Nepalese Horticulture 17 : 60-68, 2023
ISSN : 2092-1122 | Print : 2542-2936(Online)
DOI: https://doi.org/10.3126/nh.v17i1.60634

Research Article

OPEN ACCESS

Evaluation of Sweet Pepper Genotypes for Yield and Quality in Open Field Using Plastic Mulch in Mid Hill Condition of Nepal

Sujata Poudel[1*], Ishwori Prasad Gautam[1], Surendra Lal Shrestha[1], Dipendra Ghimire[1], Mira Dhakal[1], Suprabha Pandey[1], Sujan Subedi[1] and Rajendra Regmi[2]

[1]*National Horticulture Research Centre, Khumaltar, Lalitpur, Nepal*

[2]*Agriculture and Forestry University, Rampur, Chitwan, Nepal*

[*]Corresponding Author's Email: sujatapoudel40@gmail.com

[*]Orcid ID: https://orcid.org/0000-0002-4003-1333

Received on: 14 August, 2023 **Revised on:** 25 November, 2023 **Accepted on:** 25 November, 2023

Abstract

Sweet pepper is an emerging high value vegetable crop. There are few numbers of varieties recommended in Nepal despite of having immense commercial farming potentiality. An experiment was conducted during 2020 and 2021 at National Horticulture Research Centre, Khumaltar, in open field condition to identify high yielding capsicum genotype with longer postharvest shelf life. The field experiment was done by using the Randomized Complete Block Design (RCBD) with four replications for each treatment and the lab experiment for postharvest shelf life was studied in first year using Completely Randomized Block Design (CRD) with three replications for each treatment. The six elite capsicum genotypes under study were HRDCAP-001, HRDCAP-003, HRDCAP-004, HRDCAP-005, HRDCAP-006, and California Wonder (standard check variety). The research plot was mulched with 25-micron plastic and 4-6 leaf stage seedlings transplanted making holes in mulch at the spacing of 60 cm x 45 cm. Among the tested genotypes, HRDCAP001 and HRDCAP005 were found to be promising in terms of fruit length, fruit weight, yield per plant and yield per hectare followed by HRDCAP006 during a two-year experiment. The genotype HRDCAP001 was rich in vitamin C content with less spoilage loss while HRDCAP006 was observed most fresh followed by California Wonder and HRDCAP001 respectively. Overall, the genotype HRDCAP001 was found to be the superior among all the genotypes in terms of yield and quality parameters. However, a multi-location farmer's field trial should be conducted for further verification and varietal development purpose.

Keywords : Genotypes, sweet pepper, plastic mulch, yield, postharvest quality

Introduction:

Sweet pepper (*Capsicum annuum* L) is also known as bell pepper or capsicum. It belongs to the Solanaceae family, grown as fruit vegetables. In Nepal it is called as Bhede Khursani. It is a high value crop, and its commercial cultivation is done under protected condition as well as in open field in Nepal (Poudel et al., 2021). The sweet pepper grown under protected condition has longer harvesting period than the open field sweet pepper (HRD, 2019). The total area under sweet pepper cultivation in Nepal was 1931 ha with production 20,002 MT and productivity 10.36 MT/ha during fiscal year 2021/22 (MoALD, 2023). It is highly nutritious and consists of essentials nutrients, vitamins, carotene, antioxidants, and flavonoids (Mateljan, 2007). Sweet pepper has been one of the high demanded vegetables ingredients in Nepalese recipe mostly in functions and ceremonies as well as in fast food.

Huge amount of fresh as well as processed product of capsicum is imported annually from India (MoALD, 2023). Despite its high demand and market price, two OP and a hybrid variety (viz; California Wonder, Sagar, and NS 632 respectively) have been registered in Nepal. In Nepal, farmers are growing capsicum in both protected and open condition. This crop is very sensitive to heavy rainfall. Due to intense and frequent rainfall, the production of this crop has been much influenced. Mulching helps to reduce crop mortality caused by heavy rainfall (Poudel and Gautam, 2022). Also mulching with plastic can help to control weed whereas reflective mulch

All the authors declares that there is no any conflict of interest.

helps to reduce the insect vector responsible for viral diseases (Kasirajan and Ngouajio, 2012). The farmers in Nepal are compelled to grow commercial varieties of capsicum developed by the other countries in their own risk illegally. Again, the postharvest life of the sweet pepper is very short. At room temperature, the quality of the fruit degraded soon within a few days (Poudel et al., 2021). A better postharvest technology is needed for longer shelf life of the commodity for extended availability in market. Thus, National Horticultural Research Centre, Khumaltar has started the collection and evaluation of promising line of sweet pepper with an objective to select best genotype for their breeding and other potentialities in Nepal as an emerging vegetable crop.

