Original Research Article

Effect of organic manures on yield and quality characteristics of pomegranate (*Punica granatum* L.) cv. Bhagwa

ABSTRACT

The research work carried out during *Mrig bahar* (July to December) in 2019 and 2020 at Technology park, CTAE and laboratories of Department of Horticulture, Rajasthan College of Agriculture, MPUAT, Udaipur (Rajasthan). It was conducted to investigate the effect of organic manures on yield and quality characteristics of pomegranate (*Punica granatum* L.) cv. Bhagwa. 6 years old 42 pomegranate plants consisted of 14 treatments with different organic manures which are tested with randomized block design with three replications. Results showed that among all the treatments, the organic combination T_{13} - *Jeevamrut* 16.08 L plant^{-1} + Vermicompost 24.79 kg plant^{-1} has recorded significantly effect on fruit yield characteristics like fruit volume (190.50 cm^3) and fruit quality characteristics such as total soluble solids (13.54 ^{o}Brix), ascorbic acid (19.05 mg/100 ml juice) and reducing sugar (9.68 %) on pooled data basis of both the year 2019 and 2020.

Conventional (chemical based) farming is non-sustainable because of many problems such as loss of soil health and productivity from excessive erosion and associated plant nutrient losses, surface and ground water pollution from fertilizers and sediments, impending of non-renewable resources and low farm income from high production costs. In view of these, there is an increasing awareness about alternate agriculture system known as organic farming an approach where the aim is to create integrated, human environmentally and economically sustainable agricultural production systems.

Keywords: Pomegranate, organic, quality, vermicompost, *Jeevamrut*, NADEP and FYM

INTRODUCTION

Pomegranate (*Punica granatum* L.) is an important commercial fruit crop grown in south- western part of Rajasthan. This fruit crop can tolerant drought, salinity, winter hardy and also thrives well under rainfed conditions. Its cultivation steadily increasing because of the high commercial value of this fruit. Consumer interest in its consumption due to the organoleptic characteristics of the arils (seeds) and to the beneficial effects on health (Ephraim and Robert, 2007). In Rajasthan, it covering about area of 10,352 ha and with a production of 63,608 MT. Barmer, Jalore, Jaisalmer, Jodhpur, Sirohi, Chittorgarh, Bhilwara

and Udaipur are the most important pomegranate growing districts (Anonymous, 2020).

Improvement in nutrient availability (Sudhakar *et al.,* 2002), soil physical conditions and enzymatic activity have been reported by vermicompost application in fruit crops. Vermicompost is rich in organic carbon, which plays a key role in soil fertility and contains all essential plant nutrients in appropriate proportion. Thus, it is a complete and balanced plant food. It also contains biochemical substances that promote plant growth and fight against plant diseases. The use of vermicompost not only increases the rate of water intake into the soil but also improves the soil's ability to hold water. Its use enhances colour, smell, taste, flavour and keeping quality of fruits.

FYM being a bulky organic manure improves soil aeration in addition to the supply of essential plant nutrients and organic matter thereby increasing the soils biological activities. FYM also provided room for better microbial establishment along with the accumulation of excess humus content (Mohapatra *et al.*,2016).

Compost improves drainage and absorption of moisture in soils with structural deficiencies or lack of nutrients. They also make it possible to increase crop productivity, promote plant growth by incorporating essential nutrients, facilitate implementation in different types of soil, reduce runoff and obtain economic benefits for farmers. Adding organic composts to apple orchard soils has been shown to improve the blooming and growth of newly planted trees and fruit yields (Mosa *et al.,* 2014).

According to Boraiah *et al.* (2017) the application of *Jeevamrit* promotes biological activity in the soil and makes the nutrients available to the crop. Higher microbial load and growth hormones which might have enhanced the soil biomass thereby sustaining the availability and uptake of applied as well as native soil nutrients resulted in better growth and yield of crops. *Jeevamrit* contains an enormous amount of microbial load which multiplies in the soil and acts as a tonic to enhance microbial activity in soil.

