Effects of Crop Canopy and Rainfall Intensity on Runoff in *Alfisols* of Eastern Dry Zone of Karnataka

ABSTRACT

A field experiment was conducted at Ghandhi Krishi Vignana Kendra, University of Agricultural Sciences, Bangalore on stages of crop canopy cover and rainfall intensity as influenced by runoff in *Alfisols* of eastern dry zone of Karnatakaduring *Kharif* 2022. The study aimed to determine the relationship between rainfall characteristics, crop canopy cover and runoff under various stages of the crop growth period. Five treatments were imposed and tested, the results of the study indicated that the highest canopy cover were recorded under T_1 (Pomelo), T_2 (Castor), T_3 (Pigeon pea), T_4 (Chickpea) and T_5 (control). During the crop season from May to December 2022, there were 34 runoff events across treatments. The highest rainfall, 130.0 mm on May 18, resulted in runoff ranging from 13.72 mm to 26.39 mm across treatments. On June 18, 2022, a rainfall of 104.8 mm led to runoff ranging from 5.46 mm to 20.18 mm. The minimum rainfall of 6.0 mm on October 2 resulted in runoff ranging from 0.46 mm to 1.53 mm. Throughout the season, the Control plot (T_5) had the highest runoff of 259.77 mm, while the Pomelo plot (T_1) had the lowest runoff of 79.39 mm. In Control plots (T_5) had the highest runoff of 259.77 mm due to lack of canopy cover, while Pomelo (T_1) had the lowest runoff of 79.39 mm, correlating with its substantial canopy cover (11.66 m^2/tree). Castor (T_2) had runoff of 107.84 mm with 0.37 m^2/plant canopy cover, Pigeon pea (T_3) had 125.81 mm runoff with 0.34 m^2/plant canopy cover, and Chickpea (T_4) had 177.91 mm runoff with the least canopy coverage (0.01 m^2/plant). The crop canopy cover area trend is in the order of Control (T_5) < Chickpea (T_4) < Pigeon pea (T_3) < Castor (T_4) and < Pomelo (T_1).

Key words: *Runoff, crop canopy, Rainfall, Farm pond and Intensity*

1.INTRODUCTION

The movement of water and moisture globally, including plant life and the atmosphere, is crucial for the health of humans, flora, and fauna. By evaluating water input and output in a watershed for rainwater management in red soils of dryland regions is very important and water requirement for different human activities particularly in agriculture sector is a crucial and need of the hour which may help to develop low cost location specific socially acceptable strategies for various crops and terrains in the country and state as well. Understanding land use impacts on water balance and runoff remains a key focus in hydrological research may also helping to predict future water availability for agriculture (Todini, 2007; Alemaw and Chaoka, 2003). The systematic estimation and determination of rain water interventions and requirements in drylands as a first step in establishing improved approaches or techniques and tools for influencing policy in water management in drylands. Biological conservation methods are increasingly recognized for their long-term effectiveness and cost-efficiency under dryland areas by developing dense plant hedges with shallow roots reduce velocity of water flow, increasing time of concentration, enhance infiltration, and evenly distribute soil moisture in micro-watersheds apart from boosting crop yields (Krishnappa *et al*., 1994). Vegetation protects soil from raindrop impact reduce the detachment of soil particles from the soil mass held soil particles tightly by the roots of grass which improves infiltration rate, soil water content, structure, and stability, creating durable macropores (Loch and Orange, 1997). Studies show that increased tree/crop canopy can reduce runoff by up to 62% and the selected suitable land use systems were implemented with conservation measures is essential for cost-effective, location-specific farming practices (Armson *et al*., 2013). Tree canopies significantly reduce soil erosion and runoff by intercepting rainfall, with agri-horti systems increasing infiltration and agro-forestry reducing runoff (Johnson and Lehmann, 2006). An integrated watershed approach for the management of rain water consists of increasing moisture storage in the soil, optimum use of this moisture through efficient cropping systems, harvesting a portion of the runoff water for "life saving" irrigation, and reorienting the concepts and organization of irrigation, including that from tanks, to enhance productivity per unit of rain water (J S Kanwar, 1982).

2. MATERIALS AND METHODS

During *Kharif* 2022, a field experiment was carried out at All India Co-Ordinated Research Project for Dryland Agriculture, University of Agricultural Sciences, Bangalore aimed to study and to develop the relationship between rainfall characteristics and runoff under various land surface conditions in red sandy loam soil of Eastern Dry Zone of Karnataka.

