Indian Journal of Weed Science **51**(1): 54–61, 2019

Print ISSN 0253-8040 Online ISSN 0974-8164

Biology of weed flora, weed dynamics and weed management in different fodder crops

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Article information

DOI: 10.5958/0974-8164.2019.00012.1

Type of article: Research article

Received : 29 December 2018
Revised : 9 March 2019
Accepted : 14 March 2019

Key words
Fodder crops

Weed dynamics

Weed flora

Weed management

ABSTRACT

Appraisal has been made at the fodder farm of ICAR-IVRI, Izatnagar campus by following standard procedure adopted by AICRP on Weed Management (ICAR) during 2015 and 2016. Results revealed that *Trianthema portulacastrum* and *Trianthema monogyna* were widely distributed in the fodder farm during summer and rainy seasons. It produced flower continuously up to second fortnight of November with 224 to 504 seeds/plant and multiplied both by seeds (More than 80% germination of current seeds) and fragmented plant parts. Another broad-leaved weed *Celosia argentea* preferred the growing condition of fodder sorghum and it produced 1,716 to 3,496 seeds/plant. The broadleaved weed *Coccinia grandis* was associated with fodder maize and sorghum, and produced 2,934 to 4,428 seeds/plant. Numerous seed production capacity of these weeds supported its high profile emergence. Among the other weeds the grasses were widely distributed, whereas the sedges were appeared in patches. Three major broad-leaved weeds *Coronopus didymus, Rumex dentatus* and *Cichorium intybus* appeared during 1st, 2nd, 3rd and 4th cutting of berseem during winter season, respectively. The weeds *Trianthema portulacastrum, Trianthema monogyna, Coccina grandis, Rumex dentatus* and *Cleome viscosa* had shown the character of endozoochory dissemination. Uniform distribution of rainfall during 2015 caused rapid infestation of broad-leaved weeds (*Trianthema* sp., *Coccinia grandis, Celosia argentea*) whereas huge down pour within short period during monsoon season of 2016 caused submergence which, in turn, reduced infestation of broad-leaved weeds and side by side increased invasion of grasses. Mixed cropping of fodder maize (Variety '*African Tall*') and fodder cowpea (Variety '*Bundel Lobia* 2') controlled *Trianthema* sp. and maximum green fodder yield was obtained at 55 days after sowing beyond that cowpea showed competitive effect on maize. Turning the land from fodder sorghum to cowpea minimised distribution and seed production capacity of *Celosia argentea*. Mixed cropping of berseem (Variety '*Wardan*') + gobhi sarson (*Brassica napus* var. *napus*) and berseem (Variety '*Wardan*') + rye grass (Variety '*Makkhan Grass*') reduced infestation of *Coronopus didymus*. Growing of dual purpose (grain-cum-green fodder) wheat variety '*VL Gehun* 829' reduced infestation of resistant biotype of *Phalaris minor*.

INTRODUCTION

Like grain crops weeds are also considered as a major constraint in fodder crops. Weeds possess several characters and that attribute advantages of weeds on fodder crops. Weeds with high dry matter accumulation capacity offer strong competition to the fodder crops for growth factors since emergence of seedlings of fodder crops. Maximum crop weed competition occurs up to 4-5 weeks in most of the seasonal forage. Weed control at early stages of fodder crops is an important operation for better establishment. The losses caused by the weeds vary with the season, crop and variety. The loss in fodder yield due to weed competition has been reported to the extent of 11.7% in lucerne and 8.3% in oat. In crop like sorghum, magnitude of yield loss was as high as 54%, while uptake of nitrogen, phosphorous and potassium by weeds was to the extent of 48.8, 22.0 and 55.0 kg/ha, respectively. In berseem, the extent of yield reduction due to weed flora has been estimated to the extent of 23 to 28% in case of green fodder yield and 38 to 44% in case of seed yield (Wasnik *et al.* 2017). Therefore, the infestation of

weed in forages needs to be checked starting from land preparation (Sunil *et al.* 2012). Yaduraju (2012) estimated a total economic loss in arable crops equivalent to approximately USD 13 billion per annum. In addition to direct effect on yield, weeds result in a considerable reduction in the efficiency of input used and quality (Yaduraju *et al.* 2018). Admixture of weeds with green fodder during harvest like *Coronopus didymus* with berseem, *Coccinia grandis* with fodder maize and sorghum, *Celosia argentea* with fodder sorghum, *Trianthema* with fodder maize and sorghum, reduces palatability of green fodder and thus affects milk production of milch animals. Because of their ability to persist and spread through the multiple reproduction and dispersal of dormant seeds/vegetative propagules, and for this reason weeds are virtually impossible to eliminate from any given field (Singh 2014 and Sharma 2014). Therefore, cultural methods, which includes mixed cropping, stale seedbed technique, turning the land to other crops, using smother crop etc. provide competitive advantage to crop against weeds by reducing weed establishment (Singh 2014).

