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The Reproductive Susceptibility of Tomato Fruit Worm *Heliothis Armigera* (Hubner). (Lepidoptera: Phalaenidae) at a Different Temperatures and Hosts Plants

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ABSTRACT

The Reproductive Susceptibility of Tomato Fruitworm *Heliothis armigera* (Hubner). (Lepidoptera: phalaenidae) at a different Temperatures and Hosts plants. Reproductive viability tables have been studied for H. *armigera* were studied in three plant families and four different temperatures in the laboratory. The experiment included calculating the average life span of a female, the average age of the female at the first reproduction, the average number of eggs per female, the net compensation rate, the average duration of the generation and the average internal increase of the insect population on tomato, cotton and yellow corn at temperatures 20, 25, 30 and 35 ° C. The results showed that the adult survival rate was 83% when the insect was raised on tomato at 30 ºm, while the lowest percentage reached 55% at 35 cº on the yellow corn plant. The highest rate of insect life was 20 days at 35 ° C on yellow corn, while it decreased to the lowest rate of 10 days at 30 ° C on tomato. The results of the laboratory study showed that the highest average age of a female insect at the first reproduction was 9 days at 35 ° C on the yellow corn, while it decreased to its lowest rate at a temperature of 30 ° C on the studied plant families, when it reached 3 days, and the female placed her highest rate of eggs At a temperature of 30 ° C on tomato, it decreased to the lowest rate of 40.30 eggs at a temperature of 35 ° C on yellow corn, and it was found that the lowest net compensation rate (RO) for insect females was 7.97 female / female / generation at a temperature of 35% on yellow corn, while higher The average of 146.75 female / female / generation at a temperature of 30 ° C on tomato. The results of the study showed that the lowest rate for insect generation is 32.59 days at 30 ºm on tomato crop and offset by the highest rate of generation 65.65 days at 20 ºm on yellow corn, and also showed that the highest internal increase rate (rm) of the insect population was 0.066 at 30 ºm on tomato in When the lowest was 0.014 at 20 ºm on the yellow corn, therefore, when planting the three studied plant families, the tomato plant has a significant effect on the life aspects of the insect and consequently its numbers increase, followed by the cotton and yellow corn crop, respectively. It was found that the best temperature for insect growth and development is 30 ° C compared to the tested temperatures. These results were among the prerequisites needed to understand the life and behavioral aspects of Tomato Fruit worm *H. armigera* and an integrated program for its management.

Keywords: Reproductive Susceptibility, Tomato Fruit worm, Heliothis armigera

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INTRODUCTION

H. armigera is one of the most important pests affecting several crops, which includes more than 300 species belonging to 68 plant families in the world including cotton, soybeans, sorghum, sorghum, tomato, chickpeas, jet, okra, tobacco, lentils and Beans and others (Pearce *et al.* 2017), this pest has been registered in over 145 countries in Africa, Asia, Europe and South America (Sullivan and Molet, 2014).

One larva infects this insect during its life span from 25-30 pods in okra crop (Singh and Ali, 2005). Annual losses in world agricultural production are estimated at about 2$ billion as a result of tomato worm infestation (Hayden and Brambila, 2015). In Iraq, there are no studies that determine the economic losses of the wide family extent of this scourge, and its importance in Iraq. This study has proposed to find reproductive susceptibility with age-specific tables for insects in the laboratory and to determine the rate of internal increase in the insect population with different temperatures.

MATERIALS AND METHODS

The reproductive susceptibility scales were organized for *H. armigera* worm from its culture at constant temperatures 20, 25, 30 and 35 ± 2 c º, relative humidity 70 ± 5% and light duration 16 hours: 8 hours dark.

The insect colony was prepared from the collection of the first-generation spring and lightning 2019 from some of its plant families in Al-Muthanna Governorate in southern Iraq and the insect was raised on three of its plant families are tomato, cotton and yellow corn. Plants were placed in networked wooden boxes prepared in advance, and after obtaining appropriate numbers of eggs, they were placed on the plants according to the mentioned families separately, as the plants were planted in plastic pots covered with a gauze cloth in the form of a cone to fit the shape of the plant, The pots were placed in two Kotterman and Termaks incubators, and at their base were placed three glass containers filled with water with a diameter of 20 cm and a height of 40 cm and melted in each of them 30 g of KOH in 100 ml of water to obtain a constant relative humidity (70 ± 5)% To ensure continuous temperature and relative humidity, it also provided the incubators with a 20-watt light source with a timer to give a constant light duration of 16 hours of light: 8 hours of darkness. The incubators were used in the same conditions in all subsequent laboratory experiments.