Materials and methods:

Field experiment

An experiment was conducted on six open pollinated sweet pepper genotypes in an open field at NHRC, Khumaltar. The seeds were sown in plastic tray on 2nd week of February and transplanted on 1st week of April for two years 2020 and 2021 with the spacing of 60 cm x 45cm. The experiment was laid out in RCBD design with six treatments and 4 replications. The plot size was 5.4 m2 (2.4 m × 2.25 m) with 4 rows and 5 plants were maintained in each row. Each plot was mulched with 25-micron plastic (Silver upside and black inside) and 54 days old seedlings (germination of seed was late due to cold weather) were planted at 60 cm x 45 cm crop geometry. The standard recommended dose of fertilizers (30-ton FYM + 100:100:60 kg NPK/ha) was applied (Gotame et al., 2019). Half dose of nitrogen was top dressed at 35 days after transplanting through drenching. The first pinching-off flower buds and small developing fruits at first and second nodes was done 45 days after transplanting. All the side branches before the first node were also removed. The other inter-culture operation was done as per recommendation and disease and pest were controlled with minimum application of pesticides i.e., one spray of 1.5 ml roger was used against whitefly while Vircon-H was used to manage the virus.

Laboratory experiment

The fruits of six genotypes were harvested at green matured stage in the morning hour and brought to laboratory. The experiment was conducted on the same date after precooling. The experiment was set-up under the coolbot storage condition of 8-10 ºC and 95-98% relative humidity. Ten sample fruits were kept under an experimental unit. The study was carried out in CRD with six treatments and three replications altogether with 18 total observations. The daily record of cold storage temperature and relative humidity was done until the last day of storage period. The research was carried out for 3 weeks during the month of July 2020.

Data collection

Fruits were harvested at full size when they became firm and shiny at green mature stage for data recording. Observation was recorded on different morphological (growth habit, branching habit, number of lobes in fruit, fruit cross sectional shape, fruit depression at peduncle end, presence of abscission layer, fruit shape at blossom end, flower position, leaf shape, fruit shape, fruit color at ripe stage and duration of fruit maturation), yield and yield attributing Days to 50% flowering (DAT), average fruit weight, total fruit per plant, yield per plant and adjusted yield per hectare), physical characters (fruit length, fruit width and pericarp thickness), disease scoring and incidence (Virus and fungal) and postharvest characters during storage (vitamin C, Total soluble solids, titratable acidity, physiological loss in weight, firmness, spoilage loss, freshness and shelf life) in detail.

Physiological Weight Loss (PLW)

The physiological weight loss was recorded at a 10-day interval during the storage period. Initial fruit weight was recorded taking ten nondestructive samples of sweet pepper fruits on first day and final weight on each ten days interval using digital balance (SACLTEC SPB42). The difference between initial and final weight of fruits was considered as total weight loss during each storage interval and expressed as a percentage.

$$\text{PLW \%} = \frac{\text{Initial weight} - \text{Final weight}}{\text{Initial weight}} \times 100$$

Fruit Firmness

A digital handheld penetrometer (model: FR-5120) having cylindrical stainless-steel probe of 5.84 mm in diameter was used to measure fruit firmness. Each fruit was punctured from the three equatorial sides and average data was recorded. One fruit was used for the puncture test from each experimental unit.

Spoilage loss (SL)

Visual evaluation was done for decayed fruit at the end of each storage interval and sorted out for pathological identification. The pathogen causing decay was identified in pathology laboratory (NPPRC, 2020). Samples having diseased symptoms were counted and expressed in percentage as given below.

$$\text{SL \%} = \frac{\text{No.of decayed fruits}}{\text{Number of total fruits}} \times 100$$

Vitamin C content

The volumetric method was used for estimation of ascorbic acid of ripe fruits (Sadasivam and Manickam, 1991). The following formula was used to calculate the ascorbic acid content.

Ascorbic acid content (mg/100 g sample) = 0.5 mg×V2 mL×12 mL×100

V1 mL × 5mL × weight of the sample

Where, V1= amount of dye consumed during the titration

V2 = amount of dye consumed when the supernatant was titrated with 4% oxalic acid

Freshness

The fruit freshness was measured using hedonic scales ranking from 1 to 5, where 1 stands for least fresh and 5 stands for most fresh. The panelist of 10 horticulturists from National Horticulture Research Station was involved in scoring the freshness of the fruit on the last day of storage.

