BIBLIOGRAPHY

VALDEZ, DAISY JANE. APRIL 2012. Effect of Wild Sunflower Extract on the Growth and Yield of Celery (*Apiumgraveolens*L. var. *dulce Pers.)*.Benguet State University, La Trinidad, Benguet.

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ABSTRACT

The study was conducted at Horticulture Research Field, Benguet State University, La Trinidad, Benguet from November 2011 to January 2012 to determine the effect of frequency and rate of application of wild sunflower extract on the performance of celery.

Results show that plants were significantly taller and had higher marketable yield with lesser incidence of leaf miner on the crop with the application of wild sunflower extract at 7 days intervalat 15 ml/l water.

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INTRODUCTION

Celeryis one of the crops that thrive best in Cordillera Philippines. This is distinctly a cool season crop which thrives best in the areas with a monthly mean temperature ranging from 15 to 18 degrees Celsius. It grows best in sandy or loam soil with sufficient organic matter and soil pH requirement ranging from 6 to 6.8 (Knott and Deanon, 1967).

It has a high marketable demand and price due to its uses like pre-dinner and appetizer, salad, flavouring, soap, juices, and dressing as well as an excellent vegetable, either stewed or creamed (Thompson and Kelly, 1959). Besides its food purposes, it is used in aroma therapy and other traditional way of healing. Eating celery reduces high blood pressure and gives the effect of calmness. Celery clears uric acid from painful joints and may also help the treatment of arthritis and rheumatic problems. It also helps kidney by acting as anti-inflammatory and anti-oxidant (Hippocrates, 2006).

Celery has become the most profitable cash crop, but it has been a long time practice of most growers to use pesticide and inorganic fertilizer. Inorganic fertilizer is used as a mean of supplementing the recommended nutrient in the soil. It is true that the chemically made fertilizer is readily available for the plants. However long time use of this said synthetic fertilizer and pesticide causes depleted nutrients leads to soil acidity and unfavourable soil condition. Using of organic fertilizer to prevent or save the land from this said effect.

Using plant resources found in farm surroundings is helpful in making organic fertilizer. An example is the utilization of wild sunflower extracts for fertigating crops. It is rich in nitrogen which is the most common nutrient applied in fertigation. Other

nutrient elements applied more or less frequently include phosphorus, sulfur, potassium, zinc, and iron.

Fertigation (contraction of fertilization and irrigation) is a technique of supplying dissolved fertilizer to crop through on irrigation system. When combined with efficient irrigation system both nutrients and water can be manipulated and manage to obtained the maximum possible yield for marketable production from a given quality of this input (Pile, 2010). With fertigation system over feeding, waste and run-off, and stripes in the lawn from uneven application of fertilizer will be eliminated.

Wild sunflower has been known to be a good source of nitrogen (N). Besides being free, it is abundant in farms. Wild sunflower as an organic fertilizer insures vigorous growth of the plant and influences nutrient absorption due to the rule in granulation thereby improving the physical and chemical properties of the soil (Pandosen, 1986).

This is therefore necessary to study the use of organic fertilizer like wild sunflower extract to provide nutrients to have high yielding plants, minimize cost of fertilizer input to maximize profit.

The study was conducted to determine the effect of frequency of application of wild sunflower extract on the growth and yield of celery; the effect of rates of application; and the best frequency and rate of application in the production of celery.

The experiment was conducted at the Horticulture Research Field, Benguet State University, La Trinidad,Benguet from October 2011 to January 2012.

REVIEW OF LITERATURE

Fertilizer Application

The kind, amount, and method of applying fertilizer vary considerably from section to section and within a single producing area. On sandy soil in Florida there was no marketable celery was produced without fertilizer. Best result were obtain with a mixture of containing approximately 6% of nitrogen, 2-4% of phosphoric acid, and 8% potash, used at the rate of 8000 pounds per acre. In some areas in California there has been no response to applied potassium and phosphorus, but good response to nitrogen. Muck and peat soil are usually deficient in potash and often low in K. Nitrogen maybe limiting in this soil when they are cold and wet (McCollum, 1989).

Soil should be rich, high in nitrogen and with a pH of 6.6. Liquid fertilizer is beneficial from about four weeks after planting celery, or a nitrogenous fertilizer applied as a top dressing (Phillips and Rix, 1991).

When the plant are about half mature size (about 2 ½ months after planting) begin forcing them to grow rapidly. Feed and water frequently (Clifford and Wilson, 1998).

Organic Fertilizer

Organic fertilizer supply some amount of the nutrient requirements of the crops and promote favourable soil properties, such as granulation, good tilth for efficient aeration, easy root penetration and improvement of water holding capacity (PCARRD, 1982). Organic fertilizer also improve the soil structure and conserve soil moisture making it ideal for vegetable production because vegetable requires soil rich in organic matter (Doa-ines,1994).

Kinoshita (1976) stated that organic fertilizer or droppings contains mainly of nitrogen which tends to improve the physical properties of the soil.

Wild Sunflower

Wild sunflower which is abundant in the highlands can be a perfect substitute organic nitrogen source and as starter of compost for it hasten further decomposition. It also increases the nutrient content of compost (Victor, 1974). Through the laboratory analysis, Paquito (2011) found that fresh wild sunflower extract contains nitrate nitrogen at 0.5 ppm, potassium at 200ppm, and phosphorus at 37.5ppm, therefore wild sunflower extract is a good source of organic nitrogen.

Yango (1998) found that incorporation of chopped wild sunflower is effective in improving the growth and yield of Bontoc rice when applied one week before planting time. In the case of garden pea, Durante (1983) claimed that application of 8 tons of fresh wild sunflower per hectare gave highest yield.

In addition application of 20 tons of fresh wild sunflower per hectare 7 days before transplanting celery is recommended (Bernard, 2009).

Importance of Fertigation

Fertigation allows the landscape to absorb up to 90% of the applied nutrients, while granular or dry fertilizer application typically result in absorption rates of 10% to 40% (Fertigation System, 2011). Plaster (1997) stated that a third way to fertilize a growing crop is injecting a fertilizer into irrigation. Liquid application is the most commonly used of post plant surface applied systems. Benefits include ease in uniformity of application, low labor requirements and ability to automate the system (Joiner, 1981).

According to Gamboa (1977) and Tombaga (1980), liquid fertilizers to be applied as spray is more advantageous than solid fertilizers because of its security in avoiding root injury.

MATERIALS AND METHODS

Materials

The materials used were celery seedlings var. Ventura, wild sunflower extract, watering cans, grub hoe, 1.5 liter plastic container, graduated cylinder, shredder or bolo, meter stick, recording and documentation materials.