Since, very limited information is available about weed flora and weed dynamics in fodder crops, and weeds are the major constraints in cultivation of fodder crops, generation of data on weed flora, weed dynamics and weed management in fodder crops is essential. Considering the above fact, the research activities have been planned and executed with the objective to generate information on weed flora, weed dynamics and weed management in different fodder crops.

MATERIALS AND METHODS

The weed flora have been surveyed by following standard procedure for weed survey as followed by All India Coordinated Research Project on Weed Management (ICAR), by plotting one meter square quadrats in randomized manner. The weed flora have been surveyed at different stages of fodder crops from the same field. Absolute and relative values of density, frequency and basal area and ultimately importance value index for each of the species in each situation and time of weed record have been determined to screen out the dominance spectrum of the species. The weed biology *i.e.* time of flowering, seed production, mode of propagation has been determined based on field observation. The calculations have been used to determine absolute density, relative density, absolute frequency, relative frequency, important value and summed dominance ration of the weeds appeared in different crops (Raju 1997) and the data have been expressed in the form of absolute density and absolute frequency in order to highlight population and distribution of the weeds appearing in different fodder crops grown in different seasons. Pot experiments have been conducted to generate information about regeneration capacity of fragmented plant parts of *Trianthema* sp. at its different ages.

Laboratory experiments were conducted with the help of Petridish and blotting paper to generate information about germination of current seeds (%) of the weeds. Experiment on mixed cropping of maize + cowpea has been conducted with 50% seed rate of each crop (22 kg/ha of variety '*African Tall*' of fodder maize and 15 kg/ha of fodder cowpea variety '*Bundel Lobia* 2') and fertilizer dose of NPK (kg/ha) ratio 60:70:32 with the help of chemical fertilizer having NPK ratio of 12:32:16 as basal application and 34 kg of N/ha was applied as urea at 35 days after sowing. Mixed cropping of berseem (Variety '*Wardan*') + gobhi sarson (*Brassica napus* var. *napus)* was grown with the seed rate of 25 kg berseem/ha and 600 g gobhi sarson/ha and fertilizer dose of NPK (kg/ha) ratio of 26:70:32 with the help of chemical fertilizer having NPK ratio of 12:32:16 was applied as basal in puddled condition. Mixed cropping of berseem (Variety '*Wardan*') + rye grass (Variety '*Makkhan Grass*') was grown with 50% seed rate of both the crops (Berseem 12.5 kg/ha and rye grass/ makkhan grass 4 kg/ha) in un-puddled condition and fertilizer dose of NPK (kg/ha) ratio 26:70:32 with the application of chemical fertilizer having NPK ratio of 12:32:16 as basal application was adopted. 20 kg N/ha was applied in form of urea after 1st and 2nd cutting. Irrigation was given at 15 days interval and immediately after cutting both in berseem + gobhi sarson and berseem + rye grass. The dual purpose wheat (Grain-cum-green fodder) was grown with the seed rate of 120 kg/ha of each variety '*VL Gehun* 829' and '*VL Gehun* 616'. The fertilizer dose of NPK (kg/ha) ratio of 120:60:40 was applied in form of urea, SSP and MOP. The nitrogen was applied in 4 equal split doses as basal, 35 days after sowing (DAS), immediately after cutting (57 DAS) for green fodder and 30 days after cutting. Six irrigations were given at 20 DAS, 35 DAS, immediately after cutting for green fodder, 30 days after cutting, booting and grain filling stages.

RESULTS AND DISCUSSION

Weed biology

Among the weeds appeared during pre-*Kharif* and *Kharif* seasons, *T. portulacastrum* and *T.*

monogyna were widely distributed in fodder farm and this was mainly because of its strong character on seed production and multiplication both by seed and vegetative means. Each *Trianthema* flower produced 224 to 504 seeds/plant. two to three per cent of the total current seeds germinated within 6 days after imbibition, majority of the seeds germinated within 17 to 20 days after imbibition and remaining seeds germinated afterwards. This finding was corroborated with the finding of Professor Jayashankar Telangana Agricultural Univerity (PJTSAU) centre of All India Coordinated Research Project (AICRP) on Weed Management (Anonymous 2017). 10 days old plant of *Trianthema* spp. was controlled through stale seedbed technique and beyond that stage fragmented plant parts put forth the new growth. Emergence and growth of the weed was highly susceptible to high soil moisture and submerged condition. Water stagnation for the period of 1 to 2 days inhibited emergence and also restricted growth of *Trianthema* and it was also subjected to biological stresses, which restricted the growth of the weed. High feeding activity of insect (larva) was observed in high humid condition during monsoon season. Natural infection of fungus as leaf spot was also observed and the weed perished due to fungal infection during first or second fortnight of November.