Total soluble solids (TSS)

The two sample fruits from each biological replication were used for analysis of TSS content. The fruits were crushed using an electrical grinder and the juice was extracted using muslin cloth. The TSS was measured using Pocket Brix-Acidity Meter (model: PAL-BX|ACID F5 Cat. No.7100) by placing two to three drops of juice on the prism surface. The unit of TSS determined was in ºBrix.

Titratable acidity (TA)

The juice extracted was diluted 50 times and Pocket Brix-Acidity Meter (model: PAL-BX|ACID F5 Cat. No.7100) was used to record TA in percentage by placing 1 to 2 drops of diluted juice on the prism surface.

Shelf life

The fruit shelf life was recorded based on the number of days that the fruit remained marketable or until half of the fruit loss freshness or became unfit for consumption. The fruits become unmarketable due to water loss and fruit decay.

Statistical analysis

MS-Excel was used to arrange data and present parameters in graphs while R STAT software was used to analyze data statistically. The least significant difference (LSD) test at 1% or 5% level of significance was followed to find out the significant differences between treatments (Gomez and Gomez, 1984; Shrestha, 2020).

Results:

Morphological characters

The details of morphological characters, fruit characters and disease scoring are presented in Table 1.

Yield attributing parameters

The 1st year result showed that there was significant difference among the genotypes for all parameters except for days to 50% flowering (Table 2). The fruit weight of genotype HRDCAP001 was found to be the maximum (100.6 g) followed by HRDCAP006 (88.70 g) while the minimum on genotype HRDCAP004 (27.29 g). The fruit number per plant was significantly the highest (37) on genotype HRDCAP003. Significant difference was observed on fruit yield per plant and adjusted yield per hectare. The highest fruit yield per plant (0.82 kg) and adjusted fruit yield (30.53 t/ha) was recorded in HRDCAP001.

The result from the year second year 2021 showed that there was significant difference among the genotypes for all yield attributing parameters. The fruit weight of genotype HRDCAP005 was found to be the maximum (129.6 g) followed by California Wonder (116.4g) and HRDCAP001 (109.2 g) while the minimum on genotype HRDCAP004 (41.1 g). The fruit number per plant was significantly the highest on genotype HRDCAP004 (27) followed by HRDCAP003 (26). Significant difference was observed on fruit yield per plant and adjusted yield per hectare. The highest fruit yield per plant was recorded in genotype California Wonder (0.67 kg) which was statistically at par with HRDCAP001 (0.66 kg) while the maximum adjusted fruit yield was recorded in HRDCAP001 (24.54 t/ha) followed by HRDCAP005 (22.50 t/ha).

Fruit characters and disease occurrence

The first-year observation showed that the fruit length was significantly the maximum in genotype HRDCAP001 (63.77 mm) followed by HRDCAP005 (60.89 mm) (Table 3). The genotype HRDCAP005 recorded the highest fruit width (70.59 mm) whereas the minimum in genotype HRDCAP003 (43.88 mm). Among the genotypes, HRDCAP001 was found with the maximum pericarp thickness (4.92 mm) followed by California Wonder (4.91 mm) and HRDCAP005 (4.80 mm) respectively. The virus incidence was found significantly the minimum in genotype HRDCAP005 (25%) followed by HRDCAP006 (32.5%) and HRDCAP001 (38.8%) respectively. The wilt incidence was found to be the minimum in genotype HRDCAP004 (18.75%) which was statistically at par with HRDCAP003 (21.25%). No significant difference in virus and wilt severity was observed among all the genotypes under evaluation.

In the second year, the longest fruit length (66.85 mm) was observed in genotype HRDCAP001 and HRDCAP005 (Table 4) whereas the minimum was noticed in genotype HRDCAP004 (46.88 mm). The genotype HRDCAP005 recorded the widest fruit girth (77.16 mm) whereas HRDCAP004 recorded the narrowest (51. 53 mm). No significant difference was observed among the genotypes for virus incidence percentage. The wilt incidence percentage was found maximum in genotype California Wonder (43.7%) whereas the minimum was observed in genotype HRDCAP006 (10.9%).

