

Carryover effect of green manure, FYM and N-fertilization on the succeeding wheat in rice-wheat cropping system.

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ABSTRACT

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1- Introduction to the importance of the topic.
2- The purpose of the study.
3- The region in which the study was conducted, mentioning the country.
3_ Study methodology with the statistical programs and methods used.
4- Brief results and conclusions.
5- The researcher's opinion on the study along with recent studies, if any.

The present study was carried out Punjab Agricultural University, Regional Research Station, Gurdaspur, during 2020-21 and 2021-22. The experiment was laid out in split-split plot design with three factors. Main plots contain three organic fertilizers treatments, sub plot contains three nitrogen levels and sub-sub plots contain three nitrogen application stage. Plant height of succeeding wheat crop grown after basmati rice was affected non-significantly by organic fertilizers and chemical fertilizers applied to basmati rice during both the years. The number of tillers and dry matter accumulation significant affected during both the years. Greater values were obtained with FYM application @ 15 t ha⁻¹ which was significantly similar to green manuring but significantly higher than control during both the years. The various nitrogen doses and nitrogen application stages failed to significantly influence number of tillers and dry matter accumulation of succeeding wheat crop. In case of number of effective tillers and grains per spike, the maximum values were obtained with FYM. It was at par with green manuring but significantly higher than. The nitrogen doses and nitrogen application stages had non-significant effect on both these parameters. The organic fertilizers had statistical significant effect on straw and grain yield of wheat crop. The highest straw and grain yields were obtained with application of FYM @ 15 t ha⁻¹ which was significantly higher than control but statistically at par with green manuring during both the years. The harvest index was non-significant for all the treatments. The total NPK uptake in wheat was significantly affected by the organic fertilizers. Highest uptake of NPK in grain and straw was observed with FYM application which was at par with green manuring but significantly higher than control during both the years.

Key words: Green manuring, FYM, Nitrogen, Succeeding, Wheat

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INTRODUCTION

In the Indo-Gangetic plains, wheat is grown under rice-wheat cropping system. This system safeguards the food security and livelihood in the Indian sub-continent, constituting a key part of protein and energy intake by the humans (Singh *et al* 2012). But the productivity of the wheat crop in rice-wheat cropping system has suffered due to poor rooting caused by sub soil compaction after puddling in rice (Gathala *et al* 2011). Further, the sustainability of the rice-wheat cropping system is under threat due to the non-judicious use of chemical fertilizers resulting in decreased soil organic carbon and multi-nutrient deficiencies along with reduced microbiological activity (Paule *et al* 2014). The yield under any cropping system, balance between supply and demand of nutrients must be ensured by integrating the use of organic and inorganic fertilizers such as farm yard manure (FYM), green manure and synthetic fertilizers (Murali and Setty 2000). These organic manures not only provide rich nutrient supplies, but they also improve the physical, chemical, and biological characteristics of the soil, thereby increasing nutrient availability. Apart from NPK, they also contain trace elements such as boron, copper, iron, sulphur, and zinc, as well as a decent number of growth stimulating chemicals. Organic manures provide a controlled supply of nutrients by slowly releasing it, resulting in high yields and nutrient usage efficiency (Sharma 2002). After wheat harvest, there is enough time in the basmati rice-wheat cropping system to incorporate organic fertilizer sources such as green manure (GM) and farm yard manure (FYM) into the system. As a result, in order to sustain high crop production levels, it is critical to enhance the effectiveness of chemical fertilizers through appropriate procedures and their combined usage with organic manure and green manure (Meelu *et al* 1994). Farm yard manure (FYM) is a significant component of bulky organic manures. The FYM application to soil enhances biological, physical and chemical properties of the soil. Integration of organic sources into the nutrient management system can reduce the dependence upon the chemical fertilizers and make the agriculture environmentally and economically healthier. Currently, a major emphasis is being made on planning the nutrient management strategy based on the entire cropping system rather than focusing on individual crops because succeeding crops are influenced by inputs applied in preceding crops (Ratano *et al.* 2022). The responses of the succeeding crops in a cropping system are influenced greatly by the inputs applied in preceding crops (Devi *et al.* 2015).