2.1 Location of the experimental site

The geographical coordinates of the research site are approximately 12°58' North latitude and 77°35' East longitude, with an elevation of 924 meters above mean sea level. The experimental location falls within the Eastern Dry Zone (Zone – V) of the Agro-climatic zone of Karnataka.

2.2 Actual climaticconditions

During 2022, the total rainfall of 1556.8 mm of were received and recorded at meteorological station located adjacent to experimental site. The other important weather parameters such as average maximum temperatures ranged from 25.2ºC to 33.5ºC, and minimum temperatures ranged from 14.8ºC to 20.1ºC, monthly relative humidity averaged 81% in March to 91% in August. The bright sunshine hours peaked in February (8.7 hrs) and were lowest in July (3.4 hrs) with an average wind speed varied from 3.5 to 6.0 km/hr during the experimental period and open pan evaporation peaking in April (7.1 mm/day) and lowest in July (3.1 mm/day).

2.3 Soil and its characteristics

The soil sample were collected from 0-15 cm depth was collected and analyzed. The soil was a red sandy loam with good drainage, slightly acidic (pH 5.11) and had an electrical conductivity of 0.04 dS/m. The soil of experimental site 0.37% organic matter and had a maximum water holding capacity of 33.61%.

2.4 Details of experiments

The experiment studied runoff in relation to crop canopy growth stages and rainfall intensity to establish a rainfall-runoff relationship. The experimental have five plots accounting 20,304 m² totally consists of first plot T_1 (Pomelo) with 3,226 m², second plot T_2 (Castor) with 5,255 m², third plot T_3 (Pigeon pea) with 5,585 m², forth plot T_4 (Chickpea) with 5,998 m² and fifth plot T_5 (control, no crop) with 240 m². The layout of experimental plot presented in Fig.-1.

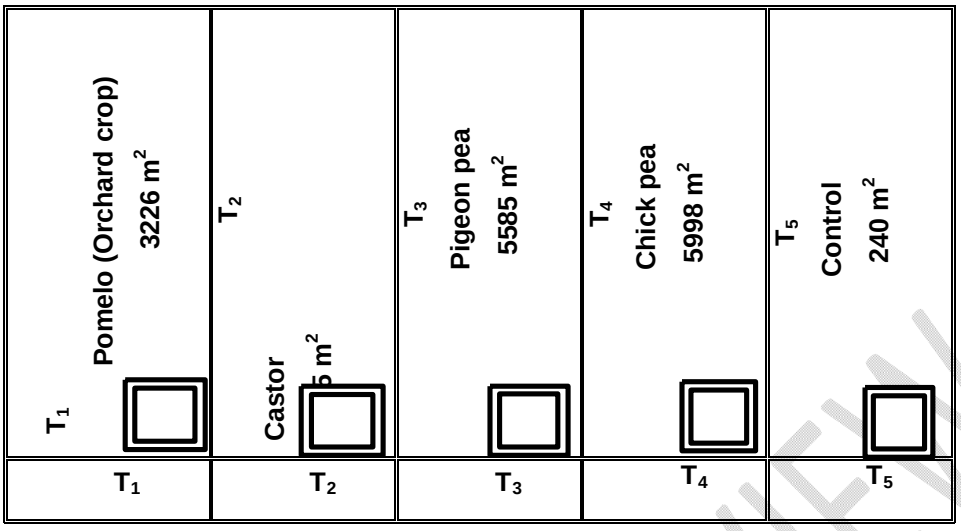

Fig. 1: Plan and layout of experimental site

2.5 Runoff measurement

The runoff from individual plots collected into the farm pond measured by taking depth of runoff water collected in the farm pond for each runoff event from each micro watershed (treatments) and when the overflow occurred, the amount of overflow was recorded by the automatic stage level recorder were installed at the outlet of the farm pond and volume of overflowed runoff water from the farm pond determined by analyzing hydrograph generated for each overflow water from farm pond and the same is added to obtain total runoff.

2.6 Volume of farm pond

Volume of farm pond = $A+4B+C6\times D$

Where, A = Top Area (m^2), C = Bottom Area (m^2),

B = Middle Area (m^2), D = Depth (m).