Therefore, in view of above mention this study was conducted to out-come the better nutritional composition of organic manures which improve the yield and quality characteristics of pomegranate fruit crop.

MATERIALS AND METHODS

Experimental site and description

The research work carried out during *Mrig bahar* (July to December) in 2019 and 2020 at Technology park, CTAE and laboratories of Department of Horticulture, Rajasthan College of Agriculture, MPUAT, Udaipur (Rajasthan) located at 582.17 m above mean sea

level with coordinates of 24º 34´ N latitude and 73º 42´ E longitudes. The experimental site's soil has pH 8.5, with clay loam texture, medium organic carbon (0.644 %), low in available nitrogen (272.68 kg ha^{-1}), available phosphorus (23.90 kg ha^{-1}) and available potassium (292.82 kg ha^{-1}). The weekly meteorological parameters of the experimental site were recorded during the crop season of 2019 and 2020. The maximum temperature (42.90 & 40.80°C) and relative humidity (94.3 & 95.7 %) was recorded in 2019 and 2020, respectively, the minimum temperature (4.7 & 3.8°C), relative humidity (11.3 and 19.9 mm) and annual rainfall (1160.6 and 862.7 mm) were recorded during 2019 and 2020, respectively are presented in Fig 1.

Experimental design and treatments

This experiment was laid out in Randomized Block Design. There were 14 treatment combinations [T_1-Control, T_2- RDF (600: 200: 200g NPK $Plant^{-1}$ $year^{-1}$), T_3- FYM (120.72 kg $plant^{-1}$), T_4- Compost (54.10 kg $plant^{-1}$), T_5- Vermicompost (49.58 kg $plant^{-1}$), T_6- NADEP Compost (70.83 kg $plant^{-1}$), T_7- *Jeevamrut* (32.17 L $plant^{-1}$), T_8- FYM (60.36 kg $plant^{-1}$) + Compost (27.05 kg $plant^{-1}$), T_9- FYM (60.36 kg $plant^{-1}$) + Vermicompost (24.79 kg $plant^{-1}$), T_{10}- FYM (60.36 kg $plant^{-1}$) + NADEP compost (35.41 kg $plant^{-1}$), T_{11}- *Jeevamrut* (16.08 L $plant^{-1}$) + FYM (60.36 kg $plant^{-1}$), T_{12}- *Jeevamrut* (16.08 L $plant^{-1}$) + Compost (27.05 kg $plant^{-1}$), T_{13}- *Jeevamrut* (16.08 L $plant^{-1}$) + Vermicompost (24.79 kg $plant^{-1}$) and T_{14}- *Jeevamrut* (16.08 L $plant^{-1}$) + NADEP (35.41 kg $plant^{-1}$)] with 3 replications and in each replication one tree served as a treatment unit. Thus 42 trees were marked for the experiment.

Considering the medicinal importance of pomegranate fruits, more rational approach to organic cultivation including exploitation of various locally available organic manures such as FYM, vermicompost, compost, NADEP compost and *Jeevamrut* should be practically implemented to rejuvenate the depleted soil fertility and enrich the available pool of nutrients to the plants, which could benefit the having long maturity time.

RESULTS AND DISCUSSION

Yield characteristics

The pomegranate yield is an ultimate objective of the growers to get maximum returns per unit area per unit time. The fruit yield characteristics of the crop significantly increased with the application of organic manures and inorganic fertilizer, except fruit diameter and fruit length recorded non-significant (Table 1). The application of treatment T_2

- recommended dose of fertilizer (RDF- 600: 200: 200 g NPK plant^{-1}) has recorded maximum the fruit volume (187.01, 196.33 and 191.67 cm^3), which was statistically at par with organic treatment combination T_{13} - *Jeevamrut* 16.08 L plant^{-1} + Vermicompost 24.79 kg plant^{-1} has recorded fruit volume (185.34, 195.66 and 190.50 cm^3) during the experimental year 2019, 2020 and pooled data, respectively.