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Keeping all these points in view, the present investigation was carried to study the residual effect of green manure, FYM and N fertilization on the succeeding wheat crop

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MATERIAL AND METHODS

The present study was carried out Punjab Agricultural University, Regional Research Station, Gurdaspur, during 2020-21 and 2021-22. Gurdaspur is situated at 75°40' E longitude and 32°04' N latitude with an average height of 241m above the sea level and is placed in the sub-mountainous region of Punjab. In summer season the temperature reaches upto 44°C or even sometimes crosses it. June is found as hottest month and January is the coldest one. The normal annual rainfall of this region is about 1325 mm, 80 percent of which is usually received during the south western monsoon season and remaining during winter season. The meteorological data recorded that the mean minimum weekly temperature varied between 4.7°C to 21.2°C and 3.9°C to 23.6°C whereas mean maximum weekly temperature varied between 14.5°C to 36.2°C and 13.6°C to 37.7°C during crop growing periods of *rabi* 2020-21 and 2021-22 respectively (fig 1 & 2). Amount of rainfall received during the growing season was 118.2 mm and 263.5 mm during *rabi* 2020-21 and 2021-22 respectively. Weekly hours of sunshine ranged from 1.1 to 7.6 and 0 to 7.9 during the crop seasons *rabi* 2020-21 and 2021-22 respectively. Rainfall was highest in 17th SMW (43.5 mm) and 2nd SMW (88.1mm) during *rabi* 2020-21 and 2021-22 respectively. The experiment was laid out in split-split plot design with three factors. Main plots contains three organic fertilizers treatments (green manuring, rice farmyard manure @ 15tha⁻¹, and control: without green manuring and FYM), sub plot contains three nitrogen levels (100% recommended nitrogen, 75% recommended nitrogen and non nitrogen) and sub-sub plots contains three nitrogen application stage (recommended: equal dose at 3, 6 and 9 weeks after sowing, 50% basal + 25% at 4 weeks after sowing + 25% at 9 weeks after sowing and 50% basal + 25% at 3 weeks after sowing + 25% at 8 weeks after sowing). Sunn hemp (*Crotalaria juncea*) as green manure crop was incorporated in the soil after 45 days of its sowing. Farmyard manure @ 15tha⁻¹ was applied to the plots as per the treatments. The soil of experiment is normal in pH (7.7), low in organic carbon (0.40 %), low in available nitrogen (135.5 kg ha⁻¹), high in available phosphorus (22.7 kg ha⁻¹) and low in potassium (99.3 kg ha⁻¹). The recommended dose of fertilizers was applied to wheat crop during both the years. Plant height and tillers of five randomly selected plants were recorded from each plot at harvest during both the years. Dry matter accumulation by the crop was noticed at harvest using plant destructive method

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then expressed as g m^{-2} . The effective tillers were recorded at harvest from one metre row length from two different sites in each plot. The count was converted into effective tillers m^{-2} . Five spikes were randomly selected from each plot and their length was measured from the base to the tip of spike excluding awns. Length of five spikes was averaged and was expressed in cm. The number of grains per spike was counted from randomly selected ten ears at harvest and the data was expressed as number of grains per spike by taking the mean value. The grain and straw yield was recorded in kilograms per plot and converted into q ha^{-1} . Harvest index was calculated as percentage of grain yield to biological yield. Nitrogen content was determined by using modified Kjeldahl's method proposed by Piper (1966). To determine phosphorus content, vanado-molybdate phosphoric yellow color method in nitric acid system was used as outlined by Jackson (1967). Potassium content was determined by using Lange's Flame Photometer (Jackson 1967).

