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Critical period for crop-weed competition in groundnut (*Arachis hypogaea* L.) under mid altitude of Meghalaya

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ABSTRACT

A field experiment was carried out during kharif and rabi seasons of 2016-17 at the experimental farm of the College of Post Graduate Studies (CAU, Imphal), Umiam, Meghalaya, India. The experiment was conducted in a randomized block design, replicated thrice with twelve treatments viz., weeds until 15, 30, 45, 60, 75 days after emergence (DAE), weedy check and weed free until 15, 30, 45, 60, 75, weed free check. Critical period for crop-weed competition under 5 and 10 per cent relative yield loss were determined through Logistic and Gompertz equations. The results showed that weed dry matter tended to decrease with increasing weeds free condition up to harvest. It was observed that the lowest weed dry matterassociated with weed free check. While, weedy check resulted in the highest weed dynamics. The highest values of yield and yield attributes were higher with weed free check, and lowest with weedy check. The critical period for weed competition under 5 per cent YIELD LOSS at kharif was 16 to 66 and rabi was 15 to 63 DAE. The estimated critical period for groundnut at 10 per cent YIELD LOSS were 22 to 62 and 21 to 61 DAE in kharif and rabis easons, respectively. The accumulated heat units of kharif and rabi seasons followed linear and quadratic trend might be the reasons for variations in the competitive period of seasons. The present study was concluded that early groundnut stage up to 15-16 DAE is more sensitive for crop weed competition to cause significant yield loss. And early stages rabi groundnut was more susceptible for competition than kharif as compare to later stage.

Keywords: Equation, Gompertz, logistic, relative yield loss, weed management

Groundnut (*Arachis hypogaea*) is the king of oilseeds grown as 4th most imoptant oilseed crop of the world (Mahantesh *et al*., 2018) and one of the most important food as well as cash crop of our country. It is mainly grown in *kharif* season (Patro *et al*., 2014) and in some places it gives good yield in *rabi* and summer also. The oilseed scenario in North East Hill (NEH) region is bleak. The per capita availability of oilseeds in this region is about 8 g, but the requirement is 50 g per day (Daphi, 2016). Despite of adoption of good management practices, the productivity of groundnut has been low. Among different constraints that are limiting the productivity of groundnut, intensive weed competition is one of the major barriers to enhance the productivity. Groundnut, being initially slow growing crop, provides congenial environment for abundant weed growth. The Computational stresses of weeds cause substantial yield losses (15-75 %) depending on the season (Jat *et al*., 2011) and 15-84 % (Mavarkar *et al*., 2015).

Removal of weeds throughout the crop season may not be economical. The exact critical period of crop-weed competition during the growing period of groundnut has to be determined, in order to avoid extravagant expenses on weed management. Timely control of weeds is very essential (Adhikary *et al*., 2016) not only to check the yield loss caused by weeds but also to increase the resource use efficiency and there by the productivity of groundnut. Higher dosage of herbicides used in field caused longer persistence in soil and damages to succeeding crop (Poonia *et al*., 2017)

Experimental evidences indicating precise and accurate information on crop growth stage at which weeds must be removed to maximize groundnut yield and the period when weeds may be allowed to grow without any adverse effect on the yield are lacking in the sub tropical hill (NEH-5) Agro-Climatic Zone of Meghalaya. Hence the present investigation was undertaken.

MATERIALS AND METHODS

The experiment was conducted at College of Postgraduate Studies, Central Agricultural university, Umiam, Meghalaya, India in both *kharif* and *rabi* seasons of the year 2016-17. The experimental site was located at 091°54.72' E longitude and 25°40.886' N latitude and at an altitude of 950 m above the mean sea level (MSL). The soil of the experimental site was sandy clay loam in texture. pH (4.9), Organic carbon (0.77 %), NPKS (282.24, 13.04, 241.98, 1.6 kg ha^{-1}). The experiment was conducted in a randomized block design, replicated thrice with twelve treatments *viz.*, weeds until 15, 30, 45, 60, 75 days after emergence (DAE), WC (weedy check) and weed free until 15, 30, 45, 60, 75, WFC (weed free check). ICGS-76 is the variety of Groundnut was

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sown in June 23 (*kharif*), and November 22 (*rabi*) during both the experimental seasons with plant spacing of 40 × 10 cm^2 on flat beds. Recommended doses of N, P and K = 25:60:60 NPK kg ha^{-1} (Full doses N, P and K were applied at the time of sowing. Standard agronomic practices were followed during crop growth period and crop was harvested at maturity. Randomly ten plants were selected from each plot and regular biometric observations of crop at 50 % germination (5 DAE) to harvest with an interval of 15 days and weed parameters were recorded from days after emergence (DAE) to 15, 30, 45, 60, 75 DAE and at harvest of the crop. Weed density (no. m^{-2}) and dry weight of weeds (g m^{-2}) were recorded by putting a quadrate of 0.25m^2 at two random spots in each plot. Both plant and weeds dry weights were determined after dehydration at 60°C for 48 hour.