2.6.1 Runoff (mm):

Runoff (mm) = Volume (m3)Catchment area (m2)×1000

2.6.2 Runoff (%):

Runoff (%) = Runoff (mm)Rainfall(mm)×100

2.7 Rainwater directly falling on farm pond

Rainwater directly falling on farm pond (mm) =
Rainwater directly collected in farmpond m3 X 1000cross sectional area of the farmpond (m2)

2.8 Density of vegetation

Plant/ Tree density (Plants /ha) = 10000Row to Row spacing X (Plant to plant spacing)

2.9 Crop canopy spread area (cm^2)

Plant spread cm2=East-West cm X North-South (cm)

3.RESULTS AND DISCUSSION

3.1 Rainfall as influenced by runoff (mm) under different treatments

In 2022, there were 75 rainy days with a total rainfall of 1556.8 mm, exceeding the normal 941.4 mm. Most of the rainfall (1490.8 mm) occurred from May to December over 71 days, with 34 runoff events. The highest single-day rainfall was 130 mm on May 18, causing the greatest runoff (29.09 mm) in the control plot (T_5). Another significant event on June 18 (104.8 mm) led to runoff, with T_5 again having the highest (22.36 mm). Even minimal rainfall (6.0 mm) on October 2 caused runoff in all treatments, ranging from 0.58 mm to 1.66 mm. On May 19, an 11.0 mm rainfall caused runoff in all treatments except the pomelo plot (Table 1).

3.2Rain water (mm) directly fall on farm pond and collected in water storage structures

Rain water directly falling on the farm ponds for each rainfall events causing runoff under various treatments are determined for quantifying the actual amount of runoff produced for each event during the cropping season and the data presented in Table 2.

Throughout the entire cropping season, the most substantial rainfall occurred on May 18, 2022, with a record of 130.0 mm rainfall. This led to the direct collection of rainwater measured in cubic meters amounting to 1.05 mm in T_1 and 1.43 mm in T_2, T_3, T_4, and T_5. Following closely, the second-highest rainfall of 104.8 mm on June 18, 2022, resulted in the direct collection of rainwater totaling 0.85 mm in T_1 and 1.16 mm in T_2, T_3, T_4, and T_5. A total of 9.31 mm in T_1 and 12.69 mm was collected in T_2, T_3, T_4, and T_5 farm ponds as throughfall during the entire period of cropping season.

3.3 Actual runoff (mm) under different treatments

During the crop season from May to December 2022, there were 34 runoff events across treatments. The highest rainfall, 130.0 mm on May 18, resulted in runoff ranging from 13.72 mm to 26.39 mm across treatments. On June 18, 2022, a rainfall of 104.8 mm led to runoff ranging from 5.46 mm to 20.18 mm. The minimum rainfall of 6.0 mm on October 2 resulted in runoff ranging from 0.46 mm to 1.53 mm. Throughout the season, the Control plot (T_5) had the highest runoff of 259.77 mm, while the Pomelo plot (T_1) had the lowest runoff of 79.39 mm. Further details are in Table 3.

Table 1: Runoff (mm) under different treatments during the cropping season, 2022

Sl. No.	Date	Rainfall (mm)	Runoff (mm)				
			T_1	T_2	T_3	T_4	T_5
1	15-May	14.0	0.6	0.56	0.9	1.32	2.07
2	17-May	16.4	0.82	3.18	2.89	3.69	5.27
3	18-May	130.0	16.99	13.97	15.57	20.74	29.09
4	19-May	11.0	-	3.74	5.80	5.30	8.26
5	06-Jun	35.8	4.01	2.27	3.14	4.53	2.12
6	17-Jun	43.4	3.43	5.11	6.58	6.49	9.27
7	18-Jun	104.8	8.09	8.68	8.86	16.21	22.36
8	08-Jul	15.2	3.83	2.29	3.49	3.28	4.57
9	21-Jul	17.6	3.57	3.97	3.82	3.64	6.69
10	31-Jul	62.4	2.6	4.22	5.41	9.46	14.11
11	02-Aug	12.6	0.57	1.11	1.79	4.04	2.26
12	03-Aug	42.4	2.23	3.49	4.79	6.34	5.48
13	05-Aug	13.8	1.28	2.66	3.45	3.9	7.4
14	26-Aug	20.2	1.82	2.99	3.45	3.87	6.41
15	27-Aug	25.4	4.47	2.89	3.35	8.28	11.33
16	30-Aug	56.4	4.75	4.92	4.89	4.78	7.11
17	01-Sep	8.2	0.46	1.28	1.57	2.56	3.77
18	04-Sep	18.6	2.62	2.72	2.42	6.86	10.08
19	05-Sep	69.8	3.45	3.66	6.58	6.42	13.02
20	01-Oct	26.4	2.13	1.63	0.8	1.34	4.13
21	02-Oct	6.0	0.67	0.58	0.66	0.82	1.66
22	08-Oct	21.2	2.17	3.68	5.15	3.4	6.61
23	11-Oct	71.2	8.6	12.07	13.24	11.65	17.29
24	14-Oct	60.0	10.77	12.87	11.03	16.94	20.4
25	15-Oct	56.2	5.91	6.49	7.46	10.68	13.19
26	16-Oct	9.0	0.64	0.29	1.29	1.44	2.22
27	17-Oct	44.0	1.75	4.87	4.37	8.49	10.44
28	19-Oct	22.2	0.86	2.64	1.49	3.46	7.16
29	20-Oct	20.0	0.45	1.84	1.22	1.9	5.47
30	30-Oct	12.4	0.4	1.64	1.93	3.87	5.79
31	03-Nov	7.0	0.24	1.02	1.1	1.49	4.99
32	13-Nov	6.4	0.19	0.42	0.39	0.64	0.84
33	24-Nov	9.4	0.28	0.47	0.53	0.28	0.76
34	11-Dec	59.4	7.25	7.68	9.06	10.92	12.69