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RESULTS AND DISCUSSION

Growth characters

The data pertaining to plant height of wheat is presented in Table 1. The application of various organic fertilizers, nitrogen doses and its various split stages in direct seeded basmati rice did not have a significant effect on plant height of succeeding wheat crop during both the years of study. To evaluate the residual effect of different organic fertilizers, nitrogen levels and nitrogen application stages, data on periodic number of tillers per m^2 of wheat recorded at harvest are provided in Table 1. Among the organic fertilizers, FYM recorded the highest number of tillers m^2 which was at par with green manuring but significantly different from control during both the years. Then nitrogen doses and nitrogen application stages did not have significant effect on number of tillers on succeeding wheat crop during both the years. The higher number of tillers per m^2 might be due to the addition of nutrients by organic sources and their availability to the next crop due to slower decomposition rates. This significant residual effect on tillers of wheat has also been reported by Jat and Singh (2019). They reported that highest number of tillers per meter row length was obtained in wheat with application of FYM and press mud along with chemical fertilizer to preceding rice crop. The data related to dry matter accumulation of wheat crop at various growth stages is depicted in Table 1. There was significant effect of various organic fertilizers on this growth parameter during both the years. FYM had the highest dry matter accumulation at

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these growth stages of the crop which was significantly similar to green manuring, but higher than control during both the years. FYM recorded 11% higher dry matter accumulation over control at harvest. The various nitrogen doses and nitrogen application stages had non-significant carryover effect on dry matter accumulation of wheat during both years. The residual effect of organic sources of nutrients was noticed in wheat and recorded higher in dry matter accumulation of crop. The application of FYM and green manuring resulted in higher amount of nutrients in soil for plant nutrition and further being as organic source, continuous and slow release of nutrients enhanced cell elongation as well as various metabolic processes that increased plant growth attributes which ultimately helped in attaining the highest soil capacity and dry matter accumulation. Significant residual effect of organic inputs succeeded in wheat crop in rice-wheat cropping system has also been reported by Lata *et al.* (2014).

Yield attributes

The data (Table 2) revealed that various organic fertilizers had a significant residual effect on the effective tillers m^{-2} during both the year of study. The application of FYM recorded the highest number of effective tillers. It was significantly similar to green manuring but significantly higher than from control during both the year. The effective tillers were neither significantly influenced by nitrogen doses nor by nitrogen application stages. Jat and Singh (2019) also reported significant residual effect of organic manures on effective tillers of wheat. They reported higher spikes per meter row length over control with application of 70% recommended dose of fertilizer + 15% nitrogen by FYM + 15% nitrogen by poultry manure to previous rice crop. These results are also corroborated by the findings of Kharuband Chander (2008). The data with respect to spike length of wheat crop is presented in Table 2. The various organic fertilizers, nitrogen doses and nitrogen application stages failed to have any significant effect on spike length of wheat. An examination of data (Table 1) revealed that numbers of grains per spike were significantly affected by organic fertilizers. The application of FYM which was on par with green manuring but substantially greater than control and produced the most grains per spike during both the years. The number of grains per spike was not significantly affected by any nitrogen dose or nitrogen application stage. The steady and liberal supply of adequate nutrients by the organic

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manures during the crop growth period, thereby assisting in the fixation and translocation of more photosynthates from source to sink and increasing the number of grains per spike. Similar results were reported by Jat and Singh (2019).

Yield

The data pertaining to grain yield is presented in Table 3. The application of organic fertilizers had a significant residual effect on the grain yield of wheat. The highest grain yield was obtained with FYM which was at par with green manuring but significantly different from control during both the years. FYM recorded higher 10.7% and 11.7 % grain yield during 2020-21 and 2021-22 over control respectively. The nitrogen doses and nitrogen application stages had non-significant effect on grain yield of wheat. The organic fertilizers, nitrogen doses and nitrogen application stages had non-significant interaction effect.

The increase in grain yield might be attributed to higher number of effective tillers and grains per panicle due to the residual effect of organic manures. Shah *et al* (2017) documented 15.8% higher wheat grain yield in Sesbania-incorporated plot than summer fallow. Similar results have also been reported by Hargilas and Sharma (2015). The data (Table 3) revealed that the straw yield of succeeding wheat crop was significantly influenced by the organic fertilizers applied to the preceding basmati rice. The application of FYM produced highest straw yield which was significantly similar to green manuring but different than control during both the years. Higher plant height, dry matter accumulation, and tillers are examples of increased morphological growth parameters that may be indirectly linked to an increase in straw yield with integrated nutrient treatments. These findings concur with those made by Jat and Singh (2019) and Dwivedi *et al* (2005). The data related to harvest index of the crop is depicted in Table 3. The harvest index varied from 43.1 to 44.0% and 43.1 to 44.7% during 2020-21 and 2021-22 respectively. The various organic fertilizers, nitrogen doses and nitrogen application stages failed to have any substantial impact on this index. Similarly, the interaction among different treatments was also non-significant.

