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Performance of cabbage hybrids under rainfed mid-hill conditions of Uttarakhand

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ABSTRACT : An experiment was undertaken during summer rainy season of 2009 and 2010 at Department of Vegetable Science, G.B. Pant University of Agriculture and Technology, Hill Campus, Ranichauri, Uttarakhand to evaluate of ten cabbage hybrids/varieties under mid - hill conditions of Uttarakhand. The pooled indicates considerable variation for vegetative characters, amongst which the maximum leaf area (1022.71 cm^2) was observed in Varun, while the hybrid T -50 top ranked with respect to number of non wrapper leaves (14.98) and plant spread (68.56 cm). Golden Acre an open pollinated check variety took minimum number of days to maturity (44 days from transplanting). With respect to quality and yield parameters *viz.*, the maximum ascorbic acid content (139.53 mg/100 g), head size (515.05 cm^2) were recorded in blue diamond and NBH-Arun, respectively, whereas, T-50 measured the maximum head weight (2.106 kg) and yield (801.19 q/ha).

KEY WORDS : Performance, Cabbage, Hybrids, Profit, Varieties

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Among the cole crops, cabbage (*Brassica oleracea* var. *capitata* L. 2n = 2x = 18) grown in more than ninety countries throughout the world and consumed globally Singh *et al.* (2010). It is a rich source of protein comprising all essential amino acids, especially sulphur containing amino acids, minerals such as calcium, iron, magnesium, sodium, potassium, phosphorus and antioxidants, which are reported to have anti-carcinogenic properties (Singh *et al.*, 2009). Although, in developed countries more than 90 per cent cabbage area is under hybrid, while in India hybrids are confined to only 30 per cent of cabbage grown area. In Uttarakhand mid-hills, it is grown from April to November during the time its production is not possible under the agro-climatic condition of plains, as a result the cabbage growers in hilly areas fetch premium prices and immense potential in maximizing the profit and improving the socio-economic status of vegetable growers. The cabbage cultivars show great variation in respect of shape, size and colour of the leaves as well as texture of head and behave differently under different agro-climatic region. The hill farmers are growing the varieties / hybrids recommended for the irrigated condition of northern plains and these perform poorly during the summer- rainy season (off-season) under the different altutidic zone of hills. Therefore, in order to maximize cabbage yield in it has become imperative to select the suitable varieties and workout cultural practices. Therefore, it is the needed to evaluate the yield performance of some of the varieties of cabbage especially hybrids, under the agro-climatic condition of Uttarakhand to find out the best variety / hybrid for commercial cultivation at farmers field in order to maximize the profit.

RESEARCH METHODS

The studies were conducted in the research block of Department of Vegetable Science, G.B. Pant University of Agriculture and Technology, Hill Campus, Ranichauri, Uttarakhand during the year 2009 and 2010. Ranichauri is located at an elevation of about 2000 meters above mean sea level with 30018' N latitude and 78024' E longitude. It falls under mid-hills of Western Himalayas. The soil was silty clay loam (0-15 cm), acidic (pH 6.06), 326 kg ha^{-1} available N, 17.70

kg ha^{-1} available P and 480 kg ha^{-1} available K. The experimental materials comprised of 09 cabbage hybrids from different leading seed companies *i.e.* FM-Super, Suttind Manas, T-50, T-621, Green Hero, Varun, NBH-Arun, Indica, and Blue Diamond were tested with the available popular variety of the region *i.e.* Golden Acre in a Randomized Complete Block Design replicated thrice. About one month old seedling was transplanted on 8th July 2009 and 3rd July 2010 (1st and 2nd year, respectively) in a plot size of 3 x 2 m^2 at a spacing of 50× 50 cm. During transplanting FYM and N: P_2O_5: K_2O @ 20 t ha^{-1} and 120:75:60 kg ha^{-1}, respectively, was applied uniformly during both years. Data were recorded for leaf area (cm^2), number of non-wrapper leaves, plant spread (cm), head size (cm^2), net head weight (kg), plant mortality (%), days to marketable maturity, head compactness (g/cm^3), ascorbic acid content (mg/100 g) and yield of marketable head (q ha^{-1}). Compactness of head was calculated by Pearson formula and ascorbic acid was determined by volumetric method suggested by AOAC (1980). The data regarding above mentioned characters were averaged and subjected to analysis of variance was done as procedure given by Panse and Sukhatme (1978). All the package of practices recommended for Western Himalayas region was followed during the study.

RESEARCH FINDINGS AND DISCUSSION

The data presented in Table 1 and 2 revealed that the different cabbage hybrids selected for the study during both years experiment differed significantly with each other for the traits under investigation.