Methods

Celery seedlings were planted in an area of 135 m^2 that was thoroughly prepared and divided into 27 plots measuring 1x5 m (Figure 1). The field layout followed the Randomized Complete Block Design (RCBD) involving factorial arrangement. The level of significance was tested using the Duncan's Multiple Range Test (DMRT). There were 9 treatment combinations with 3 replication. The treatments were as follows:

Factor A. Frequency of Application	Factor B. Rate of Wild Sunflower Extract
F_1 -7 days interval	R_1 - 5ml /l water
F_2 -14 days interval	R_2 - 10ml /l water
F_3 - 21 days interval	R_3 - 15ml /l water

Young shoots of wild sunflower measuring one foot long from the tip to the base at its vegetative stage were gathered and chopped or shredded for faster extraction (Figure 2). It was weighed and 68 kilograms of chopped wild sunflower was placed in a 200 liter capacity drum. Then it was covered with plastic sheet. After two weeks, the extract was collected and put into 1.5 liter containers.

Application of the wild sunflower extract was done following the frequency and rate treatment. The rate of wild sunflower extract was based on the recommended

fertigation used that is 10ml/l of water (Paquito, 2011). From this recommended rate, higher and lower rates were formulated. The extract was measured and mixed with the corresponding amount in watering cans then applied overhead on the celery plants. Application started two weeks after transplanting then following the frequency application treatments thereafter.

Proper cultural management like weeding, hilling-up at 30 days after transplanting, spraying of fungicide and insecticide at 7 days interval and stopped 15 days prior to harvest. Practices like removal of leaf miner infested and early blight infected parts were done to insure proper growth and development.

Figure 1. Transplanted celery seedlings

Figure 2. Preparation of wild sunflower extract

The data gathered were as follows:

1. Plant vigor. Plant vigor was rated using the following scale:

Scale	Description
1	Very vigorous
2	Vigorous
3	Slightly vigorous
4	Not vigorous

2. Plant height (cm). This was taken from 10 sample plants selected at random by measuring from the base of the plant to the longest leaves at harvest.

3. Average plant weight (g). This was obtained by taking the weight of the plants per plot divided by the number of plants.

4. Total yield (kg/5m^2 plot). The weight of non-marketable and marketable plants.

5. Marketable yield (kg/5m^{2}plot). This was the total weight of the harvest plants without defects that can be sold in the market.

6. Non- marketable yield (kg/5m^{2}plot). This was the total weight of the harvest with defects that cannot be sold in the market.

7. Computed marketable yield (t/ha). It was obtained multiplying the marketable yield per plot by two thousand which is the number of 1x5m plots per hectare.

8. Incidence of insect pest and disease. This was taken from 10 sample plants selected at random using the following rating scale(Cho, 1987) as cited by Menes (2010) at 30 and 60 days after transplanting.

Scale	Description
1	No infestation /infection
2	1-25% of the total plants affected
3	26-50% of the total plants affected
4	51-75% of the total plants affected
5	76-100% of the total plants affected

9. Allelophatic effects. All abnormalities were observed during the study.

10. Documentation. This was taken through pictures of the study.

RESULTS AND DISCUSSION

Plant Vigor

Effect of frequency of application. Result shows that plants applied more frequently at 7 or 14 days interval were significantly more vigorous (Table 1).

Effect of rate of application.Plant vigor was not significantly affected by the rates of wild sunflower extract applied (Table 1).

Interaction effects. No significant interaction effects of frequency of application and rate of wild sunflower extract was observed on plant vigor.

Table 1. Plant vigor as affected by wild sunflower extract application

TREATMENT	MEAN
Frequency of Application	
7 days interval	1.556[b]
14 days interval	1.778[b]
21 days interval	3.111[a]
Rate of Wild Sunflower Extract	
5 ml/l water	2.444 [a]
10 ml/l water	2.222[a]
15 ml/l water	1.778[a]

Means with common letters are not significantly different at 5% by DMRT

Rating:

1- Very vigorous 3- Slightly vigorous
2- Vigorous 4- Not vigorous

Figure 3. Plant vigor at 60 days after transplanting

Plant Height

Effect of frequency of application. Table 2 shows that celery plants that were applied at 7 days interval were significantly taller.

Effect of rate of application. Application of 10 ml/l water and 15 ml/l water significantly promoted development of taller plants (Table 2).

Interaction effects. There were no significant interaction effectsof frequency and rate of application of wild sunflower extract on the plant height 60 days after transplanting.

Table 2. Plant height as affected by wild sunflower extract application

TREATMENT	MEAN (cm)
Frequency of Application	
7 days interval	42.276[a]
14 days interval	37.710[b]
21 days interval	29.458[c]
Rate of Wild Sunflower Extract	
5 ml/l water	33.388[b]
10 ml/l water	37.494[a]
15 ml/l water	38.561[a]

Means with common letters are not significantly different at 5% by DMRT

Average Plant Weight

Effect of frequency of application. Table 3 shows that frequent application at 7 days interval significantly effected heavier plant weight.

Effect of rate of application.Average plant weight was significantly heavier with the application of 15ml/l water as shown in Table 3.

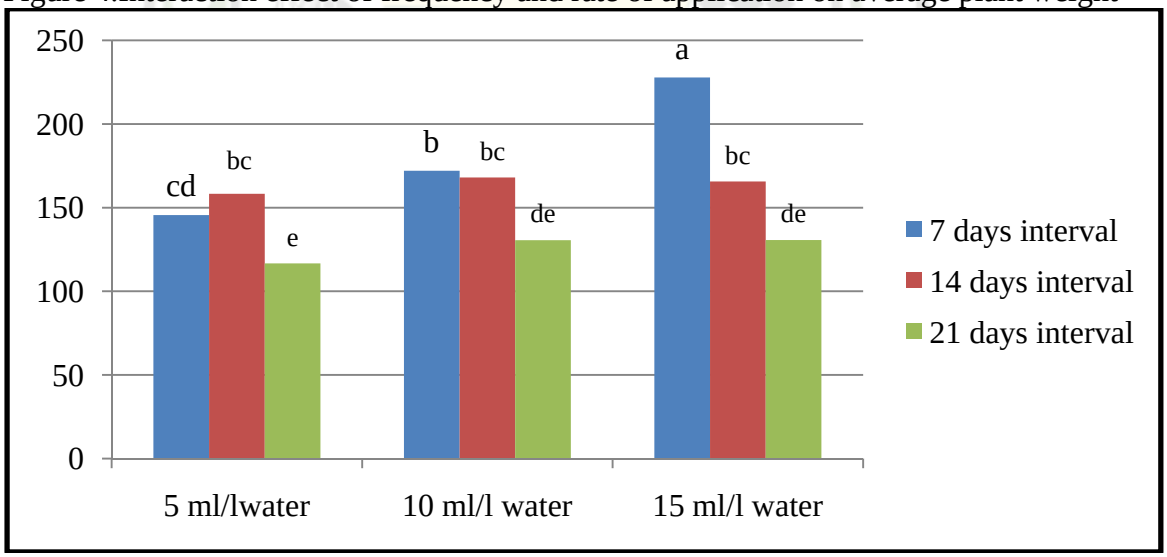
Interaction effect. Significantly heavier plants were observed with the application of 15ml/l water at 7 days interval (Figure 4).