The result shows that the inorganic fertilizer had significantly promote the yield characteristics which was statistically at par with organic manures. The better results of inorganic fertilizer was due to increased supply of major plant nutrients, which are required in larger quantities for growth and development of plants. The application of nitrogen at optimum level attributed to acceleration in development of growth and reproductive phases. Ray *et al.* (2014) found that the yield of pomegranate plant significantly increased with different levels of nitrogen.

Among the different organics, vermicompost proved best and the growth was superior, which could be attributed to the readily available and higher nutrient content in vermicompost. The improvement in growth may also be due to better moisture retention capacity and supply of nutrients due to favourable soil condition brought out by vermicompost application. Improve up take of nutrients during vital growth period, synthesis of carbohydrates, translocation and water status of plants might have enabled the plant to put up better vegetative growth and profuse flowering combined with high fruit set resulting in higher number of fruits per plants, increase diameter and length of fruits. Nutrients in organic manures were released slowly and made available throughout the growth period and resulted in better uptake of nutrients, plant vigour and yield of the plants. Increased microbial population and better soil physical environment could have facilitated easy absorption of nutrients in balanced form which translated into increased fruit diameter, fruit length and fruit volume. Marathe *et al.* (2017) found that application of poultry manure recorded highest fruit yield in pomegranate. Similar results was observed by Pachuau *et al.* (2019) in Assam lemon.

Supply of nutrients might have increased the production, translocation and accumulation of photosynthates into sink. This might have stimulated the plants to produce productive flowers ultimately resulting in increased fruit diameter, fruit length and fruits volume (Anisa *et al.*, 2016) in okra. Beura *et al*. (2017) recorded that the increase in number of fruits owing to this treatment might be due to the greater availability of mineral nutrient from nitration of vermicompost.

The beneficial effects of *Jeevamrut* reported by Boraiah *et al.* (2017) was attributed to higher microbial load and growth hormones which might have enhanced the soil biomass thereby sustaining the availability and uptake of applied as well as native soil nutrients which ultimately resulted in better growth and yield of capsicum. These research findings are in accordance with Chaudhari *et al*. (2016), the liquid manures (*Panchgavya*, *Jeevamrut* and *Sanjeevak*) provide balanced nutrition to the crops and helped to improve the yield as it provides readily available nutrients, growth hormones and microbes to *Vigna radiata*. Gore and Sreenivasa (2011) concluded that *Jeevamrut* contains enormous amount of microbial load which multiply and act as soil tonic. Its application enhances microbial activity in the soil and ultimately ensuring the availability and uptake of nutrients by the crops. *Jeevamrut* promotes immense biological activity in soil and enhance nutrient availability to crop. *Jeevamrut* is a low-cost improvised preparation that enriches the soil with indigenous microorganisms and helps for mineralization.

The increased fruit diameter, fruit length and fruit volume basis might be attributed due to the fact that, increasing levels of nutrients in assimilating area of crop due to which the yield characteristics was enhanced. Similarly, due to rational partitioning of economic sink, the quality attributes were improved. The above results are in conformity with the findings in sapota (Baviskar *et al.,* 2011). Increase in fruit volume and yield due to application of organic manures was might be responsible for synthesis of plant growth hormone, development of root system and therefore high nutrient utilization by crop plants (Kaur and Singh, 2019 in cape gooseberry). Similar, findings have been reported by Singh and Singh (2013) in tomato.

Quality characteristics

The effect of organic manures upon fruit quality characteristics like TSS (^{o}Brix), ascorbic acid (mg/100 ml juice) and reducing sugar (%) were recorded significant but colour of fruit, acidity and TSS/acidity ratio has found non-significant with organic manures application during investigation (Table 2 & 3). The highest total soluble solids (13.30, 13.78 and 13.54 ^{o}Brix), ascorbic acid (18.66, 19.44 and 19.05 mg/100 ml juice) and reducing sugar (9.54, 9.81 and 9.68 %) were recorded with organic combination T_{13}- *Jeevamrut* 16.08 L plant^{-1} + Vermicompost 24.79 kg plant^{-1} which was at par with the treatment T_2- RDF (600: 200: 200g NPK Plant^{-1} year^{-1}) as compare to control T_1 (nothing applied) during the experimental year 2019, 2020 and pooled data, respectively.

