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The Intensity of Tomato Post-Harvest Rot in the Surroundings of Tandojam

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ABSTRACT

Tandojam is one of the main tomatoes producing city in Pakistan. Several tones of tomatoes are produced in the Tandojam each year. The main objective of the study was to estimate the intensity of tomato post-harvest rot in the vicinity of Tandjam, so curative strategies can be explored. A survey was conducted in the surrounding of Tandojam viz; Tando Allahyar, Sultanabad Vegetable Market, Tandojam city, Tando Qaiser, Bahawal Zaur, and Hyderabad Vegetable Market. A total of 20 tomato growers/farmers, 30 brokers, and 23 small shopkeepers were interviewed based on the proforma developed in the current study. The fruit rot infection among all 20 different fields ranged from 5 to 65% with 31.85% infected fruits by Alternaria. At Sultanabad and Hyderabad vegetable markets infection was ranged from 20 to 60% and 10 to 70%, respectively, with mean percentages 37 and 38.5% infected by Alternaria sp. Infection in small shops was ranged from 16.67 to 60% in Tandojam city and 16.67 to 53.33% in Tando Qaiser. The overall comparison revealed 30 percent infected fruit by Alternaria under field conditions, 36 percent at the vegetable market, and 43 percent at small shops level. Controlling tomato rots is a big challenge as the intensity of this disease is unknown in different regions. This research has significantly contributed to estimating the intensity of this disease.

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Introduction

Tomato and several tomato-based products are an important source of many established nutrients and phytochemicals though have several health benefits. Several products of tomato are being used in our daily life such as sun-dried, juice, soup, sauce, ketchup, and unsullied as a salad (Nazli et al., 2006). It is more frequently used as a source of daily diet vegetable, consumed raw as well as cooked, and is used as soups, salads, preserves, pickles, sauces, and many other products. It is a rich source of several important macro and micronutrients including carbohydrates, proteins, fats, minerals, and vitamins (Talvas et al., 2010). People have realized the importance of tomatoes to be a healthy diet because tomatoes are known to contain many compounds that play an important role in the prevention of cancer, heart disease, cataracts, and many other common health problems (Olaleye et al., 2014).

In Pakistan, climatic conditions are very conducive that favor the good quality production of tomatoes round a year. Pakistan annually produces two crops; first in spring and second in autumn. However, it can be grown throughout the year in the southern part of Pakistan. In Pakistan, tomato is grown on an area of 1680 and 38549 hectares with an average production of 142114 and 423930 tonnes during Kharif (summer) and Rabi (winter) seasons, respectively. Sindh province contributes a major proportion of tomato production (202386 Tonnes) followed by Punjab (94549 Tonnes) and KPK (31552 Tonnes), particularly in Rabi

season (GOP, 2016). Besides the nutritional and economic importance of tomatoes, several biotic and abiotic factors are responsible for the decline in yield. The yield of tomatoes is also affected by many pathogenic diseases every year. The world over reported diseases of tomato are about 59, including 17 viral, 28 fungal, 4 bacterial, 3 plants parasitic nematode, and 4 miscellaneous diseases or disorders (Jones et al., 1993). Among these, the common fungal diseases are damping-off of seedlings and wilt of the adult crop (Fusarium oxysporum f. sp. lycopersici, Rhizoctonia solani, Pythium spp. and Verticillium albo-atrum) and fruit rot (Alternaria tenuis). These diseases are responsible to deteriorate quantity and quality of the product and the yield losses are reported from 30 to 100% in tropical regions (Pandey et al., 2017). Opportunistic pathogens which generally cause fruit rots diseases are such kinds of microorganisms though survive on the debris of plant. Such microorganisms can infect wounded and/or exposed tissues that do not have a protective surface. These microbes are normally good saprophytes that can be found everywhere in nature. At the time of harvesting and different handling stages unintentionally several cuts and punctures (mechanical injuries) are occurring, which are the initial and frequent sites for post-harvest rot development on the fruit surface. Inconsistently, those that have entered deeply in tissues below the surface of fruit (internalized pathogens) also cause inside rots in the fruit (Charchar et al., 2003). Moreover, certain fungi can colonize the damaged tissues due to internal bruises occurred during harvest, and ultimately producing black rot. Normally, the lesions that are quickly developing are a major cause of texture loss progress until the fruit collapse (soft rots). The structures and materials are produced during lesion development and progression that can cause rot to other nearby adjacent fruits, leading to a nest of infection. Post-harvest handling, weak storage practices, transportation, and improper marketing are the major contributing factors for fruit rot disease in tomatoes (Rani and Khetarpaul, 2009).

