Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
www.phytojournal.com
JPP 2020; 9(5): 1790-1794
Received: 18-06-2020
Accepted: 18-08-2020

Ruchi Chourasia
School of Agriculture Science & Technology, Sardar Patel University, Balaghat, Madhya Pradesh, India

AK Jain
Department of Plant Pathology, JNKVV, College of Agriculture, Rewa, Madhya Pradesh, India

Corresponding Author:
Ruchi Chourasia
School of Agriculture Science & Technology, Sardar Patel University, Balaghat, Madhya Pradesh, India

Effect of *Striga asiatica* Kuntze on crop phenology of kodo millet (*Paspalum scrobiculatum* L.)

Ruchi Chourasia and AK Jain

Abstract
Phaneragamic partial root parasite, *Striga asiatica* is one of the key biotic stress in kodo millet (*Paspalum scrobiculatum* L.) grown in low fertile soils and considered as a major constraint in successful cultivation of kodo millet. In the present study, crop phenology of kodo millet was found adversely affected due to infestation of *S. asiatica*. Maximum average loss was recorded in grain yield per plant (41.9%) closely followed by plant height (39.6%), panicle weight (38.3%), leaf area index (37.3%), tillers pr plant (36.3%) and panicles per plant (34.3%). whereas minimum loss was noted in 1000 grain weight (10.9%) followed by panicle length (26.0%) and leaves per plant (29.9%). This shows the significance of *S. asiatica* in kodo millet field. *Striga* tolerance index (STI) ranging from 0.33 (RPS 687) to 0.74 (RPS 531) was estimated in 10 kodo millet cultivars. Three kodo millet cultivars namely RPS 531, RPS 683 and JK 13 exhibited tolerance index of above 0.70 with relative yield loss of 25.8, 30.1 and 29.3%, respectively along with low relative loss in yield traits and may be considered tolerant to *S. asiatica*. The results suggest for viable management programme to minimize the losses due to *S. asiatica* for livelihood of the kodo millet growers.

Keywords: Kodo millet, *Striga asiatica*, retarding effect, crop phenology

Introduction
Kodo millet (*Paspalum scrobiculatum* L.) is one of the nutritious minor cereal crop grown by tribal farmers in low fertile lands with poor management under rainfed ecosystem. The crop is low water demanding, climate resilient, versatile in use and suitable for mono as well as mixed/inter cropping system. The grains are nutritionally as well as medicinally rich and recommended for diabetic patients. Besides fungal diseases and insect pests, the crop is also found infested with partial root parasite (*Striga* species) particularly under stress environment. Considerable loss in kodo millet yield due to infestation of *Striga* spp. was reported from Bombay (Kumar, 1940) [8], Andhra Pradesh (Reddy and Dastagiraiah, 1987) [13] and Madhya Pradesh (Jain and Tripathi, 2002) [4]. *Striga* incidence ranging from 0.0 to 17.5% with higher frequency varied from 66.7 to 100.0% was recorded in 7 districts of Madhya Pradesh by Jain *et al* (2016) [5] in farmer's field. Ramaiah *et al*. (1983) [11] described important species of *Striga* by illustrations occurring on crops, their biology, symptoms of attack and brief information about the options for controlling the parasites. Watson *et al* (1998) [17] reported that *Striga* like other root parasitic weeds, drain essential organic and inorganic resources from their hosts leading to poor crop development and low yield. *Striga hermonthica* (Del.) Benth. and *S. asiatica* (L.) Kuntze adversely affect grain production of cereal crops including maize, pearl millet, sorghum, sugarcane, upland rice, finger millet, kodo millet and cause substantial annual yield losses in small-holder farmers' fields (Ejeta, 2007) [2]. Information of *Striga* infestation on kodo millet in different aspects is meager. Hence, in the present investigation, studies on effect of *Striga* infestation on yield and yield contributing traits of kodo mille cultivars exhibiting varying degree of resistance were carried out.