The insect eggs were collected from the breeding boxes 24 hours after they were placed by the females and placed in white, transparent, cylindrical plastic cups, dimensions of 7 x 5 cm, and put in each mug two sheets of paper filter moistened with water to provide the necessary moisture to hatch the eggs, the cylindrical plastic were covered with a cloth tied with a rubber band to prevent the hatching of the hatching larvae. The larvae were transferred to the pre-prepared plants for each experiment separately, which were planted in plastic pots with a diameter of 25 cm and a height of 30 cm. For the roles of the insect moving from the exit and placing each plant under the indicated temperature.

At the exit of the adult, every couple (male and female) of newly insect adults put on each of the above mentioned plants for the purpose of mating and laying eggs, where the modern eggs were removed continuously from the adult breeding boxes and after obtaining appropriate numbers of eggs, they were counted and placed on plants The aforementioned families individually and according to the above method, taking into account the constant substitution of plants when stocking the leaves as a result of feeding the larvae and the adults of the insect tested and left the pots inside the incubators from the role of the egg until the conversion to adults, and the outgoing adults were counted at each temperature degree and the percentage calculated by comparison With the combined score of extracting survival rates for incomplete roles.

Preparations for the mating procedure referred to previously were prepared for each of the tested plant families. Each unmarried male and female were placed on each of the mentioned vegetable families, such as each one repeated plant and at the rate of ten iterations for each temperature of the four temperatures and for each family, and the examination was conducted Daily to record the number of eggs placed by insect females and the number of live females. Age-Specific Survival rates and Age-Specific fecundity rate were extracted according to the Stiling formula (1999).

Lx =Nx/N0

whereas:

Lx = survival rate during age x

Nx = Number of individuals at the end of age x

N0 = Number of individuals at the beginning of age x

According to Stein 1998, the Mx values for all age groups were divided by 2 to derive the average number of females produced at each age stage. The sex ratio of the alfalfaweevil at constant temperature is approximately 1: 1 (Zahiri*et al*., 2014), through theage-Specific survival rate and age-Specific fecundity rate, the net reproductive rate, the mean of generation time (T) and the internal rate of increase (intrinsic rate of increase) are calculated according to the equations developed by Birch (1948):

Ro = Σ Lxmx .... (1)

whereas:

Ro = Net reproductive rate (Number of the productive females / female / generation)

Σ Lxmx = The sum of age-Specific survival rate for females multiplied bythe age-Specific fecundity rate.

T = ΣX Lxmx / Σ Ixmx ……………… (2)

whereas:

T = Mean of the generation time

ΣX Ixmx = The sum of Lxmx multiplied by age x

ΣIxmx = Net reproductive rate

rm = Loge Ro /T………… (3)

whereas:

rm = Rate of internal increase in population

Loge Ro = Inverse logarithm of netreproductive rate

T = Mean of generation time

RESULTS AND DISCUSSION

Tables (1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 and 13) show that *H. armigera* can survive in laboratory conditions and at constant temperatures 20,25,30,35 c º which It was revealed through it the effect of temperature and the type of plant host on the life of the insect in general and on female egg production rates in particular, As it was found that the average female life span (16.16,17), (11,12,12), (10,11,12) and (19,15,20) days at the aforementioned temperatures on plant families (tomato, cotton and corn Yellow) respectively.

With regard to the age of females at the first reproductive rates, it reached (7,7 and 8), (4,4 and 5), (3,3and 4) and (8,3 and 9) days at the temperatures and the tested plant families, respectively. The average number of eggs laid from insect females (180.61, 160.30 and 133.60), (387.10, 264.88 and 69.53), (542.80, 444.52 and 383.0) and (63.84, 55.56 and 40.30) eggs / females at temperatures and the same plant families.