The mature plant of *Celosia argentea* produced 1,716 to 3,496 seeds/plant when it was associated with fodder sorghum. One mature *Coccinia grandis* plant produced 2,934 to 4,428 seeds/plant and *Cleome viscosa* produced 672 to 1755 seeds/plant. Seeds of *Trianthema* spp., *Coccinia grandis, Rumex dentatus* and *Cleome viscosa* have shown the character of endozoochory mechanism of dispersion and passed through the cattle rumen successfully. The seeds became viable into fresh cattle dung. Application of undecomposed manure/FYM and use of cattle shed water for irrigation led to disseminate these weeds into the fields. Three major broad-leaved weeds *Coronopus didymus, Rumex dentatus, Cichorium intybus* were appeared during 1st, 2nd, 3rd and 4th cutting of berseem, respectively, during winter season.

Weed dynamics during pre-*Kharif* and *Kharif* seasons

Well distributed rainfall during the year 2015 caused rapid infestation of broad-leaved weeds like *Trianthema* spp., *C. grandis, Celosia argentea* whereas infestation of grasses were at lower level compared to broad-leaved weeds. Huge down pour within short period especially during monsoon season of 2016 caused submergence which, in turn, reduced infestation of broad-leaved weeds and side by side increased invasion of grasses (**Figure 1**).

Weed dynamics during winter season

The results revealed that infestation of all weeds appeared during the winter season got reduced in successive years (**Figure 1**). This was mainly due to intervention of growing mixed cropping of berseem with gobhi sarson (*Brassica napus var. napus*), which has not only reduced emergence of weeds in berseem but also reduced seed bank potential of these weeds. Aggressive growth of berseem after 1st cut suppressed these weeds successfully. Removing *C. intybus* seeds by treating berseem seeds with 10% salt solution also reduced its infestation in berseem.

Weed management in different fodder crops

Mixed cropping of maize +cowpea

Results revealed that mixed cropping of maize (Variety '*African Tall*') + cowpea (Variety '*Bundel Lobia* 2') (50% seed rate of both the crops) reduced infestation of *Trianthema* sp. considerably.

Cowpea started to show smothering effect on weeds at 20-25 DAS. Mixed cropping not only reduced infestation of weeds but also provided balanced green fodder of cereal and legume combination to the cattle (**Figure 2** and **3**).

However, time of harvesting was very important to harness the benefit of green fodder production of maize + cowpea mixed cropping. The results revealed that maximum benefit was obtained when both the crop was harvested at 55 DAS at which both fodder maize and fodder cowpea have complementary effect on each other.

Beyond this stage cowpea showed supplementary effect up to 65 DAS and after that it became competitive to maize causing yield reduction to the tune of 19.4 and 37.3%, respectively, compared to the yield obtained at 55 DAS (**Figure 4**).

Replacement of fodder sorghum by fodder cowpea for controlling *Celosia argentea*

Celosia argentea was associated with fodder sorghum as it grew well within the canopy of sorghum and reached to the top of the canopy. It reached to the seeding stage much earlier than the harvest of green fodder sorghum. The fodder sorghum was severely infested with *Celosia argentea* and harvested green fodder sorghum contained large quantities of *Celosia argentea* which, in turn, reduced the quality of fodder sorghum. Intervention of turning the land to fodder cowpea (Variety '*Bundel Lobia* 2')