Alternaria species have been a major plant pathogens world nowadays. It causes at least 20% of agricultural spoilage, while severe losses may reach up to 80% of yield. It affects the leaves, stems, flowers, and fruits. This pathogen severely damages tomato production by causing a disease namely tomato fruit rot (Nowicki et al., 2012). Tomato post-harvest rot is becoming a major threat in Pakistan including all provinces and cities. The control of tomato fruit rots is going to be a big challenge for researchers as the intensity of this disease is still known in different regions of Pakistan. Under such situations, it is impossible to implement preventive and curative strategies against this threatening disease. The present research was therefore organized to focus on the main tomato producing city of Pakistan, whereby the key objective was to estimate the intensity of tomato fruit rot disease for the formulation of future research and integrated tomato fruit rot management strategies.

Materials and Methods

Study Location

The present study was conducted in the laboratories of the Department of Plant Protection, Sindh Agriculture University, Tandojam, Pakistan, and surrounding tomato fields, local shops, and big markets.

Estimation of Tomato Post-Harvest Rot

Survey for tomato post-harvest rot was conducted from February to April 2017 in the surrounding of Tandojam viz; Tando Allahyar, Sultanabad Vegetable Market, Tandojam city, Tando Qaiser, Bahawal Zaur, and Hyderabad Vegetable Market to estimate the tomato postharvest rots.

A total of 20 tomato growers/farmers from different fields, 30 brokers from vegetable markets, and 23 small shopkeepers were interviewed based on the proforma developed in the current study. A comprehensive set of questionnaires was developed to record the interviews of the selected respondents. The questionnaire comprised the queries about tomato fruit rot losses, production, and marketing (Table 1). Primary data were collected which included the field, market, and shops for fruit post-harvest losses. Farmers, brokers, and shopkeepers were interviewed using a structured questionnaire with open and closed questions. The questions sought to obtain information on production, grading, sale, and post-harvest losses. To estimate the percent fruit rot caused by fungi, a total of 20 fruits from each farmer's field, 10 from each broker of the vegetable market, and all available injured/rotted samples from each small shopkeeper were randomly observed based on the visual symptoms produced by fruit rot causing fungi. The disease intensity (Percentage of infected fruit: PIF) was calculated by using the formula of diseases incidence as under:

$$PIF=\frac{\text{Number of Infected Fruits}}{\text{Total Number of Observed Fruits}}\times 100$$

Laboratory Confirmation of Post-Harvest Tomato Rot

Random samples were collected from the fields, markets, and small shops and brought to the laboratory, department of Plant Protection. The collected samples were washed with tap water and small pieces of infected portion were cut. Pieces were surface sterilized in 0.1% mercuric chloride solution for 30 seconds and then washed with sterilized distilled water thrice. After drying the sample pieces, five bits were transferred aseptically to the Petri-dishes containing sterile potato dextrose agar (PDA) medium amended with an antibacterial agent and filled up to quarter strength. The inoculated plates were incubated at 25±20°C. The culture, thus, obtained was subjected to purification. A single spore culture technique was used to purify the isolates. Further, slides of fungal isolates from pure cultures were made and observed under a light microscope. Morphological and cultural characters of isolated fungi were recorded and compared with standard keys for establishing their identity (Barnett and Hunter, 1972; Nelson et al., 1983).

Statistical Analysis

The data obtained in present were statistically analysed by using the standard procedures for analysis of variance, ANOVA (linear model), and mean separation (least significant difference, LSD) of all parameters including frequency (%), fruit infection (%) (after calculating with corresponding formulas) were analysed by using the computer software Statistics 8.1 (Analytical Software, 2005). All differences described in the text were significant at the 5% level of probability. Some data were analysed using MS Excel Programme of MS Office 2007.

