (V_2) and Pusa Hybrid-82 (V_3) and two private sector hybrids, viz. Glorious (V_4) and Field Rocket Plus (V_5) were evaluated for three seasons viz. rainy (*kharif*) season (S_1), winter (*rabi*) season (S_2) and summer season (S_3). The experiment was laid out in a factorial randomized complete block design (RCBD-Factorial) in three replications with a spacing of 45 cm × 45 cm was kept between plant to plant and row to row. The 4-6 week old seedlings were transplanted in the main field during the month of July (*kharif*), October (*rabi*) and March (summer season). The data was recorded on different growth, yield and quality parameters, viz. plant height (cm), plant spread (cm), number of non-wrapper leaves, core length (cm), days to head maturity (days), head compactness (%), heading percentage (%), gross plant weight (g), net head weight (g), head polar diameter (cm), head equatorial diameter (cm), head size (cm^2), harvest index (%), yield (q/ha) and vitamin C (mg/100 g). 'Vitamin C' was calculated by using standard procedure given by Rangana (1986). Data for all characters were collected from seven plants selected randomly and mean were worked out for statistical analysis.

RESULTS AND DISCUSSION

Among the different hybrids of cabbage, Pusa Hybrid-82 (V_3) had the shortest stalk length (5.40 cm) which was found at par with Pusa Cabbage-1 (V_1) and Pusa Hybrid-81 (V_2) (Table 1). However, longest stalk length (6.74 cm) was obtained in V_5 (Field Rocket Plus). The effect of different seasons was also recorded on stalk length and it was reported minimum (4.76 cm) in S_2 (*rabi*) and the maximum stalk length (7.79 cm) was observed in the S_1 (*kharif*). Interaction between varieties and seasons (V×S) revealed that shortest stalk length (4.46 cm) was reported in Pusa Hybrid-82 during winter season ($V_3 \times S_2$) which was found at par with six other treatment combinations and on the other hand significantly maximum stalk length (9.42 cm) was observed in Field Rocket Plus during rainy season ($V_5 \times S_1$). The variation in the stalk length of different hybrids is due to their genetic character and the appropriate planting season might have provided the optimum conditions for the expression of the genetic trait under study.

The maximum plant spread (44.18 cm) was recorded in the Pusa Hybrid-82 (V_3) which was significantly superior to other hybrids and minimum plant spread (40.48 cm) was noticed in Field Rocket Plus (V_5) which was found at par with V_1, V_2 and V_3 (Table 1). In the meanwhile, significantly highest (51.21 cm) and lowest (26.94 cm) plant spread was observed in winter (S_2) and rainy season (S_1), respectively. Interaction studies revealed that highest plant spread was exhibited by Pusa Hybrid-82 (V3) when planted during winter season (S_2) and it was found at par with $V_1 \times S_2$, $V_3 \times S_3$ and $V_4 \times S_2$. The minimum plant spread (24.16 cm) was observed in the hybrid Field Rocket Plus (V_5) when planted during summer season (S_3) which was followed by $V_1 \times S_1$, $V_3 \times S_1$ and $V_1 \times S_1$.The optimal plant spread is essential for higher yield. A low plant spread results in a poor net weight and yield. Kavalgi *et al.* (2019) had also reported variations in plant spread of red cabbage genotype grown at different planting times.

The hybrid V_3 (Pusa Hybrid-82) had the significantly lowest number of non-wrapper leaves (12.74), while highest number of non-wrapper leaves (14.81) were recorded Field Rocket Plus (V_5) which was followed by the hybrid, Glorious (V_4) (Table 1). Among the seasons, winter season (S_2) recorded lowest number of non-wrapper leaves (13.23) which was found at par with S_3 (13.45), while significantly highest number was noticed in S_1 (15.19). Among the interactions, $V_3 \times S_2$ (Pusa Hybrid-82; Winter Season) had lowest number of non-wrapper leaves (12.07) while $V_4 \times S_1$ (Glorious; *Kharif*) exhibited highest number of non-wrapper leaves (16.01), however results were found non-significant for the interaction studies. A greater number of non-wrapping leaves in cabbage is regarded an unfavourable characteristic Agarwal *et al.* (1972). Ullah *et al.* (2013) had reported significant variations for number of non-wrapper leaves due to the different planting time in cabbage. Our findings were also supported by Yadav *et al.* (2023).

