Impact of Irrigation Methods and Mulches on Chilli (*Capsicum annuum* L.) Leaf Curl Complex and Yield in Jaffna District of Sri Lanka

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Abstract – *A field study was conducted to evaluate the varietal performance of green Chilli (Capsicum annum) for Chilli leaf curl complex with different mulches and irrigation system from May to October 2016. Chilli is one of the most important cash crop grown in Sri Lanka. Generally Jaffna farmers get low yield (8- 10 ton / ha) from Chilli cultivation, mainly due to pest and diseases incidence. This research was carried out to study the effect of irrigation with different mulch material on leaf curl complex and the yield of green Chilli. The factors consisted of irrigation systems (sprinkler, drip and basin), varieties (Galkiriyagama, Super Hybrid and Vijaya hybrid) and mulch (No mulch, Neem leaves, Giliridicia leaves) in split plot design with three replicates. Results were analyzed by SAS package and the mean separation was done by Duncan method.(Probability 5 %).Plant height and canopy width were statistically not significant among irrigation, varieties and mulches. The difference in yield of chilli was statistically significant among varieties, mulches and irrigation systems. Higher yield was recorded in neem mulch under sprinkler irrigation system due to the low incidence of pest attack at 2nd harvesting (12 ton / ha). Therefore, sprinkler irrigation system with neem is more suitable for Super Hybrid chilli cultivation to reduce leaf curl complex and to obtain optimum yield.*

Keywords: *Leaf Curl Complex, Mulch, Irrigation system, Green Chilli*

1 INTRODUCTION

Chilli (*Capsicum annuum* L.) belongs to the Solanaceae family, originated from South and Central America. Chilli is an indispensable spice due to its pungency, taste, appealing colour and flavour and has its unique place in the diet as a vegetable cum spice crop.The alkaloid 'capsaicin' present in placenta of the chilli fruit responsible for its pungency has diverse prophylactic and therapeutic uses in Allopathic and Ayurvedic medicine (Kanewardena, 2002) and directly scavenge various free radicals (Wierenga, 2005; Abbaset al., 2010; Ravinder et al, 1997) and has wide applications in the food, medicine and pharmaceutical industries. Chilli is a good source of vitamin C (ascorbic acid) used in food and beverage industries (Bosland and Votava, 2000).

It is one of the most important spice crops of the world and widely cultivated throughout the warm temperature in tropical and subtropical countries. A large extent under chili is cultivated in the dry zone of Sri Lanka. At present major Chilli growing districts are Anuradhapura, Moneragala, Ampara, Jaffna, Puttlam, Vavuniya, Kurunegala,

Hambantota and Mahaweli system. Department of Agriculture has recommended eight Chilli varieties up to now namely MI-1, MI-2, KA-2, Arunalu, MI-Hot, MI green, Galkiriyagama selection and the recently released varieties, MICH 3, MI Waraniya 1 and PC 1 (DOA, 2012).

The potential yield of these varieties are 10–12ton / ha. But the national average yields are as poor as 8–10 ton / ha (Department of Agriculture, 2015). Such low yields are mainly due to high incidences of pest and disease, moisture stress, the use of inferior quality of seeds, poor crop management and high input costs. Chilli Leaf Curl Complex (CLCC) is the major problem resulting in heavy yield losses up to 53%, especially during yala season. CLCC is caused by several factors (thrips, mites and viruses) of which thrips are the most important factor (Lewis, 1997). The Chilli crop can grow in field for about five months. The peak production is gained from the second picking. Early planting (before April) helps to get the high production due to low incidence of pest and disease. That means the second and third pickings are done before the severe attack of leaf curl complex (Kanewardena, 2002).

Irrigation method plays a major role in increasing the yield and enhancing cropping intensity. In North of Sri Lanka water scarcity and inefficient irrigation method are the major reasons for increasing cost of production. Therefore micro irrigation methods were proved to be an efficient method in saving water and reducing cost of production. Micro irrigation was also proved that it influence on increasing yield up to 20% to 30% and reduce the pest attack (Sadasivam and Senathraja, 2005). Most of the Jaffna farmers cultivate Chili under basin irrigation systems in small holding level (Kuepper, 2004). Even in small holding with well lift irrigation system water has been expensive because of the energy crisis (Demirbas, 2004).

Studies of different countries have confirmed that sprinkler irrigation is most effective for Chili cultivation as increasing yield, low incidence of pest and disease attack and low cost of cultivation (Shinde et al,1999; Wieranga, 2005). Further the Dry zone farmers are facing soil moisture lost by evaporation. Therefore different types of easily available mulches were introduced in this study to reduce evaporation losses and conserve soil moisture. Different countries studies confirmed that different mulches had tremendous effects on the number of pods yield (Abbas and Raza, 2010; Shinde et al, 1999; Ranvinde,et al 1997). Therefore the objective of this research is to study the impact of irrigation system and mulch on leaf curl complex and yield in Chili.

2 MATERIALS AND METHODS

Site selection

A Field experiment was carried out at the District Agricultural Training Centre, Thirunelvely during May end to October end 2016 in Calcic Red Yellow Latasol soil to study the impact of different mulches under different irrigation systems on varietal performance of green chilli.

