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Competition of Different Densities of Wild Mustard (*Brassica kaber*) and Rapeseed (*Brassica napus*) in Greenhouse

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Abstract

A greenhouse experiment was conducted to evaluate the competitive effects of different densities of wild mustard as against rapeseed. The experiment was performed in a randomized complete block design with four replications using replacement series in which wild mustard and rapeseed were respectively planted in different ratios of 4:0, 3:1, 2:2, 1:3 and 0:4 plants per pot. Results indicated that the maximum height, number of siliques per plant, silique length and number of seeds per silique in rapeseed vs. the maximum height, silique length and number of seeds per silique in wild mustard were obtained in their monoculture states. Overall evaluation of relative yield showed that both species were exploiting the resources in different ways or even somehow benefiting each other. Relative crowding coefficient of rapeseed as against wild mustard in the 3:1 treatment was greater than that in the other plant ratio treatments. Competition indices revealed that rapeseed benefited from a more competitive ability than wild mustard.

Keywords: Competition; Replacement series; Rapeseed; Wild mustard

1. Introuduction

Rapeseed, from Brassicaceae, provides a convenient alternative for cereal-based agricultural systems, as it is broad leaved and can be grown as a break crop in a continuous run of cereals (Khachatourians *et al*., 2001). It is increasingly becoming a popular oilseed crop in Iran, including Fars province, due to its high oil and protein content.

Wild mustard is a dominant weed in rapeseed fields of Iran bringing about major yield losses. A strongly persistent seedbank, competitive growth habit, and high fecundity all contribute to its weedy nature ensuring that it will be a continuing problem (Warwick *et al*., 2000).

Replacement series experiment is a method of studying crop-weed competition (Radosevich *et al*., 1997). It includes pure stands as well as mixtures in which the proportion of two species studied is varied. The total plant density is kept constant over all treatments in such experiments. Wild mustard densities of 10 plants m^{-2} can reduce rapeseed seed yield by 20%, whereas 20 plants m^{-2} can reduce rapeseed yield by more than 36 % (Warwick *et al*., 2000). In a field replacement series, competition for available water and light rather than nutrients was found to play a major role in the noted interference, where wild mustard was the strongest competitor for both, followed by rapeseed, and lambsquarters (*Chenopodium album*) (Blackshaw and Dekker 1988; Blackshaw *et al.*, 1989). With weed densities of 20-80 plants m^{-2}, rapeseed seed yields in Ontario were reduced by 19 to 77 % by interference from wild mustard, but only by 20 to 25 % with lambsquarters (Blackshaw *et al.*, 1987). In addition to yield losses in rapeseed, wild mustard can reduce crop quality even at its low densities (Rose and Bell, 1982). Rapeseed seeds contaminated with wild mustard seeds had caused an increase in linolenic and erucic acid

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levels in the extracted oil and glucosinolate content in the meal (McMullan *et al.*, 1994).

This greenhouse study was conducted to evaluate the effects of different densities of wild mustard as against rapeseed on the growth as well as yield of rapeseed.

2. Materials and methods

The experiment was performed in a completely randomized design with four replications using replacement series in which wild mustard and rapeseed were planted in different ratios of 4:0, 3:1, 2:2, 1:3 and 0:4 plants per pot in 2005. Mature seeds of wild mustard were collected from Kushkak Experimental Station farm, college of agriculture, Shiraz University, located in Kushkak, 60 km northwest of Shiraz, Iran. Wild mustard and rapeseed seeds were planted 1 and 2 cm deep, respectively, in 35 cm diameter plastic pots filled with a sandy clay loam soil. Plants were harvested from the soil surface at maturity and were oven dried at 75°C for 48h, while total shoot biomass for each species being determined. Measurements included plant height, number of siliques per plant and number of seeds per silique in rapeseed and plant height, silique length and number of seeds per silique in wild mustard. Relative Yield (RY), Relative Yield Total (RYT), Relative Crowding Coefficient (RCC), and Aggressivity (A) were calculated.