The nature of population fluctuation in insects is described by the measures of growth and reproduction derived from the production and survival tables which include the net compensation rate (RO), the generation period rate (T), and the rate of internal population increase (rm), According to the values of the net compensation rate (RO) for one female at all studied temperatures (Table 13), the population of the tomato worm *H. armigera* is not of the stable type, so the values of RO) ((45.41, 52.56 and 31.29), (128.27, 65.81 and 61.56)), (146.75, 118.81 and 111.74), (14.31, 10.66 and 7.97) female / female / generation at temperatures and the same plant families, respectively.

It was observed that the highest value of RO) reached (146.75) female / female / generation at a temperature of 30 مْm on the tomato plant (Table 13) and this is due to the increase in the average number of total eggs of the insect at the same temperature, as it reached 542.80 eggs / female as well On the high survival rate of female-producing eggs, which amounted to 0.83 (Table 7), while the lowest value for RO)) for insect females was 7.79 female / female / generation at a temperature of 35 ° C on the yellow corn, The reason for this is due to the lower survival rates for the insect's growth roles, which amounted to 0.55, and the decrease in female productivity of eggs. Then there is a sharp drop at 35 cº, as it decreased from 146.75 female / female / generation at 30 cº on the tomato crop to 7.79 female / female / generation at a temperature of 35 ºm on the yellow corn (Table 13). This decrease is mainly due to the sharp drop in Survival and yields are at 35 cº on yellow corn, this is consistent with what (Meeri, 2019) mentioned when studying the aqueous rice mite Picia mesopotamica that the effect of temperature on productivity was similar to its effect on the speed of growth, at a certain range of temperatures the productivity is at its maximum and then stabilizes if the temperature decreases or rises at This level.

The results of this study indicated that the values of generation time rates (T) were (48.38, 60.89 and 65.65), (37.01, 51.36 and 51.83), (32.59, 47.98 and 54.06), (56.39, 58.33 and 60.65) days at temperatures 20, 25, 30 and 35 cº and the tomato plant families, cotton and yellow corn respectively (Table 13), meaning that the average duration of the generation decreases with a rise in temperature up to 30 cº as it reaches 60.65 at 35 cº on the yellow corn crop (Table 13) to increase the rate of growth The insect increases the temperature until it reaches a certain point, after which the effect of the temperature is reversed.

Hemati *et al.* (2013) explained that the effect of higher temperatures above the optimum temperature is evident in the incomplete roles in the life cycle of the insect, as it was observed that the decrease in the rate of growth is reflected in the increase in the time needed to complete the development and then increase the duration of the generation. The large increase in the average duration of the insect generation at a temperature of 35 ° C may be the result of an increase in the time required to complete the development of incomplete roles, as it requires completion of the development of incomplete roles of the insect at this degree (43, 50 and 47) days, respectively (Table 10, 11 and 12) after (26, 41 and 46) days were on tomato crops, cotton and yellow corn, respectively, at a temperature of 30 ° C (Table 7, 8 and 9).

Naseri *et al*. (2009) explained when studying the insect in the laboratory that the optimum temperature for the development of insect roles ranged between (25-31) ºm and that within this range the insect completes its life cycle with the least possible time. The results of the study showed that the value of the internal increase in the population of the insect studied was (0.035, 0.028 and 0.022), (0.056, 0.035 and 0.034), (0.066, 0.043 and 0.047), (0.020, 0.017 and 0.014) female / female / day at temperatures 20, 25, 30 and 35 ºC and the studied plant families respectively (Table 13), this means that the value of rm) increases with increasing temperatures up to 30 ° C, and the highest value of rm was recorded at temperature of 30 ° c. When 0.037 females / females / day reached the yellow corn yield (Table 13) due to the decrease in the average generation time (T) at the same temperature, Nunes and others (2017) stated that the value of the rate of the internal increase in the population increases with the decrease in the value of the average duration of the insect generation, Meeri (2019) also stated that the increase in the value of the internal increase in the population of the insect Picia mesopotamica when increasing temperatures decreased to the rate of the generation period with that increase in temperature, that the lowest value of rm)) of *H. armigera* amounted to (0.020, 0.017 and 0.014) female / female / generation at a temperature of 35 °Cover the above-mentioned crops, respectively, due to a decrease in (RO) and an increase in the value of (T) at the same degree .