Experimental design

The experiment was conducted in split plot design with three replicates. For the design three types of irrigation systems namely sprinkler irrigation system (I1), Drip irrigation system (I2) and Basin irrigation system (I3) were used. There varieties, namely Galkiriyagame selection; Super hybrid and Vijaya hybrid were planted under two types of

mulches such as Neem (Azadirachta indica) and Gliciridia(Gliricidia sepium), and no mulch. Irrigation was included in the main plot. Subplot contained variety and mulches in the split-plot design. Twenty seven treatment combinations were tested in this experiment as shown in Table 1. Results were analyzed by SAS package (University version) and the mean separation was done by Duncan method (Probability 5 %).

Table 1: Treatments and its descriptions

Treatment	Treatment Code	Treatment Description
T1	I1VIMI	Sprinkler system, Galkiriyagame selection with no mulch
T2	I1V2M1	Sprinkler system, Super hybrid with no mulch
T3	I1V3M1	Sprinkler system, Vijaya hybrid with no mulch
T4	I1V1M2	Sprinkler system, Galkiriyagame selection with Neems leaves
T5	I1V2M2	Sprinkler system, Super hybrid with Neems leaves
T6	I1V3M2	Sprinkler system, Vijaya hybrid with Neems leaves
T7	I1V1M3-	Sprinkler system, Galkiriyagame selection with Gliciridia
T8	I1V2M3	Sprinkler system, Super hybrid with Gliciridia
T9	I1V3M3	Sprinkler system, Vijaya hybrid with Gliciridia
T10	I2V1M1	Drip system, Galkiriyagame selection with no mulch
T11	I2V2M1	Drip system, Super hybrid with no mulch
T12	I2V3M1	Drip system, Vijaya hybrid with no mulch
T13	I2V1M2	Drip system, Galkiriyagame selection with Neem leaves
T14	I2V2M2	Drip system, Super hybrid with Neem leaves
T15	I2V3M2	Drip system, Vijaya hybrid with Neem leaves
T16	I2V1M3	Drip system, Galkiriyagame selection with Gliciridia
T17	I2V2M3	Drip system, Super hybrid with Gliciridia
T18	I2V3M3	Drip system, Vijaya hybrid with Gliciridia
T19	I3VIM1	Basin system, Galkiriyagame selection with no mulch
T20	I3V2M1	Basin system, Super hybrid with no mulch
T21	I3V3M1	Basin system, Vijaya hybrid with no mulch
T22	I3V1M2	Basin system, Galkiriyagame selection with Neem leaves
T23	I3V2M2	Basin system, Super hybrid with Neem leaves
T24	I3V3M2	Basin system, Vijaya hybrid with Neem leaves
T25	I3VIM3	Basin System, Galkiryagame selection with Giliciridia
T26	I3V2M3	Basin system, Super hybrid with Giliciridia
T27	I3V3M3	Basin system, Vijaya hybrid with Gilicirida

Nursery management

Soil was sterilized by burning straw and beds (3 m×1 m×15 cm) were prepared. Seeds were directly sown at 10 cm between lines and 1 cm depth. A Thin layer of top soil was laid above the seed lines. After that, beds were treated with fungicide Homai (tetramethylthioperoxydicarbonic diamide)(6g / 5l H20). Nursery beds were covered with dried banana leaves to prevent water loss. Then beds were treated with Elson (pyrethroidsbifenthrin) to prevent the termite and ant problem. Nursery bed was protected from rain by covering with white polythene.

Field preparation and layout

For proper establishment of seedlings, soil should be moist, friable, well aerated and weed free. Thus ploughing and two hoeing were done to obtain the fine tilled condition. Three blocks were made and one block was further divided in to 27 plots of 3m×3m size (Figure 1). Nine plots were covered by drip or basin or sprinkler irrigation system. One block included 675 hills and every block included sprinkler, drip and basin irrigation system. Each plot contained 9m^2 land areas with 25 hills.