The short core lengths of less than 25% of the head diameter are often desired. The lowest value of core length (5.59 cm) was recorded in the hybrid, Pusa Hybrid-82 (V_3) which was found significantly superior than the other hybrids under study, while significantly highest core length (7.42 cm) was observed in V_5 (Field Rocket Plus) (Table 1). The significantly minimum (5.79 cm) and maximum core length (7.56 cm) was observed during the winter (S_2) and *kharif* (S_1), respectively. The results pertaining to interaction were found non-significant, however lowest and highest core length was recorded with the treatment combination $V_3 \times S_2$ (4.72 cm) and $V_5 \times S_1$ (8.20 cm), respectively. As heads mature, a reduction in the proportion of core volume within the head leads to an increase in the amount of usable product accessible to processors and consumers. Kumar *et al.* (2019) has also reported similar findings in cabbage hybrid planted at different times, while Yadav *et al.* (2023)

Table 1 Effect of planting time on yield contributing traits of different hybrids of cabbage

Treatment	Stalk length (cm)	Plant spread (cm)	No. of non-wrapper leaves	Core length (cm)	Days to head maturity	Head compactness (%)	Heading percentage (%)
V_1	5.65	41.11	13.82	6.75	68.16	46.80	78.47
V_2	5.45	40.89	13.71	6.33	66.94	48.32	81.22
V_3	5.40	44.18	12.74	5.59	63.92	48.89	84.32
V_4	6.62	42.29	14.69	6.60	70.77	45.78	73.61
V_5	6.74	40.48	14.81	7.42	70.43	41.76	75.69
SEM±	0.11	0.70	0.22	0.13	0.69	1.43	2.21
CD (*P*=0.05)	0.32	1.88	0.65	0.37	2.01	4.15	5.80
S_1	7.79	26.94	15.19	7.56	58.48	32.75	56.43
S_2	4.76	51.21	13.23	5.79	79.01	53.98	92.90
S_3	5.36	47.11	13.45	6.27	66.65	52.21	86.67
SEM±	0.09	0.54	0.17	0.10	0.53	1.10	1.72
CD (*P*=0.05)	0.25	1.57	0.51	0.28	1.56	3.23	5.00
$V_1 \times S_1$	7.02	26.46	14.96	7.57	58.42	33.60	54.17
$V_1 \times S_2$	4.77	50.61	13.27	6. 09	77.53	54.32	93.75
$V_1 \times S_3$	5.18	46.25	13.23	6.58	68.52	52.49	87.50
$V_2 \times S_1$	6.96	27.31	15.53	7.03	55.39	36.04	62.50
$V_2 \times S_2$	4.68	48.08	12.73	5.81	83.93	51.38	91.58
$V_2 \times S_3$	4.71	46.70	12.89	6.16	61.51	57.57	89.58
$V_3 \times S_1$	7.01	27.02	13.72	6.97	57.36	32.83	63.39
$V_3 \times S_2$	4.46	53.36	12.07	4.72	75.30	57.72	97.92
$V_3 \times S_3$	4.72	52.18	12.44	5.09	59.09	56.11	91.67
$V_4 \times S_1$	8.54	29.74	16.01	8.03	59.51	30.77	50.00
$V_4 \times S_2$	4.90	52.46	13.60	5.48	76.53	58.53	89.58
$V_4 \times S_3$	6.41	44.67	14.45	6.30	76.28	48.05	81.25
$V_5 \times S_1$	9.42	24.16	15.74	8.20	61.74	30.53	52.08
$V_5 \times S_2$	5.01	51.53	14.47	6.86	81.73	47.95	91.67
$V_5 \times S_3$	5.79	45.75	14.21	7.20	67.85	46.82	83.33
SEM±	0.19	1.21	0.39	0.21	1.20	2.47	3.84
CD (*P*=0.05)	0.56	3.52	NS	NS	3.49	7.19	NS

Treatment details are given under Materials and Methods.

had observed variation in core length of different genotypes of cabbage planted in same season.