T_1: Pomelo (Orchard crop) *T_3: Pigeon pea* *T_5: Control (No crop)*
T_2: Castor *T_4: Chickpea*

Table 2: Rainwater directly fall on farm pond (mm) during the cropping period, 2022

Sl. No.	Date	Rainfall (mm)	Rainwater directly fall on Farm pond (m^3)	
			Cross sectional area of Farm pond (P_1) under T_1 (81 m^2)	Cross sectional area of Farm ponds (P_2, P_3, P_4& P_5) under T_2, T_3, T_4& T_5 (110.25 m^2)
1	15-May	14.0	0.11	0.15
2	17-May	16.4	0.13	0.18
3	18-May	130.0	1.05	1.43
4	19-May	11.0	0.09	0.12
5	06-Jun	35.8	0.29	0.4
6	17-Jun	43.4	0.35	0.48
7	18-Jun	104.8	0.85	1.16
8	08-Jul	15.2	0.12	0.17
9	21-Jul	17.6	0.14	0.19
10	31-Jul	62.4	0.51	0.69
11	02-Aug	12.6	0.1	0.14
12	03-Aug	42.4	0.34	0.47
13	05-Aug	13.8	0.11	0.15
14	26-Aug	20.2	0.16	0.22
15	27-Aug	25.4	0.21	0.28
16	30-Aug	56.4	0.46	0.62
17	01-Sep	8.2	0.07	0.09
18	04-Sep	18.6	0.15	0.21
19	05-Sep	69.8	0.57	0.77
20	01-Oct	26.4	0.21	0.29
21	02-Oct	6.0	0.05	0.07
22	08-Oct	21.2	0.17	0.23
23	11-Oct	71.2	0.58	0.79
24	14-Oct	60.0	0.49	0.66
25	15-Oct	56.2	0.46	0.62
26	16-Oct	9.0	0.07	0.1
27	17-Oct	44.0	0.36	0.49
28	19-Oct	22.2	0.18	0.25
29	20-Oct	20.0	0.16	0.22
30	30-Oct	12.4	0.1	0.14
31	03-Nov	7.0	0.06	0.08
32	13-Nov	6.4	0.05	0.07
33	24-Nov	9.4	0.08	0.1
34	11-Dec	59.4	0.48	0.66
Total			9.31	12.69

Table 3: Actual runoff (mm) in different treatments during a cropping period, 2022