Materials and Methods
Ten cultivars of kodo millet comprising of eight land races and two released varieties received from All India Coordinated Research Project on Small millets, College of Agriculture, Rewa (M.P.) were sown in randomized block design with 3 replication during *Kharif* 2015. Each plot consists of 2 rows of 3.0 m length with row to row and plant to plant spacing 22.5 cm and 75 cm, respectively. One row of each plot was artificially infested with *Striga* sand mixture (1:39) ten days before sowing of kodo millet cultivars. After 10 days, kodo millet seeds were sown in *Striga* infested and non- infested row. A fertilizer dose of 20 kg N and 20 kg P_2O_5 ha^{-1} was applied for optimum growth of the host plant. Observations were recorded in 5 plants of each replication from *Striga* infested and non-infested rows for yield contributing traits viz. plant

height (cm), tillers plant^{-1}, leaves plant $^{-1}$ at dough stage. Leaf length (cm) was recorded in lower, middle and upper leaves of healthy and *Striga* infested plants at flowering stage. Similarly, leaf width (cm) was recorded from centre of lower, middle and upper leaves. Average leaf length and leaf width were used for determining the leaf area using the following formula:

leaf area = leaf length $\times$ leaf width $\times$ K constant value

Value of constant (K= 0.79) for leaf area of kodo millet was calculated by graph method. Leaf area index (LAI) was determined as total leaf area divided by ground area using the following formula (Watson, 1952) [18].

LAI = A/P (Where, A = Total Leaf Area and P = Ground Area)

Panicle Plant^{-1}, panicle length (cm), and panicle weight (g) were recorded at maturity. All the panicle of a healthy and *Striga* infested plants were harvested separately at maturity, threshed and grain yield per plant was recorded. *Striga* tolerance index (STI) of all the 10 kodo millet cultivars was calculated using following formula. (Ogunbodede and Olakoja, 2001) [10].
Striga tolerance index (STI)= Yield of infested plant/ Yield of non-infested plant
One thousand grains of healthy and *Striga* infested plants were counted and test weight was recorded. Mean data of yield and yield contributing traits were used for statistical analysis. Relative yield loss (RYL) in yield and yield components of kodo millet due to *Striga* was calculated using the following formula.

$$RYL = \frac{Yc - Ys}{Yc} x\, 100$$

Where
Yc = average value of traits in control
Ys = average value of traits grown under *Striga* infestation