Among the hybrids, V_3 (Pusa Hybrid-82) recorded lowest number of days to head maturity (63.92 days) while, maximum (70.77 days) was observed in V_4 (Glorious) which was followed by V_5 (Field Rocket Plus) (Table 1). Earlier Yadav *et al.* (2023) had also reported variation in days to harvest for different genotypes of cabbage. Among the seasons, hybrids planted in S_1 (*kharif*) season were reached first to head maturity (58.48 days) and S_2 (*rabi*) season has significantly delayed to head maturity (79.01 days). Yadav *et al.* (2021) had also observed difference in days taken to head maturity in cabbage planted at different times. Interaction studies revealed that $V_2 \times S_1$ (Pusa Hybrid-81; Rainy Season) had taken fewer days to head maturity (55.39 days) followed by $V_3 \times S_1$ and $V_1 \times S_1$ and highest was in $V_5 \times S_2$ (81.73 days) followed $V_5 \times S_2$. These results are in close agreement with the findings of Tiwari *et al.* (2023).

Head compactness is an essential attribute in cabbage because it affects transportability, marketability, shelf life, and consumer preference. The head compactness (48.89%) was found highest in Pusa Hybrid-82 (V_3) which was found at par with V_2, V_1 and V4, while significantly lowest head compactness (41.76 %) was observed in Field Rocket Plus (V_5) (Table 1). The *rabi* season (S_2) had maximum head compactness (53.98%) which was followed by summer season (S_3), while minimum value (32.75%) was recorded in S_1 (*kharif*). Interaction of $V_4 \times S_2$ (Glorious×*rabi*) resulted in highest head compactness (58.53%) which was found at par with six other treatment combinations. In the meanwhile, lowest head compactness (30.53%) was observed in $V_5 \times S_1$ followed by $V_4 \times S_1$, $V_1 \times S_1$ and $V_2 \times S_1$. Singh *et al.* (2010) had also found variation for head compactness in different genotypes of cabbage, in the meanwhile Kavalagi *et al.*

(2019) had observed differences in head compactness of a red cabbage genotypes planted at different times.

The hybrid V_3 (Pusa Hybrid-82) recorded the highest heading percentage (84.32%) followed by V_2, while lowest (73.61%) was observed in V_4 (Glorious) which was found at par with V_1 and V_5 (Table 1). Among the seasons, significantly maximum heading percentage (92.90%) was reported during *rabi* season (S_2) while minimum (56.43%) was noticed in *kharif* season (S_1). The experimental results pertaining to the interaction among variety and season were found non-significant for the trait under study, however highest heading percentage (97.92%) was recorded in the treatment combination $V_3 \times S_2$, while lowest (50.00%) was observed in $V_4 \times S_1$. These results are in close agreement with the findings of Sharma (1998).

There was significant variation in gross plant weight of different hybrids under study (Table 2). It was recorded maximum (1584.00 g) in V_3 (Pusa Hybrid-82) which was found at par with V_1 (Pusa Cabbage-1). The minimum (1179.33 g) value of gross plant weight was observed in the hybrid V_5 (Field Rocket Plus). The S_2 (*rabi*) had the highest gross plant weight of 1786.00 g, while the S_1 (*kharif*) had the lowest value of 870.53 g. In terms of hybrids-seasons interactions, $V_3 \times S_2$ viz. Pusa Hybrid-82 in *rabi* season had the highest gross plant weight of 2049.33 g which was found statistically at par with $V_1 \times S_2$ and smallest value (730.00 g) was in $V_5 \times S_1$ (Field Rocket Plus in rainy season) followed by $V_4 \times S_1$. Similar results were also reported by Singh *et al.* (2010), Ullah *et al.* (2013) and Kumar *et al.* (2019) in cabbage.