Table 3. Average plant weight as affected by wild sunflower extract application

TREATMENT	MEAN (g)
Frequency of Application	
7 days interval	181.812[a]
14 days interval	164.004[b]
21 days interval	125.943[c]
Rate of Wild Sunflower Extract	
5 ml/l water	140.181[c]
10 ml/l water	156.911[b]
15 ml/l water	174.667[a]

Means with common letters are not significantly different at 5% by DMRT

Figure 4.Interaction effect of frequency and rate of application on average plant weight



Bars with common letters are not significantly different at 5% by DMRT

Total Yield

Effect of frequency of application. Result revealed that plants applied at 7 days interval had significantly higher total yield (Table 4).

Effect of rate of application. Plants applied with 15ml/l water significantly had the highest total yield as shown in Table 4.

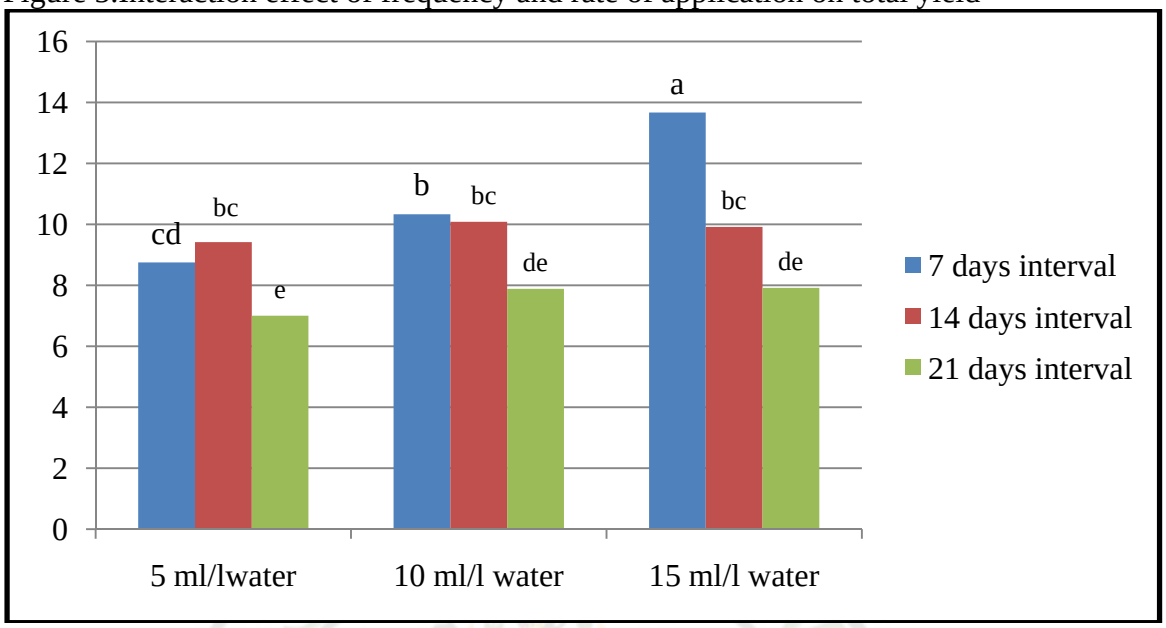
Interaction effect.Figure 5 shows that plants applied with 15ml/l water at 7 days interval had significantly higher total yield.

Table 4. Total yield as affected by wild sunflower extract application

TREATMENT	MEAN ($kg/5m^2$ plot)
Frequency of Application	
7 days interval	10.063^a
14 days interval	9.806^b
21 days interval	8.042^c
Rate of Wild Sunflower Extract	
5 ml/l water	8.389^c
10 ml/l water	9.417^b
15 ml/l water	10.500^a

Means with common letters are not significantly different at 5% by DMRT

Figure 5.Interaction effect of frequency and rate of application on total yield



Bars with common letters are not significantly different at 5% by DMRT

Marketable Yield

Effect of frequency of application. Significantly higher marketable yield was obtained with more frequent application at 7 days interval as shown in Table 5.

Effect of rate of application. Application of the highest rate of sunflower extract at 15 ml/l water significantly effected higher marketable yield (Table 5). Marketable yield increased correspondingly with an increase in the rate applied.

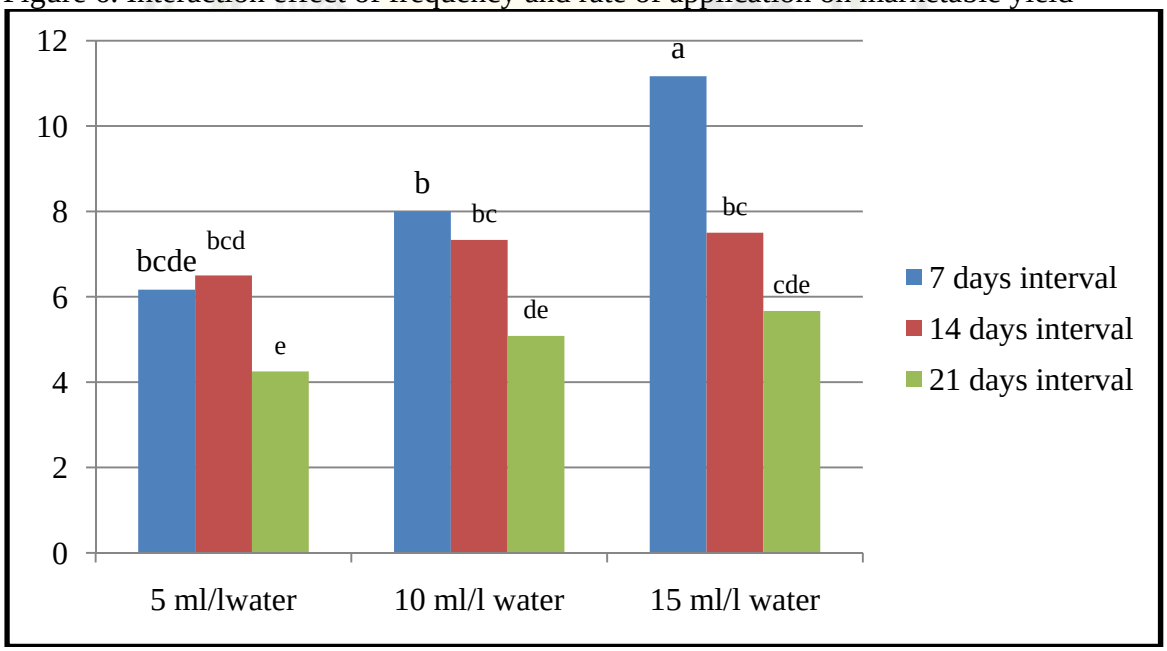
Interaction effect.Plants applied with the highest rate at 15 ml/l water more frequently at 7 days interval significantly had higher marketable yield as shown in Figure 6.

