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Evaluation of different genotypes of mustard against *Orobanche aegyptiaca*

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Abstract

Among the major weed groups that cause huge economic losses to important cropping systems, *Orobanche* species are greatly devastating. Egyptian broomrape (*Orobanche aegyptiaca*) is a parasitic weed causing major yield loss in many field and vegetable crops and is a serious threat to Indian mustard. In this study, several varieties of Indian mustard screened in order to identify resistant genotypes. In the greenhouse conditions, genotypes were different in the degree of susceptibility to Broomrape. Attachment number, emergence number, and dry matter of parasitic broomrapes was affected by biomass of genotype. A significant impact of the parasitism onto the dry weight of all infected mustard genotype with variable degree was observed. Broomrape attachment was observed in all the cultivated genotypes with Pusa mustard 24 being the most susceptible with the greatest number of emerged *Orobanche* shoots. In contrast, no emergence shoots were observed in four out of the fifteen genotype viz., Pusa Jaikisan, Pusa bold, Pusa Vijay and Pusa mustard 26 which have less of attachment number and emergence number successively appear interesting for our objective.

Key words: *Orobanche aegyptiaca, parasitic weed, resistance, susceptibility*

Introduction

Among the major weed groups that cause huge economic losses to important cropping systems, *Orobanche* species are greatly devastating (Parker and riches, 1993). They causes severe damage to a wide array of dicotyledonous families such as Brassicaceae, Solanaceae, Apiaceae, Asteraceae (Parker and Riches, 1993; Gibot-Leclerc *et al*. 2001). In India, this noxious weed is a major threat to Indian mustard [*Brassica juncea* (L.) Czen & Coss]. Due to the high parasitic seed bank in agricultural soils of Haryana, Punjab, Northern Rajasthan, Western U.P. and Northeast Madhya Pradesh, the biotic potential of these mustard growing states has declined greatly below the optimal levels. Broomrapes are plant root parasites devoid of chlorophyll and therefore autotrophic potential. The modus operandi of these highly competitive plant parasites is to attach themselves with the crop root and divert minerals, water and even nutrients (mainly carbohydrates and amino acids) (Foy *et al*., 1989). The beginning of host-parasite interactions is marked by the release of germination stimulants in the host root exudates. The qualitative analysis of some of these has revealed their chemical nature; the first one being strigol , a sesquiterpene (Cook *et al*., 1972) found on cotton root exudates. Sorghum (Netzly *et al*. 1988), Sunflower (Perez de Luque *et al*., 2000), Red clover (Yokota *et al*., 1998) have also been found to produce such stimulants but their chemical nature is still unknown.

*Orobanche aegyptiaca (*syn. *Phelipanche aegyptiaca)* or Egyptian broomrape has various vernacular names such as Margoja, Mukhri, Kumbhi or Gulli (Punia *et al*., 2012). It is a frequent, harmful and obligate holoparasite of the *Orobanche* genera. *O. aegyptiaca* with their haustorial cells penetrate crop roots and causes great damage to crops across the world. A significant reduction of around 15-49 % has been recorded in the yield of mustard, which is one of the most important oil seeds (Khattri, 1997). Various resistance strategies have been devised against this harmful weed. Accumulation of phenolic compounds in *Vicia* attacked by *O.aegyptiaca* (Goldwasser *et al*., 1999) is one such example. Besides, Chemical control and cultural practices have also been developed but these have been reported to be unsuccessful (Sauerborn *et al*., 1989; Castejon-Munoz *et al*., 1993). The reason for their failure is linked either to their feasibility, control potential or economic value. Evolution of host-parasite relationship in the form of genetic resistance in host is another important control parameter central to the management of this parasite. In view of the aforementioned, the core objective of this study was to evaluate the response of different genotypes of mustard to *O.aegyptiaca.*

Materials and Methods

The collection of *O. aegyptiaca* seeds was done during a preliminary field survey in Banda District of Uttar Pradesh 2014-15. Seeds of fifteen varieties of oilseed rape (Pusa Bold, Pusa Agrani Pusa Jagannath, Pusa Mahak, Pusa Karishma, Pusa Mustard 21, Pusa Mustard 24, Pusa Vijay, Pusa Mustard 22, Pusa Mustard 25, Pusa Tarak, Pusa Mustard 26, Pusa Mustard 27, Pusa Mustard 28 and Pusa Jaikisan) were obtained from IARI, New Delhi. Pots were arranged in two complete randomized block designs with three replicates, each for the control and the inoculated set (genotype containining *O.aegyptiaca* seeds). To break the dormancy and initiate seed germination, O. aegyptiaca seeds were exposed to Gibberellic Acid (30 mg L^{-1}) for one week at 18 °C in darkness and then mixed with autoclaved soil in earthen pots (Song *et al*., 2005). In this way, 100 seeds *O.aegyptiaca* were mixed with soil and kept for the preconditioning as described by the method of Halmouch (El- Halmouch *et al*., 2006). After the completion of condoning period, oilseeds were sown in the pots. After 10 week of sowing, host plants were uprooted and roots were observed under a binocular microscope, after gentle washing in water to determine the number and developmental stage of broomrape attachments. Moreover, total dry biomass of mustard (both shoot and root) was also recorded for statistical studies.