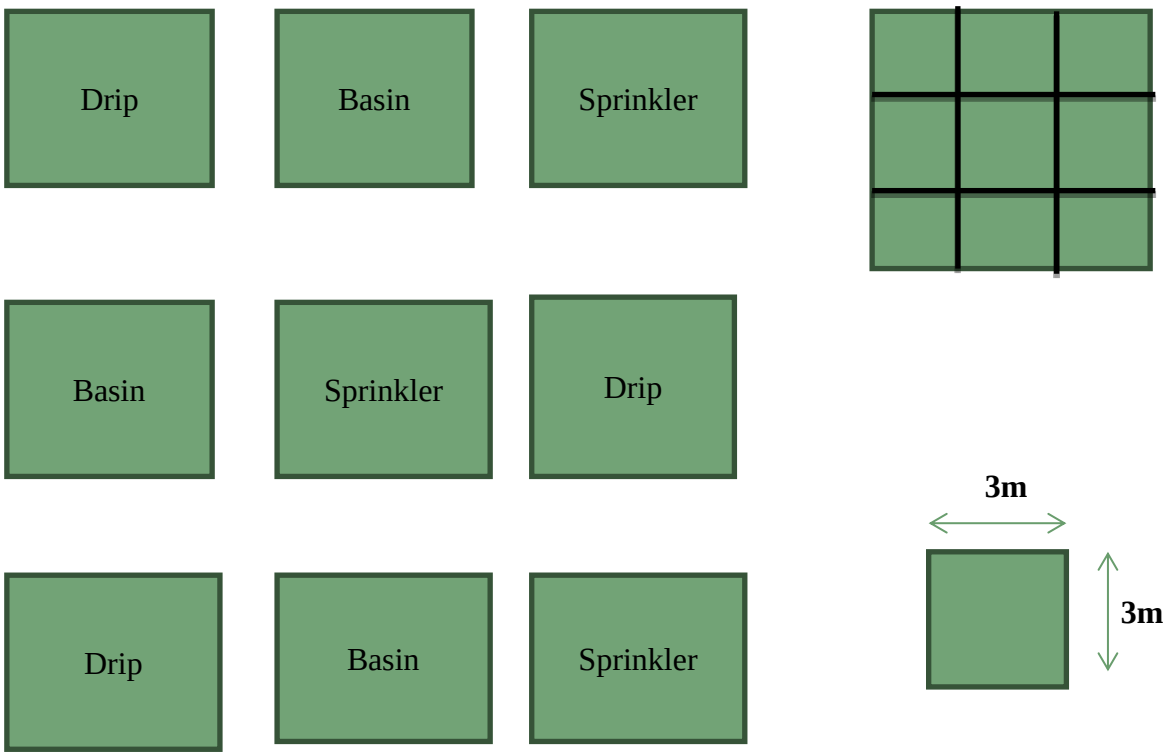

Figure 1: Lay out of the field experiment

Field planting

The 35 day old seedlings were transplanted at 60 cm×60 cm (1pts / hill). Healthy, disease free and good quality seedlings were selected from nursery. Shade was provided for 2 to 3 days. Seedlings were irrigated immediately after transplanting by basin, drip and sprinkler irrigation methods. The gap filling was done after one week of transplanting.

Cultural practices

Watering

Watering was done 3 times / day after transplanting by hand up to 2 weeks. Then at initial stage irrigation was given at 3 days interval for 2 weeks to maintain continuous moisture to ensure better establishment of plants. After that, irrigation frequency was increased to 4–5 days for 2 weeks (basin irrigation system) and thereafter irrigation was done depending on the soil moisture. But sprinkler and drip were irrigated every day (Figure 2 and 3). Duration of application of Sprinkler is 30 minutes, drip irrigation is 1hr. The water requirement for the crop was assumed to be 900 mm for the whole period and it is 6-10mm/day. Based on the irrigation interval and the irrigation system this quantity of water is was calculated to provide equal quantity of total in all irrigation methods.

Figure 2: Land preparation and layout

Figure 3: Irrigation after transplanting

Fertilizer application

In this experiment, general recommendation was given to each crop by the Department of Agriculture. Well decomposed cattle manure was applied before planting at the rate of 20 t/ha (500g/hill) and mixed well with Basel application. Basel fertilizer application was applied to every nine plot which are having respective fertilizer notation. Irrigation was applied after application of fertilizer. During the growth period, four top dressings were done at different time with DOA recommendation as shown in Table 2.

Table 2: Details of the fertilizer application

	Urea(kg/plot)	TSP(kg/plot)	MOP(kg/plot)
Basal (2 DBP)	-	7.290	3.645
1st TD (2 WAP)	4.738	-	-
2ndTD (4 WAP)	6.196	-	-
3rdTD (4 WAP)	6.196	-	3.645
4thTD (12 WAP)	6.196	-	-

DBP – Days after planting **WAP –**Weeks after planting

Weed control

Weeding is vital at the initial stage of the crop growth. Weeding was done regularly at every 25 days interval to control the weeds.

Watering, fertilizer application, weeding, pest and disease control were done according to the Department of Agriculture recommendations.

Pest and disease control

Leaf curl complex was observed during after 4 weeks of transplanting. Admire (Imidacloprid 70 WG (70% w/w)) was applied to control the vector. Anthracnose was observed in Chilli at the time of pod formation andDaconil (Active ingredient-Acibenzolar-S-methyl) was applied. Root rot was observed in Chilli during vegetative growth i.e. 2 weeks after transplanting. Homai (tetramethylthioperoxydicarbonic diamide) was applied to control this disease. Leaf eating caterpillar attack was observed during the pod formation period. Larvin (Thiodicarb 75% WP) was sprayed to prevent the leaf eating caterpillar.

Maturity and harvesting

Turning pod colour from green to dark green is the identification of maturity period. After maturity harvesting was done manually. First, three sample plants per treatment were marked by using colour ribbon and harvested separately for each treatment combination and each plot was harvested separately and pods were collected in gunny bag. First harvesting was done at two months after planting and 2nd and 3rd harvesting was done in two and half months and 3 months after planting.

Observations and readings

Readings of growth parameters and yield attribute were recorded. During the cropping season the rainfall, average temperature and average humidity were monitored.

Plant height

Randomly selected plants in each plot were used to measure the height. The plants were differentiated from others by using different colour ribbons. Plant height was measured in cm from the ground to the highest point of plant by using metal measuring tape. Plant height was measured in 4th, 5th, 6th, 7th, and 8th week after planting.

Canopy width

The width of canopy was taken at two opposite directions by means of metal measuring tape. The average was recorded as width of canopy. Canopy width was measured in 4th, 5th, 6th, 7th, and 8th week after planting.

Pest and disease affected plants were counted for all the plots at 5th, 8th, and 12th weeks. Number of pods / plant was counted from selected plants in all treatment combinations at every harvest. Pods weight per plant from pods of sampled plants was measured by using balance. The average of those pod weight was recorded. Pod length was measured from pods of sampled plants by using foot ruler. The average of those pod length was recorded. The harvested fresh weight of green Chilli was measured in each treatment combinations.