Results and Discussion
Significant variations in all the studied components were observed in healthy and *Striga i*nfested kodo millet cultivars. It indicates the existence of genetic variability in the studied cultivars. Data of plant height, tillers plant-1, leaves plant^{-1} and leaf area index in healthy and infested kodo millet plants are presented in Table 1. Plant height varied 39.7 cm in RPS 744 to 53.8 cm in JK 76 with an average of 47.7 cm in 10 healthy cultivars of kodo millet, where as in *Striga* infested cultivars it ranged 23.0 cm in RPS 744 to 34.6 cm in RPS 531 with an average of 28.7 cm. Reduction in plant height ranged 26.8 to 48.2 per cent with a mean of 39.6 per cent kodo millet cultivars. Maximum reduction was recorded in RPS 506 followed by RPS 526 (46.6%), RPS 587 (43.7%), RPS 744 (42.0%) and RPS 927 (41.7%), while minimum reduction was noted in RPS 531 followed by RPS 683 (28.4%) and JK 13 (34.2%). Average tillers plant^{-1} (2.6) in a range of 2.0 to 3.7 was recorded in healthy cultivars of kodo millet, where as average tillers plant^{-1} (1.7) in a range of 1.2 to 2.7 were noted in *Striga* infested cultivars. Percent reduction in tillers plant^{-1} due to *Striga* infestation ranged 27.3 to 48.6 per cent with an average of 36.3 per cent. Maximum reduction was recorded in RPS 687 followed by RPS 525 (48.2%) and RPS 517 (42.9%), while minimum reduction was noted in JK 13 followed by RPS 531 (30.0%), RPS 927 (32.5%) and RPS 744 (33.3%). Among the kodo millet cultivars, significant differences in leaves per plant were recorded both in healthy and *Striga* infested plants. Leaves plant^{-1} ranged 13.0 to 20.0 with an average of 16.4 in healthy plants and 9.9 to 14.5 with an average of 11.5 in *Striga* infested plants. Reduction in Leaves plant^{-1} due to *Striga* infestation ranged 23.7 to 37.5 per cent with an average of 29.9 per cent in 10 kodo millet cultivars. Maximum reduction was observed in RPS 506 followed by RPS 687 (36.4%) and RPS 744 (35.3%), where as minimum reduction was found in RPS 531 closely followed by RPS 517 (23.8%) and JK 13 (25.8%). The significant differences in leaf area index (LAI) of kodo millet cultivar was 2.23 (JK 76) to 3.93 (RPS 531) with an average of 2.89 in healthy plants and 1.21 (RPS 521) to 2.40 (RPS 531) with an average of 1.60 was in *Striga* infested plants. Maximum reduction in LAI due to *Striga* infestation was recorded in RPS 687, RPS 517 and JK 76 (44.7%), where as minimum reduction was found in RPS 863, RPS 525, RPS 927 and JK 13 (36.3%). Reduction in LAI ranged 36.3 to 44.7% with an average of 37.3% in 10 cultivars of kodo millet.
Data pertaining to panicles plant^{-1}, panicle length (cm), panicle weight (g) in healthy and *S. asiatica* infested plants and percent loss are presented in Table 2. Panicles plant^{-1} ranging from 2.0 to 3.8 with a mean of 2.7 were recorded in healthy kodo millet cultivars, where as in *Striga* infested cultivars, panicles plant^{-1} ranged 1.3 to 2.9 with a mean of 1.8. Maximum panicles plant^{-1} was recorded in RPS 531 followed by JK 13 (3.7), where as minimum panicles plant^{-1} was found in RPS 683 and RPS 927. Reduction in panicles plant^{-1} due to *Striga* infestation was varied in RPS 683 (21.7%) to RPS 687 (42.9%) with a mean of 34.3% in 10 cultivars of kodo millet. Panicle length (cm) varied 9.7 to 16.0 cm with an average of 11.8 cm in healthy kodo millet cultivars, where as in *Striga* infested plants panicle length ranged 7.3 to 12.4 cm with an average of 8.8 cm. the cultivars differed significantly among themselves for panicle length. Longest panicle in healthy cultivars was recorded in RPS 506, while shortest panicle was recorded in RPS 744. Reduction in panicle length ranged 16.0% (RPS 531) to 37.9% (RPS 744) with a mean of 26.0% in different kodo millet cultivars due to *Striga* infestation. Significant differences in panicle weight per plant were recorded both in healthy and *Striga* infested cultivars of kodo millet. In healthy cultivars, panicle weight per plant varied 2.9 to 9.6 g with a mean of 6.1 g, while in *Striga* infested cultivars, it ranged 27.9 to52.0g with an average of 38.3 percent weight per plant was observed in RPS 687 followed by RPS 525(43.1%) and RPS 506(40.5%) where as lowest reduction was found in RPS 525 followed by RPS 683(30.5%) and RPS 531(32.0%).
Grain yield per plant (g) and 1000 grain weight recorded both from healthy and *Striga* infested 10 cultivars of kodo millet are presented in Table 3. Significant differences in grain yield per plant ranged 3.08 to 7.59 g with an average of 5.27g in healthy kodo millet cultivars. Highest grain yield was recorded in RPS 687 followed by JK 13(7.28g) and JK 76 (6.68 g), while lowest grain yield was recorded in RPS 927 followed with RPS 744(3.45g) and RPS 517(3.84g). In *Striga* infested cultivars significant variations in grain yield ranged 1.82g (RPS 744) to 5.15g (JK 13) with a mean of 3.01 g. Relative yield loss in grain yield per plant varied 25.8 to 67.5 per cent with a mean of 41.9 per cent in 10 cultivars of kodo millet due to *Striga* infestation. Maximum loss was recorded in RPS 687 followed by RPS 525(60.4%) while minimum reduction was found in RPS 531 followed by 29.3 per cent in