Table 5. Marketable yield as affected by wild sunflower extract application

TREATMENT	MEAN (kg/5m^2 plot)
Frequency of Application	
7 days interval	8.444[a]
14 days interval	7.111[b]
21 days interval	5.000[c]
Rate of Wild Sunflower Extract	
5 ml/l water	5.539[c]
10 ml/l water	6.806[b]
15 ml/l water	8.111[a]

Means with common letters are not significantly different at 5% by DMRT

Figure 6. Interaction effect of frequency and rate of application on marketable yield



Bars with common letters are not significantly different at 5% by DMRT

Figure 7. Harvesting at 60 days after transplanting

Figure 8. Harvested plants at 60 days after transplanting

Figure 9.Marketable plants

Figure 9a. Application of wild sunflower extract at 7 days interval at 5ml/l water

Figure9b.Application of wild sunflower extract at 7 days interval at 10 ml/l water

Figure 9c.Application of wild sunflower extract at 7 days interval at 15ml/l water

Figure 9d. Application of wild sunflower extract at 14 days interval at 5ml/l water

Figure 9e.Application of wild sunflower extract at 14 days interval at 10 ml/l water

Figure 9f.Application of wild sunflower extract at 14 days interval at 15ml/l water

Figure 9g.Application of wild sunflower extract at 21 days interval at 5 ml/l water

Figure 9h. Application of wild sunflower extract at 21 days interval at10 ml/l water

Figure 9i.Application of wild sunflower extract at 21 days interval at 15 ml/l water

Non-marketable Yield

Effect of frequency of application.Non-marketable yield was not significantly affected by frequency of application as presented in Table 6.

Effect of rate of application. Table 6 shows that non-marketable yield was not significantly affected by the rates of sunflower extract applied.

Interaction effect.Results show that there were no significant interaction effectsof frequency and rate of wild sunflower extract on non-marketable yield.

Table 6. Non marketable yield as affected by wild sunflower extract application

TREATMENT	MEAN ($kg/5m^2$ plot)
Frequency of Application	
7 days interval	2.500[a]
14 days interval	2.694[a]
21 days interval	2.528[a]
Rate of Wild Sunflower Extract	
5 ml/l water	2.694[a]
10 ml/l water	2.639[a]
15 ml/l water	2.389[a]

Means with common letters are not significantly different at 5% by DMRT

Figure 10.Non-marketable plants with abnormalities

Computed Marketable Yield

Effect of frequency of application. Table 7 shows the computed marketable yield per hectare. Plants applied more frequently at 7 days interval had significantly higher computed marketable yield at 16.89 t/ha.

Effect of rate of application. Plants applied with 15 ml/l water significantly had the highest computed marketable yield at 16.22 t/haas shown in Table 7.

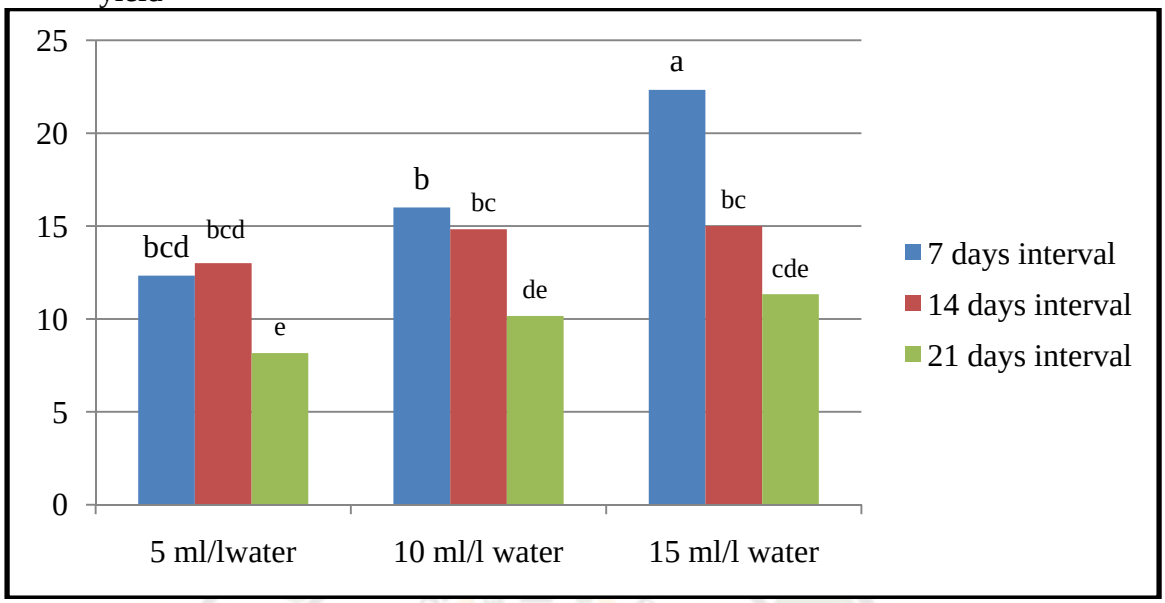
Interaction effect. Application of 15 ml/l water at 7 days interval effected the highest computed marketable yield (Figure 17). This shows that plants applied more frequently at a higher rate had higher marketable yield.

