Research Article

EVALUATION OF CAPSICUM (*Capsicum annuum* L.) GENOTYPES FOR VARIETY IMPROVEMENT

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ABSTRACT

An experiment was done at Horticulture Research Division, Nepal Agricultural Research Council (NARC), Khumaltar, Nepal under polyhouse condition to access different traits of six capsicum genotypes: HRDCAP-001, HRDCAP-003, HRDCAP-004, HRDCAP-005, HRDCAP-006, and California Wonder (check variety) with the objective to evaluate yield and quality. The experiment was done by using Randomized Complete Block Design (RCBD) with four replications for each treatment. All the collected data were analyzed by using Gentstat statistical software package. Results revealed that tested genotypes were significantly different ($p<0.05$) in terms of traits characteristics considered for the study. Accordingly, California Wonder was the best for fruit length (86.11 mm), fruit width (70.45 mm), and fruit weight (126.12 g) while HRDCAP-001 was superior in pericarp thickness (6.44 mm), fruit yield (2.46 kg per plant; 68.3 t/ha) and shelf life (6.80 days). California Wonder had lowest physiological weight loss at different days after harvest. This study recognizes HRDCAP-001 to be a promising genotype. Hence, there is a possibility to release this genotype as a variety for commercial cultivation, however, a multi location trial prior to its release is deemed necessary. Furthermore, all evaluated genotypes through this research could be utilized for capsicum breeding in Nepal.

Key words: Physiological weight loss, shelf life, fruit yield

INTRODUCTION

Bell pepper, commonly known as sweet pepper, or capsicum (*Capsicum annuum* L. var. grossum) belonging to Solanaceae family, is native to Mexico (Bukasov, 1930; CABI, 2019) with Guetemala as secondary centre of origin (Bukasov, 1930). In 16th century, Portuguese and Spanish explorers introduced bell pepper from South America to Asia through trade routes (CABI, 2019). It is highly variable herb, or sub-shrub type annual crop attending 0.5 to 1 m in height with highly branching characters (CABI, 2019), and is available in diverse colors, such as green, red, black, orange, purple etc (Kumar et al., 2015). It is grown worldwide for cooked vegetable, salad, pickle and processing purpose. The reason behind its worldwide admiration is its delicate taste, pleasant flavor, and varied colors with nutritious qualities. Its beautifully shaped form and vivid diverse color entitled it as "The Christmas ornaments of the vegetable world" (Sharma et al., 2019). Furthermore, presence of vitamin C and zinc makes it better for strong and healthy immune system. Fatty acids, flavonoids, volatile oil, carotene pigment, beta carotene, iron, potassium, calcium, vitamin A and rutin (a bioflavonoid) are some compounds which are vastly available in bell pepper (Agarwal et al., 2007). It does not comprise fat, but have low calories and higher complex carbohydrates (Kumar et al., 2015). It is only Capsicum genes which do not produce capsaicin ($C_{18}H_{27}NO_3$), causing lack of hot taste. Capsaicin causes strong burning sensation when contacted with mucus membranes (Roy et al., 2018). It covered 1,987,059 hectares of land worldwide producing 36,092,631 t with average productivity of 20 t per hectare during 2017 (FAOSTAT). In Nepal, it covered 1,193 ha of land producing 12,372 t with productivity of 10 t per hectare during fiscal year 2016-17. Even though it fetched good retail price i.e. Rs. 97 per kg during fiscal year 2016-17, trade balance was highly negative deficit i.e. Rs. 129,374,000 (MOALD , 2019).

The major reason behind negative trade deficit is its lower productivity, and lack of abundant varieties. Only three varieties have been registered till now in Nepal (Joshi et al., 2017). This scenario express the necessity and urgency of developing bell pepper variety adaptable to different regions of Nepal with reasonably high productivity that could be well disseminate to the producers so that it would help in narrow down the productivity gap between global scenario with Nepal and to increase the country's overall production to supply more, and also to reduce trade deficit.

MATERIAL AND METHODS

Experimental site

An **e**xperiment was conducted at Horticulture Research Division (HRD), Nepal Agricultural Research Council (NARC), Khumaltar, Lalitpur during summer season of 2017-2018, under poly house condition, located at 27˚39□09" N latitude and 85˚19□17" E longitude, having elevation of 1332 masl. The site lies in the valley, and represents mid hill regions of Nepal.