The analysis and interpretation of data were done using the Fisher's method of analysis of variance technique as described by Gomez and Gomez (1984). The level of significant used in 'F' and 't' test was at P = 0.05. Critical difference values were calculated wherever the 'F' test was significant. Logistic and Gompertz equations were used to determine the critical period for crop-weed competition (Hall *et al*., 1992; Knezevic *et al*., 2002 and Johnson *et al*., 2004).

RESULTS AND DISCUSSION

Leaf area index

The leaf area index of groundnut were significantly affected by increasing the length of weed interference period, whereas, on the other hand positively influenced by the increasing span of weed free period. Season long weed free treatment obtained higher leaf area index with 2.56, 2.47, and 2.51 in *kharif*, *rabi* and pooled, respectively. However, the lowest was observed in weedy treatment. The progressive development of leaves follow a definite pattern, further growth and developments of new leaves depending upon the increase in height and development of new branches in the groundnut plant with relation to the length of internodes. As the canopy development of the weeds increased it restricts the growth and development of the plants consequently the foliage coverage of the groundnut abridged. Further, it also disturbed the mineral supply, its allelopathic effect, low water potential and nutrient uptake variation by weeds which resulted in reduced growth and development of leaves as a result lower leaf area index. At later stages of crop growth leaf senescence occurs and the older leaves are not able to photosynthesize might another reason of lower leaf area and leaf area index after peak growth stage of 60 days stage. In similar way higher the duration of crop weed competition lower the leaf area as well as leaf area in (Munene *et al.*, 2008).

Weed and Plant Dry matter

When the weeds were allowed to grow up to 60 days from emergence, they showed higher dry matter (DM) than those allowed after 45 days after emergence. The weed DM accumulation for early 60 days were 2401.90, 1480.50 and 1941.20 kg ha^{-1} in *kharif*, *rabi* and pooled, while those values for late 45 days were 798.63, 694.61, and 746.62 kg ha^{-1}, respectively. Similarly, the lowest weed DM recorded in weed free check than other weed free and weedy treatments. The result shows that highest dry matter accumulation was in initial weedy treatment up to 60 DAE as compare to initial weed free treatment of 60 DAE. In general Weed dry matter accumulation increases with increasing the duration of weed competition period in both *kharif* and *rabi*. However, the highest weed DM was observed in weeds up to crop harvest. The treatments where weeds were allowed to grow at the early stages (15 DAE) accumulated higher DM than those allowed to grow at the later stages of the crop growth. The highest weed DM was observed in weedy check. Among the treatments higher plant dry matter accumulation was observed in weed free check with 28.12, 24.49 and 26.3 g $plant^{-1}$ at harvesting in *kharif*, *rabi* and pooled, respectively and lowest were found in weedy check. Accumulation of large quantity of dry matter was the consequence of better leaf area index, which made the plants to utilize the available resources more efficiently to photosynthesize and translocation to different parts, which intern resulted in higher dry matter production. Increasing the weed pressure it decreases the parsley dry matter accumulation (Karkanis *et al*., 2012).

Yield attributes and yield

Compared to *rabi* and pooled data, *kharif* season getting maximum yield attributes and yield *i.e*., higher seed index, pod, seed and stover yield was recorded in weed free check (Table.2) due to less competition within the plants, high light use efficiency, maximum leaf area, less weed pressure leads to reduced weed competition with allelopathic effect on crop. Groundnut produced higher seed weight $plant^{-1}$ and seed index in the treatment with weeds up to 15 DAE and weed free check during *kharif* season but was reverse in *rabi*. Weeds took longer period of time for germination and its establishment and thus the available resources efficiently utilised by the crops during this period. Longer the weedy periods decreased the growth, yield component and yield proportionately and weedy period up to entire growth periods leads to least values of all these parameters and in case of cultivar PR 114 and PR 115 rice cultivars getting 100 % yield losses (Olayinka and Etejere, 2015) in which yield was 6.39-6.80 t ha^{-1} for cultivar PR 114

Table 1: Weed and plant dry matter (DM), Leaf area index (LAI) of groundnut as influenced periodically by different stages of weedy and weeds free treatments.