Nutrients uptake

Nitrogen

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Data on total nitrogen uptake by succeeding wheat crops are shown in Table 4. It was found that FYM application resulted in the highest total nitrogen uptake. It was comparable to green manuring but significantly much higher than control during both the years of experimentation. The total nitrogen uptake was not impacted significantly by diverse nitrogen dosages or nitrogen application phases during both the years. Organic fertilizers, nitrogen dosages, and nitrogen application stages had no significant interaction effect. Shah *et al.* (2017) documented that residual of organic treatments had a significant effect on nitrogen uptake in grain and straw by succeeding wheat.

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Phosphorus

The total phosphorus uptake by succeeding wheat crop (Table 4) was also influenced by the organic fertilizers and the maximum value was recorded where FYM was applied @ 15 t ha⁻¹. It was significantly similar to green manuring but significantly higher than control during both the years. The nitrogen doses and nitrogen application failed to exhibit significant influence over total phosphorus uptake during both the years. No interaction effect among the various treatments was recorded. Higher grain yields, increased availability of phosphorus from organic sources, and the solubility effect of organic acids formed during their decomposition may all be contributing factors to increased P-uptake in crops. Shah *et al.* (2017) documented that residual of organic treatments had a significant effect on phosphorus uptake in grain and straw by succeeding wheat.

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Potassium

The information on potassium uptake by succeeding wheat crop is shown in Table 4. The highest total potassium uptake by wheat grains was recorded with FYM application which was at par with GM but significantly different from control during both the years. There was no significant effect on potassium uptake in case of nitrogen doses and nitrogen application stages during both the years. The interaction effect among various treatments was non-significant. Potassium uptake in wheat can be attributed to better yields, organic supplies, and the solubility action of organic acids formed during the breakdown of organic materials, which led to more native potassium being released in the soil. Similar results have been reported

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by Sharma *et al.* (1995) and Rathore *et al.* (1995).

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Table 1: Residual effect of different organic fertilizers, nitrogen levels and nitrogen application stages in direct seeded basmati rice on growth characters of succeeding wheat crop

Treatment	Plant height (cm)		Tillers (No. m ⁻²)		Dry matter accumulation (g m ⁻²)	
	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22
Organic fertilizer applied to preceding DSBR						
Green manuring	102.8	104.5	371.9	378.2	1021.5	1030.4
Farmyard manure @ 15t ha ⁻¹	105.4	106.3	380.8	384.5	1045.2	1054.2
Control (Without green manuring and FYM)	100.6	102.1	359.0	362.4	967.3	986.8
CD(p=0.05)	NS	NS	11.6	9.6	24.0	27.3
Nitrogen doses applied to preceding DSBR						
100% recommended nitrogen	104.8	106.0	373.7	377.4	1018.0	1030.2
50% recommended nitrogen	102.4	103.6	370.7	374.5	1011.7	1028.6
Control (without nitrogen)	101.5	103.3	367.3	373.2	1004.4	1012.6
CD(p=0.05)	NS	NS	NS	NS	NS	NS
Nitrogen application stage in preceding DSBR						
Recommended (3, 6 and 9 weeks after sowing)	103.7	104.3	372.5	376.0	1015.4	1025.6
50% basal + 25% at 4 weeks after sowing + 25% at 9 weeks after sowing	102.8	105.4	370.0	375.1	1010.0	1029.5
50% basal + 25% at 3 weeks after sowing + 25% at 8 weeks after sowing	102.3	103.2	369.3	374.0	1008.7	1016.3
CD(p=0.05)	NS	NS	NS	NS	NS	NS
Interaction	NS	NS	NS	NS	NS	NS

DSBR-Direct Seeded Basmati Rice

Table 2: Residual effect of different organic fertilizers, nitrogen levels and nitrogen application stages in direct seeded basmati rice on yield attributing characters of succeeding wheat crop