Vegetative characters

It is evident from the results (Table 1) that out of 9 hybrids and 1 open pollinated selected for the experiment, significant differences were observed for leaf area, number of non-wrapper leaves, plant spread, plant mortality, days to marketable maturity. The leaf area in pooled data of both years ranged from 439.96 cm^2 (Suttind Manas) to 1022.71 cm^2 (Varun). In 2009 and 2010 maximum leaf area (1113.66 cm^2 and 931.77 cm^2, respectively) was recorded in Varun hybrid (Table 1). This was significantly higher than other hybrids and variety. The higher leaf area of cabbage crop may be attributed due to its comparatively better genetic potential for growth and development of the leaf. With respect to number of non wrapper leaves in pooled data it was in between 11.75 (T-621) to 14.98 (T-50), T-50 hybrid also showed maximum number of non wrapper leaves during both years of experiment, similar observation was also observed by Boswell and Pearson (1934) who reported high variability amongst varieties with respect to non wrapper leaves. Similarly, the cultivars also differed significantly for plant spread with a maximum value in T-50 during years 2009 and 2010 (69.85 and 67.27 cm, respectively). When data for both years pooled, maximum plant spread (68.56 cm) was recorded under T-50 and minimum value of 55.73 cm in Golden Acre (Table 1). In general, the plant having the more spread will always require wider spacing for its cultivation. The similar kind of variations for plant spread in cabbage verities were also recorded by Srihari and Satyanarayans (1992) and Znidarcic *et al.* (2007). With regard to plant mortality in cabbage varieties was mainly attributed to disease like root rot, collar rot and head rot. The findings also revealed that among 9 hybrids, Blue Diamond and Indica were least affected by these disease with almost negligible per cent of plant mortality *i.e.* zero or less than 1 per cent. Whereas, contrary to these, the mortality was maximum (27.39 %) in check variety Golden Acre (Table 1), Similar kind of observations in cabbage/ hybrids was also recorded by Reis *et. al.* (2003). As evident from Table 1 that amongst all 10 varieties in the study, check variety, Golden Acre took a minimum days to maturity *i.e.* 44 days from the date of transplanting, whereas, Suttiend manas and Indica took maximum duration *i.e.* 63.66 and 63.00 days,

Table 1 : Vegetative growth performance of different hybrids/variety of cabbage under mid- hill of Uttarakhand

Hybrids/ variety	leaf area (cm^2)			Number of non-wrapper leaves			Plant spread (cm)			Plant mortality (%)			Days to maturity		
	2009	2010	Pooled	2009	2010	Pooled	2009	2010	Pooled	2009	2010	Pooled	2009	2010	Pooled
Green Hero	747.45	622.93	685.19	14.22	13.23	13.73	59.61	59.72	59.66	2.00	1.38	1.69	54.00	53.66	53.83
Blue Diamond	789.41	660.11	724.76	13.88	12.67	13.28	60.07	59.45	59.76	0.00	0.00	0.00	54.00	53.66	53.83
T-50	800.26	747.60	773.97	15.33	14.62	14.98	69.85	67.27	68.56	4.44	2.77	3.60	54.00	53.66	53.83
Suttiend Manas	440.76	439.17	439.96	12.88	12.79	12.84	57.44	57.87	57.66	4.00	4.16	4.08	65.00	62.33	63.66
Varun	1113.66	931.77	1022.71	13.88	13.74	13.81	62.02	59.58	60.80	4.44	5.55	4.99	54.00	54.33	54.16
T-64	712.22	715.95	714.08	11.99	11.50	11.75	60.52	58.82	59.67	15.33	12.50	13.92	48.00	50.33	49.16
Indica	904.18	887.42	895.80	13.88	13.27	13.58	60.02	59.52	59.77	0.00	1.38	0.69	65.00	61.00	63.00
FM-Super	620.81	609.49	615.15	13.33	13.08	13.21	58.19	57.61	57.90	6.66	6.94	6.80	58.00	58.00	58.00
NBH-Arun	845.02	829.50	837.26	12.88	12.51	12.70	62.07	62.80	62.44	8.88	11.11	10.00	58.00	57.33	57.66
Golden Acre	465.14	423.14	444.04	12.00	11.64	11.82	56.65	54.81	55.73	35.35	19.44	27.39	43.00	45.00	44.00
S.E. $\pm$	21.39	14.45	10.66	0.35	0.22	0.21	0.91	0.83	0.49	2.82	1.91	1.82	2.62	2.04	1.81
C.D. (P=0.05)	63.57	42.94	31.67	1.05	0.67	0.64	2.70	2.48	1.46	8.38	5.68	5.43	7.80	6.08	5.40

Table 2 : Quality and yield performance of different hybrids/variety of cabbage under mid- hill of Uttarakhand