3 RESULTS AND DISCUSSION

3.1 Growth parameters

Plant height

Maximum plant height (65.6cm) was obtained in super hybrid with neem mulches under drip irrigation system after 8th week of planting and minimum plant height (26.0 cm) was obtained in Galkiriyagama selection with neem mulch under basin irrigation system. The plant height increased in weekly intervals.

Plant canopy width

Plant canopy width of Chilli from 4th up to 8th week was not significantly different between block and between the variety and mulch. Figure 4 shows, graphically the maximum plant canopy width (65.6 cm) was obtained in super hybrid with neem mulches under drip irrigation system after 8th week of planting and minimum plant canopy width (26.0 cm) was obtained in Galkiriyagama selection with neem mulch under basin irrigation system.

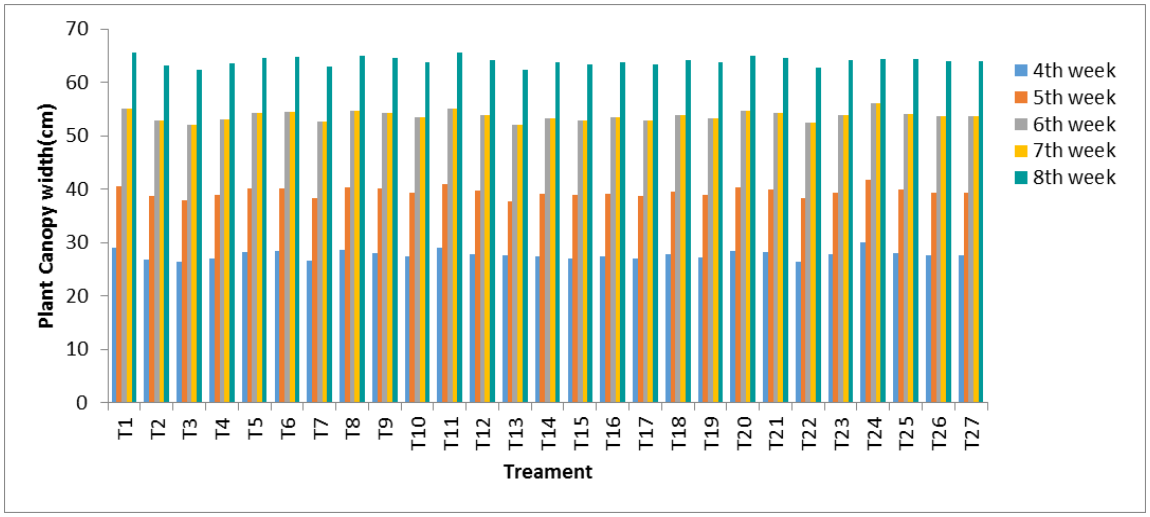

Figure 4: Mean performance of canopy width from 4th up to 8th week after planting

3.2 Incidence of Thrips for Chili Leaf Curl Complex attack

Chilli leaf curl complex (CLCC) incidence was significantly different between irrigation methods and was significantly differed between the variety and mulches (Figure 5). Thus it could be concluded that there is three way interaction between Irrigation, Mulch and Variety (I*M*V). Incidence of CLCC attack was low at 5th weeks after transplanting. After that CLCC damage was increased due to the hot weather. Figure 6 shows, graphically the maximum CLCC was observed (10 plants) in Galkiriyagama selection with no mulch under basin irrigation system (T19) minimum was in Vijiya Hybrid with no mulch under sprinkler irrigation system at 12th weeks after planting and these treatments were statistically significant.

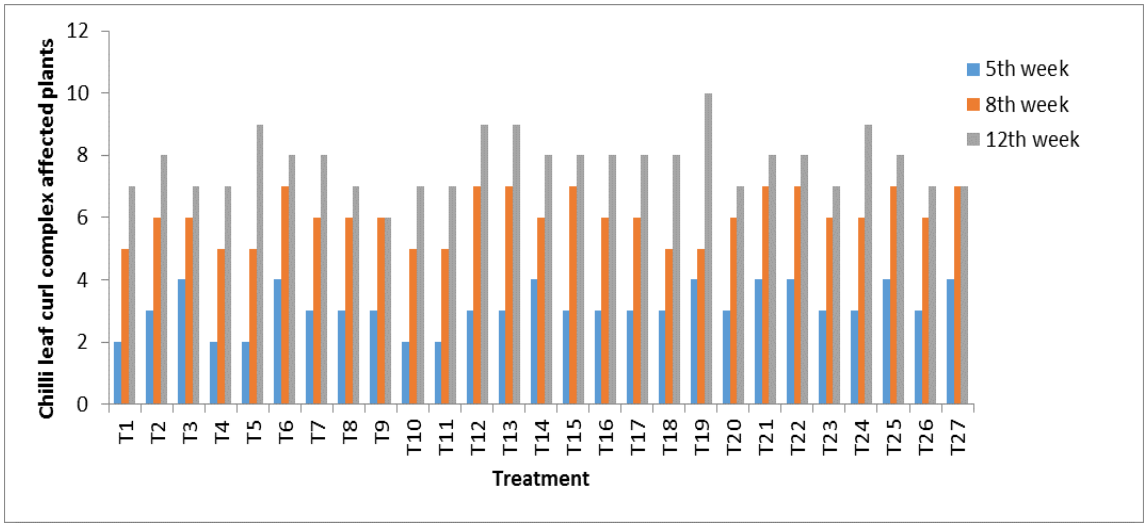

Figure 5: Chilli leaf curl complex in different treatment at 5th, 8th and 12th weeks after planting

Chilli leaf curl complex attack among the irrigation

CLCC was significantly different among the irrigation systems (Figure 6). Incidence of CLCC was low under sprinkler irrigation at 5th week. This may be due to the flushing of insects and pests by sprinkler irrigation system. Further the sprinkler irrigation reduces the temperature within the plant canopy. But with weeks after that CLCC was increased due to the high air temperature of 34°C-35°C.