Vitamin C content and total soluble solids (TSS)

Results showed that there was a significant difference in the number of postharvest quality parameters as the storage duration extended (Table 5, Figure 1 and 2). No significant change in vitamin C was noticed during 10th day of the storage period while HRDCAP001 was noticed with maximum vitamin C content (69.81 mg/100g) on 20th day of storage which was statistically at par with

Table 1 : Morphological characters of capsicum genotypes at NHRC, Khumaltar, 2020

Genotype	Growth habit	Branching habit	No.of lobes in fruit	Fruit cross sectional shape	Fruit depression at peduncle end	Fruit shape at blossom end	Abscission layer	Flower position	Leaf shape	Fruit shape	Fruit color at ripe stage	Duration of fruit maturation (Days)
HRDCAP001	Intermediate	Intermediate	4	Intermediate	Medium	Sunken, pointed	Present	Intermediate	Ovate	Rectangular	Yellow	28-32
HRDCAP003	Erect	Dense	3	Slightly corrugated	Medium	Sunken	Present	Erect	Ovate	Trapezoidal	Red	25-30
HRDCAP004	Erect	Dense	3	Slightly corrugated	Weak	Blunt	Present	Erect	Ovate	Moderately Triangular	Red	26-30
HRDCAP005	Intermediate	Intermediate	4	Corrugated	Medium	Sunken, pointed	Present	Erect	Ovate	Rectangular	Red	28-32
HRDCAP006	Intermediate	Intermediate	4	Corrugated	Medium	Sunken	Present	Erect	Deltoid	Rectangular	Red	27-31
California Wonder	Intermediate	Intermediate	4	Intermediate	Weak	Sunken	Present	Erect	Deltoid	Rectangular	Red	28-32

Table 2 : Yield attributing characters of the capsicum genotypes at NHRC, Khumaltar, 2020

Genotype	Days to 50% flowering (DAT)	Average fruit wt. (g)	Total fruit/plant	Yield per plant (kg)	Adjusted yield (mt/ha)
HRDCAP001	46	100.6	14	0.82	30.53
HRDCAP003	50	31.98	37	0.70	26.01
HRDCAP004	49	27.29	28	0.56	19.87
HRDCAP005	49	82.85	13	0.71	26.22
HRDCAP006	51	88.70	20	0.72	26.49
California Wonder	54	71.36	15	0.56	19.26
F-test	NS	***	***	***	**
LSD	5.67	21.81	3.39	0.08	5.17
CV%	7.56	21.56	10.76	8.26	13.88

Table 3 : Fruit characters and disease scoring of capsicum genotypes at NHRC, Khumaltar, 2020

Genotype	Fruit length (mm)	Fruit width (mm)	Pericarp thickness (mm)	Virus incidence (%)	Virus severity (1-5)	Wilt incidence (%)	Wilt scoring (1-5)
HRDCAP001	63.77	67.02	4.92	38.8	1.24	42.50	2
HRDCAP003	54.43	43.88	3.25	50.8	1.17	21.25	2
HRDCAP004	44.39	44.26	2.97	50	1.30	18.75	2
HRDCAP005	60.89	70.59	4.80	25	1.27	45.0	3
HRDCAP006	55.73	67.73	4.22	32.5	1.11	25.0	2
California Wonder	54.57	65.59	4.91	42.56	1.11	37.50	3
F-test	**	***	***	***	NS	***	NS
LSD	9.36	7.02	0.93	5.38	0.44	9.63	1.85
CV%	11.17	7.79	14.90	8.93	24.24	20.17	57.59

Table 4 : Fruit and yield attributing characters of the capsicum genotypes at NHRC, Khumaltar, 2021

Genotype	Fruit length (mm)	Fruit width (mm)	Fruit wt. (g)	Total fruit/ plant	Yield per plant (kg)	Adjusted yield (t/ha)	Virus incidence (%)	Wilt incidence (%)
HRDCAP001	66.85	73.28	109.2	15	0.66	24.54	46.7	40.9
HRDCAP003	52.82	51.68	44.3	26	0.57	21.10	42.5	33.5
HRDCAP004	46.88	51.53	41.1	27	0.48	16.58	25.5	26.5
HRDCAP005	66.85	77.16	129.6	13	0.63	22.50	30.9	26.5
HRDCAP006	61.68	73.79	108.3	12	0.57	21.18	41.9	10.9
California Wonder	63.75	73.56	116.4	13	0.67	20.04	27.5	43.7
F-test	***	***	***	***	*	**	NS	*
LSD	4.65	6.59	20.35	2.31	0.12	3.58	16.77	17.79
CV (%)	5.2	6.5	14.8	8.7	13.5	11.3	31.1	39

HRDCAP005(66.54 mg/100g) and HRDCAP006 (65.99 mg/100g). The TSS content was slightly increased in all genotypes with significant difference. On the 10th and 20th day of storage, the maximum TSS content was observed in genotype HRDCAP001 (3.7 and 3.73 °Brix respectively) and minimum in HRDCAP004 (1.9 and 1.96 °Brix respectively).

