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Weed dynamics and its interference in pea

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ABSTRACT

In the *rabi* season of 2020-21, a field experiment was conducted at the experimental farm of College of Post Graduate Studies in Agricultural Sciences (CAU, Imphal), Umiam to investigate the weed dynamics in pea crop. The experiment consisted of 14 treatments, which were divided into two sets, *viz*., weedy and weed free, replicated thrice. Results revealed that the weed community had a species richness of 13, belonging to 7 different families. Higher weed growth rate was recorded where weeds were allowed to compete with crop for longer duration. The highest relative yield loss in pea (44.31 %) was recorded in season long weedy plot. The plot where weeds were allowed to emerge after 60 DAS showed the highest weed diversity with Shannon-Weiner diversity index, H′=1.948 and Simpson index D= 0.244. *Galinsoga parviflora* was found to be the most dominant weed with the highest importance value index (98.33 to 300) in all the treatments.

1. Introduction

Pulses are one of the most important food crops grown globally due to higher protein content and as a soil building crop. Pulses also play an important role in Indian agriculture, which is evident by the fact that India is the largest producer (25% of global production) and consumer (27% of global consumption) of pulses in the world (Tyagi and Kumar, 2019). Pulses are an integral part of Indian diet as it provides the most of required protein in an otherwise carbohydrate rich diet. Pea (*Pisum sativum* L.) is an important *rabi* season pulse crop, an excellent source of cheap proteins (23.4 %), carbohydrates (60.1%), fat (1.2%), dietary fiber (21.2%), minerals, vitamins and phytochemicals, and therefore can ascertain food security, (Tulbek, 2014). In India, green pea is cultivated in an area of 0.56 m ha with a total production and productivity of 5.86 m t and 10.3 t ha^{-1}, respectively (FAOSTAT, 2021). The area, production and productivity of pea in Meghalaya is 2271 ha, 4432 t and 1952 kg ha^{-1}, respectively (DES, 2016). The deep root system of peas along with the considerable nitrogen fixing ability, makes it an excellent rotational crop. However, wide variation in pea yield is unavoidable due to various abiotic and biotic stress. Among the various biotic factors, weeds are found to cause substantial yield losses. Wider spacing and slow initial growth of pea plants provide ample competitive advantage to the weeds and ultimately lead to decrement in yield. Kaur *et al.,* 2020 reported 45 % reduction in pea yield due to unchecked weed growth. However, the cumulative effect of diverse weed species in crop productivity is little known (Adeux *et al.,* 2019). Measurement of diversity could give a meaningful insight to understand crop-weed interference and can be done by using various diversity indices. A weed community containing a few highly dominant species and remaining non dominant species is expected to put forward higher competitive pressure compared to a more diverse weed community due to more crop-weed interference. Thus, weed controls measures should be targeted toward the most dominant weed species in the community. The most dominant weed in the system can be identified using importance value index, which is the sum of relative density, relative frequency and relative abundance. A diversity index may be defined as a

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quantitative measure that indicates the number of different species and the evenness of distribution of individual species among them. The Simpson's index denotes the dominance of species and measures the probability of two individuals randomly selected from a sample belonging to the same species. The Shannon-Weiner diversity index measures the degree of uncertainty of predicting the species of a random sample (Kiernan, 2013). Therefore, the estimation of weed diversity along with precise information of dominant weed species in the system will allow developing more efficient, sustainable and cost-effective weed management strategies and thereby improve the productivity.