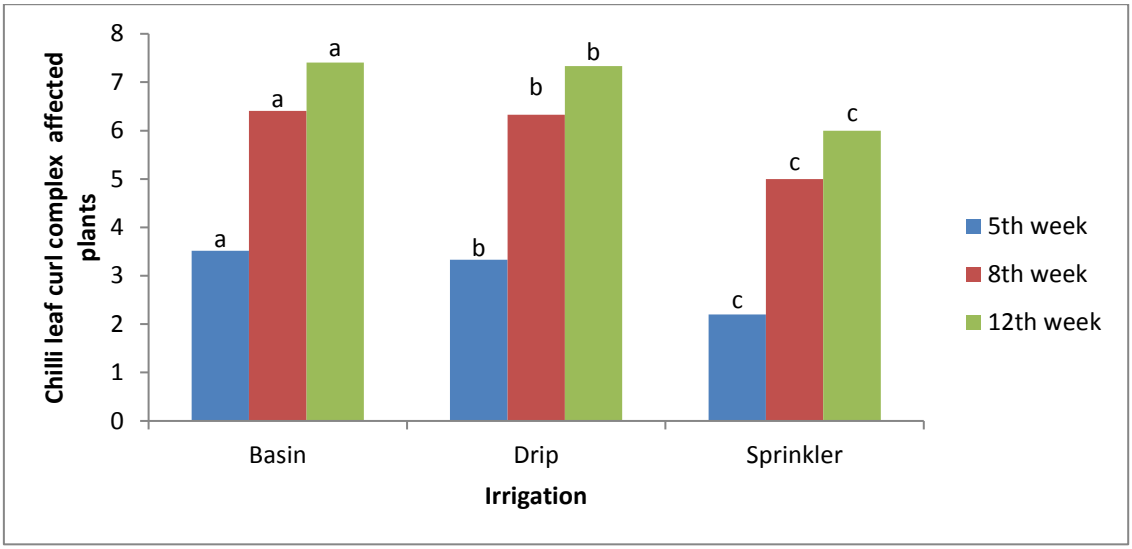

Figure 6: Chilli leaf curl complex attack among the irrigation

(a, b and c are comparison within irrigation and among weeks)

Chilli leaf curl complex attack among the mulches

CLCC was significantly different among the mulch systems and lowest affected plants were observed in neem mulch at 5th week after transplanting. Highest was observed in no mulch system at 5th, 8thand 12th week after transplanting (Figure 7).

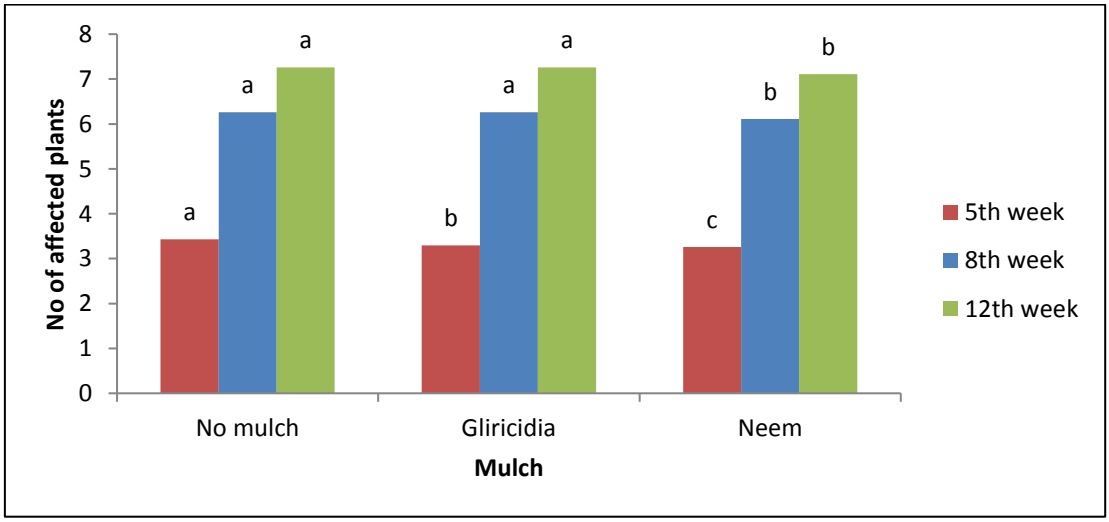

Figure 7: CLCC attack among the mulch

(a, b and c are comparison within mulches and among weeks)

Chilli leaf curl complex attack among the variety

CLCC was significantly different among the variety. Minimum attack was observed in super hybrid and maximum attack was observed in Vijaya at 5th, 8th and 12th week after transplanting in shown in Figure 8. These results agree with the findings of Lewis (1997).