Treatments	Weed DM (kg ha^{-1})			Plant DM (g plant^{-1})			Plant LAI		
	Kharif	Rabi	Pooled	Kharif	Rabi	Pooled	Kharif	Rabi	Pooled
Weeds until 15 days	394.22i	294.47i	344.35g	20.83b	19.11c	19.97de	2.42bc	1.58de	2.00cde
Weeds until 30 days	671.30gh	437.81h	554.56fg	17.78bc	18.20cd	17.99e	2.35c	1.56de	1.96cde
Weeds until 45 days	1237.51e	477.91h	857.71e	16.56cd	13.06f	14.81f	2.35c	1.44e	1.89de
Weeds until 60 days	2401.90d	1480.50e	1941.2d	15.53cd	11.29f	13.41fg	2.18d	1.44e	1.81e
Weeds until 75 days	2851.79b	2273.62c	2562.7b	13.77de	12.18f	12.98fg	2.17d	1.43e	1.80e
Weedy plot	4296.59a	4020.90a	4158.74a	11.02e	11.63f	11.32g	2.12d	1.38e	1.75e
Weed free until 15 days	2641.59c	2545.63b	2593.61b	25.10a	15.64e	20.37de	2.48ab	1.75cd	2.11bcd
Weed free until 30 days	2278.11d	2135.99d	2207.05c	25.53a	18.59cd	22.06bcd	2.48ab	1.91bc	2.20bc
Weed free until 45 days	976.01f	836.07f	906.04e	26.25a	16.70de	21.48cd	2.49ab	2.05b	2.27ab
Weed free until 60 days	798.63fg	694.61g	746.62ef	26.52a	21.14b	23.83abc	2.52ab	2.51a	2.51a
Weed free until 75 days	503.48hi	447.95h	475.71g	26.77a	22.81ab	24.79ab	2.53a	2.44a	2.48a
Weed Free plot	-	-	-	28.12a	24.49a	26.30a	2.56a	2.47a	2.51a
SE m (±)	**66.80**	**33.29**	**27.56**	**1.16**	**0.67**	**0.50**	**0.03**	**0.09**	**0.03**
LSD (0.05)	**195.91**	**97.62**	**77.71**	**3.41**	**1.96**	**1.40**	**0.09**	**0.26**	**0.10**

***Figures not sharing the same letters in the same column differs significantly at p<0.05*

Table 2: Seed index, pod yield (t ha$^{-1)}$, seed yield (t ha$^{-1)}$ and stover yield (t ha^{-1}) as nfluenced periodically by different stages of weedy and weeds free treatments in groundnut.

Treatments	Seed index			Pod yield t ha^{-1}			Seed yield t ha^{-1}			Stover yield t ha^{-1}		
	Kharif	Rabi	Pooled	Kharif	Rabi	Pooled	Kharif	Rabi	Pooled	Kharif	Rabi	Pooled
Weeds until 15 days	23.67a	23.52a	23.59a	1.70c	1.36ab	1.65a	1.30b	0.88b	1.09b	3.62a	3.15c	3.39a
Weeds until 30 days	21.80abc	21.79abc	21.80bc	1.50e	1.20c	1.46b	1.12d	0.78d	0.95d	3.05a	2.65f	2.85a
Weeds until 45 days	20.83bcd	20.64bcd	20.74cd	1.33f	1.06e	1.29c	0.98e	0.68e	0.83e	2.98a	2.60g	2.79a
Weeds until 60 days	20.17cde	20.02cd	20.09def	1.21gh	0.97g	1.18de	0.86fg	0.60fg	0.73fg	2.64a	2.30i	2.47a
Weeds until 75 days	19.52de	18.84de	19.18ef	1.20hi	0.96g	1.17de	0.85g	0.59g	0.72fg	2.64a	2.29i	2.46a
Weedy plot	19.03e	18.77de	18.90f	1.16i	0.93h	1.13e	0.82h	0.52i	0.67h	2.54a	2.21j	2.38a
Weed free until 15 days	18.20e	17.04e	17.62g	1.18i	0.93h	1.14e	0.83h	0.56h	0.70gh	2.56a	2.23j	2.39a
Weed free until 30 days	20.00cde	19.20d	19.60def	1.25g	1.00f	1.21d	0.88f	0.62f	0.75f	2.90a	2.52h	2.71a
Weed free until 45 days	20.87bcd	19.97cd	20.42de	1.50e	1.10d	1.33c	1.13d	0.77d	0.95d	3.25a	2.83e	3.04a
Weed free until 60 days	23.13ab	22.18ab	22.65ab	1.60d	1.19c	1.45b	1.19c	0.83c	1.01c	3.35a	2.92d	3.13a
Weed free until 75 days	23.87a	23.09a	23.48a	1.78b	1.34b	1.63a	1.35a	0.94a	1.14a	3.73a	3.25b	3.49a
Weed Free plot	24.01a	23.28a	23.64a	1.82a	1.37a	1.66a	1.35a	0.94a	1.15a	3.87a	3.37a	3.62a
SEm (±)	**0.75**	**0.6**	**0.35**	**0.01**	**0.01**	**0.00**	**0.01**	**0.01**	**0.00**	**0.04**	**0.01**	**0.01**
LSD (0.05)	**2.2**	**1.76**	**1.00**	**0.03**	**0.02**	**0.01**	**0.03**	**0.02**	**0.01**	**NS**	**0.04**	**NS**