Among the hybrids, net head weight was recorded significantly highest (840.62 g) in V_3 (Pusa Hybrid-82) and minimum (576.63 g) value of net head weight was observed in the hybrid V_5 (Field Rocket Plus) which was followed by V_4 (Table 2). The S_2 (*rabi*) had the highest net head weight (948.46 g), while the S_1 (*kharif*) had the lowest value of 360.84 g. The temperature difference between seasons may be the source of the variation in net weight between different seasons (Theodore *et al.* 2004). Among the interactions, $V_3 \times S_2$ viz. Pusa Hybrid-82 in *rabi* season had the significantly highest net head weight (1150.49 g) and smallest value (303.58 g) was in $V_5 \times S_1$ (Field Rocket Plus in *kharif*) which was found at par with five other treatment combinations. Kavalagi *et al.* (2019), Kumar *et al.* (2019), Yadav *et al.* (2021), Verma *et al.*(2024) have also found concurrent results for net head weight in cabbage.

The maximum head polar diameter (10.75 cm) was exhibited by Pusa Hybrid-82 (V_3) followed by V_1 and V_2 whereas minimum (9.17 cm) was observed in V_4 (Glorious) which was found at par with V_5 (Table 2). Among the seasons, S_2 (*rabi*) had significantly highest value (10.69 cm) for head polar diameter, while lowest (9.25 cm) was noticed in S_1 (*kharif*). Interaction studies revealed that Pusa Hybrid-82 (V_3) recorded highest head polar diameter (11.81 cm) during *rabi* season (S_2) followed by $V_1 \times S_3$, $V_1 \times S_2$ and $V_2 \times S_3$. In the meanwhile, lowest head polar diameter (8.33 cm) was recorded in $V_4 \times S_3$ (Glorious in summer season) which was found at par with five other treatment combinations. Similar results were also found in case of head equatorial diameter in respect of varieties, seasons and their interactions The variation with respect to these traits due to variety or planting time have also been reported earlier by Singh *et al.* (2010), Ullah *et al.* (2013), Kumar *et al.* (2019), and Yadav *et al.* (2023).

The recorded data revealed that largest head size (138.03 cm^2) was found in V_3 (Pusa Hybrid-82), while V_4 (Glorious) had smallest head size (112.25 cm^2) followed by V_5 (Table 2). The significantly highest (139.26 cm^2) and lowest head size (103.47 cm^2) was recorded in the S_2 (*rabi*) and S_1 (*kharif*), respectively. The treatment combination, $V_3 \times S_2$ had the maximum head size (157.11 cm^2) followed by $V_3 \times S_3$, while minimum head size (93.30 cm^2) was observed in $V_5 \times S_1$ which was found at par with $V_4 \times S_1$ and $V_3 \times S_1$. Yadav *et al.* (2023) have also reported variation in head volume due to varietal differences in cabbage, while Kavalagi *et al.* (2019) observed the differences in head volume due to different planting times in red cabbage.

It is also apparent that hybrid V_3 exhibited the highest harvest index of 50.13% which was followed by V_2 and V_1, while hybrid V_5 (Field Rocket Plus) had the lowest harvest index of 42.60% (Table 2). The season S_2 (*rabi*) had maximum harvest index (53.65%) followed by S_3, while minimum (37.49%) was found in S_1 (*kharif*). Interactions revealed that $V_3 \times S_2$ (Pusa Hybrid-82 in *rabi* season) resulted in highest harvest index (59.45%) which was followed by $V_2 \times S_3$, $V_4 \times S_2$ and $V_3 \times S_3$. On the other hand, minimum value (31.06%) for harvest index was observed in V_5S_1 (Field Rocket Plus in *kharif* season). Similar results for harvest index in cabbage have also been reported earlier by Singh *et al.* (2010).

The significantly highest yield (330.34 q/ha) was obtained with the V_3 (Pusa Hybrid-82) and lowest yield (239.64 q/ha) was recorded in V_5 (Field Rocket Plus) followed by V_4 (Glorious) (Table 2 and Fig. 1). Among the seasons, *rabi* season (S_3) exhibited the maximum yield (375.16 q/ha), while minimum (130.52 q/ha) was observed in rainy season (S_1). The interaction effect revealed that significantly highest yield was recorded in $V_3 \times S_2$ (Pusa Hybrid-82 in *rabi* Season), while lowest was exhibited by $V_5 \times S_1$ (Field Rocket Plus in *kharif* Season) followed by V_4S_1. Singh *et al.* (2010), Kavalagi *et al.* (2019), Kumar *et al.* (2019), Yadav *et al.* (2021) and Yadav *et al.* (2023) have also observed the variations in yield due to varietal differences or different planting times in cabbage.

