

Yield of peanuts (*Arachis hypogaea* L.) under the influence of weed competition and determination of the critical period of their control

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Abstract

Stamatov, I. & Stamatov, S. (2022). Yield of peanuts (*Arachis hypogaea* L.) under the influence of weed competition and determination of the critical period of their control. *Bulg. J. Agric. Sci.*, 28 (5), 855–859

During the period 2018 – 2020, a study was conducted on the negative impact of weed on the elements of yield in peanuts type Valencia with the Bulgarian variety Kremena. It was found that duration of the period with weeds after the fourteenth day after the emergence of peanuts leads to a statistically significant loss of yield. Extending this period over time exponentially reduces the yield. The harmful effect of weeds is shown by the duration of weeding, the conditions of the year and the interaction between them. Of the three factors studied, the most detrimental is the detrimental effect of duration of the period with weeds. The critical period of weeding was calculated using the Compertz model. The three-parameter equation describes the effect of the negative influence of weeding duration on the relative yield. For the subject elements of yield, the established critical period is between the fifteenth and thirty-third day after the emergence of the peanuts.

Keywords: peanuts; yield; weeding period; critical period

Introduction

Peanut growers (*Arachis hypogaea* L.) rely on herbicides to control weeds, but weeds in crops are common due to environmental conditions, application herbicide errors, and more recently the evolution of herbicide-resistant weeds (Heap, 2014).

Peanuts compete with weeds for soil and air resources during the crop development cycle. According to (Pitelli 1985; McDonald, 2003; Watson et al., 2006; Andrew et al., 2015) the factors that determine the competitiveness of weeds are mainly: size and architecture, germination rate, root depth, plasticity of climatic factors, and excretion of allelopathic substances. Peanuts and weeds under certain conditions can grow together for a certain period without significant yield losses. However, if a factor becomes limited for a plant growth, it will reduce the yield and / or quality of the product (Buchanan et al., 1982).

Farmers often and mistakenly believe that weed elimination is beneficial at any time during the growing season (Yadav et al., 1983).

The critical period of competition between weeds and peanuts is the minimum time during which peanut plants must be freed from weeds to avoid loss of yield. The critical period of weed control is defined as the interval in the life cycle of the crop, when it must be maintained without weeds to prevent loss of yield. This period consists of two separate periods: (1) the critical weeding time or the length of time that weeds that appear with the crop may remain uncontrolled before competing with the crop and causing a loss of yield, and (2) the critical period without weeds or the length of time the crop must be free of weeds after sowing to prevent yield losses (Nieto et al., 1968; Kropff et al., 1993).

Woodroof (1983) reports that in peanut culture, critical periods of competition with weeds occur first when the plants are very young and then after the onset of fruiting.

Other studies have shown that there are large differences in the yield of peanut yields due to weed competition, reflecting the influence of many factors that influence the interaction between weeds and crops (Hill & Santelmann, 1969; Feakin, 1973; Hauser et al, 1975; Buchanan et al., 1976; Drennan & Jennings, 1977; York & Coble, 1977; Martins & Pitelli, 1994; Agostinho et al., 2006; Place et al. 2012).

The aim of the experiment was to assess the influence of weed duration and to establish the critical period for weed control, after which the yield of peanuts decreases relative to the relative one.

Material and Methods

Plot experiment

The experiment was conducted in the period 2018 – 2020 in the region of Haskovo, Bulgaria. The setting of the experiment is formed by twelve experimental variants with the size of the experimental plot for each variant 10.0 m². It covers the periods during which the peanuts were weeded after germination. Weeds were removed manually as follows:

- in the first variant, the weeds were removed on the seventh day after germination;
- the second variant was weeded after fourteen days;
- the third after twenty-one days;
- the fourth after twenty-eight days;
- the fifth after thirty-five days;
- the sixth after forty-two days.

After weeding, the plants were kept free of weeds until the end of the growing season (WF). In the parallel variants, the weeds were allowed to develop before and after the 7th, 14th, 21st, 28th, 35th and 42nd day (WC), respectively.