Titratable acidity (TA) and physiological loss in weight (PLW)

The TA content was found significantly highest in HRDCAP005 (0.35%) on 10th day of storage and in HRDCAP006 (0.26%) on 20th day of storage while minimum TA content was measured in HRDCAP004 on both 10th (0.16%) and 20th (0.12%) day of storage period. No significant change in PLW was observed during the storage period of 20 days.

Fruit firmness

A significant difference in fruit firmness was observed in which maximum firmness was noticed in genotype HRDCAP001 (2.65 kg/cm2) followed by HRDCAP006 (2.64 kg/cm2) on 10th day of storage. Similarly, on the 20th day of storage genotype HRDCAP006 recorded the maximum fruit firmness (2.58 kg/cm2) which was statistically at par with HRDACAP001 (2.40 kg/cm2).

Spoilage Loss, Freshness, and shelf life

The significant differences in genotypes were revealed in terms of spoilage loss (figure1.a), fruit freshness (figure 1.b) and shelf life (figure 2). The spoilage loss due to fruit rotting was found to be the highest on genotype HRDCAP004 (8.82%) whereas no spoilage on the genotype California Wonder and minimum loss of (2.70%) on genotype HRDCAP001 during the storage period. The freshness of the fruit of genotype HRDCAP003 and HRDCAP004 was unmarketable later than 14th day of storage hence not included the freshness scoring on 20th day of storage. On the 20th day of storage, HRDCAP005 was recorded with maximum freshness (score 2.40) followed by HRDCAP001 (score 2.52). The shelf life of two genotypes viz. HRDCAP003 and HRDCAP004 was found to be 14 days while the rest of the genotypes records the shelf life of 20 days. The fruit decay was due to Penicillium sp. (NPPRC 2020).

Discussions:

Yield attributing parameters

Growth habit might be attributed to earliness in flowering (Dahal et al., 2006). Similar results were illustrated by Bhattarai et al. (2020) who reported significantly higher fruit weight, fruit number per plant and yield per hectare among the same genotypes grown under polyhouse condition inside Kathmandu valley. This might be due to the favorable climatic conditions, for photosynthesis inside the polyhouse condition. Also, Farooq et al. (2015) reported significantly different fruit number and fruit weight per plant in different hybrids genotypes of sweet pepper. Odeleye and Odeleye (2001) described that it's the genotype and genetic make-up which influenced yield and yield attributing characters.

Fruit characters and disease occurrence

The present study is not in line with findings of Bhattarai et al. (2020) who reported maximum fruit length and width in genotype California Wonder grown under protected condition. This might be due to differential in performance of genotypes in open and polyhouse condition. However, similar results on pericarp thickness were reported which might be varietal characteristics of the genotypes. Also, Dahal et al. (2006) reported variations in fruit length and diameter in different varieties of hot pepper. Parisi et al. (2020) reported that genotype's genetic material determines extent of resistance to the fungal, bacterial, and viral disease in pepper.

Vitamin C content, total soluble solids, titratable acidity, and physiological loss in weight

Poudel et al. (2021) elaborate the gradual decreasing trend of ascorbic acid content in capsicum stored under coolbot storage which might be due to degradation of ascorbic acid during metabolism or oxidation by enzymatic action (Palma et al. 2015). The TSS content significantly varies between the genotypes, maturity stage and storage duration (Tsegay et al., 2013). The increase in TSS content may be due to conversion of complex carbohydrates to simpler form.

The reduction in fruit titratable acidity could be due to consumption of organic acids as a substrate for respiration (Anthon and Barrette, 2012). The morpho-anatomical characters, fruit skin types and underlying tissues of the genotype is responsible for the major water loss from the fruit (Bondada and Keller, 2012)

Fruit firmness

The disintegration of the polymers on the fruit cell due to enzymatic activity and biological processes cause fruit to soften which leads to reduction in fruit firmness (Paniagua et al., 2014). Maalekuu et al. (2003) also reported that fruit moisture loss and softening might be the result of thin skin and lower level of epicuticular wax content in the fruit. Water loss in fruit is a major factor to reduce firmness (Paniagua et al., 2013)

Spoilage Loss, Freshness, and shelf life

The congenial environment inside the cold storage condition (9.82 ±2 °C, 86+5% RH) might be taken into consideration for disease development (Poudel et al., 2021). The permeability of cell membranes increases during fruit ripening making fruit more vulnerable to water loss (Samira et al., 2013). Thus, fruit freshness and shelf life are affected continuously. Also, the genotype's fruit morphological and anatomical feature and the storage condition might be subtle to fruit shrinkage and reduced postharvest life. The loss of freshness and short shelf life of the two genotypes HRDCAP003 and HRDCAP004 might be due to small fruit size i.e., higher