The quality characteristics of pomegranate was significantly influence with the application of organic manures as compare to inorganic fertilizer. Because organic manures

like vermicompost which contains essential nutrients in accessible forms which escalates the plant growth by easily supplying to plant physiological activity. There was enhancement in the physico-chemical properties of soil, enzymatic activity and microbial population due to the imposition of vermicompost. The improvement in quality of fruits may be due to the proper supply of micronutrients and induction of hormones, which enhances cell division and elongation, improve fruit size and weight, root development, water uptake and deposition of nutrients. It may also be due to the increased N addition and catalytic activity of several enzymes (Pachuau *et al.,* 2019).

Application of organic sources improved the quality parameters. This may be due to improvement in soil physical properties like bulk density, hardness, porosity, soil pH, EC, hormone etc., and biological properties like bacteria, fungi, actinomycets and earth worm activity etc. Improvement in soil properties might have improved the root growth, nutrient uptake and quality of pomegranate. Among the organic sources, application of nutrients in the form of vermicompost and *Jeevamrut* combination improved the quality characteristics.

In general quality of the juice of the fruits produced with the application of organic manure was better as compared to inorganic fertilizer. Increased fruit quality of pomegranate with the increased leaf K levels was reported under south Indian conditions (Marathe *et al.,* 2017). Increase in quality parameters in tomato might be due to increased availability of major as well as minor nutrients especially nitrogen and potassium, as they play vital role in enhancing the fruit quality and minimum might be due to lack of availability of sufficient nutrients (Laxmi *et al.*, 2015).

The effect of potassium on fruit quality may be explained from the fact that potassium improved photosynthetic activity and also help in better translocation of metabolites from leaves to fruit (Maity *et al.,* 2006)

The addition of organic manures supplements ample of nutrients, moisture and growth promoting substances which enhances metabolic and hormonal activity of the plant and that promotes production of more photosynthates which was stored in fruits in the form of starch and carbohydrates. It is an established fact that the transformation of mature fruit into ripe form i.e., during the process of ripening the fruit undergoes physical, physiological and biochemical changes. The increase in TSS, Total sugar and ascorbic acid content of papaya fruits could be attributed to the conversion of reserved starch and other insoluble carbohydrates into soluble sugars. The reduction of titratable acidity of papaya fruits through

application of different organic manure with inorganic fertilizer might be due to the positive influence of boron and zinc in conversion of acids into sugar and their derivatives by the reaction involving glycolytic path way or be used in respiration both in fruit crops (Singh *et al*., 2012).

In guava Athani *et al*. (2005) reported that the increased fruit quality parameters are due to the addition of different organic manures and amendments to the soil and in turn to plants, which might had enhanced the biosynthesis and translocation of carbohydrates in to fruits. Further, the availability of nitrogen from different sources might have increased leaf area with higher synthesis of assimilates which is due to enhanced rate of photosynthesis. Such effects have been attributed to increase rate of translocation of photosynthetic products from leaves to developing fruits and thereby increasing total sugars. Similar results have also been reported by Singh *et al*. (2015) in strawberry.

CONCLUSION

It may be concluded that the application of inorganic treatment T_2 - recommended dose of fertilizer (RDF- 600: 200: 200 g NPK plant^{-1}) enhanced fruit yield characteristic like fruit volume (191.67 cm^3) which is at par with organic treatment T_{13} - *Jeevamrut* 16.08 L plant^{-1} + Vermicompost 24.79 kg plant^{-1} has recorded fruit volume (190.50 cm^3). Fruit quality characteristics such as total soluble solids (13.54 ^{o}Brix), ascorbic acid (19.05 mg/100 ml juice) and reducing sugar (9.68 %) were recorded with organic combination T_{13}- *Jeevamrut* 16.08 L plant^{-1} + Vermicompost 24.79 kg plant^{-1}. Based on the above findings, it could be recommended that pomegranate growers should be apply organic combination *Jeevamrut* 16.08 L plant^{-1} + Vermicompost 24.79 kg plant^{-1} to enhance yield and quality characteristics of pomegranate cv. Bhagwa fruits.