**Figures not sharing the same letters in the same column differs significantly at p<0.0*

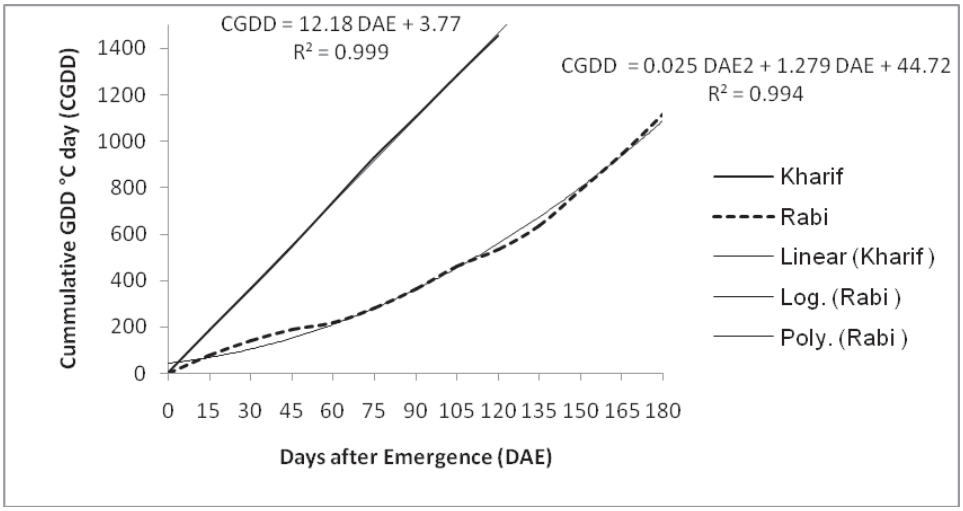

Fig. 1: Total GDD°C day of both *kharif* and *rabi* groundnut.