Experimental design and research management

This **e**xperiment was done by using six Capsicum genotypes as treatments, each arranged with four replications by using Randomized Complete Block Design (RCBD), and were conducted under poly house condition. Seedlings were raised during 2nd week of March, and transplanted inside poly house on 3rd week of April. 60 cm×60 cm were maintained between plant to plant and row to row with the accommodation of 28 plants per plot. Each plot was of 2.8 m× 4.2 m in size where fertilizers and manure were provided as per the government's recommendation (MOALD, 2017). Plants were irrigated with a fine watering can based on their requirements, and weeding was done manually. HRDCAP-001, HRDCAP-003, HRDCAP-004, HRDCAP-005 and HRDCAP-006 genotypes were assessed as treatments for the experiment with California Wonder as check variety.

Data collection

Data related to fruit characters and yield parameters viz, fruit length (mm), width (mm), weight (g), number of fruit per plant, pericarp thickness (mm) were measured. Yield per plant were determined and productivity (t/ha) were calculated based on yield per plant and spacing maintained during planting. Postharvest parameters i.e. physiological weight loss at 2, 4, 6, 8, 10 days after harvest were measured, and shelf life of capsicum fruit were also determined. Total soluble solid (˚Brix) content was measured by using refractometer. Number of seeds per fruit and test weight of seed (g) were some important seed parameters chronicled in the experiment.

Statistical analysis

All **c**ollected data were entered into Excel and analyzed statistically by using Genstat statistical software package. Analysis of variance (ANOVA) was computed at α level 0.05% Least Significant Differences (LSD) (Steel & Dickey, 1997). Difference between treatments was assessed by Duncan's Multiple Range Test (DMRT) at 5% level of significance (Gomez & Gomez, 1984).

RESULTS AND DISCUSSION

Fruit characteristics and yield parameters

Fruit length of capsicum genotypes varied markedly with California Wonder having longest fruit length (86.31 mm) which was at par ($p>0.05$) with HRDCAP-001 while HRDCAP-004 had shortest length (Figure 1 & Table 1). Farooq et al., (2015) reported significantly different fruit length in different sweet pepper hybrids whereas similar information was also documented by Khokhar et al., (2006) in different tomato hybrids. Furthermore, Hasan et al., (2014) also reported the varietal variance in fruit length of chilly lines.

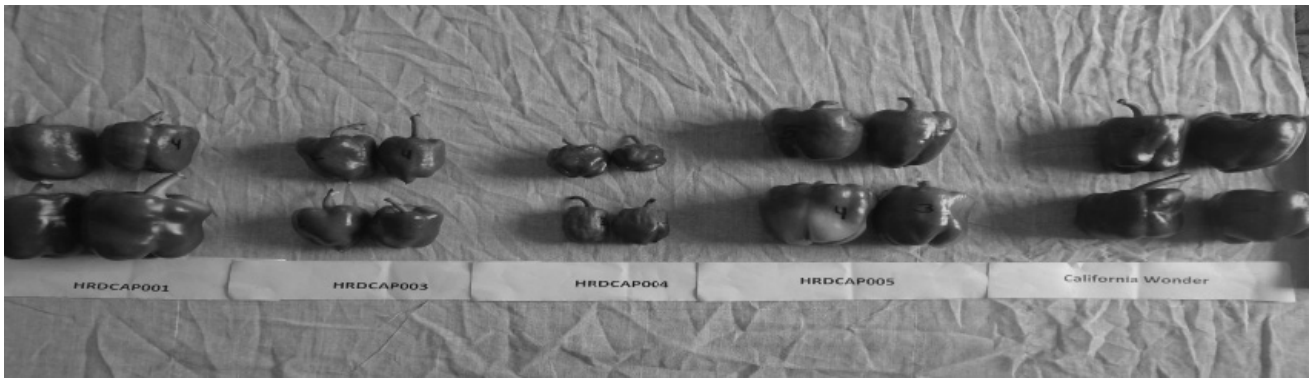

Figure 1. Fruit of capsicum genotypes under study

Fruit width was also significantly influenced by genotypes in bell pepper. California wonder had largest per fruit width (70.45 mm) which was statistically similar ($p>0.05$) with HRDCAP-001, HRDCAP-006, and HRDCAP-005 while HRDCAP-004 bear narrowest fruit width (42.49 mm). Effect of genotypes showed

significant difference ($p<0.001$) in per fruit weight with California Wonder having heaviest weight (126.12 g) and HRDCAP-004 with lightest (29.48 g), which was statistically similar ($p<0.001$)with HRDCAP-003 (Table 1). This shows that yield difference could be genetically influenced. Odeleye & Odeleye (2001) reported that cultivars and genetic make-up attribute yield difference. The variation in fresh weight was reported by Srinivas et al., (2017) and Nagaraju et al., (2018) in Chilli genotypes. Difference in number of fruit per plant was statistically different ($p<0.001$) with HRCCAP-003 having maximum number of fruit per plants followed by HRDCAP-004, but were statistically at par ($p>0.05$). Fruit per plant in those genotypes had wide variation with lowest number of fruit produced by HRDCAP-006 (Table 1). Sattar et al., (2015) reported significant difference in number of fruit per plant among sweet pepper genotypes along with wide difference. Findings of our research result corroborate with their findings.