2. Materials and methods

Field study was conducted in *rabi* season (2020-21) at the experimental farm of College of Post Graduate Studies in Agricultural Sciences, Central Agricultural University, Umiam, Meghalaya, India. The experimental site is situated at 25°68.157' N latitude and 91°91.203' E longitude and at an altitude of 950 m above the mean sea level. The soil of the experimental site was sandy clay loam in texture, acidic in reaction (pH 4.86), very high organic carbon (1.7%), low in available N (213.25) and P (18.24) and medium in K (202.72) kg/ha. The experiment was conducted in a randomised block design, with 14 treatments replicated thrice. The 14 treatments were divided into two sets *viz*., weedy set containing, weed free, weed free following 10, 20, 30, 40, 50 and 60 DAS; and weed free set containing, never weed free, weed free until 10, 20, 30, 40, 50 and 60 DAS. Pea (Variety *Arkel*) was selected as the test crop and sown at a spacing of 30 cm x 10 cm. Standard agronomic practices other than weed management practices were followed during crop growth period. Recommended fertilizer dose of 40 kg N, 40 kg P_2O_5 and 20 kg K_2O per hectare was applied using Urea, SSP and MOP as sources. Irrigation water was provided as and when needed as rainfall during the cropping season was meagre. The weeds were managed only by hand-weeding and according to the treatment requirement. The density in individual plots and total dry weight of weeds were recorded from three randomly selected quadrates (0.25 m^2) in each plot at 10 days interval. Weed samples were oven dried at 60 °C to constant weight and was used to evaluate the weed growth rate. Pod yield was recorded at harvest and relative yield loss was calculated.

Numerical analysis

$$\text{Relative yield loss (\%)} = \frac{\text{Yield of weed free plot-yield of treatment in question}}{\text{Yield of weed free plot}} \times 100$$

The rate of dry matter production by weeds per unit land area per unit time or Weed growth rate (WGR) was worked out by using formula and expressed as g m^{-2} day^{-1}.

$$\text{WGR} = \frac{W2-W1}{t2-t1}$$

Where, W1= Weed dry weight m^{-2} at time t1

W2= Weed dry weight m^{-2} at time t2

$$\text{Density} = \frac{\text{Total number of individuals of a species in all quadrats}}{\text{Total number of quadrats studied x area in m}^2\text{ of a quadrat}}$$

$$\text{Abundance} = \frac{\text{Total number of individuals in a species in al the quadrats}}{\text{Total number of quadrats in which the species occured}}$$

$$\text{Frequency} = \frac{\text{Number of quadrats in which the species occured}}{\text{Total number of quadrats studied}} \times 100$$

$$\text{Relative Density} = \frac{\text{Density of the species in question}}{\text{Sum total of densities of all the species}} \times 100$$

$$\text{Relative Abundance} = \frac{\text{Abundance of a species}}{\text{Sum total of abundance of all species}} \times 100$$

$$\text{Relative frequency} = \frac{\text{Frequency value of a species}}{\text{Sum total of frequency values of all the species}} \times 100$$

Importance value index (IVI) = Relative density + Relative abundance + Relative frequency

The Shannon-Weiner diversity index (Shannon and Weaver, 1963) (H′) is calculated by the following equation-

$$H' = \sum_{n=1}^{s} pi(\ln pi)$$

The Simpson index was introduced by Simpson (1949) in order to measure the degree of dominance of individuals weed species, according to the following equation:

$$D = \sum_{n=1}^{s} pi^2$$

Where pi is the proportion of individuals belonging to the i^{th} species and S is the total number of species.

Relative yield loss is calculated as the percentage of weed free yield.

3. Results and discussion

Weed Flora

The species richness observed in the plot under experimentation during the *rabi* season of 2020-21 were 13. The weed species observed were *Ageratum conyzoides, Ambrosia artemisiifolia, Bidens bipinnata, Bidens Pilosa, Cardamine flexuosa, Crassocephalum crepidioides, Cynodon dactylon, Echinochloa crus-galli, Emilia sonchifolia, Galinsoga parviflora, Oxalis acetosella, Polygunum aviculare* and *Vicia sativa*. Weeds belonging to the Asteraceae family dominated the weed flora, recording 7 out of the 13 identified weed species. The Poaceae family was the subsequent dominant family with 2 species. While one species from the Brassicaceae, Oxalidaceae, Polygonaceae and Fabaceae was observed. Similar weed flora was noticed in groundnut grown under similar condition by Korav *et al.* (2018).

Weed Growth Rate (g/m^2/day)

Weed growth rate was influenced with increasing duration of weed interference period. Maximum weed growth rate was observed in season long weedy plot (2.27 g/m^2/day).

As the duration of crop weed interference decreased, a decrease in the weed growth rate was observed at harvest stage. Minimum weed growth rate (0.08 g/m^2/day) was recorded from the plot where the weeds were allowed to compete with pea plants for initial 10 DAS (fig. 1). As the duration of weed interference increases the competitive ability of weeds increased, subsequently smothering the plants and reducing the light interception, allowing weeds to accumulate dry matter at higher rates.