Table 1. The questionnaire used for the collection of information and further analysis of data for tomato fruit

A. Farmer/Growers									
S. No	Name of G/F/L	T. Cropped Area (Acre)	T. Production (Kg)	Field Grading A	B	C	T. S. Taken from C grade	Infected S.	Infection (%)
1									
2									
B. Brokers									
S. No	Name of Broker/M	T. Purchase (Kg)	T. Sale (Kg)	Market Grading A	B	C	T. S. Taken from C grade	Infected S.	Infection (%)
1									
2									
C. Shopkeeper/seller									
S. No	Name of shopkeeper/Sh/L	T. Purchase (Kg)	T. Sale (Kg)	Shop Grading A	B	C	T. S. Taken from C grade	Infected S.	Infection (%)

Grading: A = First Class; B = Second Class; C = Mechanical injury/rotted/infected, G: Grower, F: Farmer, L: Location, T: Total, S: Sample, M: Market, Sh: Shop

Table 2. Information taken based on the questionnaire from different tomato growers/farmers under field conditions

S. No	Location/ Grower	Total Cropped Area (Acre)	Total Production (Kg)	Field Grading		
				A	B	C
1	Sadam	5.5	12800	9600	3200	192
2	Moonwar	3	9120	8640	480	48
3	Sobhat	3	9280	8320	960	80
4	Alidino	2	8320	7360	960	64
5	Ata Muhammad	2.5	6400	5920	480	32
6	Shebair	2.5	7520	6960	560	40
7	Muhammad Khan	2.5	6480	5920	560	32
8	Ali Hassan	5	9600	9120	480	32
9	Mujeeb	3	7200	6960	240	16
10	Irfan	3	6544	6224	320	16
11	Majeed	6	14432	9664	4768	288
12	Muneer	3.5	8928	8416	512	32
13	Abbas	1.5	4448	4320	128	16
14	Shahnawaz	1.5	3200	3040	160	16
15	Hakeem	1.5	4224	4000	224	16
16	Ghalum Shah	4.5	8080	7840	240	16
17	Shokat	5	9728	9328	400	16
18	Saleem	4	5056	4768	288	16
19	Rasheed	3	6416	6080	336	32
20	Abid	3.5	8368	7808	560	32
Total		66	156144	140288	15856	1032
Mean		3.3	7807.2	7014.4	792.8	51.6
Per Acre		1.1	2602.4	2338.13	264.266	17.2
SE		0.298	611.65	436.26	255.5	15.317

Results

The estimation of post-harvest losses of tomato fruits was calculated based on the interviews conducted through open and close questions structured in the questionnaire of the current study. The data collected from 20 different farmers/growers of the Tando Allahyar region indicates the total mean production of about 2602.4 Kg per 1.1 acres as per their verbal discussion. They also categorized their products into different field grades based on the quality of tomatoes like size, colour, and mechanical injuries or diseases. About 2338.133 Kg tomato were graded superior as A categories and 264.2667 Kg into B grade category out 2602.4 Kg per 1.1 acres (mean of 20 farmers) as per the requirement of the commercial market. Whereas, about 17.2 Kg tomato fruits per 1.1 acre were spoilt due to mechanical injury during harvesting, insect pest problems, physiological disorders, and fruit rot problems sorted after harvesting (Table 2).

The estimation of post-harvest losses of tomato fruits was calculated from Sultanabad and Hyderabad vegetable markets based on the interviews conducted through open and closed questions structured in the questionnaire of the current study. The recorded from 30 brokers for tomato fruit rot losses, total purchase, and sale per day, market grading showed great variation among different brokers. In Sultanabad vegetable market, a total purchase per day by one broker was 148.8 Kg (mean of 10 brokers) and per day sale was 140.8 Kg. When they were asked for market grading, as per their verbal discussion, a total of 72 Kg was

separated as A grade and 14.4 Kg as B grad tomato fruits (mean of 10 brokers). They also responded for post-harvest losses due to mechanical injury during transportation, physiological disorders, and fruit rot problems for about 22.4 Kg per day. It was also noticed that some brokers were selling without any grading and sorting (Figure 1; Table 3). Similarly, in the Hyderabad vegetable market, a total purchase and sale per day by one broker has recorded 310.4 and 255.2 Kg (mean of 20 brokers), respectively. For market grading, 261.33 Kg were separated as A grade and 50.667 Kg as B grad tomato fruits (mean of 20 brokers). The post-harvest losses due to mechanical injury during transportation, physiological disorders, and fruit rot problems as per their verbal feedback; 23.11 Kg per day was recorded. Similar to Sultanabad, some brokers were selling without any grading and sorting in the Hyderabad vegetable market (Table 3).

