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Predicting Emergence of the Most Important Weed Species in Soybean (*Glycine max* L.) under Different Management Operation

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Introduction: Summer annual weeds typically germinate in spring and early summer, grow throughout the summer, and set seeds by fall. Summer annual weeds are a persistent problem in summer annual row crops, competing directly for water, light, and nutrients, causing yield losses in quantity and quality.

Although agriculture is increasingly relying on modern technology, knowledge of the biological systems in which these technologies are used is still critical for implementation of management strategies. Biological information about weeds is valuable and necessary for developing management strategies to minimize their impact. Scouting fields for pest problems are essential in any cropping system and knowledge of the timing and sequence of weed species emergence could increase the effectiveness of weed scouting trips and subsequent management practices.

The success of any annual plant is directly correlated to its time of seedling emergence because it determines the ability of a plant to compete with its neighbors, survive biotic and abiotic stresses, and reproduce. The period and pattern of emergence of the weed community depend on the species present in the seed bank and their interaction with the environment. Therefore, knowledge of the weed species present in the soil seed bank and when these species are most likely to emerge is important in planning effective weed control programs.

Temperature has been reported to be the main environmental factor regulating germination and emergence of weed species. Scientists have developed TT models to predict the emergence of weed species based on a daily accumulation of heat units or growing degree days (GDD) above a minimum base threshold value (T_{base}). The predictive models for weed emergence based on the accumulation of TT appear to be accurate enough for projections of weed emergence time (Grundy 2003). Moreover, soil temperature data are easily accessible, making this type of model practical and useful to farmers. Many studies of weed growth, and thus predicting models for areas outside of Mazandaran is performed as a particular study. Because the differences in soil conditions, climatic, geographic and weed species there is a possibility that these models are not appropriate to predict weed species in Mazandaran province. Furthermore, the purpose of this experiment is investigation growth of weeds and develops an empirical model based on GDD to predicting the growth of several species of summer weeds in soybean.

Materials and methods: The experiment was conducted as split split-plot in a randomized complete block design with three replications in the summer of 2016 in Dasht-e-Naz Company Sari-Iran with geographical coordinates 36º 39´ N 53º 11´ E, and 1 meters above sea level. The treatments included two tillage system (No Tillage, Tillage), three densities of 20, 30 and 40 plants per square meter of soybeans and Pursuit-doses (imazethapyr) (0, 50%, 75%, standard dose and 25% of the standard dose, respectively).

To predict the growth pattern in each plot a fixed 50 × 50 cm quadrat fixed in the center of each plot and since the beginning of the season and after the first irrigation, counting of new grown seedlings was began based on weeds species. The Counting was performed weekly and then counted seedlings were eliminated after in any stage as long as new emergence was not seen.

Non-linear regression (Sigma Plot 12.5) was used for the expression pattern of cumulative emergence of seedlings. The 3 parameter logistic function was fitted to the data.

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$$Y = \frac{a}{1 + \left(\frac{x}{x_0}\right)^b}$$

where y represents the predicted cumulative percent emergence, X0, GDD to reach the %50 cumulative emergence, a is the upper asymptote (theoretical maximum percent emergence), b is the slope of the curve.

We considered that soil water was not a limiting factor for weed emergence, using soil temperature (growing degree days, GDD) as the only independent variable for predicting cumulative emergence. Thus, GDD were calculated with the soil temperatures by using the formula:

$$GDD = \left(\frac{T_{max} + T_{min}}{2}\right) - T_b$$

where T_{max} and T_{min} are the daily maximum and minimum temperature, respectively, and T_b is the base temperature. Base temperatures used in the calculations of GDD were: 9.0ºC for *A. theophrasti*, 12.0ºC for *S. halepense*, 22.3ºC for *A. retroflexus*, 8.1ºC for *E. maculate*, 7.5ºC for *P. oleracea*, 4.0ºC for *B. napus*.

From the emergence count data, mean emergence time (MET) and emergence rate index (ERI) were calculated as follows:

$$MET = \frac{N_1 t_1 + \ldots + N_n t_n}{N_1 + \ldots + N_n}$$

$$ERI = \frac{N_1 + \ldots + N_n}{MET}$$

where $N_1, \ldots, N_n$ is the number of newly emerged seedlings since the time of the previous count, $t_1, \ldots, t_n$ are the GDD after sowing, and n is the number of sampling occasions. These two indices give us a simple indication of the emergence process, providing a useful tool to compare the progress of seedling emergence of each species in the two sites. However, they cannot provide more detailed information on emergence duration and speed.

Results and Discussion: The results showed that except sorghum that in tillage treatment had the lowest cumulative emergence, other species in no-tillage treatment had the lowest cumulative emergence. At the end of the sampling patterns of emergence has been specified, all species of weeds, in the density of 40 plants per square meter of soybean and dose of 1.25 liter per hectare of herbicide Pursuit had the lowest cumulative emergence and in the density of 20 plants per square meter of soybean and dose of 0 liters per hectare of herbicide Pursuit had the maximum cumulative emergence. Among other species, *Amaranthus retroflexus* needed the lowest mean emergence time (MET) and the lowest growing degree days (GDD) to reach 50% emergence. Whereas, among the species, *Abutilon theophrasti* needed maximum mean emergence time (MET) and maximum growing degree days (GDD) to reach 50% emergence. On this basis, growth stage suitable for controlling pigweed, when the main wave of seedlings of other species still have not found growing. The best management practice used to manage weeds will depend upon the weed species present in the soil seed bank, and diversity of management tactics (e.g., planting dates) will result in fewer shifts in species composition.

Keywords: Emergence pattern, Tillage, Planting density, Herbicide dose