Weed Diversity and relative yield loss in pea

Weed diversity indices as shown in table 1, was found to vary with different durations of weedy and weed free period. The species richness in the experimental plots increased with increasing duration of crop weed competition. While, at harvest the species richness in weed free set of treatments were same. The Shannon wiener diversity index values when estimated for the various treatments resulted that the treatment which was kept weed free until 60 DAS (T14) had the highest value (1.948), indicating highest diversity.

The Simpsons index values estimated for various treatments revealed that weed free plot following 10 DAS recorded the highest value 1.0, indicating the presence of only one species in the plot. Lower values of Simpsons index were recorded in weed free plots until 40, 50 and 60 DAS, indicating the reduced dominance of single species in these treatments.

The relative yield loss value indicated that with the increase in the weedy period, yield loss increases. Treatments where weeds were allowed to compete for the entire duration crop growth reduced the yield by 44.31%, where the diversity index values were 1.169 (H´) and 0.401 (D). The highest diversity in the system was observed in weed free plot until 60 DAS followed by weed free plot until 40 and 50 DAS where the relative yield loss of 0.24 %, 14.69 % and 3.06 %, recorded respectively. This proves the higher influence of duration of weed growth on yield, however the effect of weed diversity on pea yield was volatile.

Importance Value Index

The important value index (IVI) is calculated based on the density (table 2), abundance (table 3) and frequency (table 4) of the weed species. It is the sum of relative density, relative abundance and relative frequency, presented in table 5, 6 and 7, respectively. The IVI of all the weed species observed in the experimental plot as influenced by different weedy and weed free treatments are presented in table 8. *Galinsoga parviflora* recorded the highest value of IVI disparate of various duration of crop weed competition. Treatments kept weedy from early growth of crop (T2, T3, T4, T5, T6, T7, T8, T9 and T10) reported higher values of IVI of *G. parviflora* (117.11-300), indicating that the initial crop growth season was congenial for growth of *G. parviflora,* and its competition with other species may explain the lower weed diversity during that period. Conversely, when weeds were allowed to emerge after 30 DAS (T11, T12, T13 and T14) the dominance of *G. parviflora* was lowered and thereby provided ample opportunity for other weed species to emerge and thrive, which explains the higher values of Shannon-Wiener index and lower values of Simpson's index in these treatments. The observation recorded on weed diversity at different weed free and weedy treatments revealed that the duration of crop-weed competition did not necessarily influence the weed diversity. However, weed diversity is more dependent on time of emergence of weeds. It might be due to the weed seed bank developed at various depths consequently their gemination time varies and ultimately regulates their developmental behaviours. At harvest stage, in treatments T8, T9 and T10, *Polygonum aviculare* and *Ageratum conyzoides,* were the most important weed species following *G. parviflora*. While in T11, T12 and T13 *Oxalis acetosella* was second most important weed and in T14, it was *Bidens bipinnata*.

In this experiment, it was noticed that when weeds were allowed to compete with crops for more than initial 20 DAS, resulted in higher relative yield losses. Deb (2021) reported that the CPWC for pea crop in Meghalaya was 21 to 48 DAS at 5% relative yield loss. Similarly, Singh *et al.* (2016) reported that the CPWC for field pea began at 20 DAS and continued upto 63 DAS at 5% accepted yield loss. The intersection of curves (0.7) representing Shannon-Wiener and Simpson's index which also occurs at 21 DAS, indicated that the weed diversity when Shannon-Wiener index value is higher than 0.7 and Simpson's index value is lower than 0.7 can cause relative yield losses beyond 5% level (Fig. 2). *G. parviflora*, the most dominant weed reaches its peak dominance at around 20 DAS, while *Polygonum aviculare,* another predominant weed in the system obtained its maximum IVI value at around 32 DAS. The two weeds have comparable dominance at around 25 DAS (Fig. 3), which might explain the beginning of critical period of pea weed competition during that period.