Table 1. Change in the magnitude of yield elements depending on the period of weeding

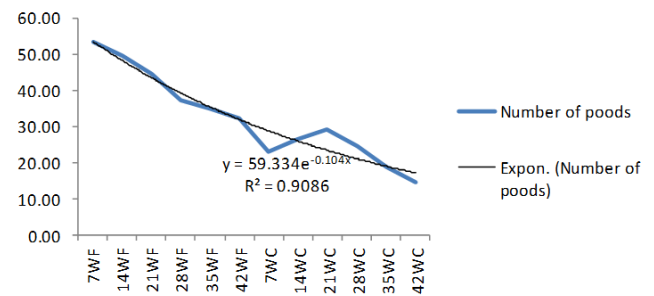
Period of weed competition	Number of fruits/plant	Mass of fruits/plant, g	Mass of nuts/plant, g
7WF	53.47	93.03	64.23
14WF	49.57*	86.50*	59.67*
21WF	44.67*	74.13*	49.77*
28WF	37.27*	63.37*	43.27*
35WF	34.90*	57.93*	38.57*
42WF	32.27*	51.27*	34.17*
7WC	22.93*	39.40*	27.17*
14WC	26.53*	44.00*	29.80*
21WC	29.03*	48.23*	32.60*
28WC	24.67*	41.20*	28.37*
35WC	18.77*	32.90*	22.33*
42WC	14.57*	25.80*	17.03*

Differences were demonstrated at significance level LSD 0.05%

Plant material

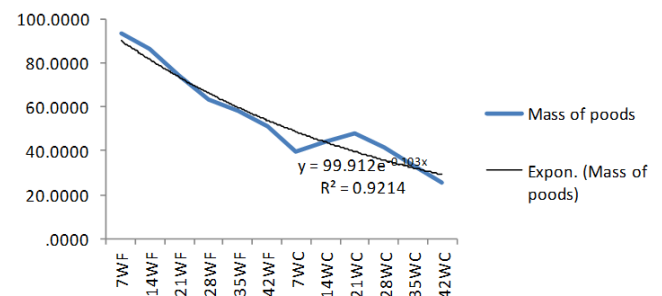
The experiment was conducted with the Bulgarian variety Kremena, which belongs to the Valencia type. Number of fruits, yield of nuts and seeds from a plant are reported. Each measurement was performed from 10 randomized plants on a variant.

Number of pods



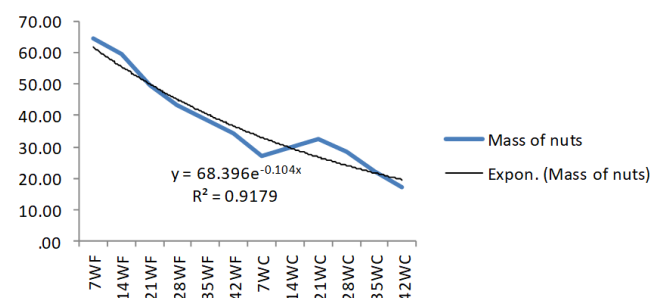
Reduce the number of fruits by increasing the duration of weeding period

Mass of pods



Critical period of weeding in terms of the number of fruits

Mass of nuts



Critical period of weeding in terms of the mass of nuts

Fig. 1. Exponential reduction of yield elements depending on the weeding period

Statistical methods

The assessment of the influence of the duration of weeding on the elements of yield and yield of fruits and nuts in peanuts was performed with the help of analysis of variance and is expressed by an exponential curve. The influence of experimental year, the influence of weeding duration period and the interaction between them is shown by means of two-factorial analysis of variance.

The beginning and end of the critical period during which weed control is mandatory was assessed from the relative yield response curves compared to the variant in which they

were removed throughout the growing season after the seventh day. The critical period for weed control was calculated by installing a Logistic and Compertz model. The three-parameter equation describes the effect of the negative influence of the studied factor on the relative growth of the object of study (Compertz, 1825). The Compertz model predicts the relationship between relative yields, influenced by the length of the weed-free period. The Logistic equation used determines the beginning of the critical period in which crops can be weeded, and the Compertz equation is used to determine the end of the period for acceptable levels of yield loss.