Table 7. Computed marketable yield as affected by wild sunflower extract application

TREATMENT	MEAN (t/ha)
Frequency of Application	
7 days interval	16.888[a]
14 days interval	14.227[b]
21 days interval	9.889[c]
Rate of Wild Sunflower Extract	
5 ml/l water	11.167[c]
10 ml/l water	13.667[b]
15 ml/l water	16.222[a]

Means with common letters are not significantly different at 5% by DMRT

Figure 11. Interaction effect of frequency and rate of application on computed marketable yield



Bars with common letters are not significantly different at 5% by DMRT

Incidence of Insect Pest and Disease

Leaf Miner Infestation

Effect of frequency of application. At 30 days after transplanting, incidence of leaf miner was significantly lower with application at 7 or 14 days interval while at 60 days after transplanting, frequency of application did not affect leaf miner infestation (Table 8).

Effect of rate of application. Table 8 shows that rate of wild sunflower extract application did not significantly affect the leaf miner infestation at 30 days after transplanting but at 60 DAT, leaf miner infestation was significantly lower with the application of 15ml/l water.

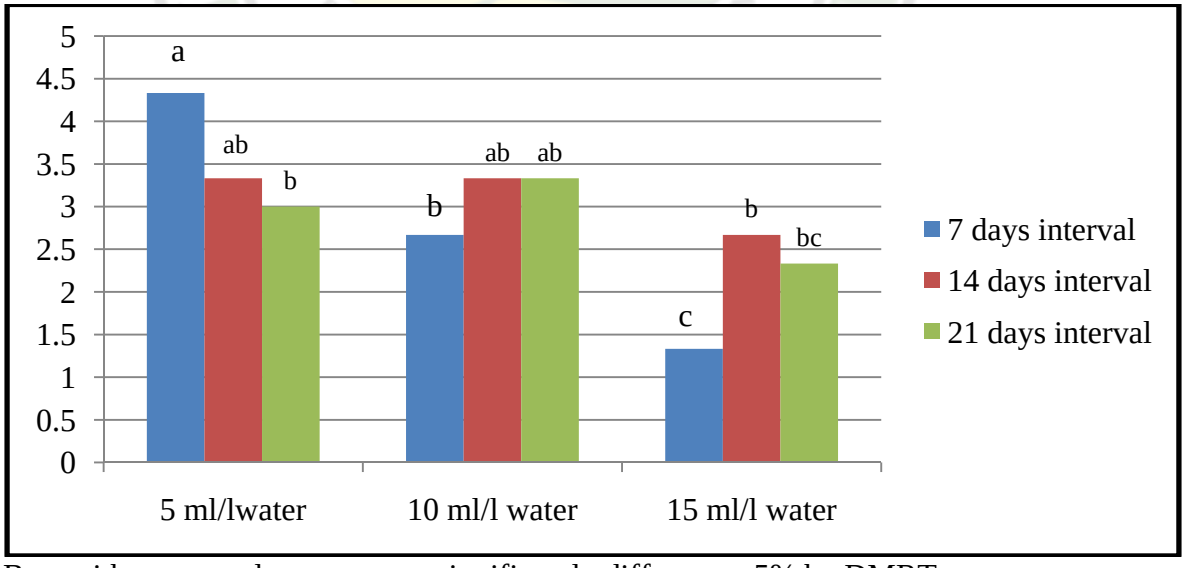
Interaction effect. Application of sunflower extract with 15ml/l water at 7 days interval had significantly lowered infestation of leaf miner at 60 days after transplanting as shown in Figure 18

Table 8.Leaf miner infestationas affected by wild sunflower extract application

TREATMENT	MEAN	
	30 DAT	60 DAT
Frequency of Application		
7 days interval	2.556[b]	2.778[a]
14 days interval	2.778[b]	3.111[a]
21 days interval	3.888[a]	2.889[a]
Rate of Wild Sunflower Extract		
5 ml/l water	3.000[a]	3.556[a]
10 ml/l water	3.333[a]	3.111[a]
15 ml/l water	2.889[a]	2.111[b]

Means with common letters are not significantly different at 5% by DMRT

Figure 12.Interaction effect of frequency and rate of application on leaf miner infestation 60DAT



Bars with common letters are not significantly different at 5% by DMRT

Rating:

1- No infestation
2- 1-25% infestation
3- 26-50% infestation
4- 51-75% infestation
5- 76-100% infestation

Figure 13. Leaf miner infestation

Early Blight

Effect of frequency of application.Table 9 shows that incidence of early blight was significantly lower with application at 7 days interval at 30 DAT. At 60 DAT, frequency of application did not significantly affect the early blight infection.

Effect of rate of application. Result shows that rate of application of wild sunflower extract had no significant effect on the infection of early blight at 30 and 60 DAT (Table 9).

Interaction effect.There were no significant interaction effectsof frequency and rate of wild sunflower extract application on early blight infection.

Table 9.Early blight infectionas affected by wild sunflower extract application

TREATMENT	MEAN	
	30 DAP	60 DAP
Frequency of Application		
7 days interval	1.444[b]	2.667[a]
14 days interval	2.444[a]	3.000[a]
21 days interval	3.111[a]	3.000[a]
Rate of Wild Sunflower Extract		
5 ml/l water	2.667[a]	3.222[a]
10 ml/l water	2.222[a]	2.889[a]
15 ml/l water	2.111[a]	2.556[a]

Means with common letters are not significantly different at 5% by DMRT

Rating:

1- No infection
2- 1-25% infection
3- 26-50% infection
4- 51-75% infection
5- 76-100% infection

Allelophatic effects

There were no observed abnormalities on the celery plants during the conduct of the study.

SUMMARY, CONCLUSION AND RECOMMENDATION

Summary

The experiment was conducted to determine the effect of frequency of application of wild sunflower extract on the growth and yield of celery, determine the effect of different rates of wild sunflower extract, and determine the best frequency and rate of wild sunflower extract application in the production of celery.

Results show that celery had significantly better growth in heightand higher marketable yield with lesser leaf miner infestationwith the application of wild sunflower extract at 7 days intervalat 15 ml/l water.

Conclusion

Based on the results, it is concluded that application of wild sunflower extract at 7 days interval at a rate of 15ml/l water enhances growth and yield of celery.

Recommendation

It is therefore recommended that celery be applied with wild sunflower extract at 7 days interval at 15ml/l water to attain better growth and higher yield.

