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WEED SEED PRODUCTION POTENTIALS IN *BIDENS PILOSA* L. IN PLANTATION CROPS IN HILL ZONE OF KARNATAKA

K. V. SHIVAKUMAR[1], R. DEVENDRA[2], M. V. MUNISWAMAPPA[3], G. K. HALESH[4] & M. MAHADEVAMURTHY[5]

[1,3]College of Agriculture, Mandya, University of Agricultural Sciences, Bangalore, Karnataka, India

[2,5]University of Agricultural Sciences, Bangalore, Karnataka, India

[4]College of Horticulture, Kolar, University of Horticultural Sciences, Bagalkot, Karnataka, India

ABSTRACT

Bidens pilosa L. is an annual weed in many cropping systems where it reduces crop yield up to 9 to 48 percent because of its fast growth and competitive ability. This weed is commonly found in gardens, cultivated areas, waste lands and along road sides. The reproductive biology of weed has an implication on controlling practices that minimize the populations on agricultural fields. With this background the study was conducted to know the biology of weed seed production under the canopy of plantation crops. Heavy growth is observed during July to September in South India. A wide variation in plant height, Number of branches, biomass, seed production potential were observed. There was no definite pattern in seed production between seed rain episodes and branches of weed but significant differences were observed in the growth parameters Viz. number of seeds produced from different branches. The time interval between seed rain episodes significantly varies from 4 to15 days and 37 to 73 days taken to complete entire seed rain episode varies among population. Test weight of seeds collected during seed rain episodes had significantly high (1.64g) between early and (1.08g) at later stage of seed rain episode. There is a positive significant correlation between the growth parameters and the seed yield was observed.

KEYWORDS: *Bidens pilosa,* Seed Production Potential, Seed Rain Episode, Correlation

INTRODUCTION

Bidens pilosa L is a major weed of numerous crops (maize, sorghum, vegetables, cotton, tea, coffee, coconut, oil palm, citrus, rubber and tobacco) in many countries (Holm et al 1977). Generally found in full sun or partial shade on grazing land, roadsides or waste ground and invades remnant grassy vegetation in farming areas. High seed production and ability to thrive in any environment are most important survival strategy (Souza et. al. 2009). *Bidens pilosa* grows quickly and comes to flowering 4 months after germination and produce mature seeds 4 weeks after flowering.

Bidens pilosa is an erect annual herb commonly called as beggar's tick or Spanish needle with branching habit to about 0.3-1.8 m tall with pinnately compound leaves of 2.5-13.5 cm length from petiole and deeply divided into three toothed lobes. The terminal lobe is larger than the other two lobes. Flowers are tiny, yellow and held in dense terminal clusters. Each flower cluster has 4-5 short, broad, white petals but these do not persist for a longer time. Fruit is (achene) dark brown to black, straight, wingless, and 8-16 mm long. The seeds are black about 1 cm long, with 2-3 barbed awns at the tip. Heavy growth is observed during July to September in south India. A survey on weed flora associated with cardamom and coffee plantations indicated that out of ten major weeds, *Bidens pilosa*, *Ageratum conyzoides* and *Crassocephalum crepidioides* occupy top three ranks in the order of predominance (Annon, 2001).

A single plant typically bear 80 flower heads with seeds production potential of 3000 seeds per year (DPI, 2008; Mvere, 2004; PIER, 2007). It can form dense stands (Weber 2003) and significantly reduce crop yield (Cerna & Valdez 1987; Ugen, Wien & Wortmann 2002). Studies about reproductive biology of *Bidens pilosa* L. can have an implication on controlling practices that minimize the effects of these populations in fields.

Annual weeds depend on seed production as the sole means of propagation and survival. Production of abundant small seeds is a common adaptation that ensures a high probability of dispersal and re-infestation. Due to high seed production potential combined with dormancy, seed longevity possesses higher advantage as there is a chance of at least for some of them to germinate and grow into new plant a single plant of an annual weed can produce enough seeds in one season to cover an area of one acre. one plant of *Tripleurospermum inodorum* produces over a million seeds (1,000,000) (Lutman, 2002).

Amaranthus powellii, *Echinochloa crus-galli* and *Setaria faberi* produce 30,000, 100,000 and 28,700 seeds per plant respectively, while *Matricaria perforata* produces 300,000 seeds per plant (Blackshaw and Harker, 1997). With this background, the experiment was to know the biology of *Bidens pilosa* seed production and variation in the existing population was studied under the canopy of plantation crops in hill zone.