4. Conclusion

Weed community in the experimental plot of pea comprised of 13 species. The longer duration crop-weed interference resulted in higher weed growth rate. Weeds when allowed to compete with the crops for the entire growing season resulted in 44.31% relative yield loss of pea. Weed diversity was more influenced by time of emergence of weeds as compared to duration of weed growth. *Galinsoga parviflora* was found to be the most dominant weed in the cropping season and therefore the weed management practices should be targeted towards the management of this

weed. However, the effect of a more diverse weed community on pea yield could not be explained properly by the experiment.

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Table 1. Species richness, Shannon Wiener Index, Simpson's index and relative yield loss as influenced by different stages of weedy and weed free treatments in pea.

Treatments	Species Richness	Shannon Wiener index	Simpson's index	Relative Yield loss (%)
Weed free (T1)	-	-	-	-
Weed free following 10 DAS (T2)	1	0.000	1.000	0.49
Weed free following 20 DAS (T3)	4	0.564	0.742	3.92
Weed free following 30 DAS (T4)	6	1.245	0.418	11.63
Weed free following 40 DAS (T5)	9	1.510	0.328	24.36
Weed free following 50 DAS (T6)	10	1.243	0.491	26.93
Weed free following 60 DAS (T7)	9	1.092	0.504	35.01
Never weed free (T8)	12	1.169	0.401	44.31
Weed free until 10 DAS (T9)	12	1.687	0.338	39.78
Weed free until 20 DAS (T10)	12	1.438	0.445	34.15
Weed free until 30 DAS (T11)	12	1.721	0.316	24.60
Weed free until 40 DAS (T12)	12	1.886	0.259	14.69
Weed free until 50 DAS (T13)	12	1.824	0.287	3.06
Weed free until 60 DAS (T14)	12	1.948	0.244	0.24

Table 2. Density of weed species as influenced periodically by different stages of weedy and weed free treatments in Pea.

Species	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T13	T14
Galinsoga parviflora	2.52	149.33	110.22	117.33	138.67	304.00	288.00	257.78	165.50	110.74	85.04	88.00	49.10
Polygonum aviculare	-	-	7.11	32.00	16.00	16.00	19.56	17.78	9.07	16.66	8.23	7.82	5.61
Vicia sativa	-	-	-	10.67	3.56	-	12.44	-	-	-	-	-	-
Bidens bipinnata	-	7.11	16.00	23.11	10.67	3.56	14.22	14.22	4.53	7.84	10.97	7.82	8.42
Oxalis acetocella	-	10.67	10.67	-	5.33	74.67	55.11	42.67	13.60	21.56	20.12	15.64	7.01
Echinochloa crusgalli	-	7.11	23.11	14.22	5.33	14.22	8.89	14.22	9.07	7.84	8.23	3.91	4.21
Cynodon dactylon	-	-	10.67	16.00	10.67	14.22	17.78	24.89	12.47	6.86	9.14	10.76	4.91
Ambrosia artemnisifolia	-	-	-	1.78	1.78	-	12.44	19.56	9.07	7.84	10.97	3.91	2.81
Emalia sonchifolia	-	-	-	1.78	-	-	7.11	8.89	4.53	2.94	3.66	4.89	2.81
Ageratum conyzoides	-	-	-	3.56	5.33	5.33	8.89	8.89	5.67	2.94	5.49	7.82	5.61
Crassocephalus crepidioides	-	-	-	-	3.56	8.89	8.89	23.11	7.94	7.84	4.57	8.80	6.31
Cardamine flexuosa	-	-	-	-	-	1.78	3.56	16.00	5.67	5.88	5.49	5.87	3.51
Bidens pilosa	-	-	-	-	-	-	10.67	10.67	4.53	6.86	6.40	6.84	5.61
Total	**2.52**	**174.22**	**177.78**	**220.44**	**200.89**	**442.67**	**467.56**	**458.67**	**251.65**	**205.80**	**178.31**	**172.09**	**105.91**

Table 3. Abundance of weed species as influenced periodically by different stages of weedy and weed free treatments in Pea.