A perusal of data also repeals that of storage condition. HRDCAP-001 had thickest pericarp (6.44 mm) and HRDCAP-004 had thinnest (3.47 mm). Hasan et al. (2014) and Bicikliski et al., (2018) also reported the difference in pericarp thickness among different Capsicum genotypes. As HRDCAP-001 had second heaviest fruit weight, thickest pericarp, and third highest number of fruit per plant, it bear maximum yield per plant and productivity. This was followed by HRDCAP-003, but was statistically at par ($p>0.05$) with HRDCAP-001. Lowest productivity and yield per plant was bear by HRDCAP-004 (Table 1). Hasan et al. (2014) and Danojevic et al., (2016) well reported about such yield difference between different genotypes.

Table 1. Fruit characteristics and yield parameters of different capsicum genotype at HRD, NARC, Khumaltar, 2017-2018

Genotype	Fruit length (mm)	Fruit width (mm)	Fruit weight (g)	No. of fruit per plant	Pericarp thickness (mm)	Yield per plant (kg)	Yield t/ ha
HRDCAP-001	75.06a	69.11a	125.24a	19.60b	6.44a	2.46a	68.3a
HRDCAP-003	58.88c	50.25b	42.54b	49.80a	4.22c	2.12ab	58.9ab
HRDCAP-004	50.93d	42.49c	29.48b	49.60a	3.47d	1.45c	40.3c
HRDCAP-005	72.08b	65.51a	117.44a	17.40bc	5.72b	2.06ab	57.3ab
HRDCAP-006	75.54b	68.86a	117.88a	14.20c	6.05ab	1.66bc	46.1bc
California Wonder	86.31a	70.45a	126.12a	14.40c	6.29ab	1.81bc	50.3bc
Mean	69.80	61.11	93.1	27.50	5.36	1.93	53.5
F value	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	0.002
LSD	6.52	6.96	17.66	3.93	0.64	0.44	12.37
CV%	7.1	8.6	14.4	10.9	9	17.5	17.5

Physiological weight loss (%) and Total soluble solid (TSS)

Physiological weight loss varied among different bell pepper genotypes (Table 2). On second day after harvest, physiological weight loss was highest for HRDCAP-004 (5.82%) followed by HRDCAP-003 ($p<0.001$) . California Wonder lost least physiological weight (3.10%) after 2nd days of harvest in room condition. Physiological weight loss among different genotypes of hot pepper was reported by Samira et al., (2011). Similarly, physiological weight lost was highest in HRDCAP-004 genotypes of bell pepper after 4, 6, 8 and 10 days of harvest while California Wonder lost least physiological weight on 4, 6, 8 and 10 days after harvest, and was statistically at par ($p>0.05$) with HRDCAP-005 and HRDCAP-001. Differential physiological weight loss was recorded by Shil et al., (2018) in different Chilli varieties in India.

Total soluble solid (TSS) content of different bell pepper genotypes varies markedly and was led by HRDCAP-006 (3.88 °Brix) followed by HRDCAP-004 ($p>0.05$). HRDCAP-003 consisted lowest (2.89 °Brix) TSS but was statistically at par ($p>0.05$) with HRDCAP-005 and California Wonder (Table 2).

Table 2. Physiological weight loss (%) and TSS of different genotypes of capsicum at 2 days, 4 days, 6 days, 8 days, and 10 days after storage at HRD, NARC, Khumaltar 2017/2018

Genotype	After 2 Days (g)	After 4 Days (g)	After 6 Days (g)	After 8 Days (g)	After 10 Days (g)	TSS (°Brix)
HRDCAP-001	3.10c	5.43bc	7.47bc	9.63bc	12.34bc	3.30b
HRDCAP-003	5.00b	8.90a	12.23a	15.51a	19.37a	2.98c
HRDCAP-004	5.82a	10.00a	13.50a	16.95a	20.51a	3.84a
HRDCAP-005	3.59c	6.19bc	8.51bc	10.95c	13.54bc	3.02c
HRDCAP-006	3.63c	6.50b	8.93b	11.44b	14.31b	3.88a
California Wonder	2.94c	5.10c	7.10c	9.27c	11.62c	3.10c
Mean	4.01	7.02	9.62	12.29	15.28	3.35
F value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
LSD	0.76	1.14	1.55	1.95	2.36	0.19
CV%	14.4	12.3	12.2	12.0	11.7	4.3