Hybrids/ Variety	Head compactness (g/cm^3)			Ascorbic acid content (mg/100g)			Head size (cm^2)			Net head weight (Kg.)			Yield (q/ha)		
	2009	2010	Pooled	2009	2010	Pooled	2009	2010	Pooled	2009	2010	Pooled	2009	2010	Pooled
Green Hero	14.43	14.35	14.39	139.12	134.49	136.80	390.81	403.29	397.05	1.14	1.23	1.19	397.85	486.05	441.95
Blue Diamond	14.83	14.73	14.78	141.29	137.78	139.53	462.55	466.72	464.63	1.44	1.28	1.36	577.60	512.00	544.80
T-50	19.76	19.51	19.63	101.19	102.21	101.70	506.82	516.18	511.50	2.33	1.87	2.10	872.72	729.66	801.19
Suttiend Manas	19.54	19.50	19.52	128.14	123.22	125.68	404.60	406.13	405.37	1.62	1.53	1.58	349.60	576.88	463.24
Varun	12.48	12.95	12.72	117.53	111.43	114.48	451.62	454.48	453.05	1.14	1.14	1.15	459.86	432.27	441.57
T-64	17.32	17.30	17.31	116.61	114.00	115.30	396.82	410.81	403.82	1.34	1.22	1.29	503.87	429.66	466.77
Indica	17.22	17.52	17.37	118.01	116.45	117.23	421.80	425.51	423.65	1.46	1.28	1.37	545.31	504.77	525.04
FM-Super	17.42	18.36	17.89	124.13	121.82	122.97	317.27	319.20	318.24	1.04	1.02	1.03	379.43	381.83	380.63
NBH-Arun	12.29	13.40	12.85	121.78	128.65	125.21	512.37	517.72	515.05	1.44	1.50	1.47	539.71	534.88	537.29
Golden Acre	14.83	14.45	14.84	95.03	91.37	093.20	309.69	312.84	311.27	0.86	0.95	0.91	232.17	307.27	269.72
S.E. $\pm$	0.60	0.39	0.30	1.55	2.46	1.13	7.05	5.96	4.42	0.14	0.08	0.07	7.89	8.79	6.02
C.D. (P=0.05)	1.79	1.09	0.90	4.60	7.31	3.36	20.95	17.73	13.16	0.42	0.24	0.21	23.46	26.13	17.89

respectively Table 1. These observations of present study had also been found in conformity with the findings reported by Bhagchandani *et al.* (1997), Islami *et al.* (1990), Srihari and Satyanarayans (1992) and Sharma and Verma (2000).

Quality and yield parameters:

A significant variation due to different hybrids/ variety was observed with all the quality and yield parameters (Table 2). The quality attributes studied were head compactness and ascorbic acid content. The head compactness during years 2009, 2010 and pooled data was maximum (19.76, 19.51and 19.63 g/cm^3, respectively) in T-50, however it was statistically at par with Suttiend Manas (19.54, 19.50 and 19.52 g/cm^3, respectively) while, the minimum value was in Varun (12.72 g/cm^3) and NBH-Arun (12.85 g/cm^3) (Table 2). Similar to the present findings, Swarup and Sharma (1965) had also noticed wide range of variations in the head compactness amongst the cabbages cultivars. Whereas, the ascorbic acid during year 2009, 2010 and pooled data was found maximum in hybrid Blue Diamond (141.29, 137.78 and 139.53 mg/100 g, respectively) followed by statistically at par Green Hero (139.12, 134.49 and 136.80 mg/100 g, respectively) and it was Golden Acre (93.20 mg/100 g) recording the minimum ascorbic acid contents in leaves (Table 2). Similar kind of variation in leaf in ascorbic acid content of broccoli varieties were also reported by Kaur *et. al.* (2007).

With regard to yield parameters *viz.*, head size, net head weight and yield (q/ha). In pooled data the hybrids NBH-Arun and T-50 which produced the largest head size being statistically at par to each other *i.e.* 515.05 cm^2 and 511.50 cm^2, respectively (Table 2). The maximum estimated net head wt. (2.33 and 1.87 kg, respectively) and yield per hectare (872.72 and 729.66 q/ha, respectively) during both years (2009 and 2010) was observed in hybrid T-50 (Table 2) and was significantly superior over all other for net head weight and yield (q/ha). The minimum yield parameters were found in open pollinated verity *i.e.* Golden Acre. When data for both years were pooled, net head weight of 2.10 kg and yield per hectare of 801.19 q per hectare recorded maximum from T-50 hybrid. It was significantly higher than other hybrids and variety. In a similar study, Pandey *et al*. (2002) reported yield of cabbage varies greatly depending upon cultivar and early maturing cultivars generally produced lower yield due to a shorter growing season compared to mid and late cultivar as observed in the present study.

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