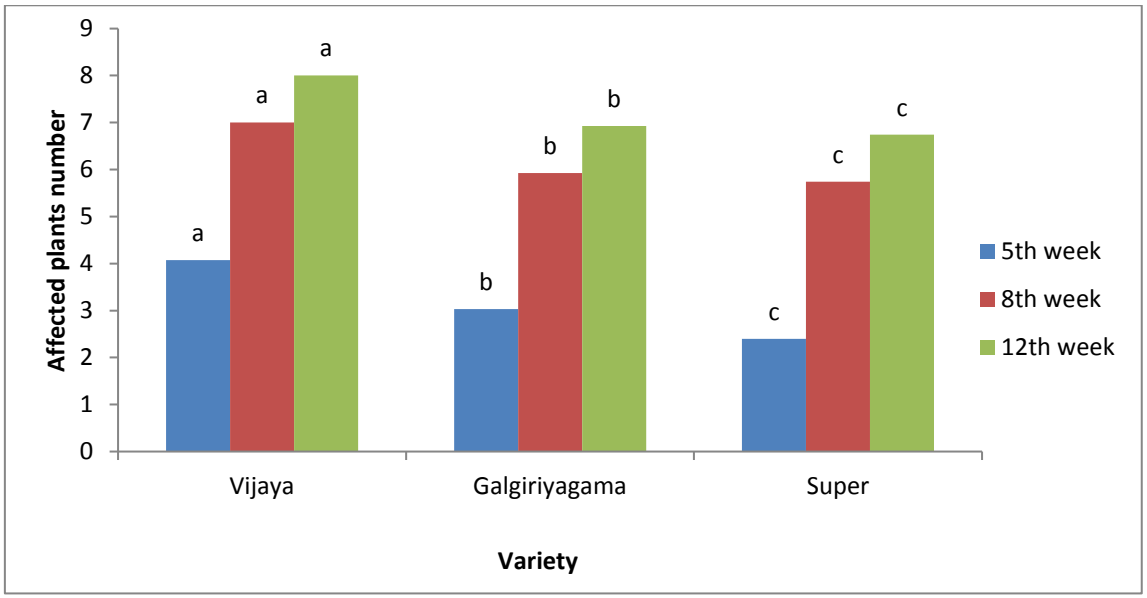

Figure 8: CLCC attack among the varieties

(a, b and c are comparison within varieties and among weeks)

3.3 Yield parameters

Number of pods / plant

Number of pods per plant was significantly different between the irrigation and mulch and non-significant between block and variety. The highest pod number per plant (105) was obtained in Galkiriyagama selection with no mulch under sprinkler irrigation system at 2nd harvesting. Figure 9 shows yield was decreased from 2nd harvesting to 3rd harvesting.

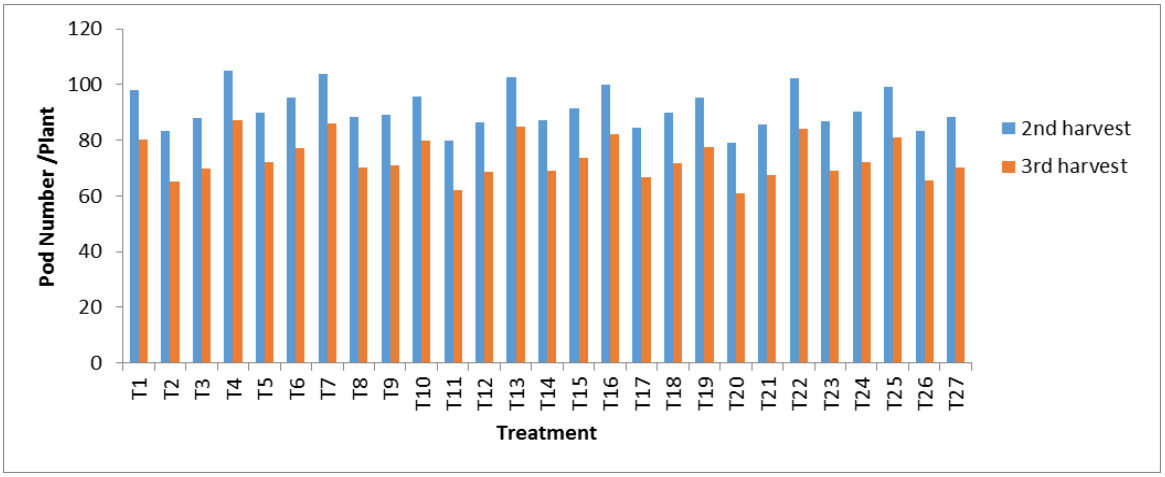

Figure 9: Number of pods / plant at 2nd and 3rd harvest

Pods weight / plant

Pods weight per plant was not significantly different between the irrigation, variety and mulch non-significant between block. The highest pod weight per plant (496g) was obtained in super hybrid with neem under sprinkler irrigation system at 2nd harvesting. Figure 10 shows; yield was decreased from 2nd harvesting to 3rd harvesting. Higher pod weight was recorded under sprinkler irrigation system due to better microclimate.