AL-Fatlawi (2005) found that the decrease in the value of the rate of increase in the population of the Colorado potato beetle *Leptinotarsa decemlineata* may be part of it due to the high decay in incomplete roles, as the survival rate of the insect itself was 0.54 at 35 مm on the tomato crop, and this was also observed in the population *H. armigera* at 35 ° C. The survival rates for incomplete roles were 0.68, 0.60 and 0.55 for tomato, cotton and maize crops, respectively (Table 10, 11 and 12), which are rates of high mortality in the incomplete roles of the insect.

The value of (rm) is one of the good indicators of the losses to which the insect population is exposed to in nature, while high values indicate that the population is exposed to high mortality ratios and that the insect has certain adaptive means to compensate for the shortfall in the population, and for this we find that females of the autumn generation of the insect tested Resort to laying a large number of eggs to compensate for the shortfall in the population of the same generation caused by the high declines of incomplete roles (Table 13).

Table 1: Reproductive ability of a tomato worm *H. armigera* at 20 ° C on a tomato crop

Age/day s x	Survival rate Ix	The rate of total eggs mx	The productive femalerate mx	Expected productivity Ixmx	xIxmx
1-37	**Incomplete stages**				
38-45	**Pre-eggs time**				
46	0.79	21.73	10.78	8.59	395.14
47	0.79	22.63	11.32	8.95	420.65
48	0.78	24.74	12.37	9.65	463.20
49	0.78	33.25	16.63	12.98	636.02
50	0.59	33.38	16.69	9.85	492.50
51	0.24	29.63	14.82	3.56	181.56
52	0.15	8.75	4.38	0.66	34.32
53	0.05	6.50	3.25	0.17	9.01
54	0.0	0.0	0.0	0.0	0.0
		180.61	Grr = 90.33	∑IxMx = 54.14	∑XIxMx = 2632.4

Table 2: Reproductive ability of a tomato worm *H. armigera* at 20 ° C on a Cotton crop

Age/day s x	Survival rate Ix	The rate of total eggs mx	The productive female rate mx	Expected productivityIxmx	xIxmx
1 - 49	Incomplete stages				
50 - 57	Pre-eggs time				
58	0.74	9.7	4.85	3.59	208.22
59	0.74	18.8	9.40	6.96	410.64
60	0.74	29.3	14.65	10.85	651.00
61	0.74	31.8	15.90	11.77	717.97
62	0.65	32.10	16.05	10.44	647.28
63	0.59	25.4	12.70	7.50	472.50
64	0.28	8.1	4.05	1.14	72.96
65	0.12	5.1	2.55	0.31	20.15
66	0.0	0.0	0.0	0.0	0.0
		160.3	Grr = 80.15	∑IxMx = 52.56	∑XIxMx = 3200.72

Table 3: Reproductive ability of a tomato worm *H. armigera* at 20 ° C on a yellow corn crop

Age/day sx	Survival rate Ix	The rate of total eggs mx	The productive female rate mx	Expected productivityIxmx	xIxmx
1 - 53	Incomplete stages				
54 - 62	Pre-eggs time				
63	0.72	9.7	4.85	3.49	219.87
64	0.69	14.1	7.05	4.86	311.04
65	0.69	19.8	9.90	6.83	443.95
66	0.51	26.9	13.45	6.85	452.10
67	0.32	25.6	12.80	4.86	325.62
68	0.29	17.7	8.85	2.56	174.08
69	0.23	10.3	5.15	1.18	81.42
70	0.14	9.5	4.75	0.66	46.20
71	0.0	0.0	0.0	0.0	0.0
		133.6	Grr = 66.80	∑IxMx = 31.29	∑XIxMx = 2054.28

Table 4: Reproductive ability of a tomato worm *H. armigera* at 25 ° C on a tomato crop

Age/day sx	Survival rate Ix	The rate of total eggs mx	The productive female rate mx	Expected productivityIxmx	xIxmx
1 - 29	Incomplete stages				
30 - 34	Pre-eggs time				
35	0.84	39.60	19.80	16.63	582.05
36	0.84	72.90	36.45	30.61	1101.96
37	0.84	77.83	38.91	32.68	1209.16
38	0.71	92.15	46.07	32.70	1242.60
39	0.38	73.42	36.71	13.94	543.66
40	0.11	31.20	15.60	1.71	68.40
41	0.0	0.0	0.0	0.0	0.0
		387.10	Grr = 139.45	∑IxMx = 128.27	∑XIxMx = 4747.83