Statistical Analysis

Pearson correlation coefficients were calculated to assess relationships between dry biomass of mustard and Egyptian broomrape. For the relationships with the highest Pearson correlation coefficient (mustard dry biomass and Egyptian broomrape total dry weight), regression analysis was conducted using PROC REG to obtain slope.

Results and Discussion

Three parameters were used to measure the resistance of mustard species to *O. aegyptiaca*: the total number of tubercles, emerged *Orobanche* shoots and broomrape dry weight per mustard plant. Concerning the total number of tubercles, none of the genotype appeared immune to broomrape since, at 10 weeks after infestation, all had at least one broomrape attachment on their roots (Fig.1). Broomrape attachment was observed in all the cultivated genotypes with Pusa mustard 24 being the most susceptible with the greatest number of emerged Orobanche shoots (Fig. 2). In contrast, no emergence shoots were observed in four out of the fifteen genotype viz., Pusa Jaikisan, Pusa bold, Pusa Vijay and Pusa mustard 26. Expressing resistance by total dry weight of *O. aegyptiaca* (tubercles + *Orobanche* shoot) showed considerable variation among the mustard genotype from 4.8 g to more than 13.8g per mustard plant. Among the genotype, Pusa bold resistant reaction with 4.8g broomrape dry weight. Moreover, genotype Pusa mustard 24 was the most susceptible in term of parasite 13.3 g dry weight.

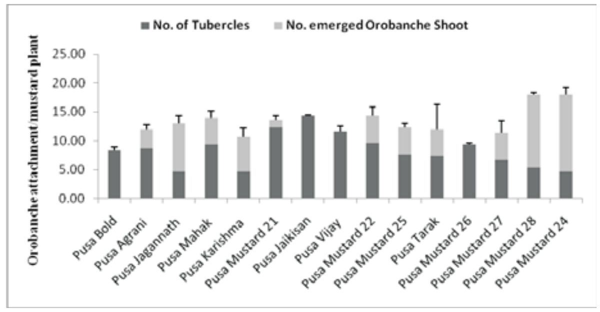

Fig 1. Tubercle and emerged Orobanche shoots grown on mustard genotype. Results represent mean numbers of three replicates.

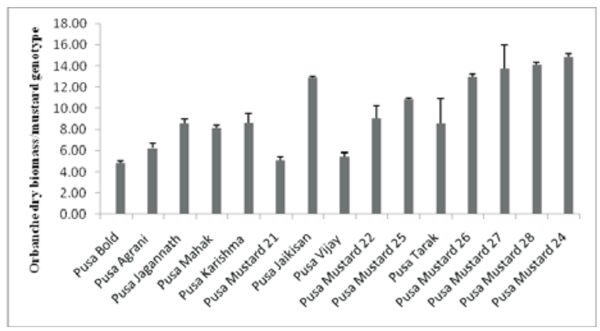

Fig 2. Total dry weight of Orobanche (tubercle+ emerged Shoot) grown on mustard genotype. Results represent mean numbers of three replicates.

Analysis of variance showed that mustard genotypes grown in the presence of Egyptian broomrape were significantly different in terms of total biomass of mustard genotype. Total mustard total dry weight (shoot and root) were all positively correlated with broomrape growth parameters. The highest Pearson correlation coefficients were observed between total mustard dry weight and Egyptian broomrape total dry weight (0.86). Regression analysis demonstrated that each 1 g increase in mustard dry weight corresponded to a 1.35 g increase in Egyptian broomrape total dry weight (Fig. 3). In other words, mustard with high biomass generally supported greater growth of Egyptian broomrape. For example, the Pusa Jaikisan genotypes had the highest biomass (27.8 g) and supported the highest broomrape dry weight (14.8 g). Conversely, genotypes with low root dry weight (e.g. Pusa Jagannath) generally had correspondingly low Egyptian broomrape dry weight. However, there were some deviations from this relationship. For example, the Pusa Vijay and Pusa mustard 22 genotypes had almost equal biomass, 15.0 and 15.1g respectively, but they showed high levels of deviation in Egyptian broomrape dry weight in correspondence their host genotype.

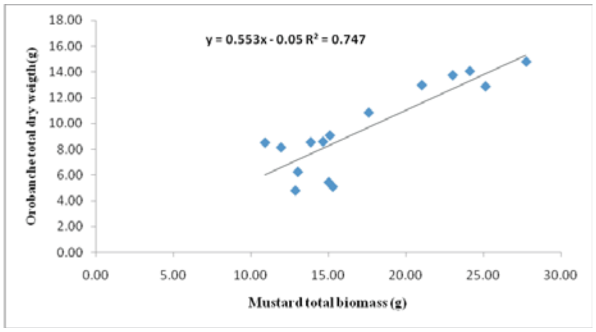

Fig 3. Correlation between mustard biomass and *Orobanche* total dry weight

To our best knowledge, no other study has been carried out to search for mustard genotype to *O. aegyptiaca*. In pot experiments all the oilseed rape varieties were susceptible to broomrape. A range in susceptibility exists within the fifteen oilseed rape genotype when the three parameters were used to measure the resistance of mustard species to *O. aegyptiaca*: the total number of tubercles, emerged *Orobanche* shoots and broomrape dry weight per mustard plant ten weeks after sowing, in all the varieties screened.

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