MATERIAL AND METHODS

The study was conducted to know the biology of *Bidens pilosa* seed production potential under the canopy of plantation crops such as Coffee, Cardamom and Pepper at Zonal Agricultural Research Station (ZARS), Mudigere, Chikmagalur district which belongs to hilly zone (Agro-climatic zone -9) of Karnataka. The zone is characterized by high elevation, undulated and rolling topography with thick vegetative cover in slope land. The zone receives heavy rain fall of 2800 to 3500 mm per annum and located at 13^{0}25'N latitude and 75^{0}25'E longitude and at an elevation of 975.6 m above mean sea level. The monthly average sunshine was ranged from 6.10 to 10.27 hour in February, March, April and May. A minimum sunshine 0.43 to 0.90 hour was observed in August. The maximum and minimum mean temperature recorded during the period of study were 32.04mm and 15.16 mm respectively. The average relative humidity (R^{H}) during morning and evening hours was 80 to 88.58 percent and 14.93 to 83.48 percent respectively. The soils are generally red in color with acidic pH and loamy in texture and rich in organic matter.

Experimental site of ten square meter land area under the canopy of Coffee, Cardamom and Pepper plantation was used for collection of data. *Bidens pilosa* plants were selected randomly in between crop rows were tagged in the marked area of the experimental site. The growth parameters were recorded.

Growth Parameters

The plant height (cms) of the tagged plant was measured at the time of flowering from ground level to the top and average height per plant was obtained. The branches of *Bidens pilosa* were numbered serially from base of the plant. Matured seeds were collected from the branches in each plant were pooled and calculated average number of seeds per plant. After the completion of seed rain episodes, the plant biomass was dried in oven and mean dry weight of each plant was calculated. Seed rain episode is the shattering of the seeds from different branches at a particular growth stage.

Subsequent seed rain episodes takes at irregular interval of time. Hence it is coded as DAFSS (Days after first seed shattering). It will take maximum of 73 DAFSS for all the seed rains from a plant.

Seeds Collection

The total number of seeds of *Bidens pilosa* were collected from all the seed rain episodes of the plant separately episode wise into the plastic bags and dried under shade and stored in the seed desiccators. The average seeds per plant was calculated and obtained seed rain episodes required to collect all the seeds from each plant and recorded the number of days taken to complete all the seed rain episodes of each plant. Seed production potential was calculated as product of Number of seeds per seed rain episode and the total number of seed rain episodes per plant. The test weight (g) of 1000 seeds collected from different seed rain episodes of different branches in each plant were recorded separately.

Statistical Analysis

The data collected from the laboratory, pot culture and field experiments were analysed statistically by adopting the ANOVA technique described by Panse and Sukhatme, (1999). Further Duncan Range test was performed using M stat-C statistical software. The percent values were first transformed to angular arcsine values before analysis. Based on additive test the data was suitably transformed and ANOVA was carried out. The data were tested at five percent level for significance using student "t" test and non significant data were indicated by the letters NS.

RESULTS AND DISCUSSIONS

Growth parameters and yield parameters among individual plants of *Bidens pilosa* Viz. plant height, number of branches per plant, biomass per plant, seeds produced per plant and days taken for complete seed rain episodes were were significantly different in plant height (102 to 200 cm/ plant), number of branches per plant (6 to 18 branches/plant), Dry weight (12 to 145 g/plant), Number of Inflorescence (54 to 531/ plant), Seed rain per plant (4 to 15), number of seeds produced per plant (1244 to 10507 seeds) and days taken to complete all the seed rain episodes from 37 to 73 DAFSS were observed.

Gawronski (2000) stated that weed amaranths is capable of producing 100,000 seed per plant. Studies on seed production potential in *Ageratum conyzoides*, *Bidens pilosa* and *Crossocphalum crepidiodes* showed that each plant produces an average of 2808, 810 and 832 seeds respectively,(Annon.,2001). *Celosia argentea* produces 11,812 seeds /plant whereas Parthenium plant produces 10,000 to 20,000 seeds/Plant. (Jayakumar and Jagannathan, 2003). One isolated *Bidens pilosa* plant can produce over 30,000 seeds (PIER, 2007). Thus B.pilosa produced 810 to 30,000 seeds per plant.