Table 5: Reproductive ability of a tomato worm *H. armigera* at 25 ° C on a Cotton crop

Age/days X	Survival rate Ix	Rate of total eggs mx	The productive female rate mx	Expected productivityIxmx	xIxmx
1 - 43	Incomplete stages				
44 - 48	Pre-eggs time				
49	0.75	26.04	13.02	9.77	478.73
50	0.75	29.14	14.57	10.93	546.50
51	0.62	40.82	20.41	12.66	645.66
52	0.45	71.24	35.62	16.03	833.56
53	0.38	65.00	32.50	12.35	654.55
54	0.28	18.34	9.17	2.57	138.78
55	0.21	14.3	7.15	1.50	82.50
56	0.0	0.0	0.0	0.0	0.0
		264.88	Grr = 132.44	∑IxMx = 65.81	∑XIxMx = 3380.28

Table 6: Reproductive ability of a tomato worm *H. armigera* at 25 ° C on a yellow corn crop

Age/days x	Survival rate Ix	Rate of total eggs mx	The productive female rate mx	Expected productivityIxmx	xIxmx
1 - 43	Incomplete stages				
44 - 49	Pre-eggs time				
50	0.74	7.31	14.63	10.83	541.50
51	0.71	10.10	20.21	14.35	731.85
52	0.63	13.90	27.80	17.52	911.04
53	0.38	16.00	32.00	12.16	644.48
54	0.18	17.22	34.44	6.20	334.80
55	0.05	5.00	10.00	0.50	27.50
56	0.0	0.0	0.0	0.0	0.0
		69.53	Grr = 139.08	∑IxMx = 61.56	∑XIxMx = 3191.17

Table 7: Reproductive ability of a tomato worm *H. armigera* at 30 ° C on a tomato crop

Age/days x	Survival rate Ix	The rate of total eggs mx	The productive female rate mx	Expected productivityIxmx	xIxmx
1 - 26	Incomplete stages				
27 - 30	Pre-eggs time				
31	0.83	78.2	39.10	32.45	1005.95
32	0.83	93.2	46.60	38.67	1237.44
33	0.83	98.8	49.40	41.00	1353.00
34	0.54	98.0	49.00	26.46	899.64
35	0.21	60.5	30.25	6.35	222.25
36	0.14	26.1	13.05	1.82	65.52
37	0.0	0.0	0.0	0.0	0.0
		542.8	Grr = 227.4	∑IxMx = 146.75	∑XIxMx = 4783.8

Table 8: Reproductive ability of a tomato worm *H. armigera* at 30 ° C on a Cotton crop

Age/days x	Survival rate Ix	The rate of total eggs mx	The productive female rate mx	Expected productivityIxmx	xIxmx
1 - 41	Incomplete stages				
42 - 45	Pre-eggs time				
46	0.77	49.6	24.80	19.09	878.14
47	0.77	68.0	34.00	26.18	1230.46
48	0.71	80.3	40.15	28.50	1368.00
49	0.58	104.7	52.35	30.36	14.87.64
50	0.29	78.2	39.10	11.33	566.50
51	0.20	33.5	16.75	3.35	170.85
52	0.08	0.22	0.11	0.00	0.00
53	0.0	0.0	0.0	0.0	0.0
		414.52	Grr = 207.26	∑IxMx = 118.81	∑XIxMx = 5701.59

Table 9: Reproductive ability of a tomato worm *H. armigera* at 30 ° C on a yellow corn crop

Age/day s x	Survival rate Ix	The rate of total eggs mx	The productive female rate mx	Expected productivityIxmx	xIxmx
1 - 46	Incomplete stages				
47 - 51	Pre-eggs time				
52	0.74	47.3	23.65	17.50	910.00
53	0.74	62.9	31.45	23.27	1233.31
54	0.73	73.1	36.55	26.68	1440.72
55	0.64	88.0	44.00	28.16	1548.80
56	0.39	60.5	30.25	11.79	660.24
57	0.17	38.2	19.10	3.24	184.68
58	0.10	13.0	6.50	1.10	63.80
59	0.0	0.0	0.0	0.0	0.0
		383.00	Grr = 191.50	∑IxMx =	∑XIxMx =