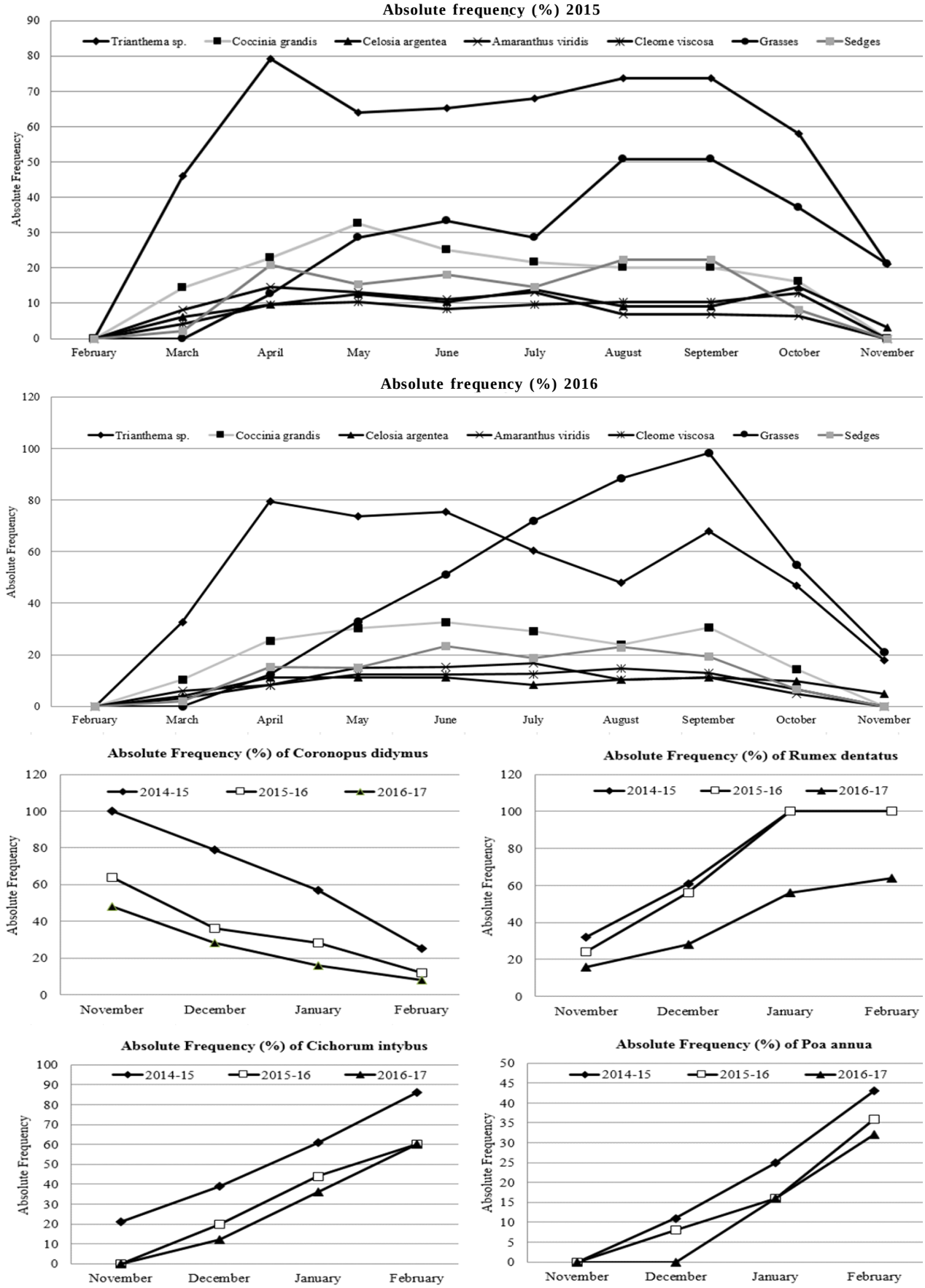


Figure 1. Weed dynamics in pre-*Kharif*, *Kharif* and winter seasons

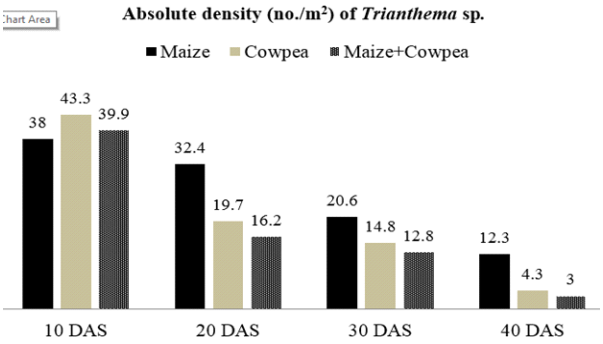


Figure 2. Absolute density (no./m²) of *Trianthema* sp. at different days after sowing (DAS)

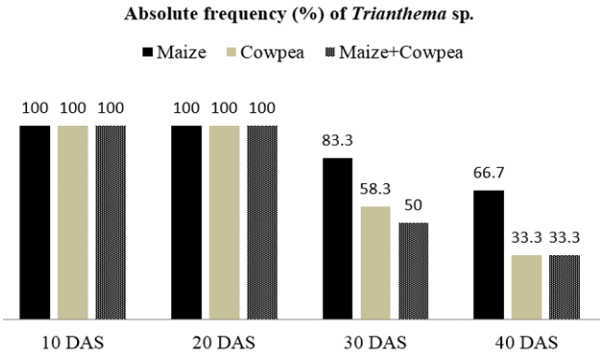


Figure 3. Absolute frequency (%) of *Trianthema* sp. at different days after sowing (DAS)

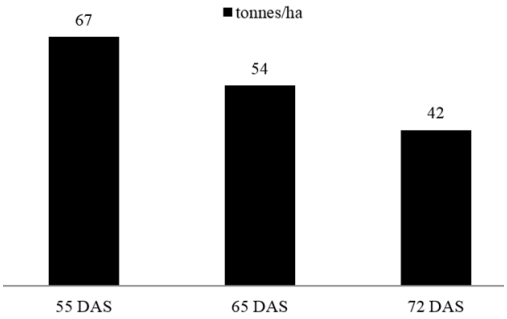


Figure 4. Green fodder yield (t/ha)

reduced population and seed production capacity of this weed. *C. argentea* usually produced on an average 2,606 seeds/plant when the weed was associated with fodder sorghum. Turning the land to fodder cowpea inhibited the growth and development of *C. argentea*, and finally hampered seed production of this weed. This was due to trailing and prostrate growth habit of cowpea. Almost 86% reduction in seed production of *C. argentea* due to turning the land to cowpea was recorded (**Figure 5** and **6**).