The different hybrids of cabbage exhibited significant variation for vitamin C content. Among the hybrids Pusa Hybrid-81 (V_2) had highest vitamin C content (13.94 mg/100 g) which was followed by V_3 (Table 2 and Fig. 2). In the meanwhile, lowest vitamin C content (11.99 mg/100 g) was found in V_1 (Pusa Cabbage-1) followed by V_4 and V_5. The *rabi* season (S_2) resulted in accumulation of highest vitamin C content (15.54 mg/100 g) in cabbage heads, while lowest value (11.05 mg/100 g) were observed in *kharif* season (S_1). Among the interactions, $V_2 \times S_2$ had

Table 2 Effect of planting time on yield and quality traits of different hybrids of cabbage

Treatment	Gross plant weight (g)	Net head weight (g)	Head polar diameter (cm)	Head equatorial diameter (cm)	Head size (cm^2)	Harvest index (%)	Yield (q/ha)	Vitamin C (mg/100 g)
V_1	1,531.45	741.43	10.64	12.09	129.29	48.66	293.69	11.99
V_2	1,378.33	719.73	10.32	11.90	122.89	49.84	288.73	13.94
V_3	1,584.00	840.62	10.75	12.84	138.03	50.13	330.34	13.16
V_4	1,314.11	581.77	9.17	11.43	112.25	47.19	256.73	12.65
V_5	1,179.33	576.63	9.25	11.68	117.41	42.60	239.64	12.66
SEM±	33.40	22.31	0.24	0.21	2.31	0.94	7.59	0.30
CD (*P*=0.05)	97.25	64.97	0.70	0.63	6.73	2.73	22.09	0.89
S_1	870.53	360.84	9.25	11.09	103.47	37.49	130.52	11.05
S_2	1,786.00	948.46	10.69	12.93	139.26	53.65	375.16	15.54
S_3	1,535.80	766.81	10.14	11.95	129.20	51.92	339.81	12.06
SEM±	25.87	17.28	0.19	0.17	1.79	0.72	5.87	0.24
CD (*P*=0.05)	75.33	50.32	0.54	0.48	5.21	2.11	17.11	0.69
$V_1 \times S_1$	920.00	376.15	9.52	10.81	106.56	40.88	148.60	10.40
$V_1 \times S_2$	1,998.67	1,001.60	11.30	13.13	144.52	54.46	398.02	15.08
$V_1 \times S_3$	1,675.67	846.56	11.10	12.33	136.80	50.65	334.43	10.52
$V_2 \times S_1$	961.67	403.36	10.05	11.63	117.04	41.96	159.35	12.23
$V_2 \times S_2$	1,600.00	845.55	10.11	12.29	124.24	51.13	334.04	17.97
$V_2 \times S_3$	1,573.33	910.28	10.83	11.76	127.41	56.43	372.81	11.61
$V_3 \times S_1$	859.33	362.47	9.23	11.32	104.81	36.14	137.93	10.75
$V_3 \times S_2$	2,049.33	1,150.49	11.81	13.64	157.11	59.45	454.52	14.48
$V_3 \times S_3$	1,843.33	1,008.89	11.22	13.57	152.16	54.81	398.57	14.27
$V_4 \times S_1$	881.67	358.64	8.87	10.79	95.63	37.42	117.01	11.00
$V_4 \times S_2$	1,760.67	983.07	10.32	12.99	133.55	55.83	388.37	14.74
$V_4 \times S_3$	1,300.00	403.61	8.33	10.54	107.58	48.31	264.79	12.24
$V_5 \times S_1$	730.00	303.58	8.58	10.89	93.30	31.06	89.64	10.88
$V_5 \times S_2$	1,521.33	761.60	9.94	12.59	136.89	47.37	300.85	15.44
$V_5 \times S_3$	1,286.67	664.72	9.24	11.58	122.04	49.38	328.44	11.66
SEM±	57.85	38.64	0.41	0.37	4.00	1.63	13.14	0.53
CD (*P*=0.05)	168.45	112.53	1.21	1.08	11.65	4.73	38.26	1.54

Treatment details are given under Materials and Methods.

significantly highest vitamin C content (17.97 mg/100 g), while lowest was observed in $V_1 \times S_1$ (10.40 mg/100 g) which was found at par with six other treatment combinations. These findings were supported by Kavalagi *et al.* (2019) who observed the differences in ascorbic acid (vitamin C) content due to different planting times in red cabbage.