Species	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T13	T14
Galinsoga parviflora	0.84	49.78	36.74	39.11	46.22	101.33	96.00	85.93	55.17	36.91	28.35	29.33	16.37
Polygonum aviculare	-	-	3.56	10.67	5.33	5.33	9.78	8.89	4.53	5.55	2.74	2.61	1.87
Vicia sativa	-	-	-	5.33	3.56	-	6.22	-	-	-	-	-	-
Bidens bipinnata	-	7.11	8.00	7.70	3.56	1.78	4.74	4.74	2.27	2.61	3.66	3.91	2.81
Oxalis acetocella	-	10.67	11	0.00	5.33	24.89	18.37	14.22	4.53	7.19	6.71	5.21	2.34
Echinochloa crusgalli	-	7.11	7.70	4.74	2.67	4.74	2.96	7.11	3.02	2.61	2.74	1.96	2.10
Cynodon dactylon	-	-	10.67	5.33	5.33	4.74	5.93	8.30	4.16	2.29	3.05	3.59	2.45
Ambrosia artemnisifolia	-	-	-	1.78	1.78	-	6.22	6.52	3.02	7.84	3.66	1.96	1.40
Emalia sonchifolia	-	-	-	1.78	-	-	2.37	4.44	2.27	2.94	1.83	2.44	1.40
Ageratum conyzoides	-	-	-	3.56	2.67	5.33	4.44	4.44	1.89	2.94	2.74	2.61	2.81
Crassocephalus crepidioides	-	-	-	-	3.56	4.44	2.96	7.70	3.97	2.61	4.57	2.93	2.10
Cardamine flexuosa	-	-	-	-	-	1.78	3.56	5.33	1.89	1.96	1.83	1.96	1.17
Bidens pilosa	-	-	-	-	-	-	3.56	3.56	1.51	6.86	2.13	2.28	1.87

Table 4. Frequency of weed species as influenced periodically by different stages of weedy and weed free treatments in Pea.

Species	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T13	T14
Galinsoga parviflora	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Polygonum aviculare	-	-	66.67	100.00	100.00	100.00	66.67	66.67	66.67	100.00	100.00	100.00	100.00
Vicia sativa	-	-	-	66.67	33.33	-	66.67	-	-	-	-	-	-
Bidens bipinnata	-	33.33	66.67	100.00	100.00	66.67	100.00	100.00	66.67	100.00	100.00	66.67	100.00
Oxalis acetocella	-	33.33	33.33	-	33.33	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Echinochloa crusgalli	-	33.33	100.00	100.00	66.67	100.00	100.00	66.67	100.00	100.00	100.00	66.67	66.67
Cynodon dactylon	-		33.33	100.00	66.67	100.00	100.00	100.00	100.00	100.00	100.00	100.00	66.67
Ambrosia artemnisifolia	-	-	-	33.33	33.33	-	66.67	100.00	100.00	33.33	100.00	66.67	66.67
Emalia sonchifolia	-	-	-	33.33	-	-	100.00	66.67	66.67	33.33	66.67	66.67	66.67
Ageratum conyzoides	-	-	-	33.33	66.67	33.33	66.67	66.67	100.00	33.33	66.67	100.00	66.67
Crassocephalus crepidioides	-	-	-	-	33.33	66.67	100.00	100.00	66.67	100.00	33.33	100.00	100.00
Cardamine flexuosa	-	-	-	-	-	33.33	33.33	100.00	100.00	100.00	100.00	100.00	100.00
Bidens pilosa	-	-	-	-	-	-	100.00	100.00	100.00	33.33	100.00	100.00	100.00

Table 5. Relative density of weed species as influenced periodically by different stages of weedy and weed free treatments in Pea.