Sl. No.	Date	Rainfall (mm)	Actual runoff (mm)				
			T_1	T_2	T_3	T_4	T_5
1	15-May	14.0	0.25	0.27	0.62	1.07	1.78
2	17-May	16.4	0.41	2.84	2.56	3.39	4.93
3	18-May	130.0	13.72	11.24	13.0	18.35	26.39
4	19-May	11.0	-	3.51	5.58	5.1	8.03
5	06-Jun	35.8	3.11	1.52	2.44	3.87	1.37
6	17-Jun	43.4	2.34	4.2	5.73	5.69	8.37
7	18-Jun	104.8	5.46	6.48	6.79	14.28	20.18
8	08-Jul	15.2	3.45	1.97	3.19	3	4.25
9	21-Jul	17.6	3.13	3.6	3.47	3.32	6.33
10	31-Jul	62.4	1.04	2.91	4.18	8.32	12.81
11	02-Aug	12.6	0.26	0.85	1.55	3.8	1.99
12	03-Aug	42.4	1.17	2.61	3.95	5.56	4.6
13	05-Aug	13.8	0.94	2.38	3.18	3.65	7.12
14	26-Aug	20.2	1.31	2.57	3.05	3.49	5.98
15	27-Aug	25.4	3.83	2.35	2.85	7.81	10.8
16	30-Aug	56.4	3.34	3.74	3.78	3.74	5.94
17	01-Sep	8.2	0.25	1.1	1.4	2.41	3.6
18	04-Sep	18.6	2.15	2.33	2.06	6.52	9.69
19	05-Sep	69.8	1.7	2.2	5.2	5.14	11.57
20	01-Oct	26.4	1.47	1.08	0.28	0.86	3.58
21	02-Oct	6.0	0.52	0.46	0.55	0.71	1.53
22	08-Oct	21.2	1.64	3.24	4.73	3.01	6.17
23	11-Oct	71.2	6.81	10.57	11.83	10.34	15.81
24	14-Oct	60.0	9.26	11.62	9.85	15.84	19.15
25	15-Oct	56.2	4.5	5.31	6.35	9.64	12.02
26	16-Oct	9.0	0.41	0.1	1.11	1.27	2.03
27	17-Oct	44.0	0.64	3.95	3.5	7.68	9.52
28	19-Oct	22.2	0.3	2.18	1.05	3.05	6.7
29	20-Oct	20.0	-	1.42	0.83	1.53	5.06
30	30-Oct	12.4	0.09	1.38	1.69	3.64	5.54
31	03-Nov	7.0	0.06	0.87	0.96	1.36	4.85
32	13-Nov	6.4	0.03	0.28	0.27	0.53	0.71
33	24-Nov	9.4	0.04	0.27	0.35	0.11	0.56
34	11-Dec	59.4	5.76	6.44	7.88	9.83	10.81
Total			79.39	107.84	125.81	177.91	259.77

3.4 Runoff as influenced by rainfall characteristics under different treatments.

In the experimental plots, the highest recorded rainfall of 130 mm with an intensity of 80 mm/hr resulted in the highest runoff: 13.72 mm in T_1, 11.24 mm in T_2, 13.00 mm in T_3, 18.35 mm in T_4, and 26.39 mm in T_5. Another significant rainfall event of 104.8 mm, also with 80 mm/hr intensity, led to runoff of 5.46 mm in T_1, 6.48 mm in T_2, 6.79 mm in T_3, 14.28 mm in T_4, and 20.18 mm in T_5 (Table-4).

Table 4: Runoff as influenced by rainfall intensity under different treatments

Sl. No.	Rainfall (mm)	Max. RF Intensity (mm/h)	Runoff (mm)				
			T_1	T_2	T_3	T_4	T_5
1	14.0	4.0	0.25	0.27	0.62	1.07	1.78
2	16.4	26.0	0.41	2.84	2.56	3.39	4.93
3	130.0	80.0	13.72	11.24	13.0	18.35	26.39
4	11.0	16.0	-	3.51	5.58	5.1	8.03
5	35.8	80.0	3.11	1.52	2.44	3.87	1.37
6	43.4	*	2.34	4.2	5.73	5.69	8.37
7	104.8	80.0	5.46	6.48	6.79	14.28	20.18
8	15.2	26.0	3.45	1.97	3.19	3	4.25
9	17.6	*	3.13	3.6	3.47	3.32	6.33
10	62.4	80.0	1.04	2.91	4.18	8.32	12.81
11	12.6	28.0	0.26	0.85	1.55	3.8	1.99
12	42.4	36.0	1.17	2.61	3.95	5.56	4.6
13	13.8	32.0	0.94	2.38	3.18	3.65	7.12
14	20.2	22.0	1.31	2.57	3.05	3.49	5.98
15	25.4	36.0	3.83	2.35	2.85	7.81	10.8
16	56.4	40.0	3.34	3.74	3.78	3.74	5.94
17	8.2	28.0	0.25	1.1	1.4	2.41	3.6
18	18.6	18.0	2.15	2.33	2.06	6.52	9.69
19	69.8	*	1.7	2.2	5.2	5.14	11.57
20	26.4	24.0	1.47	1.08	0.28	0.86	3.58
21	6.0	8.0	0.52	0.46	0.55	0.71	1.53
22	21.2	28.0	1.64	3.24	4.73	3.01	6.17
23	71.2	40.0	6.81	10.57	11.83	10.34	15.81
24	60.0	48.0	9.26	11.62	9.85	15.84	19.15
25	56.2	34.0	4.5	5.31	6.35	9.64	12.02
26	9.0	32.0	0.41	0.1	1.11	1.27	2.03
27	44.0	48.0	0.64	3.95	3.5	7.68	9.52
28	22.2	40.0	0.3	2.18	1.05	3.05	6.7
29	20.0	24.0	-	1.42	0.83	1.53	5.06
30	12.4	10.0	0.09	1.38	1.69	3.64	5.54
31	7.0	6.0	0.06	0.87	0.96	1.36	4.85
32	6.4	8.0	0.03	0.28	0.27	0.53	0.71
33	9.4	14.0	0.04	0.27	0.35	0.11	0.56
34	59.4	*	5.76	6.44	7.88	9.83	10.81