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APPENDICES

Appendix Table 1. Plant vigor

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	III		
F_1R_1	2	2	2	6	2.0
F_1R_2	1	1	2	4	1.33
F_1R_3	1	1	2	4	1.33
Sub total	4	4	6	14	4.66
F_2R_1	2	1	2	5	1.66
F_2R_2	2	1	3	6	2.0
F_2R_3	1	1	3	5	1.66
Sub total	5	3	8	16	5.32
F_3R_1	3	4	4	11	3.66
F_3R_2	3	3	4	10	3.33
F_3R_3	2	3	2	7	2.33
Sub total	8	10	10	28	9.32
Total	17	17	24	58	19.3

FxT TWO - WAY TABLE

TREATMENT	F_1	F_2	F_3	TOTAL	MEAN
R_1	2.000	1.667	3.667	7.334	2.444
R_2	1.333	2.000	3.333	6.666	2.222
R_3	1.333	1.667	2.333	5.333	1.778
TOTAL	4.666	5.334	9.333	19.333	
MEAN	1.555	1.778	3.111		6.444

ANALYSIS OF VARIANCE

SOURCE	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	F VALUE	TABULAR F 5%	TABULAR F 1%
REPLICATION	2	3.630	1.815	5.7647		
TREATMENT	8	16.741	2.093	6.6433**	2.59	3.89
FACTOR A	2	12.741	6.370	20.2353**	3.63	6.23
FACTOR B	2	2.074	1.037	3.2941ns	3.63	6.23
AXB	4	1.926	0.481	1.5294ns	3.01	4.77
ERROR	16	5.037	0.315			
TOTAL	26	25.407				

ns- not significant
** - highly significant

Coefficient of variation: 26.12%

Appendix Table 2. Plant height (cm)

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	III		
F_1R_1	34.27	39.20	42.60	11.07	38.69
F_1R_2	38.8	43.87	46	128.67	42.89
F_1R_3	43.67	46.27	45.8	135.74	45.25
Sub total	116.74	129.34	134.4	275.48	30.61
F_2R_1	34.13	36.63	35.73	106.49	35.50
F_2R_2	38.6	42.06	39.33	119.99	39.997
F_2R_3	34	39.33	39.58	112	37.64
Sub total	106.73	118.02	114.64	338.48	37.61
F_3R_1	26.33	28.13	26.47	80.93	26.98
F_3R_2	29.4	29.53	26.47	88.79	29.60
F_3R_3	32.67	33.6	32.13	98.4	32.8
Sub total	88.4	91.26	85.07	268.12	29.79
Total	311.87	338.62	334.11	984.6	36.47

FxT TWO - WAY TABLE

TREATMENT	F_1	F_2	F_3	TOTAL	MEAN
R_1	38.690	35.497	25.977	100.164	33.388
R_2	42.890	39.997	29.597	112.489	37.494
R_3	45.247	37.637	32.800	115.684	38.561
TOTAL	126.827	113.131	88.374	328.337	
MEAN	42.276	37.71	29.458		36.482

ANALYSIS OF VARIANCE

SOURCE	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	F VALUE	TABULAR F 5%	TABULAR F 1%
REPLICATION	2	63.185	31.592	11.0051		
TREATMENT	8	926.224	115.778	40.3267**	2.59	3.89
FACTOR A	2	759.717	379.959	132.3225**	3.63	6.23
FACTOR B	2	134.289	67.149	23.3911**	3.63	6.23
AXB	4	32.209	8.052	2.8050ns	3.01	4.77
ERROR	16	45.931	2.871			
TOTAL	26					

ns- not significant
** - highly significant

Coefficient of variation: 4.64%

Appendix Table 3. Average plant weight (g)

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	III		
F_1R_1	145	150	141.67	436.67	145.56
F_1R_2	170.8	183	162.5	516.3	172.1
F_1R_3	216.67	229.167	237.5	683.44	227.78
Sub total	532.47	562.167	541.67	1636.41	181.82
F_2R_1	191.62	129.17	154.17	474.96	158.32
F_2R_2	175	162.5	166.67	504.17	168.06
F_2R_3	166.67	175	154.67	496.34	165.45
Sub total	533.29	466.67	475.51	1475.47	163.94
F_3R_1	120.83	112.5	116.67	349.97	116.66
F_3R_2	141.66	116.67	133.33	391.66	130.55
F_3R_3	121	133.33	137.5	391.83	130.61
Sub total	383.49	362.5	387.5	1133.46	125.94
Total	1449.25	1391.337	1404.68	4245.34	157.23

FxT TWO - WAY TABLE

TREATMENT	F_1	F_2	F_3	TOTAL	MEAN
R_1	145.557	158.320	116.667	417.544	140.181
R_2	172.000	168.080	130.553	470.633	156.911
R_3	227.779	165.613	130.610	524.002	174.667
TOTAL	545.336	492.013	377.83	1412.179	
MEAN	181.779	164.004	112.61		52.303

ANALYSIS OF VARIANCE

SOURCE	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	F VALUE	TABULAR F 5%	TABULAR F 1%
REPLICATION	2	201.402	100.701	0.5288		
TREATMENT	8	25168.007	3221.001	16.9155**	2.59	3.89
FACTOR A	2	14661.146	7330.573	38.4175**	3.63	6.23
FACTOR B	2	5353.463	2676.731	14.0572**	3.63	6.23
AXB	4	5753.544	1438.386	190.417**	3.01	4.77
ERROR	16	3046.672	190.417			
TOTAL	26	29016.227				

** - highly significant Coefficient of variation: 8.78%

Appendix Table 4. Non- marketable yield (kg/1x5mplot)

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	III		
F_1R_1	2.750	2	3	7.75	2.58
F_1R_2	2.750	2	2.500	7.25	2.42
F_1R_3	3.250	2	2.250	7.5	2.5
Sub total	8.75	6	7.75	22.5	2.5
F_2R_1	3	2.750	3	8.750	2.92
F_2R_2	2.750	3	2.500	8.25	2.75
F_2R_3	2.750	3	2.500	7.25	2.42
Sub total	8.5	8.75	8	24.25	2.69
F_3R_1	2.500	3	2.250	7.75	2.58
F_3R_2	2.250	3.250	2.750	8.25	2.75
F_3R_3	2.750	2	2	6.75	2.85
Sub total	7.5	8.25	7	22.75	2.53
Total	24.75	23	22.75	69.5	2.57

FxT TWO WAY TABLE

TREATMENT	F_1	F_2	F_3	TOTAL	MEAN
R_1	2.583	2.917	2.583	8.083	2.694
R_2	2.417	2.750	2.750	7.917	2.639
R_3	2.500	2.417	2.250	7.167	2.389
TOTAL	7.5	8.084	7.583	23.167	
MEAN	2.5	2.70	2.53		2.574