Table 1: Variation in Growth and Yield Parameters among Populations of *Bidens pilosa*

Plant No.	Plant Ht.(cms)	Branch/ Pl	DW (g)/ Pl	INFL/ Pl	Seed Rain/ Pl	Seeds/ Pl	Days Taken to Complete All Seed Rains
P1	122	18	52	296	11	7575	60
P2	200	9	40	231	15	6454	73
P3	182	16	70	468	14	8224	71
P4	145	10	25	157	10	2070	62
P5	139	6	18	101	5	1479	37
P6	153	7	32	79	6	1745	45
P7	134	13	50	307	12	5903	63
P8	181	17	145	531	10	10507	58

Table 1: Contd.,

P9	112	8	20	94	7	1862	52
P10	102	6	12	54	4	1244	48
Mean± σ	**147 32.21**	**11 4.64**	**46.40 39.03**	**231.80 167.24**	**9.4 3.77**	**4706.30 3414.84**	**56.90 11.41**

Pl- plant DW-Dry weight INFL-Inflorescence

Plant size and photosynthetic capacity (Kirby 1974), nitrogen assimilation by seed on the spike (Anderson *et al*., 2004) and endogenous plant hormone levels (Wang *et al*., 2001) may differ between plant to plant and contribute to the difference in seed production. The quantity of seed produced amongst plants and branch position was not uniform. Further variation in spike length between plants grown in common environment was observed (Wang *et al*., 2001; Perillex *et al*., 1991). The seed production potential significantly varied between episodes (Table 2).

There is significantly high degree of positive relationship between number of branches per plant (**B**) number of inflorescence per plant (**D**)(0.890) and between dry weight of plant with number of inflorescence (**C&D**) (0.901), between number of branches per plant (**B**) number of seeds per plant (**F**) (0.895), between dry weight of plant (**C**) and seed number per plant (**F**) (0.874), number of inflorescence per plant showed strong positive relationship with number of seeds per plant (**D&F**) (0.956), Further, number of seed rain episodes with days taken to complete seed rain (**E&G)** (0.946) were observed. Plant having more seed rain episodes positively related to long reproductive period (0.946), whereas total number of seed per plant strongly positively related to number of inflorescence per plant (0.956), biomass (0.874) and number of branches (0.895). It indicated that these parameters are important in yield determinants because the more number of branches increase more number of inflorescence similarly as increase in number of branches subsequently increase in number of seeds per plant. This was confirmation with the conclusion of earlier workers that a strong relationship between seed production and plant dry weight in weeds of *Senecio vulgari*, *S media*, *Tripleurospermum inodorum* (L) and *Sinapis arvensin* L. (Lutman, 2002: Lutman et al. 2008), Suleyman (2006) and Rashid et al.(2007). There is positive and significant correlations between growth characters of *Biden*s *pilosa* and the final seed yield. Dry matter production contributed more to seed yield, and this could be probably meant that seed yield is greatly depending on the biomass of the plant.

Table 2: Relationship between Growth and Seed Yield Parameters in *Bidens pilosa* (N=10)

Characters	A	B	C	D	E	F	G
A	1	0.312	0.557	0.596	0.680	0.600	0.567
B		1	0.760	**0.890***	0.639	**0.895***	0.586
C			1	**0.901***	0.422	**0.874***	0.359
D				1	0.686	**0.956***	0.616
E					1	0.735	**0.946***
F						1	0.658
G							1

A- Plant Height (cms)
B- Number of Branchs/Plant
C- Dry Weight (g)/plant
D- Inflorescence/Plant
E- Number of seed Rain/plant
F- Number of seeds /plant
G- Days taken to complete seed rain

The total duration between first seed rain episode to last seed rain episode were 73 days. Unlike crop plants which produce seeds synchronomously between plants within 30 days, whereas weeds produce seeds non synchronomously and shattering in different seed rain episodes. The time interval between seed rain episodes and days taken to complete entire seed rain episode varies within species and among population.

The total number of seeds produced per plant in *B. pilosa* (plant No.1) in entire seed rain episode was 7575. The percent seed production in each seed rain was 2,4,4,15,8,6,23,20,13 and 5 for different seed rain episodes of 0, 2, 5, 7, 11, 15, 21, 28, 36 and 51 days respectively (figure 1). This data suggest that the seed shedding in different seed rain episodes varied from 2 to 23 percent depending on plant nutrient status, moisture and environmental factors influence during seed production period. In other words only 2 percent of total seed produced by the plant was shed at first seed rain episode and 23 percent was observed 21 DAFSS. Susko and Doust (2000) showed that plant size and fruit position of *Alliaria petiolata* affected fruit size, seed production and pattern of ovule fate. Large plants had more seed fecundity than their smaller counterparts. Maternal investment was regulated according to plant mass at two levels. 1. Among fruit (small plants had significantly lower fruit set than did large plant). 2. Within fruit (small plants had significantly fewer ovule and significantly higher propogation of aborted ovules per fruit than did large plants). Small plants tend to produce same total seed number per biomass and total seed mass/unit plant biomass comparable to large plants. Seed production by fruit position depends on spikelet position on spike. (Fredrich and Smith, 2006).