Species	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T13	T14
Galinsoga parviflora	100.00	85.71	62.00	53.23	69.03	68.67	61.60	56.20	65.77	53.81	47.69	51.14	46.36
Polygonum aviculare	-	-	4.00	14.52	7.96	3.61	4.18	3.88	3.60	8.10	4.62	4.55	5.30
Vicia sativa	-	-	-	4.84	1.77	-	2.66	-	-	-	-	-	-
Bidens bipinnata	-	4.08	9.00	10.48	5.31	0.80	3.04	3.10	1.80	3.81	6.15	4.55	7.95
Oxalis acetocella	-	6.12	6.00	-	2.65	16.87	11.79	9.30	5.41	10.48	11.28	9.09	6.62
Echinochloa crusgalli	-	4.08	13.00	6.45	2.65	3.21	1.90	3.10	3.60	3.81	4.62	2.27	3.97
Cynodon dactylon	-	-	6.00	7.26	5.31	3.21	3.80	5.43	4.95	3.33	5.13	6.25	4.64
Ambrosia artemnisifolia	-	-	-	0.81	0.88	-	2.66	4.26	3.60	3.81	6.15	2.27	2.65
Emalia sonchifolia	-	-	-	0.81	-	-	1.52	1.94	1.80	1.43	2.05	2.84	2.65
Ageratum conyzoides	-	-	-	1.61	2.65	1.20	1.90	1.94	2.25	1.43	3.08	4.55	5.30
Crassocephalus crepidioides	-	-	-	-	1.77	2.01	1.90	5.04	3.15	3.81	2.56	5.11	5.96
Cardamine flexuosa	-	-	-	-	-	0.40	0.76	3.49	2.25	2.86	3.08	3.41	3.31
Bidens pilosa	-	-	-	-	-	-	2.28	2.33	1.80	3.33	3.59	3.98	5.30

Table 6. Relative abundance of weed species as influenced periodically by different stages of weedy and weed free treatments in Pea.

Species	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T13	T14
Galinsoga parviflora	100.00	66.67	47.51	48.89	57.78	65.64	57.45	53.31	62.53	44.84	44.29	48.26	42.30
Polygonum aviculare	-	-	4.60	13.33	6.67	3.45	5.85	5.51	5.14	6.75	4.29	4.29	4.83
Vicia sativa	-	-	-	6.67	4.44	-	3.72	-	-	-	-	-	-
Bidens bipinnata	-	9.52	10.34	9.63	4.44	1.15	2.84	2.94	2.57	3.17	5.71	6.43	7.25
Oxalis acetocella	-	14.29	13.79	0.00	6.67	16.12	10.99	8.82	5.14	8.73	10.48	8.58	6.04
Echinochloa crusgalli	-	9.52	9.96	5.93	3.33	3.07	1.77	4.41	3.43	3.17	4.29	3.22	5.44
Cynodon dactylon	-		13.79	6.67	6.67	3.07	3.55	5.15	4.71	2.78	4.76	5.90	6.34
Ambrosia artemnisifolia	-	-	-	2.22	2.22	-	3.72	4.04	3.43	9.52	5.71	3.22	3.63
Emalia sonchifolia	-	-	-	2.22	-	-	1.42	2.76	2.57	3.57	2.86	4.02	3.63
Ageratum conyzoides	-	-	-	4.44	3.33	3.45	2.66	2.76	2.14	3.57	4.29	4.29	7.25
Crassocephalus crepidioides	-	-	-	-	4.44	2.88	1.77	4.78	4.50	3.17	7.14	4.83	5.44
Cardamine flexuosa	-	-	-	-	-	1.15	2.13	3.31	2.14	2.38	2.86	3.22	3.02
Bidens pilosa	-	-	-	-	-	-	2.13	2.21	1.71	8.33	3.33	3.75	4.83

Table 7. Relative frequency of weed species as influenced periodically by different stages of weedy and weed free treatments in Pea.

Species	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T13	T14
Galinsoga parviflora	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Polygonum aviculare	-	-	66.67	100.00	100.00	100.00	66.67	66.67	66.67	100.00	100.00	100.00	100.00
Vicia sativa	-	-	-	66.67	33.33	-	66.67	-	-	-	-	-	-
Bidens bipinnata	-	33.33	66.67	100.00	100.00	66.67	100.00	100.00	66.67	100.00	100.00	66.67	100.00
Oxalis acetocella	-	33.33	33.33	-	33.33	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Echinochloa crusgalli	-	33.33	100.00	100.00	66.67	100.00	100.00	66.67	100.00	100.00	100.00	66.67	66.67
Cynodon dactylon	-		33.33	100.00	66.67	100.00	100.00	100.00	100.00	100.00	100.00	100.00	66.67
Ambrosia artemnisifolia	-	-	-	33.33	33.33	-	66.67	100.00	100.00	33.33	100.00	66.67	66.67
Emalia sonchifolia	-	-	-	33.33	-	-	100.00	66.67	66.67	33.33	66.67	66.67	66.67
Ageratum conyzoides	-	-	-	33.33	66.67	33.33	66.67	66.67	100.00	33.33	66.67	100.00	66.67
Crassocephalus crepidioides	-	-	-	-	33.33	66.67	100.00	100.00	66.67	100.00	33.33	100.00	100.00
Cardamine flexuosa	-	-	-	-	-	33.33	33.33	100.00	100.00	100.00	100.00	100.00	100.00
Bidens pilosa	-	-	-	-	-	-	100.00	100.00	100.00	33.33	100.00	100.00	100.00

Table 8. Importance value index of weed species as influenced periodically by different stages of weedy and weed free treatments in Pea.