Table 5 : Postharvest quality of six different capsicum genotypes under coolbot storage condition at HRD, Khumaltar

Genotype	Vit C (mg/100 g)		TSS (0 Brix)		TA (%)		PLW (%)		Firmness (kg/cm3)	
	10 DAS	20 DAS	10 DAS	20 DAS	10 DAS	20 DAS	10 DAS	20 DAS	10 DAS	20 DAS
HRDCAP001	71.75	69.81	3.7	3.73	0.26	0.24	5.14	8.37	2.65	2.40
HRDCAP003	78.47	61.98	2.36	2.40	0.24	0.18	4.64	6.61	1.68	1.57
HRDCAP004	79.56	62.49	1.9	1.96	0.16	0.12	4.34	6.03	2.23	1.63
HRDCAP005	67.45	66.54	3.23	3.36	0.35	0.21	5.40	8.65	2.11	1.96
HRDCAP006	67.45	65.99	3.2	3.63	0.34	0.26	5.34	8.64	2.38	2.11
California Wonder	67.20	60.01	3.53	3.70	0.26	0.21	5.89	8.58	2.64	2.58
Mean	71.96	64.47	2.98	3.13	0.27	0.20	5.13	7.81	2.28	2.04
F test	NS	**	***	***	***	**	NS	NS	*	***
LSD	30.14	4.66	0.41	0.44	0.074	0.058	1.02	2.42	0.55	0.34
CV	28.19	4.79	9.33	9.53	18.5	19.15	13.91	20.58	16.50	11.31

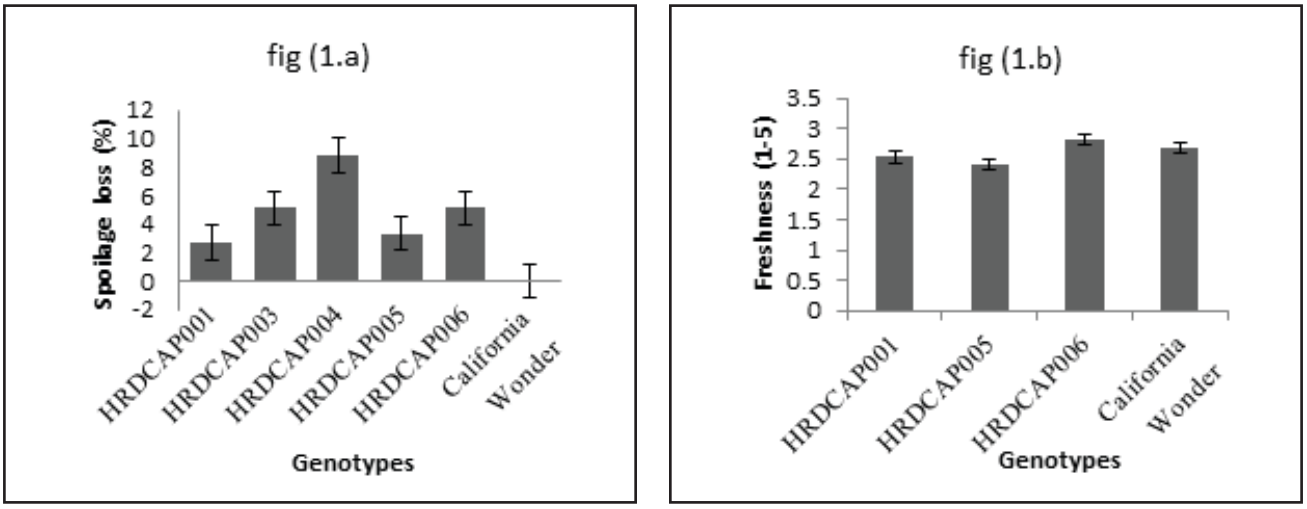

Figure1: Spoilage loss (fig 1.a) and freshness ranking (fig 1.b) of six different capsicum genotypes under coolbot storage condition at NHRC, Khumaltar.