ANALYSIS OF VARIANCE

SOURCE	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	F VALUE	TABULAR F 5%	TABULAR F 1%
REPLICATION	2	0.449	0.225	1.2456		
TREATMENT	8	1.019	0.127	0.7076^{ns}	2.59	3.89
FACTOR A	2	0.119	0.100	0.5522^{ns}	3.63	6.23
FACTOR B	2	0.447	0.238	1.3226^{ns}	3.63	6.23
AXB	4	0.343	0.086	0.4751^{ns}	3.01	4.77
ERROR	16	2.884	0.180			
TOTAL	26	4.352				

^{ns}- not significant Coefficient of variation: 16.49%

Appendix Table 5. Marketable yield (kg/1x5m plot)

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	III		
F_1R_1	6	7	5.500	18.5	6.17
F_1R_2	7.750	9	7.25	24	8
F_1R_3	9.750	11.750	12	33.5	11.17
Sub total	23.5	27.75	24.75	76	8.44
F_2R_1	4.250	5	6.250	19.5	6.5
F_2R_2	7.750	6.750	7.500	22	7.33
F_2R_3	7.250	8.500	6.750	22.5	7.5
Sub total	19.25	20.25	20.5	64	7.11
F_3R_1	4.250	3.750	4.750	12.75	4.25
F_3R_2	6.250	3.750	5.250	15.25	5.08
F_3R_3	4.750	6	6.250	17	5.67
Sub total	15.25	13.5	16.25	45	5
Total	58	61.5	61.5	185	6.85

FXT TWO WAY TABLE

TREATMENT	F_1	F_2	F_3	TOTAL	MEAN
R_1	6.167	6.500	4.250	16.917	5.039
R_2	8.000	7.333	5.083	20.416	6.806
R_3	11.167	7.500	5.667	24.334	8.111
TOTAL	25.334	21.333	15	61.667	
MEAN	8.44	7.111	5		6.85

ANALYSIS OF VARIANCE

SOURCE	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	F VALUE	TABULAR F 5%	TABULAR F 1%
REPLICATION	2	0.019	0.009	0.0081		
TREATMENT	8	97.448	12.181	10.6384**	2.59	3.89
FACTOR A	2	54.296	27.148	23.7169**	3.63	6.23
FACTOR B	2	27.532	13.766	12.0263**	3.63	6.23
AXB	4	15.620	3.905	3.4115*	3.01	4.77
ERROR	16	18.315	1.145			
TOTAL	26	115.782				

*- significant
**- highly significant

Coefficient of variation: 15.61%

Appendix Table 6. Total yield (kg/1x5m plot)

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	III		
F_1R_1	8.750	9	8.500	26.25	8.75
F_1R_2	10.250	11	9.750	31	10.33
F_1R_3	13	13.750	14.250	41	13.67
Sub total	32	33.75	32.5	98.25	10.92
F_2R_1	11.250	7.750	9.250	28.25	9.42
F_2R_2	10.500	9.750	10	30.25	10.08
F_2R_3	10	10.500	9.250	29.75	9.92
Sub total	31.75	28	28.5	88.25	9.81
F_3R_1	7.250	6.750	7	21	7
F_3R_2	8.500	7	8	23.5	7.83
F_3R_3	7.500	8	8.250	23.75	7.92
Sub total	23.25	21.75	23.25	68.25	7.58
Total	87	83.5	84.25	251.75	9.23

FXT TWO WAY TABLE

TREATMENT	F_1	F_2	F_3	TOTAL	MEAN
R_1	8.750	9.417	7.000	25.167	8.389
R_2	10.333	10.083	7.833	28.249	9.417
R_3	13.667	9.917	7.917	31.501	10.500
TOTAL	32.75	29.417	22.75	84.917	
MEAN	10.92	9.81	7.58		9.44

ANALYSIS OF VARIANCE

SOURCE	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	F VALUE	TABULAR F 5%	TABULAR F 1%
REPLICATION	2	0.755	0.337	0.6168		
TREATMENT	8	91.907	11.448	18.7719**	2.59	3.89
FACTOR A	2	51.852	25.926	42.3841**	3.63	6.23
FACTOR B	2	20.060	10.030	16.3974**	3.63	6.23
AXB	4	19.995	4.999	8.1722**	3.01	4.77
ERROR	16	9.787	0.612			
TOTAL	26					

** - highly significant Coefficient of variation: 8.29%

Appendix Table 7. Computed marketable yield (t/ha)

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	III		
F_1R_1	12	14	11	37	12.33
F_1R_2	15.5	18	14.5	48.5	16.167
F_1R_3	19.5	23.5	24	67	22.33
Sub total	47	55.5	49.5	152.5	16.94
F_2R_1	16.5	10	12.5	39	13
F_2R_2	15.5	13.5	15.5	44.5	14.83
F_2R_3	14.5	17	13.5	45	15
Sub total	46.5	40.5	41.5	128.5	14.28
F_3R_1	8.5	7.5	8.5	24.5	8.167
F_3R_2	12.5	7.5	10.5	30.5	10.167
F_3R_3	9.5	12	12.5	34	11.33
Sub total	30.5	27	31.5	89	9.89
Total	124	123	122.5	370	13.70

FXT TWO WAY TABLE

TREATMENT	F_1	F_2	F_3	TOTAL	MEAN
R_1	12.333	13.000	8.167	33.500	11.167
R_2	16.000	14.833	10.167	41.000	13.667
R_3	22.333	15.500	11.333	48.666	16.222
TOTAL	50.666	43.333	29.667	123.166	
MEAN	16.89	14.44	9.889		13.685

ANALYSIS OF VARIANCE

SOURCE	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	F VALUE	TABULAR F 5%	TABULAR F 1%
REPLICATION	2	129.630	64.814	0.0143		
TREATMENT	8	401574.074	50196.759	9.2560**	2.59	3.89
FACTOR A	2	225240.740	112620.370	24.8987**	3.63	6.23
FACTOR B	2	115018.518	57509.259	12.7144**	3.63	6.23
AXB	4	61314.814	15328.703	3.3889*	3.01	4.77
ERROR	16	72370.370	4523.148			
TOTAL	26	474074.074				