Treatment	Effectiv tillers (No. m ⁻²)		Spike length (cm)		Grains (No. m ⁻²)	
	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22
Organic fertilizer applied to preceding DSBR						
Green manuring	322.0	333.6	9.60	9.8	46.7	53.5
Farmyard manure @ 15t ha ⁻¹	329.0	345.0	9.95	10.0	48.6	54.9
Control (Without green manuring and FYM)	303.6	312.8	9.07	8.9	40.9	47.0
CD(p=0.05)	11.4	21.3	NS	NS	5.1	4.6
Nitrogen doses applied to preceding DSBR						
100% recommended nitrogen	323.1	335.8	9.88	9.8	46.9	52.7
50% recommended nitrogen	317.7	330.4	9.42	9.7	45.6	52.4
Control (without nitrogen)	313.8	325.2	9.31	9.2	43.7	50.3
CD(p=0.05)	NS	NS	NS	NS	NS	NS
Nitrogen application stage in preceding DSBR						
Recommended (3, 6 and 9 weeks after sowing)	320.9	332.4	9.64	9.5	46.2	52.6
50% basal + 25% at 4 weeks after sowing + 25% at 9 weeks after sowing	317.6	330.5	9.50	9.7	45.1	52.2
50% basal + 25% at 3 weeks after sowing + 25% at 8 weeks after sowing	316.1	328.5	9.48	9.5	44.8	50.6
CD(p=0.05)	NS	NS	NS	NS	NS	NS
Interaction	NS	NS	NS	NS	NS	NS

DSBR-Direct Seeded Basmati Rice

Table 3::Residual effect of different organic fertilizers, nitrogen levels and nitrogen application stages in direct seeded basmati rice on grain yield, straw yield and harvest index of succeeding wheat crop

Treatment	Grain yield(qha ⁻¹)		Straw yield(qha ⁻¹)		Harvest index(%)	
	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22
Organic fertilizer applied to preceding DSBR						
Green manuring	46.8	52.6	61.0	65.6	43.5	44.5
Farmyard manure @ 15tha ⁻¹	48.6	53.2	63.5	68.2	44.0	44.7
Control (Without green manuring and FYM)	43.9	47.6	57.6	60.3	43.2	43.1
CD(p=0.05)	2.6	5.2	3.3	4.2	NS	NS
Nitrogen doses applied to preceding DSBR						
100% recommended nitrogen	46.7	51.2	61.9	64.5	43.9	44.3
50% recommended nitrogen	46.5	52.7	60.4	65.2	43.8	44.7
Control (without nitrogen)	46.1	49.5	59.7	63.4	43.1	43.8
CD(p=0.05)	NS	NS	NS	NS	NS	NS
Nitrogen application stage in preceding DSBR						
Recommended (3, 6 and 9 weeks after sowing)	46.6	51.4	61.4	65.3	43.3	44.0
50% basal + 25% at 4 weeks after sowing + 25% at 9 weeks after sowing	46.4	51.9	60.5	64.6	43.7	44.5
50% basal + 25% at 3 weeks after sowing + 25% at 8 weeks after sowing	46.3	50.1	60.1	63.2	43.8	44.2
CD(p=0.05)	NS	NS	NS	NS	NS	NS
Interaction	NS	NS	NS	NS	NS	NS

DSBR-Direct Seeded Basmati Rice

Table 4: Residual effect of different organic fertilizers, nitrogen levels and nitrogen application stages in direct seeded basmati rice on total N, P and K uptake of wheat