Shelf life and seed parameters

Shelf life of different sweet pepper genotypes varied significantly ($p<0.001$; Figure 2). HRDCAP-006 had longest shelf life (7.40 days) followed by HRDCAP-001 but were statistically at par ($p>0.05$). Shortest shelf life was recorded for HRDCAP-004 but it was statistically similar ($p>0.05$) with HRDCAP-005 and HRDCAP-003. Shil et al., (2018) had reported difference in shelf life among different Chilli genotypes irrespective of storage condition. Accordingly, they can be categorized to different types of market. For example, HRDCAP-006 could be best for distant market whereas HRDCAP-005 could be the worst. Table (3) describes about the seed production potential of these genotypes under study, Accordingly, HRDCAP-001 topped among all tested genotypes with an average of 307.4 numbers of seeds per fruit while HRDCAP-005 produced lowest number of average seeds per fruit. Sattar et al. (2015) and Sharma et al. (2017) also reported about significant differences in number of seeds per fruit in sweet pepper genotypes. In our experiment, California Wonder had heaviest 1000 seed weight while HRDCAP-001 had the lowest seed weight (Table 3).

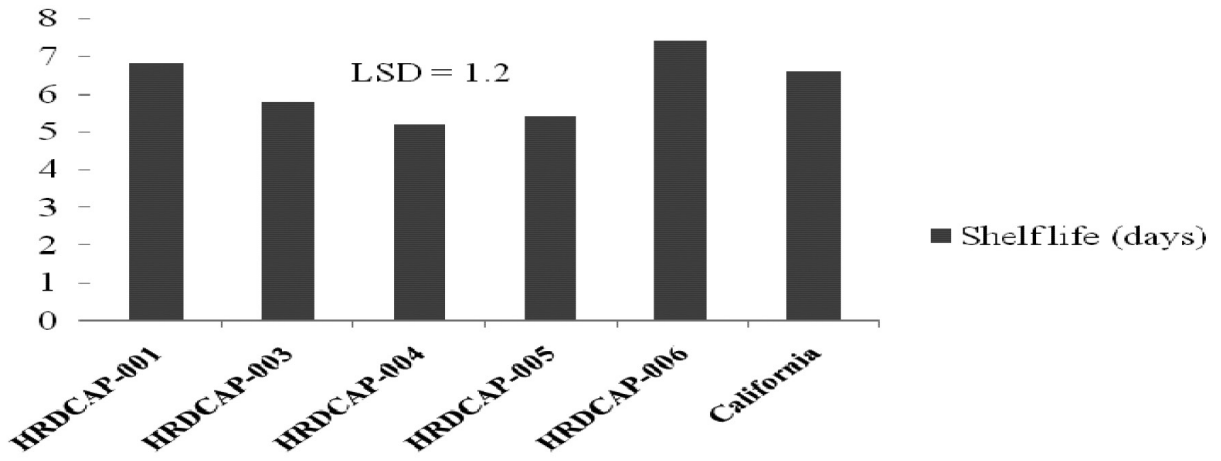

Figure 2. Shelf life of different capsicum genotypes under study

Table 3. Seed parameters of different capsicum genotype at HRD, NARC, Khumaltar (2017/2018)

Genotypes	No. of seeds per fruit	1000 seed weight (g)
HRDCAP-001	307.4a	6.0d
HRDCAP-003	261.4ab	6.12d
HRDCAP-004	239.4ab	6.38c
HRDCAP-005	122.2c	6.96b
HRDCAP-006	194.2bc	7.23a
California Wonder	226.6ab	7.44a
Mean	225	6.68
F value	0.01	<0.001
LSD	92.7	0.22
CV%	31.2	2.5

CONCLUSION

California Wonder had longest fruit length, largest fruit width, and heaviest fruit weight, but bears least number of fruit per plant, resulting 4th position in yield per hectare under polyhouse condition. Similarly, HRDCAP-001 had second largest fruit length, width and weight, but bear 3rd largest number of fruit per plant among all experimented genotypes. It was also superior in pericarp thickness, and produced highest yield. In spite of comparatively less fruit yield produced, California Wonder exhibited lower physiological weight loss than other genotypes followed by HRDCAP-001. On the other hand, genotype HRDCAP-001 had attained longest shelf life followed by California Wonder. Thus, these important and well performed genotypes could be utilized for further specific variety improvement and capsicum breeding in Nepal.

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