The response of 23 small shopkeepers interviewed based on the proforma developed in the current study also showed great differences among all noticed parameters. In Tandojam city, a total purchase per day by one shopkeeper has recorded 124.8 Kg (mean of 10 brokers) and per day sale noticed was 98.8 Kg. When they were asked for tomato grading, as per their verbal discussion, a total of 65.2 Kg was separated as A grade and 22.1 Kg as B grad tomato fruits (mean of 10 brokers) in their shops. They also responded for post-harvest losses due to mechanical injury during transportation, physiological disorders, and fruit rot problems for about 14.3 Kg per day. It was also noticed that some shopkeepers were selling without any grading and sorting of tomato fruits in their shops (Table 4). Similarly, in Tando Qaiser, a total purchase and sale per day by one shopkeeper were recorded 56 and 39.3 Kg (mean of 10 Shopkeepers), respectively. For tomato grading at the shop, 22.4 Kg were separated as A grade and 7.4 Kg as B grad tomato fruits (mean of 20 brokers). The post-harvest losses due to mechanical injury during transportation, physiological disorders, and fruit rot problems as per their verbal feedback; 07 Kg per day was recorded. Similar to Tandojam, some shopkeepers were selling without any grading and sorting in Tando Qaiser (Table 4).

Table 3. Information taken based on the questionnaire from different tomato brokers in commercial markets

S. No	Market/ Broker	Total Purchase (Kg/Day)	Total Sale (Kg/Day)	Market Grading		
				A	B	C
Sultanabad Vegetable Market (28-2-2017)						
1	Raza Ali	208	192	160	32	16
2	Mansokah	160	144	128	32	32
3	Gewan Das	128	128	Mixed		16
4	Ashok Kumar	160	144	Mixed		16
5	Terath Raj	128	128	Mixed		16
6	Lukhy	80	80	64	16	16
7	Wasiu	64	64	48	16	16
8	Irfan Ahmed	192	176	144	16	32
9	Gulab	128	128	Mixed		16
10	Altaf	240	224	176	32	48
	Total	1488	1408	720	144	224
	Mean	148.8	140.8	72	14.4	22.4
	SE	17.37	15.235	21.367	3.5777	3.5377
Hyderabad Vegetable Market (02-03-2017)						
1	M. Afzal	480	416	352	80	48
2	Sardar	192	176	Mixed		
3	Noor Muhammad	288	256	192	64	32
4	Naeem	192	160	176	16	0
5	Vakram	320	240	Mixed		
6	Wanood	224	176	192	16	16
7	Iftikhar	160	128	128	16	16
8	Shankar	400	320	304	48	48
9	Manthar	480	400	Mixed		0
10	Barkat	192	144	Mixed		0
11	Asghar	480	368	272	112	96
12	Ali Muhammad	400	336	304	64	48
13	Papoo	240	144	Mixed		0
14	Haji Ramzan	400	368	336	48	16
15	Ali Ahmed	160	160	Mixed		0
16	Faheem	240	192	Mixed		0
17	Imran	400	400	320	32	48
18	Iqbal	432	288	320	80	32
19	Noor Ali	240	208	Mixed		0
20	Mujtaba	288	224	240	32	16
Total		6208	5104	3136	608	416
Mean		310.4	255.20	261.33	50.67	23.11
SE		25.34	22.008	21.24	8.77	6.23

Table 4. Information is taken based on the questionnaire from different tomato seller/shopkeeper in the bazaar

S. No	Location/ Shopkeeper	Total Purchase (Kg/Day)	Total Sale (Kg/Day)	Market Grading (Kg)		
				A	B	C
	Tandojam (30-1-2017)					
1	Arshad	32	24	20	8	4
2	Aslam	32	21	22	6	4
3	Janie	64	46	40	14	10
4	Ahmed Ali	128	112	80	33	15
5	Aamir	96	80	70	14	12
6	Abdul Aziz	144	120	100	24	20
7	Aziz	80	65	50	7	8
8	Shokat	96	70	Mixed		10
9	Muhammad Usman	320	265	160	65	40
10	Ali Muhammad	256	185	110	50	20
	Total	1248	988	652	221	143
	Mean	124.8	98.8	65.2	22.1	14.3
	SE	29.867	24.138	15.253	6.9764	3.3667
	Bahawal Zaur (03-02-2017)					
1	Ashfaque Ali	32	20	18	9	5
2	Azim	16	10	9	5	2
3	Aziz	48	30	30	10	8
	Total	96	60	57	24	15
	Mean	32	20	19	8	5
	SE	9.2376	5.7735	6.0828	1.5275	1.7321
	Tando Qaiser (29-1-2017)					
1	Roshan Khaskheli	48	30	30	8	10
2	Ashfaq Nizamani	80	65	50	15	15
3	Fateh Ali Dhamach	32	24	24	6	2
4	Ashfaq Nizamani (Kharo Khoh)	64	48	40	10	14
5	Sheeral Khore	80	48	45	20	15
6	Ghulam Nabi Lohar	48	45	Mix	0	0
7	Hanif Nizamani	96	65	Mix	0	0
8	Abdul Majeed	64	40	35	15	14
9	Rasheed Nizamani	32	20	Mix	0	0
10	Shanjan	16	8	mix	0	0
	Total	560	393	224	74	70
	Mean	56	39.3	22.4	7.4	7
	SE	8	5.9424	3.9299	2.3627	2.2509