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Table 1. Effect of organic manures on fruit yield characteristics of pomegranate cv. 'Bhagwa'.

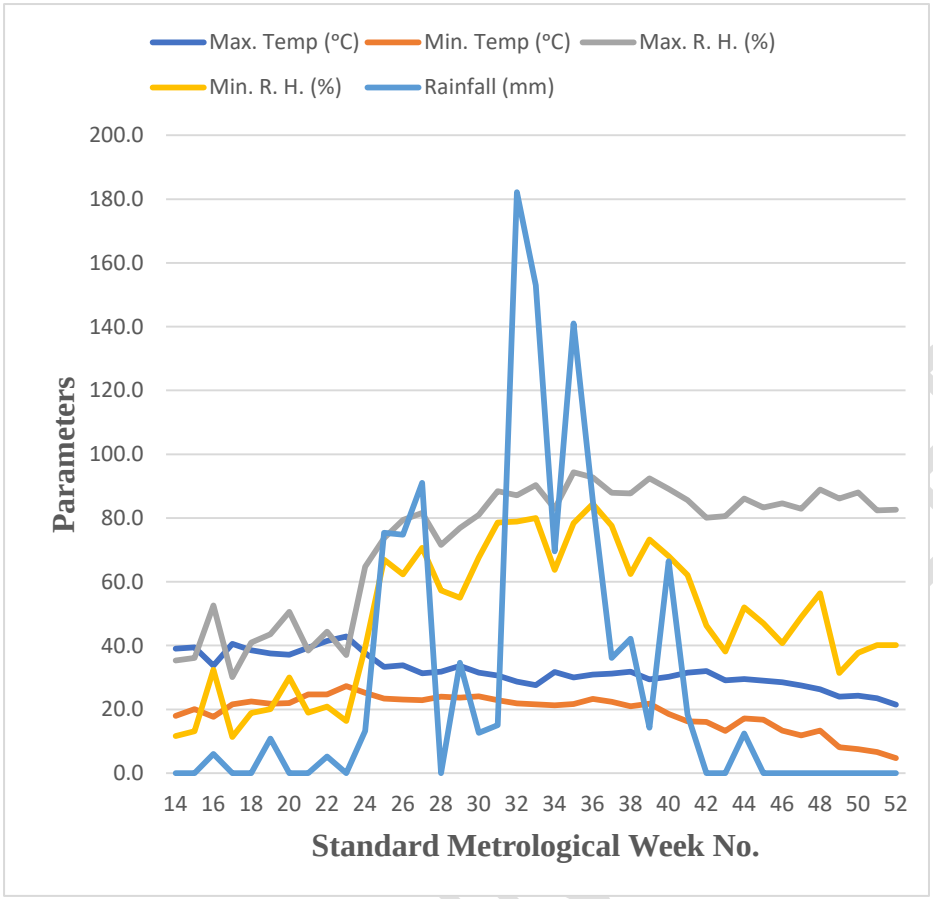
Treatment	Fruit diameter (cm)			Fruit length (cm)			Fruit volume (cm^3)		
	2019	2020	Pooled	2019	2020	Pooled	2019	2020	Pooled
T_1	5.0	5.1	5.1	5.2	5.3	5.2	155.68	162.74	159.21
T_2	6.0	6.2	6.1	6.1	6.3	6.2	187.01	196.33	191.67
T_3	5.3	5.5	5.4	5.3	5.5	5.4	164.37	170.77	167.57
T_4	5.4	5.6	5.5	5.5	5.6	5.5	165.64	172.47	169.06
T_5	5.5	5.7	5.6	5.6	5.7	5.6	171.45	177.34	174.40
T_6	5.2	5.2	5.2	5.3	5.4	5.4	158.46	163.55	161.01
T_7	5.2	5.2	5.2	5.3	5.4	5.4	159.34	164.37	161.86
T_8	5.5	5.7	5.6	5.7	5.8	5.8	175.11	184.00	179.56
T_9	5.6	5.8	5.7	5.7	5.9	5.8	176.39	185.12	180.76
T_{10}	5.5	5.6	5.6	5.5	5.6	5.6	163.47	169.56	166.52
T_{11}	5.7	6.0	5.9	5.8	6.0	5.9	181.07	190.45	185.76
T_{12}	5.8	6.0	5.9	5.9	6.2	6.1	184.66	193.98	189.32
T_{13}	5.9	6.1	6.0	6.0	6.3	6.2	185.34	195.66	190.50
T_{14}	5.4	5.4	5.4	5.5	5.6	5.5	161.53	166.33	163.93
SEm±	**0.22**	**0.24**	**0.15**	**0.24**	**0.24**	**0.16**	**2.75**	**2.86**	**1.83**
CD p=0.05 %	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**7.98**	**8.31**	**5.21**