JK 13 and 30.1 per cent in RPS 683. Significant variation in 1000 grain weight (test weight) of healthy kodo millet cultivars ranged from 4.47 g (RPS 525) to 5.78 g (RPS 744) with an average of 5.03 g, while in *Striga* infested cultivars, 1000 grain weight ranged 3.86 g (RPS 525) to 5.12 g (RPS 744) with an average of 4.49 g. Per cent reduction in 1000 grain weight due to *Striga* infestation ranged from 6.7 to 13.7 per cent with an average of 10.9 per cent. Maximum reduction was in RPS 525 and 12.9 per cent in RPS 687, whereas minimum reduction was observed in RPS 531 followed by RPS 683 (7.0%) and JK 13(8.5%). Over all, crop phenology of kodo millet was adversely affected due to infestation of *S. asiatica*. Maximum average loss (Fig.1) was recorded in grain yield plant (41.9%) closely followed by plant height (39.6%), panicle weight (38.3%) and leaf area index (37.3%). whereas minimum loss was noted in 1000 grain weight (10.9%).

Striga tolerance index (STI) ranging from 0.33 (RPS 687) to 0.74 (RPS 531) was found in 10 kodo millet cultivars (Table 4). Lowest tolerance index was found in RPS 687 (0.30) and RPS 525 (0.40) with highest relative loss in grain yield plant^{1} of 67.5 and 60.4%, respectively. Relative loss in yield traits was also very high in these cultivars. Hence, these cultivars may be considered highly susceptible to *S. asiatica*. Three kodo millet cultivars namely RPS 531, RPS 683 and JK 13 exhibited tolerance index of above 0.70 with relative yield loss of 25.8, 30.1 and 29.3%, respectively along with low relative loss in yield traits. These cultivars may be considered tolerant to *S. asiatica*. Kodo millet cultivars namely RPS 531 and JK 13 were reported resistant to *S. asiatica* by Jain *et al* (2018) [6].

The interaction between the host and *Striga asiatica* resulted significant changes in yield and yield components of kodo millet cultivars indicating inverse relationship between the degrees of host resistance. In the present study, significant reduction in plant height, tillers plant^{-1}, leaves plant^{-1}, LAI, panicles plant^{-1}, panicle length, panicle weight, grain yield plant^{-1} and 1000 grain weight were recorded in *Striga* infested plants. Jain and Tripathi (2002)[4] also reported retarding effect of *Striga densiflora* on kodo millet yield ranging from 42.4 to 65.8% in grain yield per plant, 6.6 to 13.7% in 1000 grain weight and yield attributing traits viz. plant height (9.5 to 18.9%), number of tillers per plant (4.8 to 32.7%), number of panicles per plant (5.9 to 27.3%) and length of panicles (2.8 to 11.9%). Significant reduction in shoot height, shoot yield, total dry matter accumulation due to infestation of *S. hermonthica* in sorghum was reported by Shetty and Hosmani (1981) [14], Press and Stewart (1987) [11], Hassan *et al* (2009) [3], Yagoub *et al* (2014) [19]. Significantly lower ligule height, less pseudo-stem dry mass, lower leaf biomass and lower stomatal conductance in infected maize due to *S. hermonthica* compared to uninfected control were reported by Taylor *et al* (1996) [16]. Clear impact of *S. hermonthica* infestation in cob yield of maize was also reported by Kim *et al* (2002) [7], Lendzemo *et al* (2005) [9] and Bawa *et al* (2015) [1]. Differences in dry matter accumulation between infested and non-infested plants partly results from the parasite acting as a sink for carbon, inorganic solutes and water particularly in the later stages of infection, but also because of lower rates of carbon gain by infested cereals (Smith *et al.*, 1995 [15] and Hassan *et al*, 2009) [3]. These results confirm the present findings.

Table 1: Plant height, tillers plant^{-1}, leaves plant^{-1} and leaf area index in healthy and Striga infested cultivars of kodo millet.