Mixed cropping of berseem and gobhi sarson (*Brassica napus* var. *napus*) for controlling *Coronopus didymus* in berseem

Growth of berseem was slow up to 1st cutting (up to 40 DAS). The weed *C. didymus* took the advantage of slow growth of berseem and flourished aggressively below the vegetative parts of berseem

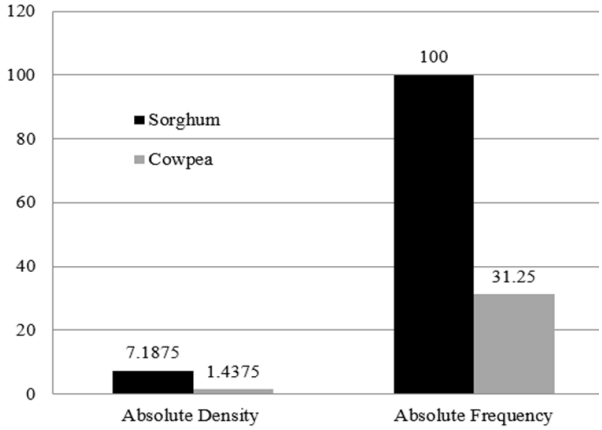


Figure 5. Distribution and population (no./m²) of *Celosia argentea* in fodder sorghum and cowpea

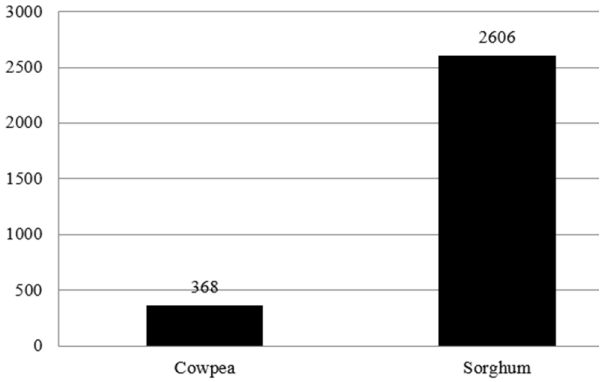
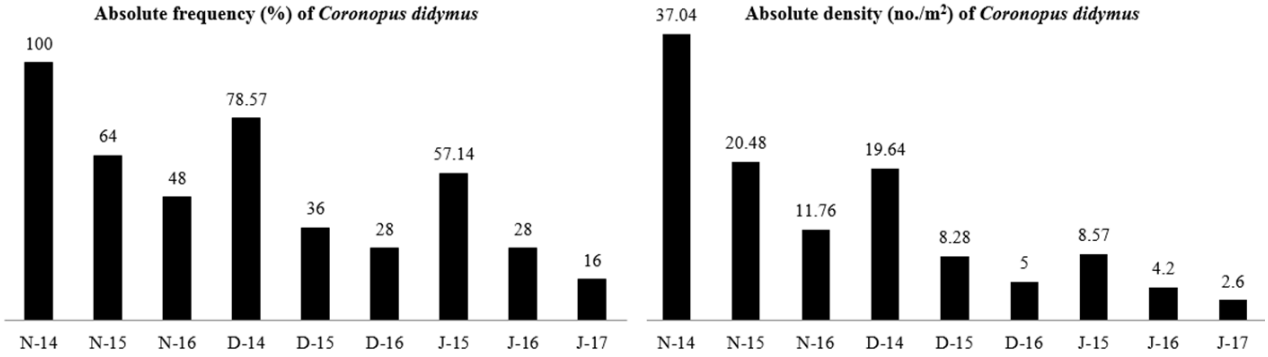


Figure 6. Average seed production capacity (no./plant) of *Celosia argentea*

along with the ground surface. Growing berseem + gobhi sarson (at the seed rate of 600 g/ha) as mixed cropping offered strong competition to *C. didymus* and prevented its growth and spread within berseem. This intervention reduced spread and population of the weed during winter seasons of 2015 and 2016 (**Figure 7**). Besides, gobhi sarson also compensated low green fodder yield of berseem during 1st cut.