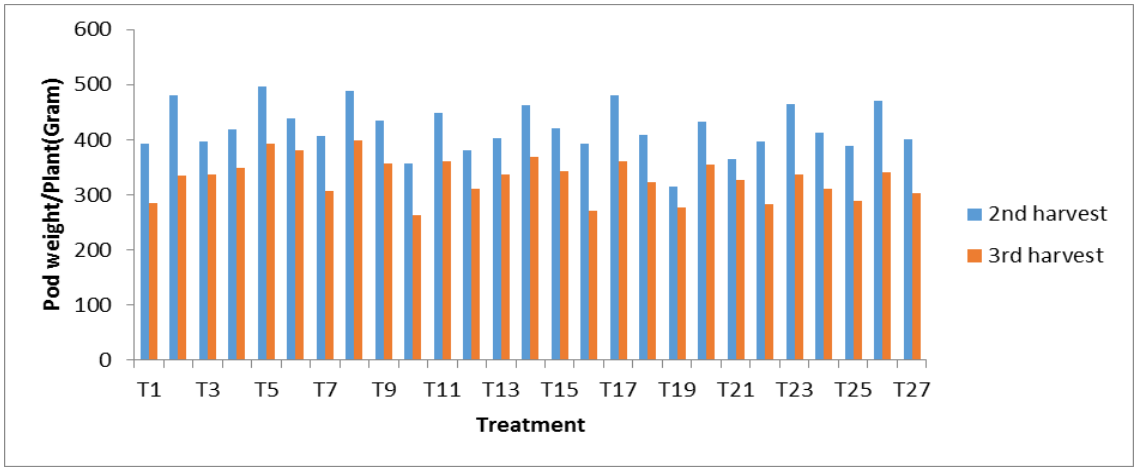

Figure 10: Pods weight / plant

Yield

Chilli yield was significantly different between the irrigation, variety and mulch and non-significant between block. Figure 11 shows that yield was decreased from 2nd harvesting to 3rd harvesting. Highest (12 ton/ha) yield was recorded under sprinkler irrigation system due to the low incidence of pest attack and better microclimate (Maheswaran *et al*, 2017) and lower yield was recorded Galkiriyagama selection with no mulch under basin irrigation system (Figure 12 and 13). These findings agree with Shinde *et al*, (1999) and Wijerathana Banda, (1997) as they too found that low incidence of pest attack under sprinkler irrigation system.

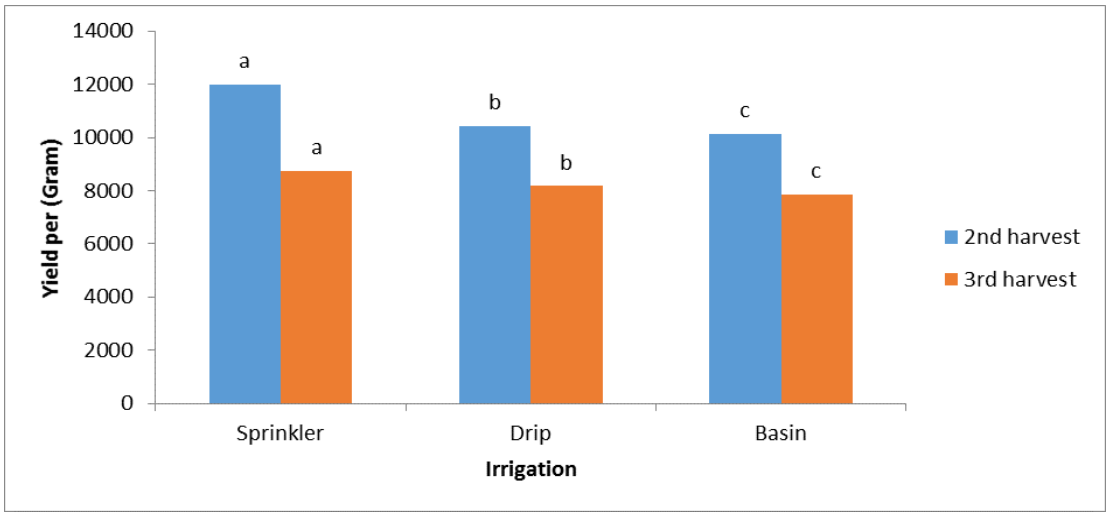

Figure 11: Yield (gram) of Chilli under different irrigation systems at 2nd and 3rd harvesting