The smallest rainfall of 6 mm, with an intensity of 8 mm/hr, resulted in minimal runoff: 0.52 mm in T_1, 0.46 mm in T_2, 0.55 mm in T_3, 0.71 mm in T_4, and 1.53 mm in T_5. Throughout the entire cropping period the highest rainfall recorded was 130.0 mm followed by 104.8 mm with the highest rainfall intensity of 80 mm/hr. The highest rainfall intensity resulted in higher runoff contribution from the treatments.

3.5 Stages of crop growth as influenced by runoff

Crop growth is affected by climatic factors, especially rainfall patterns in rainfed agriculture. Table 5 and Figure 2 illustrate runoff variations among treatments during the cropping period. November had the least runoff, with Pomelo (T_1) having 0.13 mm, followed by Castor (T_2), Pigeon pea (T_3), Chickpea (T_4), and Control (T_5). Canopy size differences explain runoff variances, consistent with Kang *et al.* (1982).

The study indicated that the percentage of runoff to monthly rainfall in different treatments stated that the Control (T_5) plot had the highest runoff percentage in October (24.13%), while Pomelo (T1) had the lowest in November (0.43%). The runoff trend followed Pomelo < Castor < Pigeon pea < Chickpea < Control (Table 5 & Figure 3). The results of the study confirmed with Ground vegetation retards water flow and extends soil seepage time, consistent conducted by Sharma *et al.* (2000).

In the plots, Control (T_5) had the highest runoff of 259.77 mm due to lack of canopy cover, while Pomelo (T_1) had the lowest runoff of 79.39 mm, correlating with its substantial canopy cover (11.66 m^2/tree). Castor (T_2) had runoff of 107.84 mm with 0.37 m^2/plant canopy cover, Pigeon pea (T_3) had 125.81 mm runoff with 0.34 m^2/plant canopy cover, and Chickpea (T_4) had 177.91 mm runoff with the least canopy coverage (0.01 m^2/plant). Table 5 details crop canopy cover and runoff.

Table 5: Effect of runoff (mm) in different treatments during the cropping period of 2022

Month	Rainfall (mm)	Runoff (mm)				
		T_1 Pomelo	T_2 Castor	T_3 Pigeon pea	T_4 Chick pea	T_5 Control
May	285.2	14.38 (5.04)	17.86 (6.26)	21.76 (7.63)	27.91 (9.79)	41.13 (14.42)
Jun	216.8	10.91 (5.03)	12.20 (5.63)	14.96 (6.90)	23.84 (11.00)	29.92 (13.80)
Jul	149.8	7.62 (5.09)	8.48 (5.66)	10.84 (7.24)	14.64 (9.77)	23.39 (15.61)
Aug	211.4	10.85 (5.13)	14.50 (6.86)	18.36 (8.68)	28.05 (13.27)	36.43 (17.23)
Sep	141.8	4.10 (2.89)	5.63 (3.97)	8.66 (6.11)	14.07 (9.92)	24.86 (17.53)
Oct	361	25.64 (7.10)	41.31 (11.44)	41.77 (11.57)	57.57 (15.95)	87.11 (24.13)
Nov	30	0.13 (0.43)	1.42 (4.73)	1.58 (5.26)	2.00 (6.66)	6.12 (20.40)
Dec	94.6	5.76 (6.09)	6.44 (6.81)	7.88 (8.33)	9.83 (10.39)	10.81 (11.43)
Total	1490.6	79.39 (5.33)	107.84 (7.23)	125.81 (8.44)	177.91 (11.94)	259.77 (17.43)