S. No.	Cultivars	Plant height (cm)		RYL	Tillers plant^{-1} (g)		RYL	Leaves plant^{-1}		RYL	Leaf area index		RYL
		H	S		H	S		H	S		H	S	
1	RPS 683	40.7	29.1	28.4	2.0	1.2	38.3	18.3	13.3	27.3	3.06	1.90	36.3
2	RPS 531	47.3	34.6	26.8	3.7	2.6	30.0	19.0	14.5	23.7	3.93	2.40	37.3
3	RPS 687	48.7	27.4	43.7	2.3	1.2	48.6	14.7	9.3	36.4	2.34	1.19	44.7
4	RPS 525	50.3	26.9	46.6	2.8	1.4	48.2	13.0	9.0	30.8	2.52	1.21	36.3
5	RPS 744	39.7	23.0	42.0	2.0	1.3	33.3	17.0	11.0	35.3	2.80	1.48	37.3
6	RPS 517	53.0	29.3	44.7	2.3	1.3	42.9	14.0	10.7	23.8	2.38	1.46	44.7
7	RPS 927	42.3	24.7	41.7	2.7	1.8	32.5	17.7	12.0	32.1	3.07	1.48	36.3
8	RPS 506	52.3	27.1	48.2	2.3	1.5	35.7	16.0	10.0	37.5	3.19	1.35	37.3
9	JK 76	53.8	32.7	39.2	2.7	1.8	33.8	14.3	10.3	27.9	2.23	1.42	44.7
10	JK 13	48.7	32.0	34.2	3.7	2.7	27.3	20.0	14.8	25.8	3.38	2.12	36.3
	Mean CD(5%)	47.7 6.310	28.7 6.506	39.6	2.6 1.040	1.7 0.910	36.3	16.4 3.959	11.5 2.674	29.9	2.89 0.900	1.60 0.512	37.3

RYL=Relative yield loss H=Healthy S= *Striga* infested

Table 2: Panicles plant^{-1}, panicle length and panicle weight in healthy and *Striga* infested cultivars of kodo millet.

S. No.	Cultivars	Panicles plant^{-1}		RYL	Panicle length (cm)		RYL	Panicle weight (g)		RYL
		H	S		H	S		H	S	
1	RPS 683	2.0	1.6	21.7	10.7	8.6	19.1	6.3	4.4	30.5
2	RPS 531	3.8	2.9	25.2	12.7	10.6	16.1	6.0	4.1	32.0
3	RPS 687	2.3	1.3	42.9	12.0	8.0	33.6	9.0	4.3	52.0
4	RPS 525	2.7	1.7	37.5	12.0	8.8	26.4	3.9	2.2	43.1
5	RPS 744	3.3	2.0	40.0	9.7	6.0	37.9	2.9	2.1	27.9
6	RPS 517	2.3	1.4	38.6	11.3	7.3	35.3	5.1	3.2	37.5
7	RPS 927	2.0	1.3	36.7	10.7	7.9	25.9	4.4	2.9	34.1
8	RPS 506	2.3	1.6	32.9	16.0	12.4	22.3	6.5	3.9	40.5
9	JK 76	2.7	1.7	37.5	11.7	8.9	23.4	7.7	4.6	39.8
10	JK 13	3.7	2.6	30.0	11.7	9.3	20.0	9.6	6.3	34.9
	Mean CD(5%)	2.7 1.081	1.8 0.885	34.3	11.8 2.280	8.8 2.956	26.0	6.1 1.512	3.8 1.108	38.3

RYL=Relative yield loss H=Healthy S= *Striga* infested

Table 3: Grain yield plant^{-1} and 1000 grain weight in healthy and *Striga* infested cultivars of kodo millet.

S. No.	Cultivars	Grain yield plant^{-1}		RYL	1000 grain weight (g)		RYL
		H	S		H	S	
1	RPS 683	5.48	3.83	30.1	5.03	4.68	7.0
2	RPS 531	4.85	3.60	25.8	5.15	4.80	6.7
3	RPS 687	7.59	2.47	67.5	5.08	4.43	12.9
4	RPS 525	5.08	2.01	60.4	4.47	3.86	13.6
5	RPS 744	3.45	1.82	47.2	5.78	5.12	11.4
6	RPS 517	3.84	2.33	39.3	5.12	4.41	13.7
7	RPS 927	3.08	2.10	31.8	4.95	4.39	11.2
8	RPS 506	5.36	3.06	42.9	4.65	4.11	11.5
9	JK 76	6.68	3.69	44.8	5.04	4.44	12.0
10	JK 13	7.28	5.15	29.3	5.08	4.65	8.5
	Mean CD (5%)	5.27 1.700	3.01 0.769	41.9	5.03 0.599	4.49 0.360	10.9