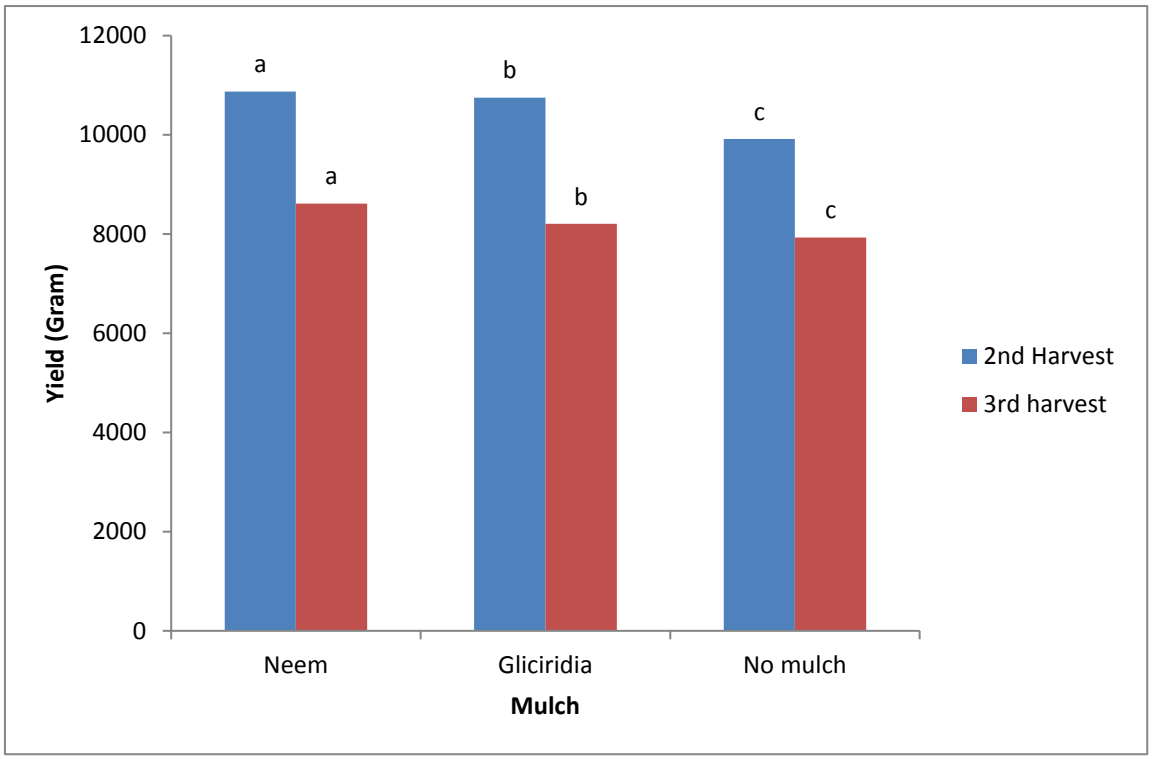

Figure 12: Yield (gram) of Chilli among different mulches

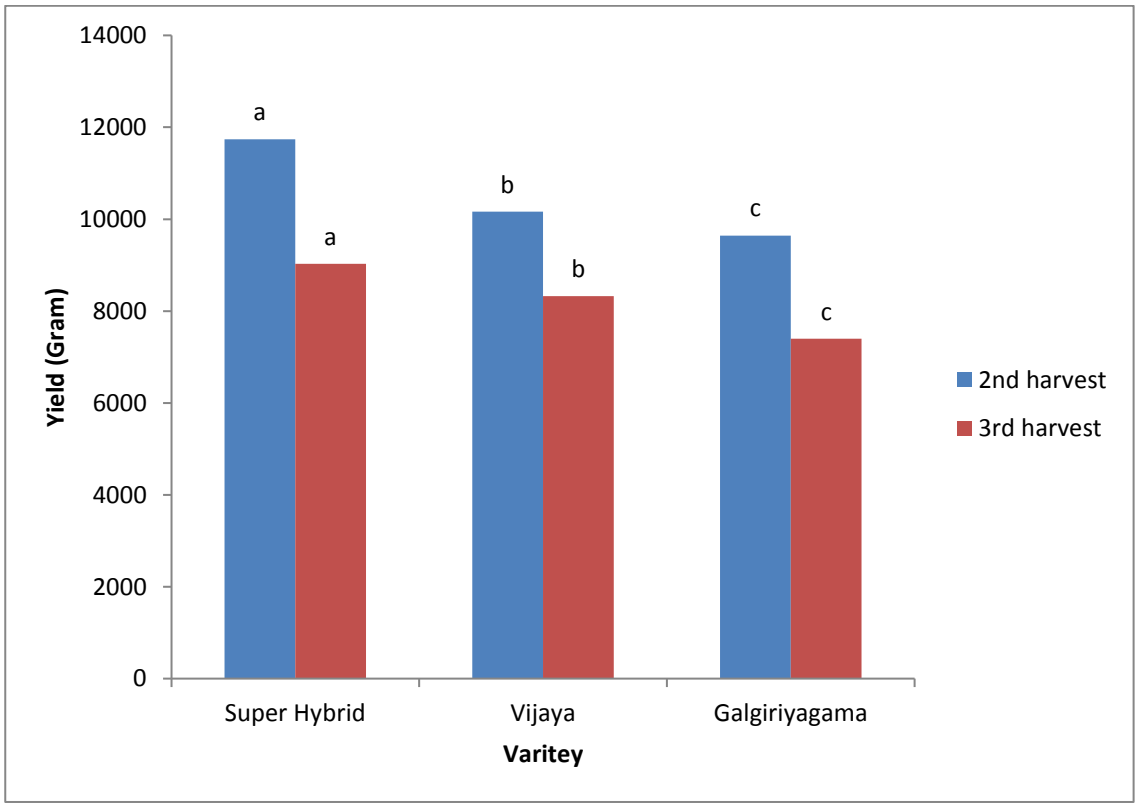

Figure 13: Yield of Chilli among varieties

4 CONCLUSIONS AND RECOMMENDATIONS

Plant height of Chilli was not statistically significant with irrigation, variety and mulch. Plant canopy width of Chilli was not significantly different between varieties, irrigation and mulch in each week. Chilli Leaf Curl Complex was significantly different among the varieties and irrigation systems but not significant in mulch system. In sprinkler irrigation system and super hybrid variety plot is resistant to Chili Leaf Curl Complex. Weed population was significantly different with irrigation systems and different mulches over control.

The difference in yield of Chilli was statistically significant among varieties, irrigation systems and mulch. Higher yield was recorded under sprinkler irrigation system super hybrid variety with neem mulch 2nd harvesting (12 ton/ha). Peak production was obtained from the second harvesting of the same treatment.

Maximum yield was obtained in Super hybrid and minimum yield was obtained in Galkiriyagama selection variety at 2nd and 3rd harvesting. Sprinkler irrigation system is the best in Chilli cultivation with the use of neem mulch to reduce the thrip attack and Chilli leaf curl complex. Because, it will flush away the pests present in leaves. The micro climate of the plant and soil were changed respectively by the sprinkler irrigation and neem mulch system.

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