Note: Figures in parenthesis indicate percent of runoff

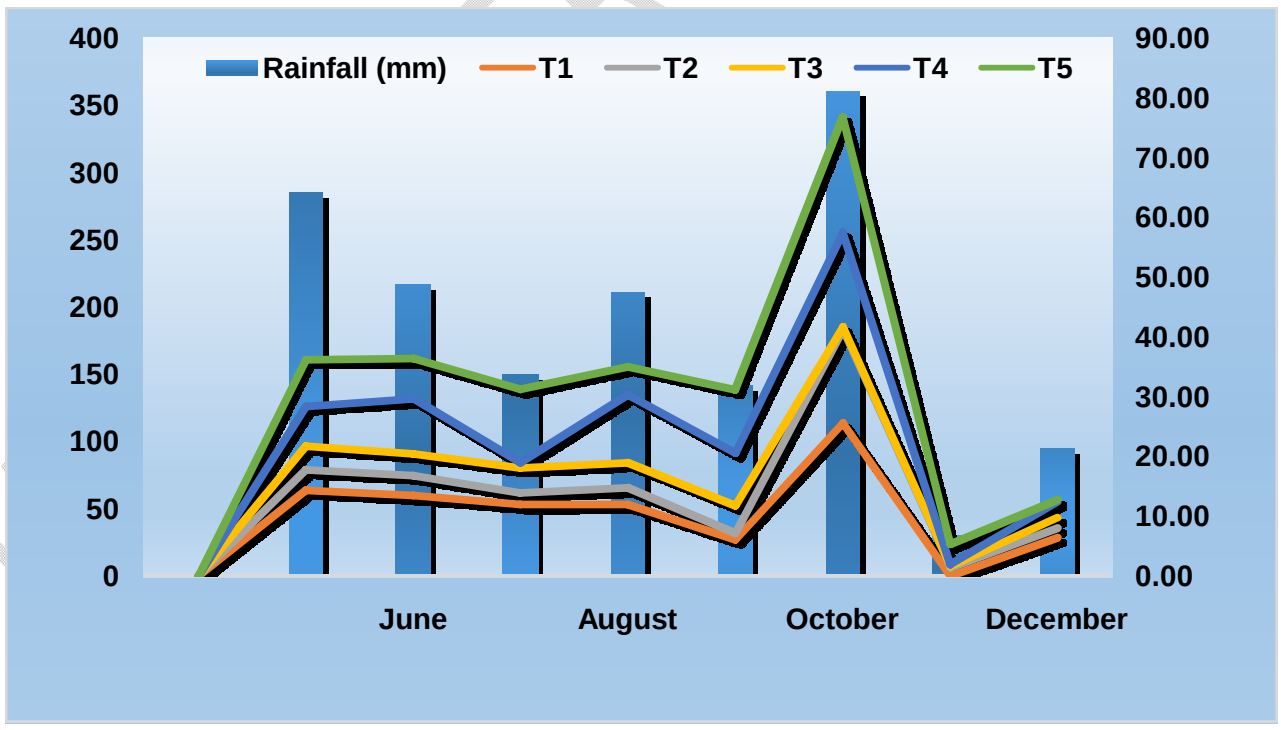

Fig. 2: Effect of runoff (mm) in different treatments during the cropping period of 2022