Table 10: Reproductive ability of a tomato worm *H. armigera* at 35 ° C on a tomato crop

Age/day s x	Survival rate Ix	The rate of total eggs mx	The productive femalerate mx	Expected productivity Ixmx	xIxmx
1-43	Incomplete stages				
44-52	Pre-eggs time				
53	0.68	3.0	1.50	1.02	54.06
54	0.68	3.4	1.70	1.15	62.10
55	0.65	7.5	3.75	2.43	133.65
56	0.53	11.2	5.60	2.96	165.76
57	0.52	11.4	5.70	2.96	168.72
58	0.46	8.3	4.15	1.90	110.20
59	0.31	8.0	4.0	1.24	73.16
60	0.19	4.2	2.10	0.39	23.40
61	0.12	3.8	1.90	0.22	13.42
62	0.03	3.04	1.52	0.04	2.48
63	0.0	0.0	0.0	0.0	0.0
		63.84	Grr = 31.92	∑IxMx =	∑XIxMx =

Table 11: Reproductive ability of a tomato worm *H. armigera* at 35 ° C on a Cotton crop

Age/day s x	Survival rate Ix	The rate of total eggs mx	The productive femalerate mx	Expected productivity Ixmx	xIxmx
1-50	Incomplete stages				
51-54	Pre-eggs time				
55	0.60	3.8	1.90	1.14	62.70
56	0.59	4.6	2.30	1.35	75.60
57	0.59	5.0	2.50	1.47	83.79
58	0.46	6.8	3.40	1.56	90.48
59	0.43	9.0	4.50	1.93	113.87
60	0.35	9.2	4.60	1.61	96.60
61	0.22	7.6	3.80	0.83	50.63
62	0.18	4.7	2.35	0.42	26.04
63	0.18	3.5	1.75	0.31	19.53
64	0.09	1.0	0.50	0.04	2.56
65	0.04	0.36	0.18	0.00	0.00
66	0.0	0.0	0.0	0.0	0.0
		55.56	Grr = 27.78	∑IxMx =	∑XIxMx =

Table 12: Reproductive ability of a tomato worm *H. armigera* at 35 ° C on a yellow corn crop

Age/day s x	Survival rate Ix	The rate of total eggs mx	The productive femal erate mx	Expected productivity Ixmx	xIxmx
1- 47	Incomplete stages				
48-57	Pre-eggs time				
58	0.55	1.62	0.81	0.45	26.10
59	0.55	5.26	2.63	1.45	85.55
60	0.51	7.0	3.50	1.78	106.80
61	0.44	10.8	5.40	2.37	144.57
62	0.40	5.3	2.65	1.06	65.72
63	0.35	3.2	1.60	0.56	35.28
64	0.28	1.2	0.60	0.16	10.24
65	0.21	1.0	0.50	0.10	6.50
66	0.13	0.5	0.25	0.03	1.98
67	0.09	0.3	0.15	0.01	0.67
68	0.0	0.0	0.0	0.0	0.0
		40.30	Grr = 20.15	∑IxMx = 7.97	∑XIxMx = 483.41

Table 13: values of net compensation rates (Ro) and rates of generation length (T) and rates of internal increase (rm) derived from the reproducibility tables

Temperature ºc	host	Average life span of a female (day)	Average age of the female at first reproduction	Average number of eggs per female (egg)	Net Compensation Rate (Ro)	Generation Length (T)	Internal Increase Rate (rm)
20	**Tomato**	16	7	180.61	54.41	48.38	0.035
	cotton	16	7	160.30	52.56	60.89	0.028
	Yalow corn	17	8	13360	31.29	65.65	0.022
25	**Tomato**	11	4	387.10	128.27	37.01	0.056
	cotton	12	4	264.88	65.81	51.36	0.035
	Yalow corn	12	5	69.53	61.56	51.83	0.034
30	**Tomato**	10	3	542.80	146.75	32.59	0.066
	cotton	11	3	444.52	118.81	47.98	0.043
	Yalow corn	12	3	383.00	111.74	54.06	0.037
35	**Tomato**	18	8	63.84	14.31	59.39	0.020
	cotton	15	4	55.56	10.66	58.33	0.017
	Yalow corn	20	9	40.30	7.97	60.65	0.014

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