RYL=Relative yield loss H=Healthy S= *Striga* infested

Table 4: *Striga* tolerance index and relative loss (%) in yield and yield traits due to *Striga asiatica* in kodo millet

S. No.	Cultivars	*Striga* tolerance index (STI)	Relative loss (%)								
			Plant height	Tillers plant^{-1}	Leaves plant^{-1}	Leaf area index	No. of panicles	Panicle length	Panicle weight	Grain yield plant^{-1}	1000 grain weight
1	RPS 683	0.70	28.4	38.3	27.3	36.3	21.7	19.1	30.5	30.1	7.0
2	RPS 531	0.74	26.8	30.0	23.7	37.3	25.2	16.1	32.0	25.8	6.7
3	RPS 687	0.33	43.7	48.6	36.4	44.7	42.9	33.6	52.0	67.5	12.9
4	RPS 525	0.40	46.6	48.2	30.8	36.3	37.5	26.4	43.1	60.4	13.6
5	RPS 744	0.53	42.0	33.3	35.3	37.3	40.0	37.9	27.9	47.2	11.4
6	RPS 517	0.61	44.7	42.9	23.8	44.7	38.6	35.3	37.5	39.3	13.7
7	RPS 927	0.68	41.7	32.5	32.1	36.3	36.7	25.9	34.1	31.8	11.2
8	RPS 506	0.57	48.2	35.7	37.5	37.3	32.9	22.3	40.5	42.9	11.5
9	JK 76	0.55	39.2	33.8	27.9	44.7	37.5	23.4	39.8	44.8	12.0
10	JK 13	0.71	34.2	27.3	25.8	36.3	30.0	20.0	34.9	29.3	8.5
	Mean	0.58	39.6	36.3	29.9	37.3	34.3	26.0	38.3	41.9	10.9

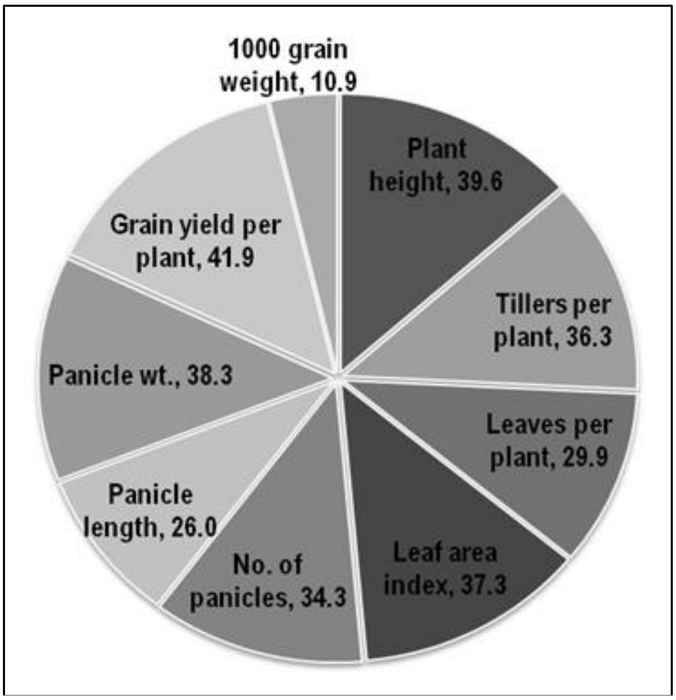

Fig 1: Average relative loss (%) in yield and yield traits due to *Striga asiatica* in kodo millet

Conclusion

It may be concluded that *Stirga asiatica* is a key constraint to limit the production of kodo millet. Infestation of *Striga asiatica* adversely affected the yield and yield contributing parameters of kodo millet. Average reduction of 39.6% in plant height, 36.3% in tillers plant^{-1}, 29.9% in leaves plant^{-1}, 37.3% in leaf area index, 34.3% in panicles plant^{-1}, 26.0% in panicle length, 38.3% in panicle weight, 41.9% in grain yield plant^{-1} and 10.9% in 1000 grain weight was recorded. Three kodo millet cultivars namely RPS 531, RPS 683 and JK 13 showed tolerance index of above 0.70 with relative yield loss of 25.8, 30.1 and 29.3%, respectively along with low relative loss in yield traits and may be considered tolerant to *S. asiatica* and desirable for cultivation in *Striga* endemic areas.