Relative yield (RY) is a measure of the relative competitive ability of the two species. Large RY values indicate a high degree of competitiveness of one species relative to the other. Values of approximately one indicate that interspecific and intraspecific competition is equal. Values greater than one indicate that intraspecific competition is more than interspecific competition. Values less than one indicate that intraspecific competition is less than interspecific competition.

RY was calculated using the equation (Ghadiri, 2005):

$$RY = \frac{Y_{mix}}{Y_{mon}}$$

where Y_{mix} and Y_{mon} are yields in mixture and monoculture.

Relative Yield Total (RYT) describes how the species pair utilizes resources. Values of approximately one indicate that two species are competing for the same limiting resources. Values greater than one suggests that species are making demands on different resources, avoiding competition, or maintaining a symbiotic relationship. Values less than one imply mutual antagonism. When the RYT of a pair of species is approximately one, the combined yield of species in a mixture is predictable from species monocultures (Ghadiri, 2005). RYT was calculated using the equation:

$$RYT = \sum_{i=1}^{n} RY$$

Relative Crowding Coefficient (RCC) is a measure of competitiveness between the two species. Large RCC values indicate a high degree of competitiveness of one species relative to the other. The RCC was calculated using the equation (Ghadiri, 2005):

$$RCC = \frac{YA_{mix}/YB_{mix}}{YA_{mon}/YB_{mon}}$$

Where YA_{mix} and YB_{mix} are average yield per plant of A and of B grown in mixture, respectively, YA_{mon} and YB_{mon} are average yield per plant of A and B grown in monoculture, respectively (Ghadiri, 2005).

Aggressivity (A) values of approximately zero indicate that there is no competition between the two species. Larger A values indicate a high degree of aggressiveness of one species relative to the other. A was calculated using the equation:

$$A = RY\,A - RY\,B$$

(Ghadiri, 2005). Means were compared using Duncans, Multiple Range Test (P= 0.05) (SAS, 2002).

3. Results and discussion

3.1. Rapeseed Yield Components

Maximum silique number per plant (Fig. 1), number of seeds per silique (Fig. 2) and silique length (Fig. 3) were obtained in monoculture. These parameters decreased as the number of wild mustard plants per pot increased. There were highly significant negative correlations between the weed dry matter and rapeseed silique (r=-0.96) and number of seeds per silique (r=-0.95). Morishita *et al.* (1991) in a study on barley (*Hordeum vulgare*) and wild oat (*Avena fatua*) showed similar results. Ghadiri (2005), using a similar replacement series experiment, reported that pinto beans (*Phaseolus vulgaris* L.) shoot and root dry matter, number of pods, as well as yield decreased as the number of field bindweed (*Convolvulus arvensis* L.) plants per pot increased.

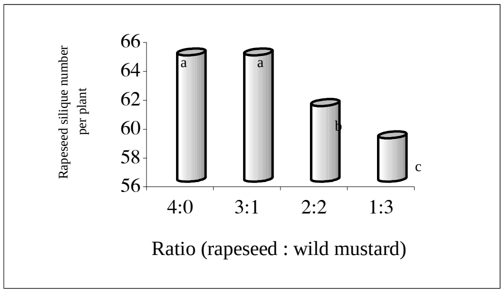

Fig. 1. Effect of the ratio of rapeseed to wild mustard plants on silique number per plant. Means followed by the same letters are not significantly different (Duncan 5%)

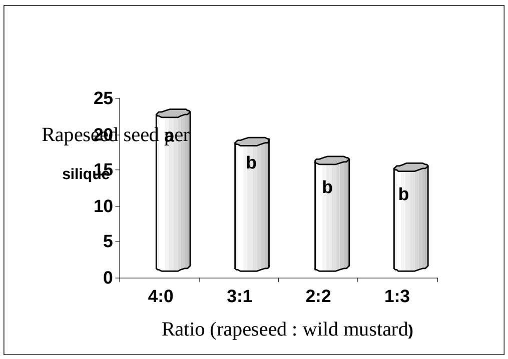

Fig. 2. Effect of the ratio of rapeseed to wild mustard on seed per silique. Means followed by the same letters are not significantly different (Duncan 5%)