The response of shopkeepers in Bahawal Zaur also remained almost the same as to Tandojam and Tando Qaiser. A total purchase and sale per day by one shopkeeper have recorded 32 and 20 Kg (mean of 03 Shopkeepers), respectively. For tomato grading at the shop, 19 Kg were separated as A grade and 8 Kg as B grad tomato fruits (mean of 03 shopkeepers). The post-harvest losses due to mechanical injury during transportation, physiological disorders, and fruit rot problems as per their verbal feedback; 05 Kg per day was recorded (Table 4).

Alternaria Post-Harvest Tomato Fruit Rot Intensity

Survey for tomato post-harvest fruit rot caused by Alternaria sp. conducted in the surrounding of Tandojam viz; farmer's field in Tando Allahyar, Sultanabad and Hyderabad vegetable markets, small shops of Tandojam city, Tando Qaiser and Bahawal Zaur showed great variability. The percent of infected fruits by Alternaria in 20 different farmer/grower's fields is presented in Figure 2. The fruit rot infection noticed among all 20 different fields was ranged from 5 to 65%. However, the mean percent of infected fruits by Alternaria for all 20 farmers/grower's fields was recorded at 31.85% (Figure 2).

The percent of infected fruits by Alternaria in Sultanabad and Hyderabad vegetable markets also showed the variation (Figure 3 and 4). The fruit rot infection noticed in both vegetable markets, Sultanabad and Hyderabad; was ranged from 20 to 60% and 10 to 70%, respectively. However, the mean percent of infected fruits by Alternaria for Sultanabad and Hyderabad vegetable markets were recorded 37 and 38.5%, The results regarding the percent of infected fruits by Alternaria in small shops of Tandojam, Tando Qaiser, and Bahawal Zaur is presented in Figure 5. The fruit rot infection was ranged from 16.67 to 60% in Tandojam city, whereas in Tando Qaiser it was ranged from 16.67 to 53.33%, respectively. However, the mean percent of infected fruits by Alternaria in both Tandojam and Tando Qaiser shops were recorded 36.187 and 35.46%, respectively (Figure 5). On overall basis farmer fields, vegetable markets, and small shops were also compared for percent of post-harvest fruit rot of tomato. The result revealed 30 percent infected fruit by Alternaria under field conditions, 36 percent at the vegetable market, and 43 percent at small shops level (Figure 6).

Figure 1. Different grading of tomato-based on the quality of tomato

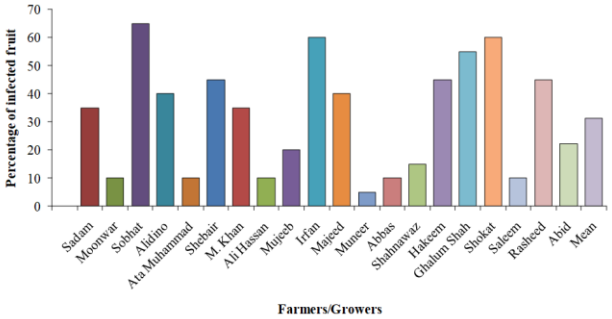

Figure 2. Percentage of fruit infected with Alternaria rot observed under field conditions

SE = 4.4487, LSD (P<0.05) = 0.0000

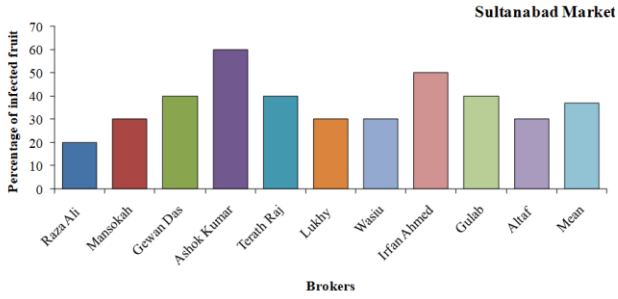

Figure 3. Percentage of fruit infected with Alternaria rot observed under the vegetable market of Sultanabad.