Acknowledgement

Authors are thankful to ICAR, Project Coordinator (Small millets), authorities of Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur and College of Agriculture, Rewa for providing financial assistance, kodo millet cultivars, guidance, encouragement and facilities during the course of present investigation.

References

1. Bawa A, Abdulai MS, Addai IK. Evaluation of inbred lines and hybrid maize (*Zea mays* L.) for tolerance to *Striga hermonthica* (Del.) Benth. in the Guinea savanna Agro-ecological zone of Ghana. American Journal of Agricultural and Biological Sciences. 2015; 10(3):128-36.
2. Ejeta G. Breeding for *Striga* resistance in sorghum: exploitation of intricate host parasite biology. Crop Science. 2007; 47:216-27.
3. Hassan MM, Abdel Gani ME, Babiker AGE. Effects of fungal strains on seeds germination of millet and *Striga hermonthica*. Universal Journal of Agricultural Research. 2009; 2(2):83-88.

4. Jain AK, Tripathi SK. Occurrence of *Striga* and its influence on yield of kodo millet. Crop Research. 2002; 23(3):532-35.
5. Jain AK, Joshi RP, Chauhan SS. Prevalence of *Striga* spp. in farmers field and host plant resistance in kodo millet against *Striga asiatica* (L.) Kuntze. JNKVV Research Journal. 2016; 50(1):52-55.
6. Jain AK, Chourasia Ruchi, Kumar A, Joshi RP. Identification of resistant genotypes against *Striga asiatica* (L.) Kuntze in kodo millet. Electronic Journal of Plant Breeding. 2018; 9(2):603-10.
7. Kim SK, Adetimirin VO, The C, Dossou R. Yield losses in maize due to *Striga hermonthica* in west and central Africa. International Journal of Pest Management. 2002; 48:211-17.
8. Kumar LSS. Flowering plants which attack economic crops. I. *Striga*. Indian Farming. 1940; 1:541.
9. Lendzemo VW, Kuyper ThW, Kropff MJ, Ast AV. Field inoculation with arbuscular mycorrhizal fungi reduces *Striga hermonthica* performance on cereal crops and has the potential to contribute to integrated *Striga* management. Field Crops Research. 2005; 91:51-61.
10. Ogunbodede BA, Olakoja SA. Development of *Striga asiatica* tolerant hybrid maize (*Zea mays* L.) varieties. Tropical Agricultural Research and Extension. 2001; 4(1):16-19.
11. Press MC, Stewart GR. Growth and photosynthesis in *Sorghum bicolour* infected with *Striga hermonthica*. Annals of Botany. 1987; 60:657-62.
12. Ramaiah KV, Parkar C, Rao MJV, Musselman LJ. *Striga* identification and control hand book. ICRISAT, Patencheru, A.P., India, 1983, 1-52.
13. Reddy PL, Dastagiraiah P. Preliminary screening of kodo millet varieties against witch weed. Millets Newletter. 1987; 6:57.
14. Setty TKP, Hosmani MM. Effect of *Striga* infestation on sorghum. In Proceedings of the 8th Asian- Pacific Weed Science Conference, India, 1981, 287.
15. Smith LJ, Keys AJ, Evans MC. *Striga hermonthica* decreases photosynthesis in *Zea mays* through effects on leaf cell structure. Journal of Experimental Botany. 1995; 46:759-65.
16. Taylor A, Martin J, Seel WE. Physiology of the parasitic association between maize and witch weed (*Striga hermonthica*): Is ABA involved. Journal of Experimental Botany. 1996; 47:1057-65.
17. Watson AK, Ciotola K, Peden D. Controlling of the noxious *Striga* weed. Weed Research. 1998; 35:303-09.
18. Watson DJ. The physiological basis of variation in yield. Advances in Agronomy. 1952; 4:101-05.
19. Yagoub SO, Hassan MM, Abdel Gani ME, Babiker AGE. Screening sorghum for resistance to *Striga hermonthica* (Del.) Benth. Nove Journal of Medical and Biological Sciences. 2004; 2(4):1-7.