Species	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T13	T14
Galinsoga parviflora	300.00	202.38	134.51	117.11	142.59	148.60	128.13	118.89	137.67	109.37	101.35	108.77	98.33
Polygonum aviculare	-	-	25.26	42.85	30.42	21.36	16.09	15.64	14.99	25.56	18.28	18.21	19.81
Vicia sativa	-	-	-	21.51	11.48	-	12.45	-	-	-	-	-	-
Bidens bipinnata	-	30.27	36.01	35.11	25.54	11.48	14.97	15.42	10.62	17.70	21.24	17.23	24.88
Oxalis acetosella	-	37.07	28.13	-	14.58	47.28	31.87	27.50	19.92	29.92	31.13	27.04	22.34
Echinochloa crusgalli	-	30.27	47.96	27.38	16.51	20.57	12.77	13.76	16.40	17.70	18.28	11.74	15.86
Cynodon dactylon	-	-	28.13	28.92	22.50	20.57	16.44	19.95	19.04	16.83	19.27	21.52	17.43
Ambrosia artemisiifolia	-	-	-	8.03	8.37	-	12.45	17.68	16.40	16.90	21.24	11.74	12.73
Emilia sonchifolia	-	-	-	8.03	-	-	12.03	10.95	10.62	8.57	11.16	13.11	12.73
Ageratum conyzoides	-	-	-	11.06	16.51	9.42	10.62	10.95	13.77	8.57	13.61	18.21	19.00
Crassocephalus crepidioides	-	-	-	-	11.48	14.41	12.77	19.19	13.90	17.70	12.83	19.31	21.08
Cardamine flexuosa	-	-	-	-	-	6.32	5.92	16.17	13.77	15.95	15.31	16.00	16.01
Bidens pilosa	-	-	-	-	-	-	13.50	13.91	12.89	15.24	16.30	17.11	19.81

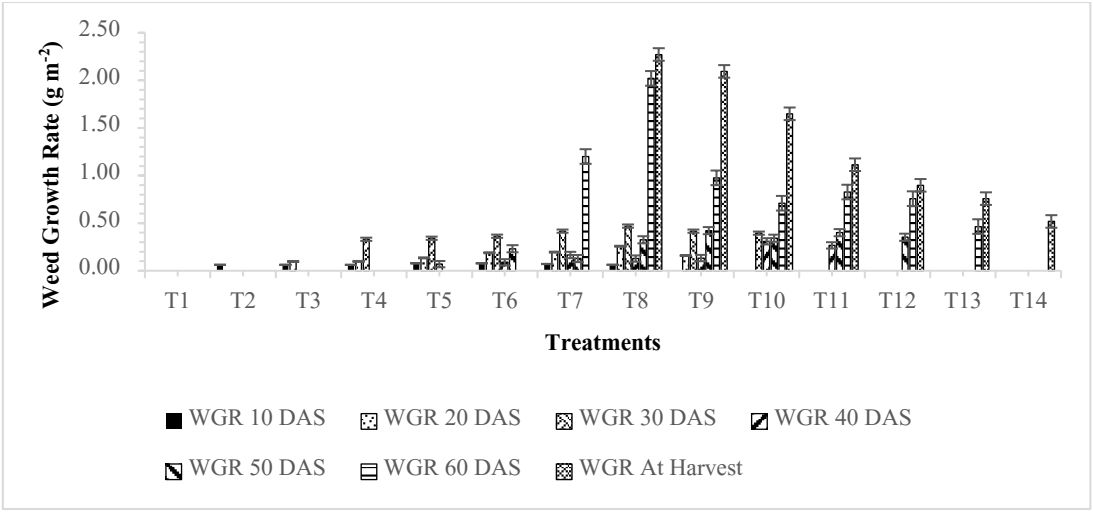

Figure 1. Growth rate of weeds in pea as influenced periodically by different stages of weedy and weed free treatments.