Mixed cropping of berseem and rye grass in un-puddled soil for controlling *Coronopus didymus* in berseem

Coronopus didymus was highly prevalent in berseem with higher value of absolute density and 100% absolute frequency under puddled condition. Growing of berseem and rye grass as mixed cropping system with 50% seed rate of both the crop in un-puddled condition reduced the infestation of *C. didymus* at greater extent, which registered the absolute density (no./m²) of 5.8 and absolute frequency of 33.3% during 1st cut at 56 DAS and absolute density (no./m²) of 2.27 and absolute frequency of 20% at 41 days after 1st cut. This was mainly due to high tillering capacity, faster growth and rapid coverage of ground surface which, in turn,



(N-November, D-December, J-January, 14-2014, 15-2015, 16-2016, 17-2017)

Figure 7. Absolute density (no./m^2) and absolute frequency (%) of *Coronopus didymus*

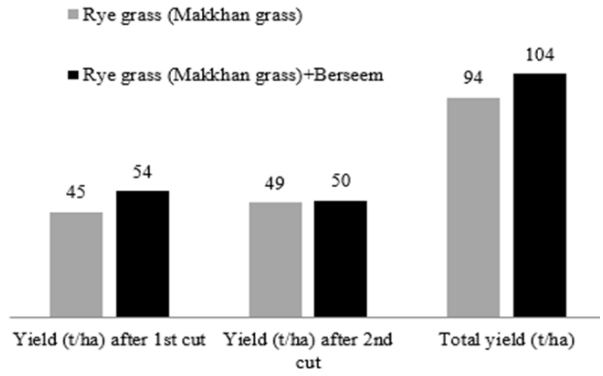


Figure 8. Green fodder yield (t/ha)

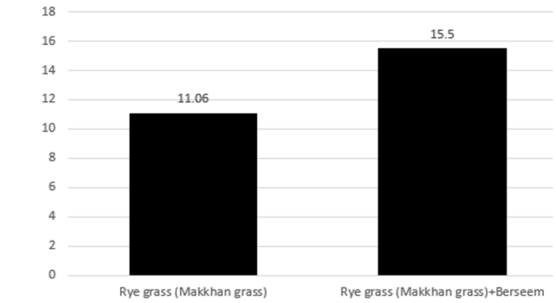


Figure 9. Crude protein content (%) at 2nd cutting

made the condition unfavourable for *C. didymus* as this weed preferred to grow along with the ground surface. Besides, the mixed cropping also produced higher amount of balanced green fodder (Legume + cereal) with desirable crude protein content (**Figure 8** and **9**).

Turing the berseem fields to oat cultivation and oat fields to berseem cultivation for controlling *Coronopus didymus*, *Rumex dentatus* and *Cichorium intybus*

Turing the berseem fields to oat cultivation and oat fields to berseem cultivation recorded lower values of absolute density and absolute frequency of the dominant weed flora and this was due to the breaking of cycle perpetuation of *C. didymus*, *R. dentatus* and *C. intybus*. Oat acted as a very good smother crop because of its fast tillering capacity and dense canopy development. Oat crop made the ecosystem completely unfavourable for growth and development of *Coronopus didymus*, *R. dentatus* and *C. intybus* (**Figure 10**).

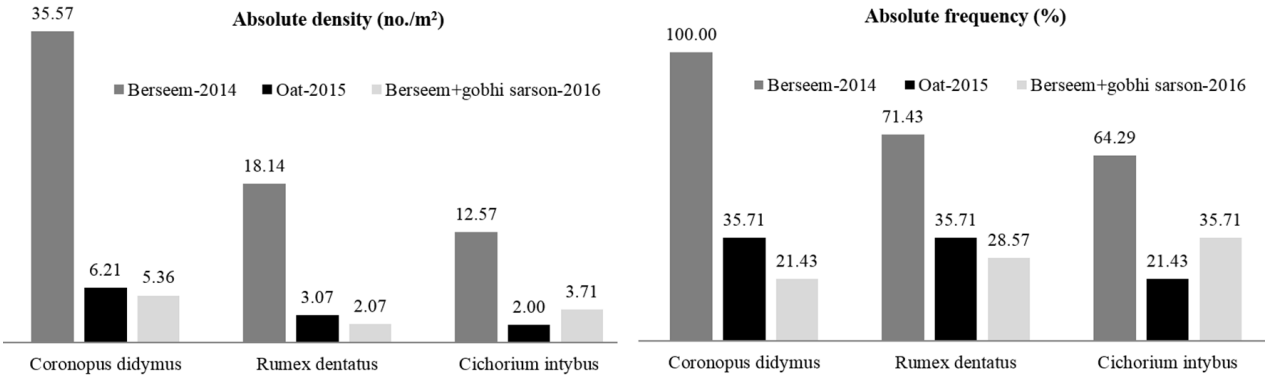


Figure 10. Reduction in weed population by turning the berseem field to oat cultivation and oat field to mixed cropping of berseem + gobhi sarson in succeeding year