*- significant
**- highly significant

Coefficient of variation: 15.54%

Appendix Table 8. Leaf miner infestation at 30 DAT

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	III		
F_1R_1	3	2	3	8	2.67
F_1R_2	3	3	3	9	3
F_1R_3	3	2	1	6	2
Sub total	9	7	7	23	2.56
F_2R_1	2	2	3	7	2.33
F_2R_2	3	3	3	9	3
F_2R_3	3	3	3	9	3
Sub total	8	8	9	25	2.78
F_3R_1	4	4	4	12	4
F_3R_2	5	4	3	12	4
F_3R_3	5	3	3	11	3.67
Sub total	14	11	10	35	3.89
Total	31	26	26	83	3.07

FxT TWO - WAY TABLE

TREATMENT	F_1	F_2	F_3	TOTAL	MEAN
R_1	2.667	2.333	4.000	9.000	3.000
R_2	3.000	3.000	4.000	10.000	3.333
R_3	2.000	3.000	3.667	8.667	2.889
TOTAL	7.667	8.333	11.667	27.667	
MEAN	2.56	2.78	3.899		3.07

ANALYSIS OF VARIANCE

SOURCE	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	F VALUE	TABULAR F 5%	TABULAR F 1%
REPLICATION	2	1.852	0.926	2.4096		
TREATMENT	8	11.852	1.482	3.8581*	2.59	3.89
FACTOR A	2	9.185	4.593	11.9518**	3.63	6.23
FACTOR B	2	0.963	0.481	1.22530ns	3.63	6.23
AXB	4	1.704	0.426	1.1084ns	3.01	4.77
ERROR	16	6.148	0.384			
TOTAL	26	19.852				

ns- not significant
*- significant
**- highly significant

Coefficient of variation: 20.16%

Appendix Table 9. Leaf miner infestation at 60 DAT

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	III		
F_1R_1	5	4	4	13	4.33
F_1R_2	3	3	2	8	2.67
F_1R_3	2	1	1	5	1.67
Sub total	10	8	7	26	2.89
F_2R_1	4	3	3	10	3.33
F_2R_2	4	3	3	10	3.33
F_2R_3	3	2	3	8	2.67
Sub total	11	8	9	28	3.11
F_3R_1	2	4	3	9	3
F_3R_2	3	4	3	10	3.33
F_3R_3	2	3	2	7	2.33
Sub total	7	11	8	26	2.89
Total	28	27	24	80	2.96

FxT TWO - WAY TABLE

TREATMENT	F_1	F_2	F_3	TOTAL	MEAN
R_1	4.333	3.333	3.000	10.666	3.556
R_2	2.667	3.333	3.333	9.333	3.111
R_3	1.333	2.667	2.333	6.333	2.111
TOTAL	8.333	9.333	8.666	26.332	
MEAN	2.78	3.111	2.889		2.93

ANALYSIS OF VARIANCE

SOURCE	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	F VALUE	TABULAR F 5%	TABULAR F 1%
REPLICATION	2	0.963	0.418	1.2093		
TREATMENT	8	16.519	2.065	5.1881**	2.59	3.89
FACTOR A	2	0.519	0.259	0.6512ns	3.63	6.23
FACTOR B	2	9.852	4.926	12.3712**	3.63	6.23
AXB	4	6.148	1.537	3.8605*	3.01	4.77
ERROR	16	6.370	0.398			
TOTAL	26	23.852				

ns- not significant
Coefficient of variation: 21.57%
*- significant
**- highly significant

Appendix Table 10. Early blight infection at 30 DAT

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	III		
F_1R_1	1	2	2	5	1.67
F_1R_2	1	1	3	5	1.67
F_1R_3	1	1	1	3	1
Sub total	3	4	6	13	1.44
F_2R_1	4	2	3	9	3
F_2R_2	3	2	1	6	2
F_2R_3	3	2	2	7	2.33
Sub total	10	6	6	22	2.44
F_3R_1	4	3	3	10	3.33
F_3R_2	3	3	3	9	3
F_3R_3	3	3	3	9	3
Sub total	10	9	9	28	3.11
Total	23	19	21	63	2.33

FxT TWO - WAY TABLE

TREATMENT	F_1	F_2	F_3	TOTAL	MEAN
R_1	1.667	3.000	3.333	8.000	2.667
R_2	1.667	2.000	3.000	6.667	2.222
R_3	1.000	2.333	3.000	6.333	2.111
TOTAL	4.334	7.333	9.333	21	
MEAN	1.45	2.44	3.111		2.33

ANALYSIS OF VARIANCE

SOURCE	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	F VALUE	TABULAR F 5%	TABULAR F 1%
REPLICATION	2	0.889	0.444	0.9143		
TREATMENT	8	15.334	1.917	3.9439**	2.59	3.89
FACTOR A	2	12.667	6.333	13.0286**	3.63	6.23
FACTOR B	2	1.556	0.778	1.6000ns	3.63	6.23
AXB	4	1.111	0.278	0.5714ns	3.01	4.77
ERROR	16	7.778	0.486			
TOTAL	26	24.000				

ns- not significant
** - highly significant

Coefficient of variation: 29.88%

Appendix Table 11. Early blight infection at 60 DAT

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	III		
F_1R_1	3	3	3	9	3
F_1R_2	3	2	3	8	2.67
F_1R_3	2	3	2	7	2.33
Sub total	8	8	8	24	2.67
F_2R_1	3	4	3	10	3.33
F_2R_2	4	3	2	9	3
F_2R_3	2	3	3	8	2.67
Sub total	9	10	8	27	3
F_3R_1	3	4	3	10	3.33
F_3R_2	4	2	3	9	3
F_3R_3	3	3	2	8	2.67
Sub total	10	9	8	27	3
Total	27	27	24	78	2.89

FxT TWO WAY TABLE

TREATMENT	F_1	F_2	F_3	TOTAL	MEAN
R_1	3.000	3.333	3.333	9.666	3.222
R_2	2.667	3.000	3.000	8.667	2.888
R_3	2.333	2.667	2.667	7.667	2.556
TOTAL	8	9	9	26	
MEAN	2.67	3	3		2.89

ANALYSIS OF VARIANCE

SOURCE	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	F VALUE	TABULAR F 5%	TABULAR F 1%
REPLICATION	2	0.667	0.333	0.7273		
TREATMENT	8	2.667	0.333	0.7279^{ns}	2.59	3.89
FACTOR A	2	0.667	0.333	0.7273^{ns}	3.63	6.23
FACTOR B	2	2.000	1.000	0.1818^{ns}	3.63	6.23
AXB	4	0.000	0.000	0.0000^{ns}	3.01	4.77
ERROR	16	7.333	0.458			
TOTAL	26	10.667				

^{ns}- not significant Coefficient of variation: 23.