Among the hybrids, Pusa Hybrid-82 (V_3) performed best over other hybrids, while among seasons; *rabi* (S_2) was found most suitable for cabbage cultivation in the low hill areas of Himachal Pradesh. In overall, Pusa

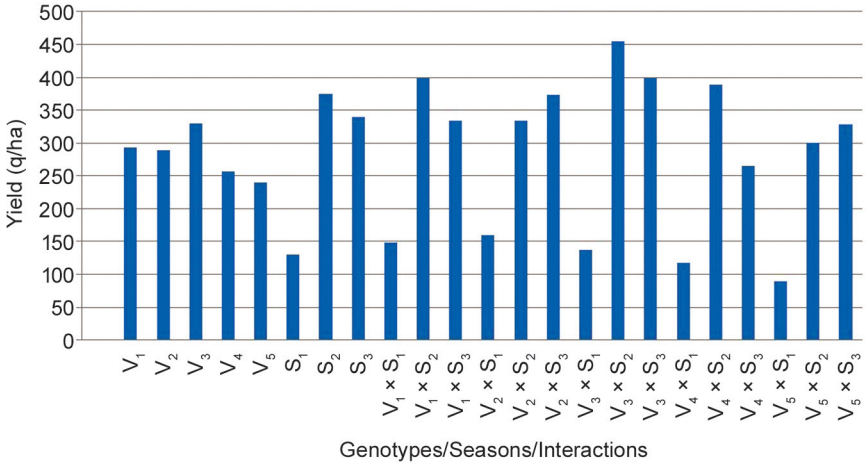

Fig. 1 Effect of varieties and seasons on yield of cabbage .
Treatment details are given under Materials and Methods.

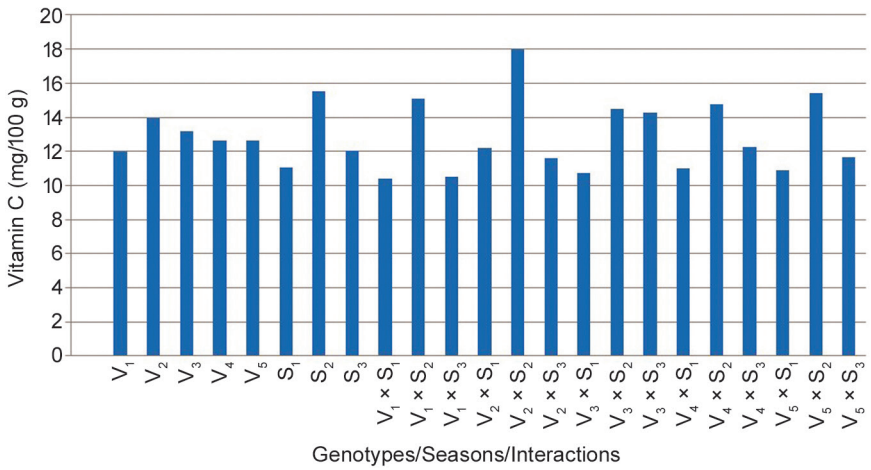

Fig. 2 Effect of varieties and seasons on 'vitamin C' content of cabbage. Treatment details are given under Materials and Methods.

Hybrid-82 (V_3) recorded highest yield (454.52 q/ha and 398.57 q/ha) during the *rabi* (S_2) and summer season (S_3), respectively. On the other hand, highest yield (159.35 q/ha) during the rainy season was observed in Pusa Hybrid-81 (V_2) and this hybrid was also found to have highest 'Vitamin C' content during all three seasons of study (*kharif*, 12.23 mg/100 g; *rabi*, 17.97 mg/100 g and Summer, 14.27 mg/100 g). Therefore, based on the present studies 'Pusa Hybrid-82 (*rabi* and summer seasons) and Pusa Hybrid-81 (*kharif*) can be recommended for round the year production of cabbage in low hill conditions of Himachal Pradesh.

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