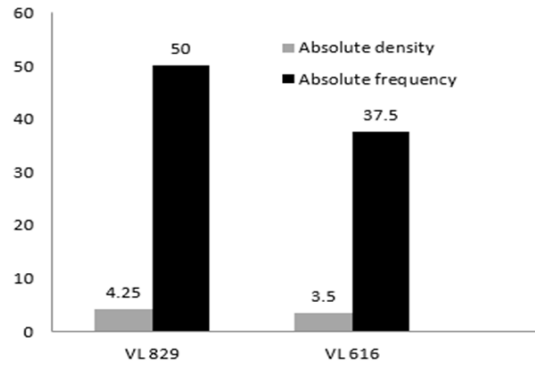


Figure 11. Absolute density (no./m^2) and absolute frequency (%) of *Phalaris minor* at 55 DAS

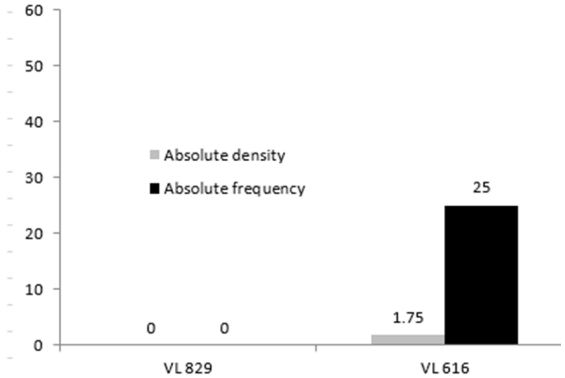


Figure 12. Absolute density (no./m^2) and absolute frequency (%) of *Phalaris minor* at 80 DAS

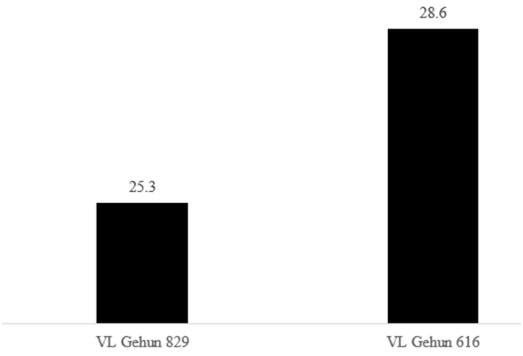


Figure 13. Green fodder yield (t/ha) at 57 DAS

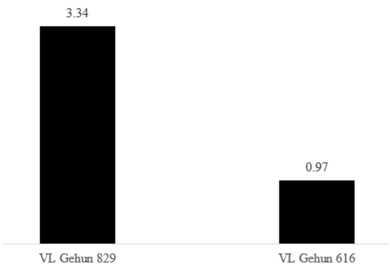


Figure 14. Grain yield (t/ha)

Control of resistant biotype of *Phalaris minor* by growing dual purpose wheat variety

Herbicide resistant *Phalaris minor* was recorded in wheat at the KVK farm of ICAR-IVRI, Izatnagar campus. The biotype showed resistant against the action of sulfosulfuron and clodinofop, however, it showed susceptibility against the action of pinoxaden. Apart from herbicide application for controlling resistant biotype, growing of dual purpose (Grain-cum-green fodder) wheat reduced infestation of resistant biotype after the 1st cut of wheat at 57 DAS for green fodder. High tillering capacity of dual purpose wheat after 1st cut suppressed the growth of *Phalaris minor* and the weed had lost the capacity to put forth the new growth (**Figure 11** and **12**). The variety '*V L Geghun* 829' has been found effective in terms of green fodder yield and grain yield (**Figure 13** and **14**). Higher number of panicle/m^2 contributed to the grain yield on account of 3.34 t/ha of the variety '*VL Gehun* 829'. Poor regeneration capacity of '*VL Gehun* 616' resulted in low grain yield of 0.97 t/ha**.** It has been observed that use of combine harvester led to the distribution of weed seeds (*Phalaris minor* and *Rumex dentatus*) throughout the field. The wind thrust ejected behind the combine harvester caused distribution of weed seeds throughout the field.