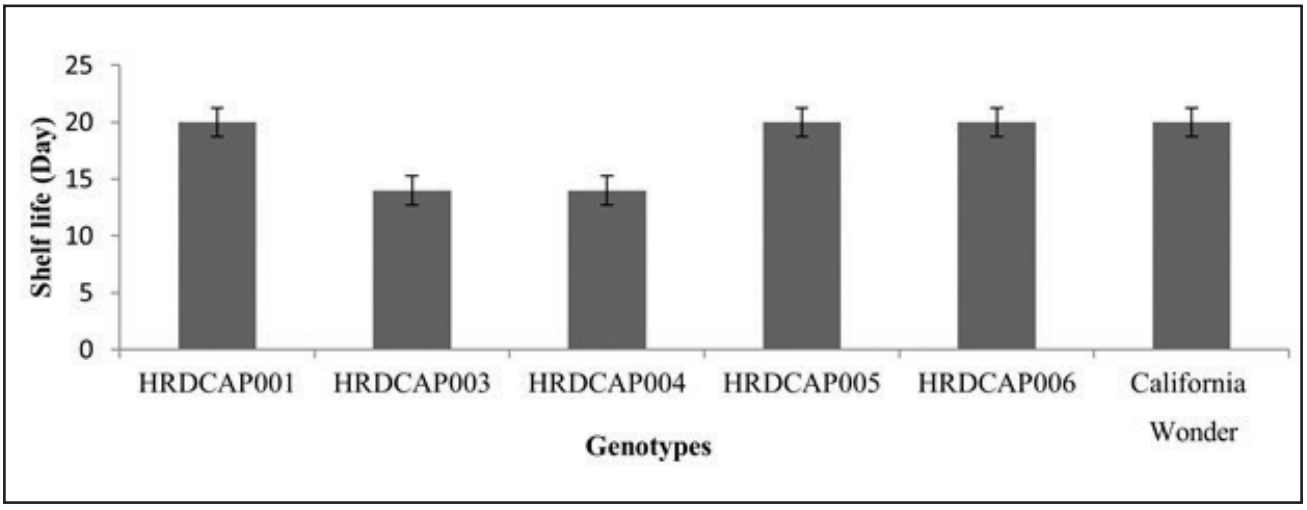

Figure 2: Shelf life of the six genotypes six different capsicum genotypes under coolbot storage condition at NHRC, Khumaltar.

surface to volume ratio than other large fruit of other genotypes under study. The present findings are in line of agreement with the findings of previous year results of Bhattarai et al. (2020).

Conclusion:

The plastic mulching practice during monsoon season in mid hill showed practical applicability to reduce the incidence and severity of wilting during production stage which is the major constraint in capsicum farming in open field. The sweet pepper genotype HRDCAP001, was found promising for cultivation on open field with plastic mulching in mid hill conditions in term of productivity and showed stability in two years' study with better postharvest fruit quality during storage.

Acknowledgement:

The authors would like to acknowledge Nepal Agricultural Research Council, National Horticulture Research Centre, Khumaltar for all the supports to conduct the research.

Declaration of conflict of interest and ethical approval:

S. Poudel designed, conducted the experiments, and prepared the manuscripts, I.P. Gautam supervised the experimental work and provided guidelines to write the manuscript. S.L. Shrestha was involved and provided guidelines for research conduct and manuscript preparation. D. Ghimire, S. Subedi, S. Pandey and M. Dhakal involved genotype evaluation and data collection. R. Regmi involved in data analysis and finalized manuscript.

The authors declare no conflicts of interest.

References:

Annual Report, (2019). Horticulture Research Division. Khumaltar, Lalitpur.

Anthon, E. & Barrette, M. (2012). Pectin Methyl esterase activity and other factors affecting pH and titratable acidity in processing tomatoes. Journal of Food Chemistry, 132, 915-920.

Bhattarai, D.R., Maharjan, S.K., Gautam, I.P., Subedi, S. & Pokhrel, S. (2020). Evaluation of capsicum (Capsicum annuum L.) genotypes for variety improvement. Journal of Agriculture and Forestry University 4, 139-144.

Bondada, B. & Keller, M. (2012). Not all shrivels are created equal - morphoanatomical and compositional characteristics vary among different shrivel forms that develop during ripening of grape (Vitis vinifera L.) berries. American Journal of Plant Science 12, 13-16.

Dahal, K.C., Sharma, M.D., Dhakal, D.D., & Shakya, S.M. (2006). Evaluation of heat tolerant chilli (Capsicum annuum L.) genotypes in western terai of nepal. Journal of Institute of Agriculture and Animal Science 27, 59-64.

Farooq, M., Ramzan, A., Chattha, M.R., Qasim, U., Nawab, N.N. & Hidyatullah. (2015). Studies on the performance of sweet pepper (Capsicum annum L.) hybrids under plastic tunnel. Science, Technology and Development, 34, 155-157. DOI: 10.3923/std.2015.155.157.