SE = 4.0000, LSD (P<0.05) = 0.0001

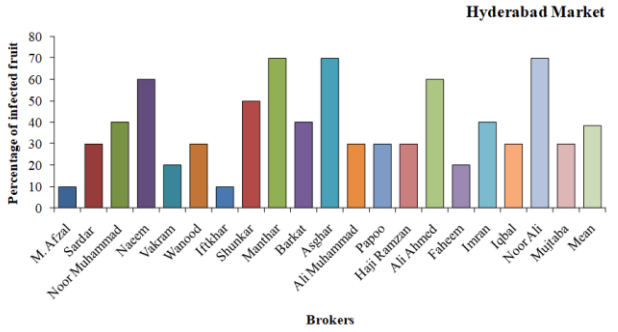

Figure 4. Percentage of fruit infected with Alternaria rot observed under the vegetable market of Hyderabad.

SE = 4.1295, LSD (P<0.05) = 0.0000

Discussion

Tomato is a highly perishable crop and more than 50% of these produces are lost between productions to consumption (Oyeniran, 1988). The main reasons for post-harvest losses are external damages that occurred during harvesting and handling, improper harvesting at the maturity stage, and then decaying (Thorne and Alvarez, 1982). The current research was conducted to estimate the intensity of tomato post-harvest rot in the surroundings of Tandojam to plan future research work and integrated tomato fruit into management strategies. Moreover, post-harvest handling, weak storage practices, transportation, and improper marketing are seriously affecting the quality of tomatoes. It has been reported that any change in the availability, edibility, wholesomeness, or quality of food that prevents it from being eaten by man is known as the post-harvest loss (Mbuk et al., 2011). In the current study, a survey for tomato post-harvest losses and fruit rot was conducted. The estimation of post-harvest losses of tomato fruits was calculated based on the interviews conducted through open and close questions structured in the questionnaire of the current study.

The data collected from 20 different farmers/growers of the Tando Allahyar region indicates the total mean production of about 2602.4 Kg per 1.1 acres as per their verbal discussion. They also categorized their products into different field grades based on the quality of tomatoes like size, color, and mechanical injuries or diseases. About 2338.133 Kg tomato were graded superior as A categories and 264.2667 Kg into B grade category out 2602.4 Kg per 1.1 acres (mean of 20 famers) as per the requirement of the commercial market. Whereas, about 17.2 Kg tomato fruits per 1.1 acre were spoilt due to mechanical injury during harvesting, insect pest problems, physiological disorders, and fruit rot problems sorted after harvesting. The data recorded from 30 brokers for tomato fruit rot losses, total purchase, and sale per day, market grading showed great variation among different brokers. In the Sultanabad vegetable market, post-harvest losses due to mechanical injury during transportation, physiological disorders, and fruit rot problems for about 22.4 Kg per day.

Similarly, in the Hyderabad vegetable market, a total purchase and sale per day by one broker has recorded 310.4 and 255.2 Kg (mean of 20 brokers), respectively. For market grading, 261.33Kg were separated as A grade and 50.667 Kg as B grad tomato fruits (mean of 20 brokers). The post-harvest losses due to mechanical injury during transportation, physiological disorders, and fruit rot problems as per their verbal feedback; 23.11 Kg per day was recorded. Similar to Sultanabad, some brokers were selling without any grading and sorting in the Hyderabad vegetable market. The response of 23 small shopkeepers for post-harvest losses due to mechanical injury during transportation, physiological disorders, and fruit rot problems for about 07-14.3 Kg per day, depending upon the consumption of the city. The magnitude of post-harvest losses varies from one country to another, one season to another, and even one day to another (Mujib et al., 2007). It has also been reported that worldwide post-harvest losses are about 25% or 28-42%, and 15-50% or 15-60% in less developed countries. This means that half quantity of food never reaches the consumers.