Treatment	N (kg ha ⁻¹)		P (kg ha ⁻¹)		K (kg ha ⁻¹)	
	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22
Organic fertilizer applied to preceding DSBR						
Green manuring	117.5	127.6	18.9	20.5	79.1	87.2
Farmyard manure @ 15 t ha ⁻¹	128.5	133.2	20.6	22.3	85.4	92.8
Control (Without green manuring and FYM)	97.8	102.5	15.6	15.9	68.5	71.3
CD(p=0.05)	6.1	11.6	1.4	3.9	8.9	11.2
Nitrogen doses applied to preceding DSBR						
100% recommended nitrogen	117.1	125.0	18.8	21.4	79.4	85.4
50% recommended nitrogen	113.7	122.2	18.4	19.2	76.7	83.5
Control (without nitrogen)	112.6	119.1	17.9	18.1	74.9	82.4
CD(p=0.05)	NS	NS	NS	NS	NS	NS
Nitrogen application stage in preceding DSBR						
Recommended (3, 6 and 9 weeks after sowing)	116.3	124.3	18.5	20.9	78.7	84.6
50% basal + 25% at 4 weeks after sowing + 25% at 9 weeks after sowing	114.2	122.0	18.3	19.2	77.1	84.2
50% basal + 25% at 3 weeks after sowing + 25% at 8 weeks after sowing	113.3	120.0	18.3	18.6	76.4	82.5
CD(p=0.05)	NS	NS	NS	NS	NS	NS
Interactions	NS	NS	NS	NS	NS	NS

DSBR-Direct Seeded Basmati Rice

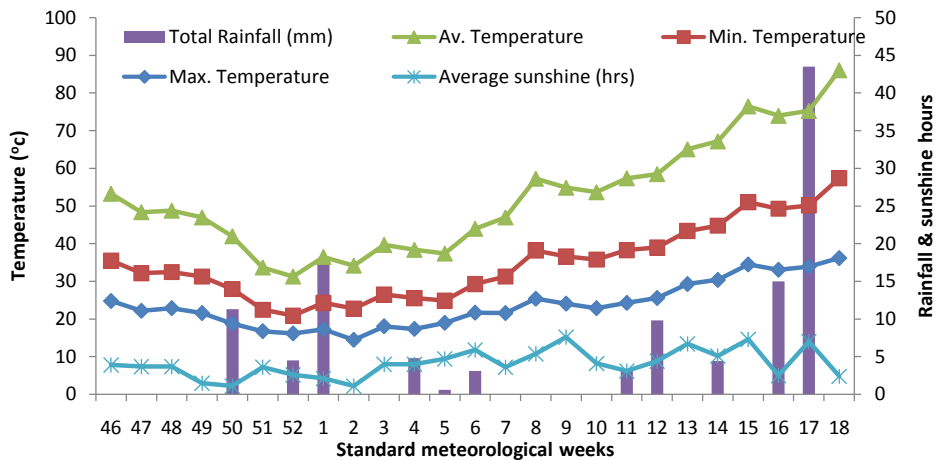


Fig.1. Weekly mean meteorological data during the crop season in rabi 2020-21

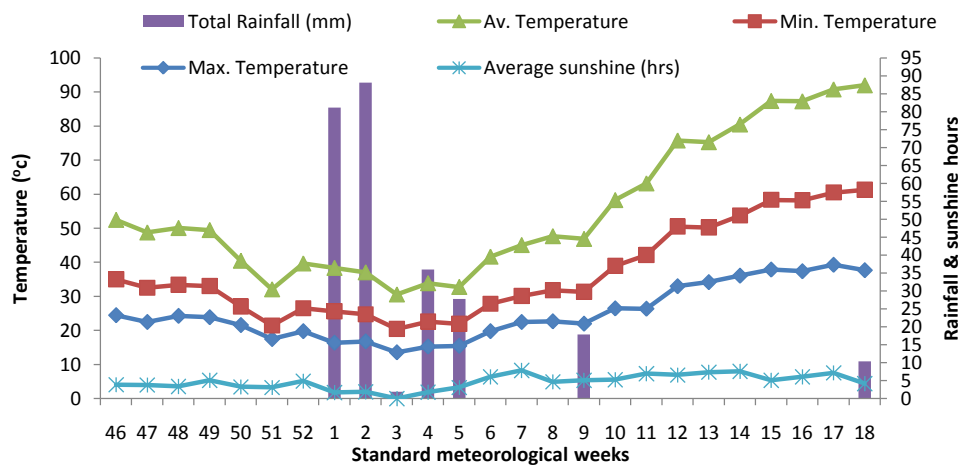


Fig.2. Weekly mean meteorological data during the crop season in rabi 2021-22