Table 2. Effect of organic manures on fruit quality characteristics of pomegranate cv. 'Bhagwa'.

Treatment	Colour of fruit (%)			Ascorbic acid (mg/100 ml juice)			Reducing sugar (%)		
	2019	2020	Pooled	2019	2020	Pooled	2019	2020	Pooled
T_1	8.00	8.00	8.00	15.60	16.27	15.94	8.89	9.03	8.96
T_2	8.67	8.67	8.67	18.53	19.31	18.92	9.51	9.74	9.63
T_3	8.33	8.33	8.33	16.50	17.19	16.85	9.20	9.42	9.31
T_4	8.33	8.33	8.33	15.83	17.29	16.56	9.22	9.45	9.34
T_5	8.33	8.67	8.50	17.18	17.73	17.46	9.32	9.60	9.46
T_6	8.00	8.00	8.00	15.62	17.62	16.62	8.93	9.15	9.04
T_7	8.00	8.00	8.00	15.21	15.73	15.47	8.96	9.24	9.10
T_8	8.33	8.33	8.33	17.32	16.13	16.72	9.35	9.63	9.49
T_9	8.33	8.33	8.33	17.82	17.35	17.58	9.38	9.65	9.52
T_{10}	8.00	8.00	8.00	16.56	17.06	16.81	9.05	9.38	9.22
T_{11}	8.33	8.33	8.33	18.00	18.62	18.31	9.45	9.70	9.58
T_{12}	8.67	8.67	8.67	18.24	19.20	18.72	9.50	9.72	9.61
T_{13}	8.67	8.67	8.67	18.66	19.44	19.05	9.54	9.81	9.68
T_{14}	8.00	8.00	8.00	16.18	16.86	16.52	9.00	9.32	9.16
SEm±	**0.45**	**0.44**	**0.29**	**0.51**	**0.66**	**0.39**	**0.15**	**0.16**	**0.10**
CD p=0.05 %	**NS**	**NS**	**NS**	**1.48**	**1.92**	**1.09**	**0.43**	**0.45**	**0.28**

Table 3. Effect of organic manures on fruit quality characteristics of pomegranate cv. 'Bhagwa'.