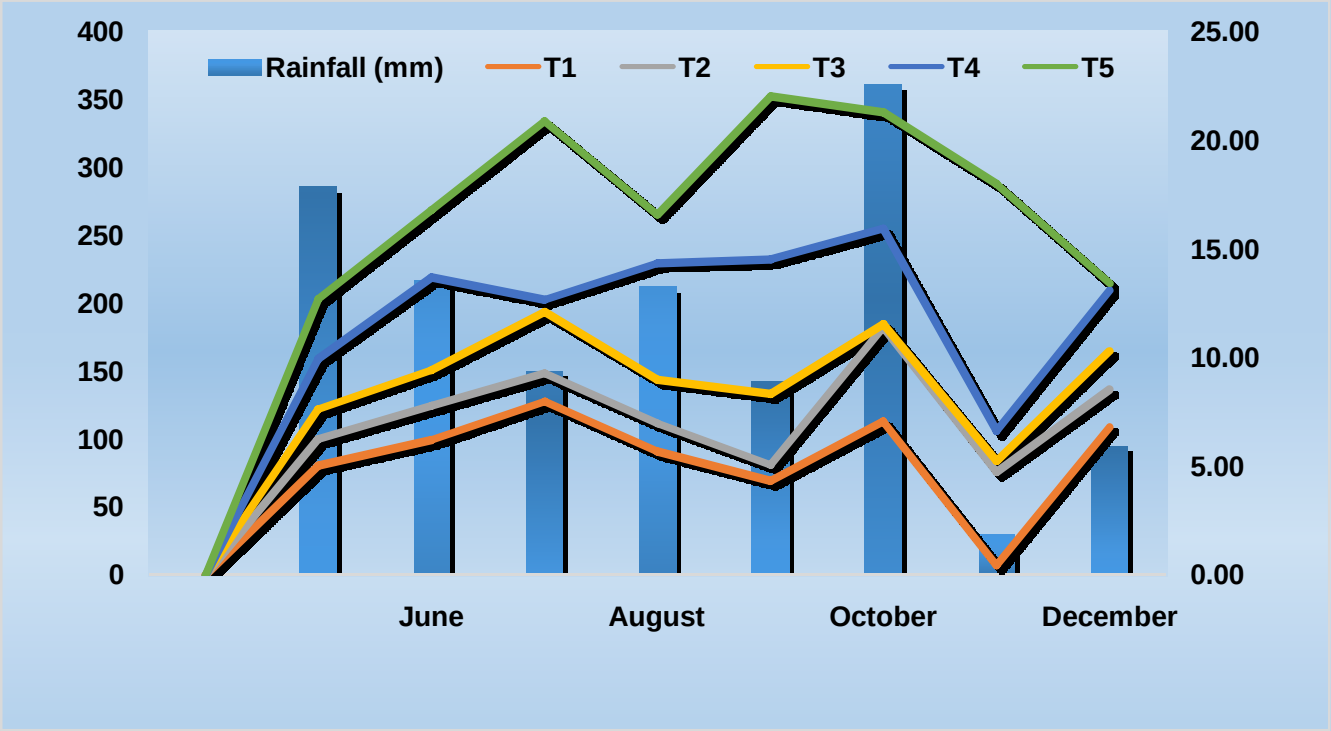

Fig. 3: Effect of per cent runoff in different treatments during the cropping period

In the experimental plots, the highest runoff of 259.77 mm was observed in (T_5) Control plot with no crop canopy cover, and the decrease in runoff observed in Pomelo (T_1) with only 79.39 mm runoff with highest crop canopy cover of 11.66 m^2/ tree, followed by Castor (T_2) 107.84 mm with canopy coverage of 0.37 m^2/ plant , followed by Pigeon pea (T_3) with 125.81 mm of runoff with a average canopy cover 0.34 m^2/ plant and finally the Chickpea (T_4) has a runoff of 177.91 mm with least canopy coverage of 0.01 m^2/ plant. The data on crop canopy cover and runoff is presented in Table 6.

The crop canopy coverage in between the treatments has a significant change which resulted in higher canopy cover crop has a less runoff when compared to least canopy cover crop this decrease in runoff is due to the presence of dense vegetation, which slows down the speed of runoff, providing more opportunity time for rainwater to infiltrate into the soil. The crop canopy cover area trend is in the order of Control (T_5) < Chickpea (T_4) < Pigeon pea (T_3) < Castor (T_4) and < Pomelo (T_1). The results of the study are on par with the result of the study conducted by Vasquez mendez. R*et al*. (2010)

Table 6: Runoff (mm) as influenced by crop canopy area (m^2) in different treatments during the cropping period of 2022

Cropping Period	T_1 Pomelo		T_2 Castor		T_3 Pigeon pea		T_4 Chick pea		T_5 Control		S.Em. ±	CD @ 5%
	Crop Canopy Area (m^2) / tree	Runoff (mm)	Crop Canopy Area (m^2) / tree	Runoff (mm)	Crop Canopy Area (m^2) / tree	Runoff (mm)	Crop Canopy Area (m^2) / tree	Runoff (mm)	Crop Canopy Area (m^2) / tree	Runoff (mm)		
May	11.37	14.38	0.10	17.86	0.05	21.76	*	27.91	-	41.13	0.14	0.41
June	11.56	10.91	0.10	12.20	0.07	14.96	*	23.84	-	29.92	0.13	0.37
July	11.66	7.62	0.16	8.48	0.15	10.84	*	14.64	-	23.39	0.12	0.35
August	11.69	10.85	0.27	14.50	0.26	18.36	*	28.05	-	36.43	0.12	0.35
September	11.71	4.10	0.43	5.63	0.40	8.66	0.00007	14.07	-	24.86	0.12	0.34
October	11.73	25.64	0.52	41.31	0.49	41.77	0.01	57.57	-	87.11	0.13	0.37
November	11.76	0.13	0.66	1.42	0.65	1.58	0.02	2.00	-	6.12	0.12	0.35
December	11.77	5.76	0.69	6.44	0.68	7.88	0.02	9.83	-	10.81	0.12	0.35
Total	11.66	79.39	0.37	107.84	0.34	125.81	0.01	177.91	-	259.77		

**Chick pea crop was sown on 12.09.2022*

T_1: Pomelo (Orchard crop) *T_3: Pigeon pea* *T_5: Control (No crop)* *S.Em: Standard error of mean*

T_2: Castor *T_4: Chickpea* *CD: Critical difference*

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