List of weeds appear in fodder and grain crops at Fodder Farm of ICAR-IVRI, Izatnagar

Grasses:

- *Cynodon dactylon* (in fodder maize during pre-*kharif* and *kharif* seasons)
- *Echinochloa colona* (in fodder maize, multi-cut sorghum and cowpea during pre-*kharif* and *kharif* seasons)
- *Echinochloa crusgalli* (in rice during *kharif* season)
- *Panicum maximum* (Non-crop area during *kharif* season)
- *Paspalum disticum* (in fodder maize and multi-cut sorghum during pre-*kharif* and *kharif* seasons)
- *Eleusine indica* (in fodder maize and non-crop area during pre-*kharif* and *kharif* seasons)
- *Digitaria longiflora* (in fodder maize, multi-cut sorghum and cowpea during pre-*kharif* and *kharif* seasons)
- *Digitaria ciliaris* (in fodder maize, multi-cut sorghum and cowpea during pre-*kharif* and *kharif* seasons)
- *Dactyloctenium aegyptium* (in non-crop area during pre-*kharif* and *kharif* seasons)
- *Sorghum halepense* (in non-crop area during pre-*kharif* and *kharif* seasons)
- *Setaria glauca* (in fodder maize during pre-*kharif* and *kharif* seasons)
- *Panicum repense* (in rice and non-crop area during *kharif* season)
- *Phalaris minor* (in wheat)
- *Poa annua* (in berseem and oat during winter season)

Sedges:

- *Cyperus rotundus* (in fodder maize, cowpea and non-crop area during pre-*kharif* and *kharif* seasons)
- *Cyperus esculentus* (in fodder sorghum and fodder maize during pre-*kharif* and *kharif* seasons)
- *Cyperus iria* (in rice and fodder sorghum during pre-*kharif* and *kharif* seasons)
- *Cyperus flavidus* (in rice during *kharif* season)
- *Cyperus pilosus* (in non-crop area during pre-*kharif* and *kharif* seasons)

Broad-leaved weeds:

- *Trianthema portulacastrum* (in fodder maize and cowpea during pre-*kharif* and *kharif* seasons)
- *Trianthema monogyna* (in fodder maize and cowpea during pre-*kharif* and *kharif* seasons)
- *Celosia argentea* (in fodder sorghum during pre-*kharif* and *kharif* seasons)
- *Ludwigia parviflora* (in rice during *kharif* seasons)
- *Ageratum conyzoides* (in fodder maize and non-crop area during pre-*kharif* and *kharif* seasons)
- *Cleome viscosa* (in fodder maize during pre-*kharif* and *kharif* seasons)
- *Physalis minima* (in fodder maize, wheat and mustard during winter season)
- *Amaranthus viridis* (in fodder maize and cowpea during pre-*kharif* and *kharif* seasons)
- *Commelina benghalensis* (in fodder maize during pre-*kharif* and *kharif* seasons)
- *Commelina diffusa* (in fodder maize during pre-*kharif* and *kharif* seasons)
- *Rumex dentatus* (in berseem, oat and wheat during winter season)
- *Cichorium intybus* (in berseem during winter season)
- *Coronopus didymus* (in berseem during winter season)
- *Spilanthes calva* (in berseem during winter season)
- *Chenopodium album* (in wheat, early summer multi-cut sorghum, mustard and cowpea)
- *Solanum nigrum* (in wheat and mustard during winter season)
- *Sonchus oleraceus* (in mustard during winter season)
- *Parthenium hysterophorus* (in non-crop area during pre-*kharif* and *kharif* seasons)
- *Cannabis sativa* (in non-crop area during pre-*kharif* and *kharif* seasons)
- *Medicago denticulate* (in berseem and non-crop area during winter season)
- *Melilotus alba* (in berseem during winter season)
- *Malva parviflora* (in non-crop area during winter season)

It has been concluded that *T. portulacastrum* and *T. monogyna* were widely distributed throughout the fodder farm and it was mainly due to its strong character on seed production and multiplication capacity. Ten days old plant of *Trianthema* sp. could be controlled through stale seedbed technique and beyond that stage fragmented plant parts had shown the capacity to put forth the new growth. Cowpea (Variety '*Bundel Lobia* 2') showed significant effect in minimising distribution and seed production capacity of *C. argentea*. Mixed cropping of maize (Variety '*African Tall*') and cowpea (Variety '*Bundel Lobia* 2') controlled *Trianthema* spp. and maximum green fodder yield was obtained at 55 days after sowing beyond that cowpea showed competitive effect on maize. Mixed cropping of berseem (Variety '*Wardan*') and gobhi sarson (*B. napus* var. *napus*) reduced infestation of *C. didymus* and mixed cropping of berseem (Variety '*Wardan*') and rye grass (Variety '*Makkhan Grass*') in un-puddled condition also reduced infestation of *C. didymus* at greater extent. The mixed cropping produced higher amount of balanced green fodder (Legume + cereal) with desirable crude protein content. Growing of dual purpose (Grain-cum-green fodder) wheat variety '*VL Gehun* 829' reduced infestation of herbicide resistant biotype of *Phalaris minor*.

ACKNOWLEDGEMENTS

Contribution of ICAR-Indian Veterinary Research Institute (IVRI) for providing necessary facilities and financial assistant in the form of Institute project is duly acknowledged.

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