Gomez, K.A. & Gomez, A.A. (1984). Statistical Procedures for Agricultural Research (2nd ed). New York, 680: John Wiley and Sons.

Gotame, T.P., Gautam, I.P., Shrestha, S.L. & Pradhan, N.G. (2019). A field guide for vegetable germplasm testing and variety registration/release. Nepal Agricultural Research Council (NARC), National Agriculture Research Institute (NARI), Horticulture Research Division (HRD) Khumaltar, Lalitpur. NARC Publication Serial No. 00669-683 (2019/20).

Kasirajan, S. & Ngouajio, M. (2012). Polyethylene and biodegradable mulches for agricultural applications: a review. Agronomy for Sustainable Development. 32, 501–529. DOI: https://doi.org/10.1007/s13593-011-0068-3

Maalekuu, K., Elkind, Y., Tuvia-Alkalai, S., Shalom, Y. & Fallik, E. (2003). Quality evaluation of three sweet pepper cultivars after prolonged storage. Advances in Horticultural Science, 17(4), 187–191. DOI: https://www.jstor.org/stable/42883362

Mateljan, G. (2007). The World's Healthiest Foods: Essential Guide for the Healthiest Way of Eating. George MateljanFoundation.S.N.,9780976918547, https://books.google.com.np/books?id=TX1VAAAACAAJ

MoAD. (2023). Statistical information on Nepalese agriculture. Ministry of Agricultural and Livestock Development, Singhadurbar, Kathmandu.

NPPRC. (2020). Lab test report. National Plant Pathology Research Centre, Khumaltar, Lalitpur

Odeleye, F. O. and Odeleye, O. M. O. (2001). Evaluation of morphological and agronomic characteristics of two exotic and two adapted varieties of tomato (Lypersiconesculentum) in southwest Nigeria. Proceedings of the 19th Annual conference of HORTSON. 1: 142 –145.

Palma, J.M., Sevilla, F., Jimenez, A., del Rio, L.A., Corpas, F.J., Alvarez de Morales, P. & Camejo, D.M. (2015). Physiology of pepper fruit and the metabolism of antioxidants: chloroplasts, mitochondria, and peroxisomes. Annals of Botany 116(4), 627–636. DOI: https://doi.org/10.1093/aob/mcv121

Paniagua, A.C., East, A.R., Hindmarsh, J.P. & Heyes, J.A. (2013). Moisture loss is the major cause of

firmness change during postharvest storage of blueberry. Postharvest Biology and Technology, Volume 79, 13-19. ISSN 0925-5214. DOI: https://doi.org/10.1016/j.postharvbio.2012.12.016.

Paniagua, C., Pose, S., Morris, V.J., Kirby, A.R., Quesada, M.A. & Mercado, J.A. (2014). Fruit softening and pectin disassembly: an overview of nano structural pectin modifications assessed by atomic force microscopy. Annals of Botany 114(6), 1375–1383. DOI: https://doi.org/10.1093/aob/mcu149, PMCID: PMC4195560

Parisi, M., Alioto, D. & Tripodi, D. (2020). Overview of biotic stresses in pepper (Capsicum spp.): sources of genetic resistance, molecular breeding and genomics. International Journal of Molecular Science 27(7), 2587, DOI:10.3390/ijms21072587.

Poudel S. and Gautam I.P. (2022). Improved farming and post-harvest technology of capsicum. Nepal Agricultural Research Council (NARC), National Agriculture Research Institute (NARI), Horticulture Research Division (HRD) Khumaltar, Lalitpur. In Nepali. ISBN: 978-9937-1-1531-5. NARC Publication Serial No. (082/078/79).

Poudel, S., Gautam, I.P., Ghimire, D., Pandey, S., Dhakal, M. & Regmi, R. (2021). Modified atmosphere packaging of capsicum for extending shelf life under coolbot condition. Journal of Agriculture and Natural Resources, 4(1), 120-129.

Sadasivam, S., and Manickam, A. (1991). Biochemical methods for agricultural sciences - Carbohydrates. Coimbatore: New age International Publisher

Samira, A., Woldetsadik, K. & Workneh. T.S. (2013). Postharvest quality and shelf life of some hot pepper varieties. Journal of Food Science and Technology 50(5), 842-855.

Tsegay, D., Tesfaye, B., Mohammed, A., Yirga, H. & Bayleyegn, A. (2013). Effects of harvesting stage and storage duration on postharvest quality and shelf life of sweet bell pepper (Capsicum annuum L.) varieties under passive refrigeration system. International Journal for Biotechnology and Molecular Biology Research 4(7), 98-104. DOI: 10.5897/IJBMBR2013.0154