To reduce post-harvest losses through economical procedures will not only decrease food losses but will also be beneficial for the farmers economically. It is safe to say that post-harvest losses occur in all countries, but the extent of such losses is greater in third world countries (Zaldivar, 1991).

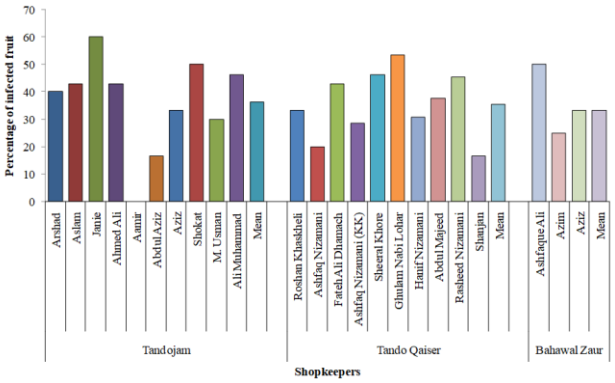

Figure 5. Percentage of fruit infected with Alternaria rot observed under different small shops

SE = 5.4748 5.7609 7.3495

LSD (P<0.05) = 0.0001 0.0001 0.0099

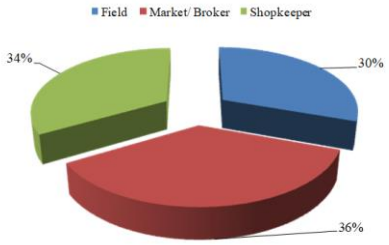

Figure 6. Overall percent infected fruit by *Alternaria* under field, market and shops level

SE = 1.7004, LSD (P<0.05) = 0.0024

Numerous micro-organisms cause post-harvest decay of tomatoes (Obetta et al., 2011). However, tomato fruit rots are mainly caused by fungi such as Geotrichum candidum, Rhizopus stolonifer, black mold rot caused by Alternaria sp., Fusarium rot by Fusarium sp. are more commonly occurring (Burgess et al., 1985; Jofee, 1986; Nelson et al., 1990). Amongst all, Alternaria rot has been considered as the most serious disease of tomato fruits and causes heavy losses in the quality of the fruits, thus rendering a large number of tomato fruits unfit for consumption. Barkai and Fauchs (1980) and Hassan (1996) have reported that Alternaria is the main decay-causing organism of post-harvest tomato fruits while responsible for black rot lesions on tomato fruits. The present study, also calculated the percent of infected fruits by Alternaria in 20 different farmer/grower's fields. The fruit rot infection noticed among all 20 different fields due to Alternaria was ranged from 5 to 65%. However, the mean percent of infected fruits by Alternaria for all 20 farmers/grower's fields was recorded at 31.85%. The fruit rot infection noticed in both vegetable markets, Sultanabad and Hyderabad; was ranged from 20 to 60% and 10 to 70%, respectively. However, the mean percent of infected fruits by Alternaria for Sultanabad and Hyderabad vegetable markets were recorded 37 and 38.5%, respectively. The fruit rot infection in the small shop was ranged from 16.67 to 60%. However, the mean percent of infected fruits by Alternaria was around 36.187 and 35.46%. On an overall basis 30 percent infected fruit by Alternaria was recorded under field conditions, 36 percent at the vegetable market, and 43 percent at small shops level. The magnitude of post-harvest losses always varies from one country to another country and one season to another and even one day to another (Mujib et al., 2007; Sajad, 2017). Our studies are in agreement with Nowicki et al. (2012), who reported that Alternaria species are major plant pathogens, which cause at least 20% of agricultural spoilage; most severe losses may reach up to 80% of yield, affecting the leaves, stems, flowers, and fruits. Recently, Sajad et al. (2017) observed that most of the tomato fruits have been suffered from fruit rot disease caused by Alternaria alternata, Aspergillus niger, Geotrichum candidum, Alternaria solani, Mucor racemosus, Aspergillus flavus, Fusarium oxysporum, Fusarium moniliforme, Penicillium digitatum, Rhizopus stolonifer, Alternaria alternata, Colletotrichum lycopersici, Sclerotium rolfsii, Myrothecium roridum, Phoma destructive, and Trichothecium roseum. However, they also reported the maximum percentage frequency (I6.51%) of occurrences on all tomato fruits for Alternaria alternata. Therefore, control of tomato fruit rots always remained a challenge for researchers not only in Sindh, Pakistan; however, throughout the world.

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