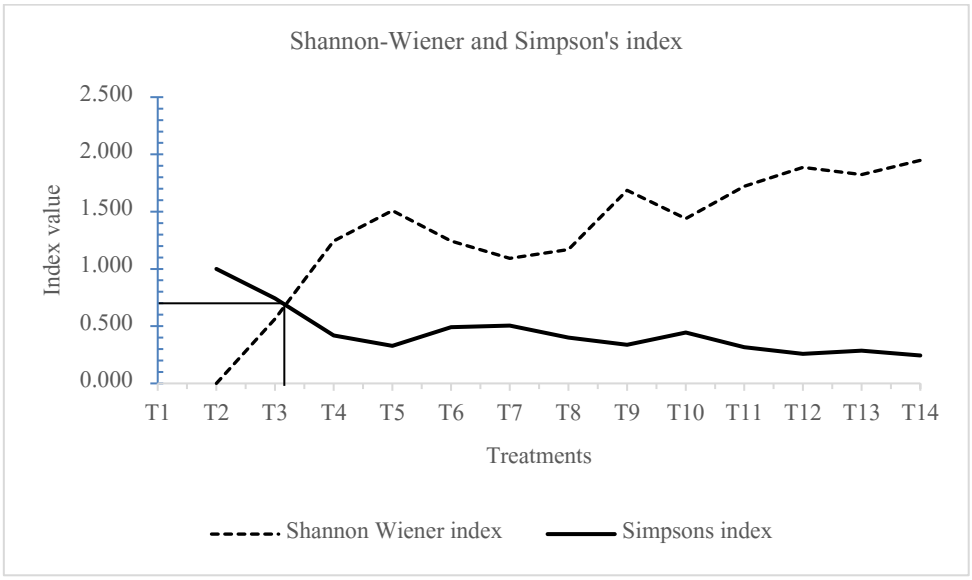

Figure 2. Shannon-Wiener and Simpson's index as influenced by various stages of weedy and weed free treatments.

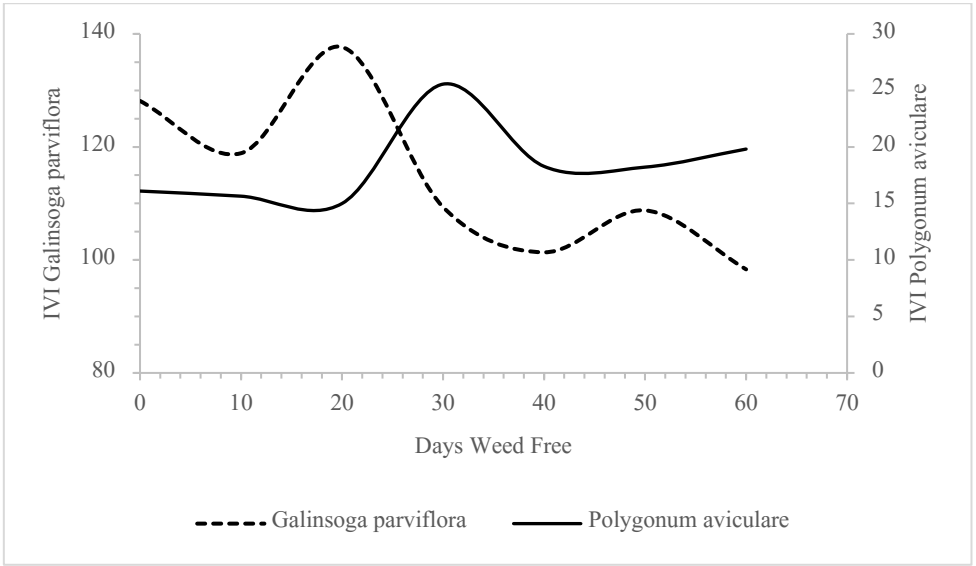

Figure 3. IVI of *Galinsoga parviflora* and *Polygonum aviculare* as influenced by various duration of weed free period.