Test weight of seeds collected from different branches in different DAFSS were recorded in order to compare the variations in seed mass in the same branch of a plant. It was observed that a later formed seed, irrespective of branches from where they have been collected, shows highly significant lower seed weight compared to early formed seeds. The highest average weight (1.64g) of 1000 seeds was observed in 0 days after first seed shattering (E1) and lowest was 1.08g in E5. 34 Percent decrease in seed weight from first seed rain to last seed rain was observed. Similar pattern of declining in seed mass towards plant distal end was observed in *Capsella bursa-pastoris* (Hurka and Benneweg, 1979), *Cassia fasciculate* Michx. (Lee and Bazzaz, 1986), *Thlaspi arvense* L.(Matthies,1990) and *Asphodelus albus* (Obeso,1993). Further it is also evidenced by Susko and Lovett-Doust (2000) that in garlic mustard (*Alliaria petiolata*) a biennial herb, seed mass was highly variable among seeds within fruits accounted for 25 percent of variance. This is mainly due to the availability of food resources from the mother plant. Seed mass varies considerably among and within species in different habitats and different stages of succession. In an individual plant seed mass decreased from base of the plant to distal position. This variation is mainly due to limited availability of parental resources such as nutrients and photosynthates.

Multiple linear regressions was applied between yield and growth parameters and obtained the equation for estimating yield factor as

$$\hat{Y} = -0.3634 - 0.0411X_1 - 0.006X_2 + 0.151X_3 + 0.041X_4 + 0.003X_5 + 0.431X_6$$

As per multiple linear regressions, significantly association between casual growth factors and the yield was observed. For every day to complete the seed rain episode 0.0411 g of seed yield decreases, and every cm of plant height 0.006 g of seed yield is also decreases. For every branch of plant, 0.151 g of seed yield increases, similarly for every gram of dry weight of plant 0.041g of seed yield is increased. The calculated R square between the seed yield of *Bidens pilosa* with respect to the growth parameters is observed 0.9566 indicates that there is 95.66 percent of determination obtained. Hence, It shows that the growth parameters were strong casual factors for seed yield of *Bidens pilosa*.

CONCLUSIONS

The study indicates that the growth status of *Bidens pilosa* is reflected by biomass per plant which had strong relationship with number of seeds per plant. There was no clear pattern of seed production among different seed rain episodes or among branches within a plant. This study may useful for preparing model for predicting timing and weed seedling emergence before and during growing season to for effective control of weed with limited use of herbicides.

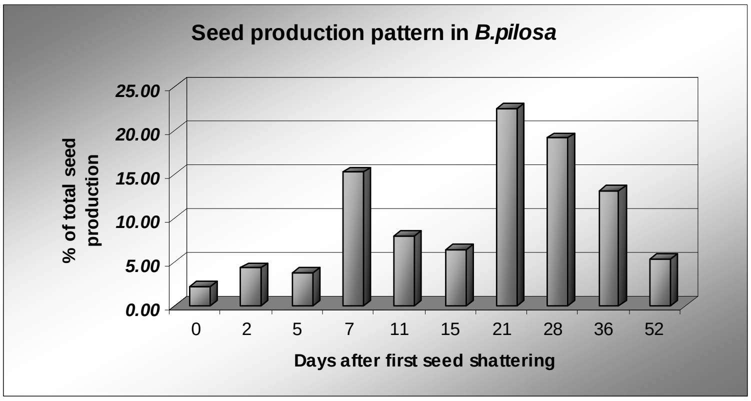

Figure 1: Pattern of Seed Production in Different Seed Rain Episodes in *Bidens pilosa*

Table 3: The Average Weight of 1000 Seeds in Different Branches in Different Seed Rain Episodes of *Bidens pilosa*

Seed Rain Episode	E1 (0 DAFSS*)	E2 (18 DAFSS)	E3 (22 DAFSS)	E4 (30 DAFSS)	E5 (52 DAFSS)	CD (P=0.05)
Mean	1.64[a]	1.45[b]	1.31[bc]	1.22[cd]	1.08[d]	0.185

(*DAFSS-Days after First Seed Shattering)

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