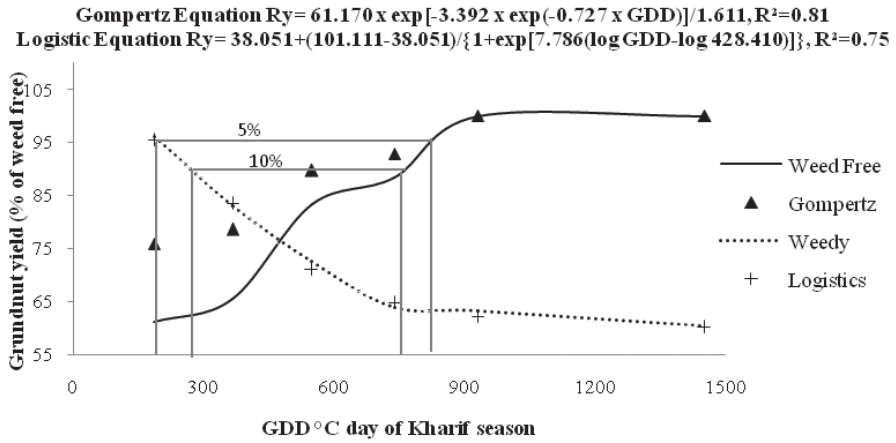

Fig. 2: Critical period for crop-weed competition in *kharif* season

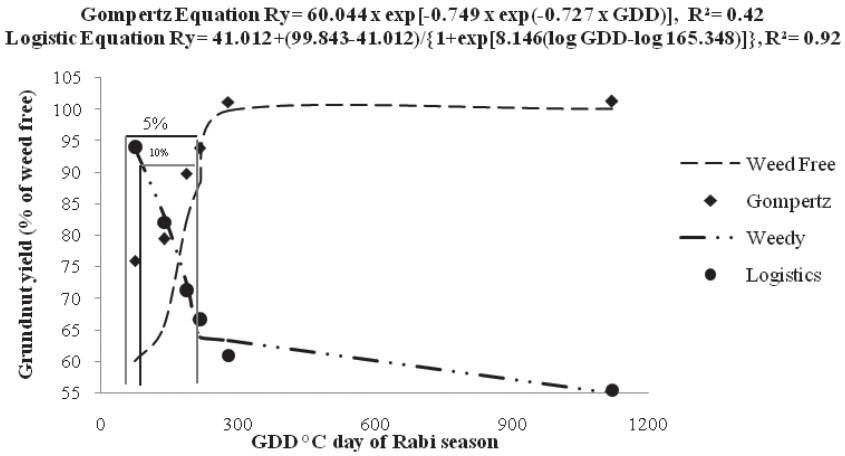

Fig. 3: Critical period for crop-weed competition in *rabi* season

and 6.49-6.87 t ha^{-1} for PR 115 (Singh *et al*., 2014) under weed free conditions.

Growing Degree Day

GDD was calculated from the date of emergence to harvesting stage in both seasons for determination of Gompertz and Logistic functions. The accumulated heat units of *kharif* and *rabi* seasons followed linear and quadratic trend might be the reasons for variations in the competitive period of seasons. The highest heat unit accumulated in *kharif* with 1452.60 and *rabi* with 1119.20 °C day heat units from the crop emergence. It shows that early stages *rabi* groundnut was more susceptible for competition than *kharif* as compared to later stage. However, the total accumulated heat units in terms of °C day from sowing to harvests were 1570.30 and 1219.35°C day during *kharif* and *rabi* seasons with 10°C of base temperature, respectively.

The accumulation of GDD of both seasons followed different pattern. The *kharif* was accumulated higher GDD °C day followed by *rabi*. On the basis of GDD *kharif* and *rabi* seasons follows linear and quadratic pattern, respectively. These shows the crop and weeds both are more sensitive at lower temperature during initial growth phases. At initial stage of the crop growth the diurnal variation was less in *kharif* as compare to *rabi* so crops are accumulated higher GDD in *kharif* season. Finally the data regarding GDD shows that the *rabi* groundnut was more susceptible to early weed competition as compare to *kharif* groundnut. The variation of GDD in both seasons was shown in fig.1.

Critical period of crop-weed competition

At beginning the treatments and seasons of experimental year significantly interacted up to end of the critical period of crop weed competition (CPCWC) so, all the yield data's were assessed separately for each season. Increasing periods of weed competition drastically reduced groundnut yield in both seasons. While average groundnut yield from the weed-free check were 1.35 t ha^{-1} in *kharif* and 0.94 t ha^{-1} in *rabi*. However, weedy check was 0.82 t ha^{-1} in *kharif* and 0.52 t ha^{-1} in *rabi*. The length of the CPCWC in groundnut was 16 and 23 in *kharif* and 15 and 21 days in *rabi* with 5 and 10% yield loss, respectively. The CPCWC in groundnut was commenced on 199 GDD in *kharif* and 75 GDD in *rabi*, at 5 % RYL (fig. 2 and 3). Based on the 10% yield loss onset of the CPCWC were 289 GDD in *kharif* and 108 GDD in *rabi*. The beginning of the CPCWC was at an earlier date in *rabi* as compared to *kharif*. The soil and weather conditions especially temperature in *rabi* would have influenced the beginning of the CPCWC in a bit earlier in *rabi* compared to *kharif*. Karkanis *et al.* (2012) reported that beginning of CPWC in parsley was 100 GDD in 2004, 50 in 2005 and 94 GDD in 2001 at 5% AYL. The end of the CPCWC ranged from 279 GDD in 2004, 258 GDD in 2005 and 284 GDD in 2006 at 5% AYL.

The critical period for weed competition under 5 per cent YIELD LOSS at *kharif* was 16 to 66 and *rabi* was 15 to 63 DAE. The estimated critical period for groundnut at 10 per cent YIELD LOSS were 22 to 62 and 21 to 61 DAE in *kharif* and *rabi* seasons, respectively. The accumulated heat units of *kharif* and *rabi* seasons followed linear and quadratic trend might be the reasons for variations in the competitive period of seasons. The yield and yield components were increasing with initial weed free treatments. The present study was concluded that early groundnut stage up to 15-16 DAE is more sensitive for crop weed competition to cause significant yield loss. And early stages *rabi*groundnut was more susceptible for competition than *kharif* as compare to later stage.

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