Treatment	TSS (°Brix)			Acidity (%)			TSS / acid ratio		
	2019	2020	Pooled	2019	2020	Pooled	2019	2020	Pooled
T_1	12.10	12.18	12.14	0.51	0.51	0.51	24.09	23.88	23.99
T_2	13.25	13.64	13.45	0.42	0.40	0.41	31.55	34.92	33.23
T_3	12.33	12.75	12.54	0.46	0.45	0.45	26.81	28.54	27.68
T_4	12.70	12.97	12.84	0.45	0.44	0.45	28.27	29.48	28.87
T_5	12.81	13.06	12.94	0.44	0.44	0.44	29.11	30.49	29.80
T_6	12.00	12.33	12.16	0.48	0.47	0.48	25.09	26.46	25.78
T_7	12.23	12.50	12.37	0.47	0.47	0.47	26.39	26.90	26.64
T_8	12.97	13.25	13.11	0.44	0.43	0.44	29.49	30.81	30.15
T_9	13.02	13.30	13.16	0.43	0.42	0.43	30.28	31.67	30.97
T_{10}	12.50	12.65	12.58	0.46	0.46	0.46	27.17	28.21	27.69
T_{11}	13.09	13.30	13.20	0.42	0.42	0.42	31.17	31.67	31.42
T_{12}	13.15	13.50	13.33	0.42	0.41	0.41	31.31	33.20	32.25
T_{13}	13.30	13.78	13.54	0.41	0.39	0.40	32.45	35.70	34.08
T_{14}	12.35	12.62	12.48	0.47	0.46	0.46	26.55	27.73	27.14
SEm±	**0.21**	**0.22**	**0.14**	**0.02**	**0.02**	**0.01**	**1.03**	**1.61**	**0.88**
CD p=0.05 %	**0.61**	**0.64**	**0.40**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**



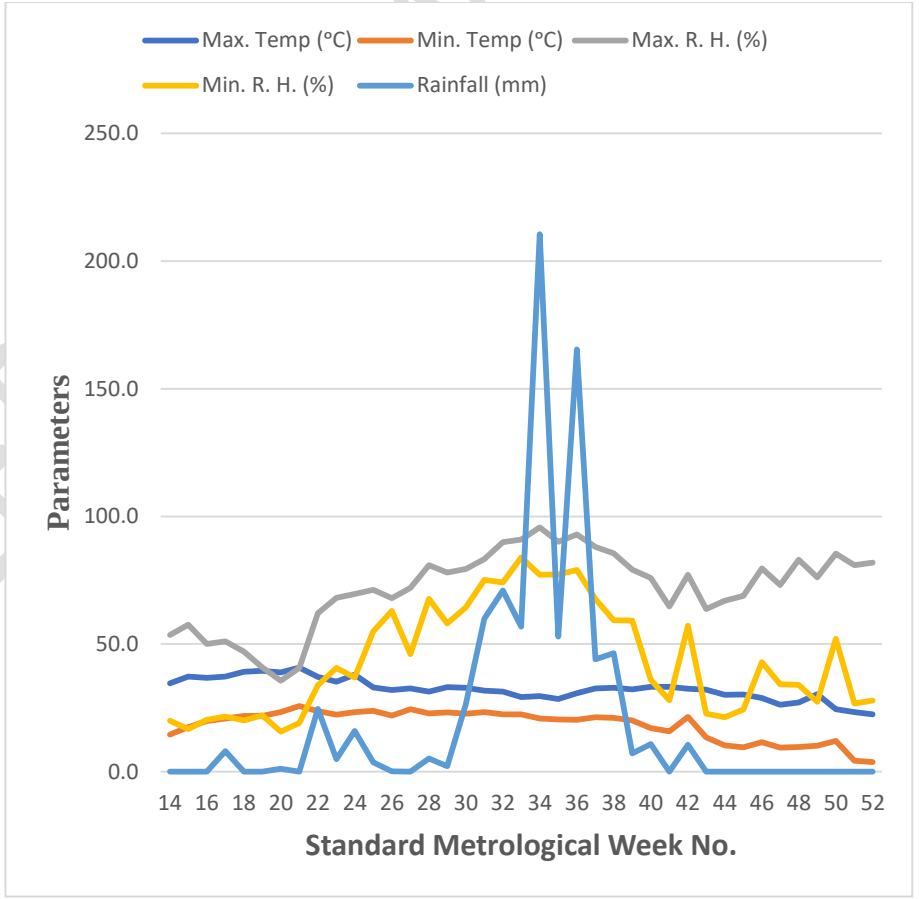


Fig. 1: Mean weekly weather parameters during cropping season 2019 and 2020