Table 2. Test of the interaction between the tested factors**Number of fruits**

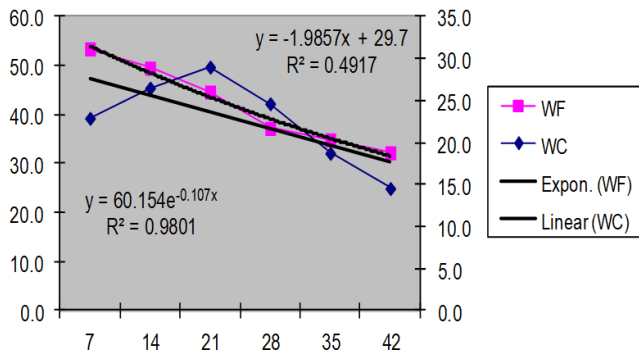
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	58746.231	35	1678.464	48.352	.000
Intercept	377589.669	1	377589.669	10877.386	.000
Annual conditions*	4827.939	2	2413.969	69.540	.000
Duration of weeding period*	48539.697	11	4412.700	127.119	.000
Annual conditions * Duration of weeding period*	5378.594	22	244.482	7.043	.000
Error	11247.100	324	34.713		
Total	447583.000	360			
Corrected Total	69993.331	359			

Mass of fruits

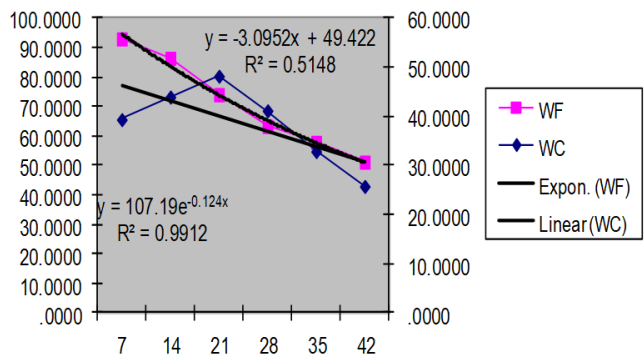
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	171052.831	35	4887.224	54.232	.000
Intercept	1081642.469	1	1081642.469	12002.732	.000
Annual conditions*	7777.006	2	3888.503	43.150	.000
Duration of weeding period*	145159.031	11	13196.276	146.436	.000
Annual conditions * Duration of weeding period*	18116.794	22	823.491	9.138	.000
Error	29197.700	324	90.116		
Total	1281893.000	360			
Corrected Total	200250.531	359			

Mass of nuts

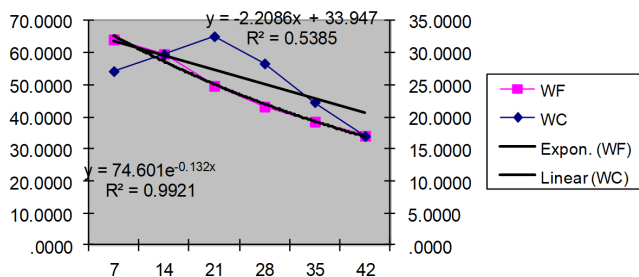
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	82160.097	35	2347.431	52.105	.000
Intercept	499448.003	1	499448.003	11085.994	.000
Annual conditions*	3156.339	2	1578.169	35.030	.000
Duration of weeding period*	69709.431	11	6337.221	140.664	.000
Annual conditions * Duration of weeding period*	9294.328	22	422.469	9.377	.000
Error	14596.900	324	45.052		
Total	596205.000	360			
Corrected Total	96756.997	359			



Critical period of weeding in terms of the number of fruits



Critical period of weeding in terms of the mass of fruits



Critical period of weeding in terms of the mass of nuts

Fig. 2. Critical period for weeding of peanuts

Results and Discussion

The data in Table 1 show that the number of fruits per plant, their weight, as well as the weight of nuts decreased statistically significantly after the seventh day of weed competition.

The exponential curve also takes into account this decrease with increasing duration of weeding period with a

high coefficient of determination (Figure 1).

The data in Table 2 show that the manifestation of the studied traits is influenced by the annual conditions, the duration of weeding period and the interaction between them. The strongest manifestation of the sign is the duration of weeding period.

The critical period after which the weeds are able to reduce the number of fruits per plant, the mass of the fruit and the nut is defined by the response curves in Figure 2. The beginning of the period is related to the resulting logistic equation and coincides with the fifteenth day of weeding. The end of the critical period is calculated using a nonlinear dependence, using Compertz equation. The graph shows that it occurs on the thirty-third day of weeding.

Conclusions

- Any delay in weed removal of the fourteenth day after peanut emergence leads to an exponential reduction in yield.
- The critical period after which peanuts cannot compensate for yield losses is concluded between the fifteenth and thirty-fifth day.

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Received: February, 15, 2021; Approved: May, 26,2021; Published: October, 2022