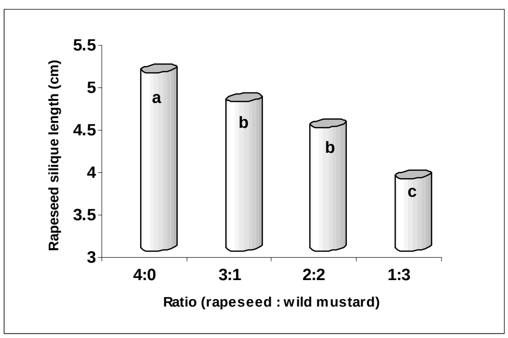

Fig. 3. Effect of the ratio of rapeseed to wild mustard on silique length. Means followed by the same letters are not significantly different (Duncan 5%)

3.2. Wild mustard silique length and number of seeds per silique

Maximum wild mustard silique length (Fig. 4) as well as maximum number of seeds per silique were obtained in the monoculture treatment (Fig. 5). These parameters decreased with the number of rapeseed plants per pot increasing. Producing more tillers, branches, siliques and seeds confer strong competitive ability upon crops, therefore, in the present study, rapeseed could be considered as more competitive than wild mustard. These results are in agreement with those of Morishita *et al.* (1991), who found that maxsimum wild oat (*Avena fatua*) tillers were obtained in a monoculture treatment.

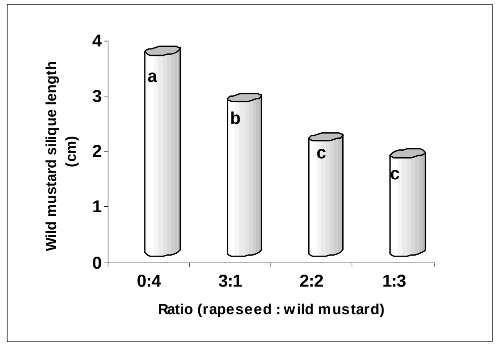

Fig. 4. Effect of the ratio of rapeseed to wild mustard on wild mustard silique length. Means followed by the same letters are not significantly different (Duncan 5%).

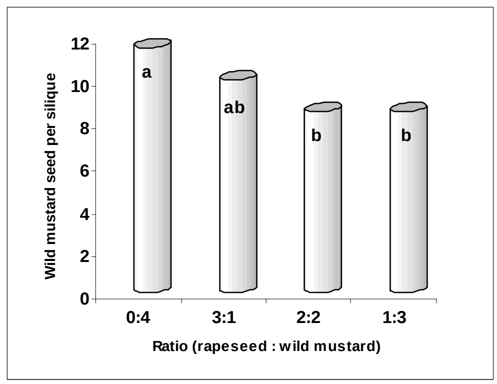

Fig. 5. Effect of the ratio of rapeseed to wild mustard on wild mustard seed per silique. Means followed by the same letters are not significantly different (Duncan 5%)

3.3. Relative Yield (RY)

RY values indicate the relative competitive ability of the two species. Two straight lines in fig. 6 indicate that the ability of the two species to competition is equivalent, whereas concave and convex lines indicate that one species is more competitive than the other gaining resources at the expense of the other species. The convex curve for rapeseed and the concave curve for wild mustard indicate that the competitive ability of rapeseed was more than that of wild mustard (Fig. 6).

The mean value of rapeseed RY (0.718) and the mean value of wild mustard RY (0.483) showed that either one of the species has more intraspecific competition than interspecific competition. Fleming *et al.* (1988) in a study on competitive relationship among winter wheat, jointed goat grass (*Aegiolps cylindrica)* and downy brome (*Bromus tectorum*) found that the competitive ability of jointed goatgrass and winter wheat was similar, but both species exhibited a more competitive ability than downy brome.

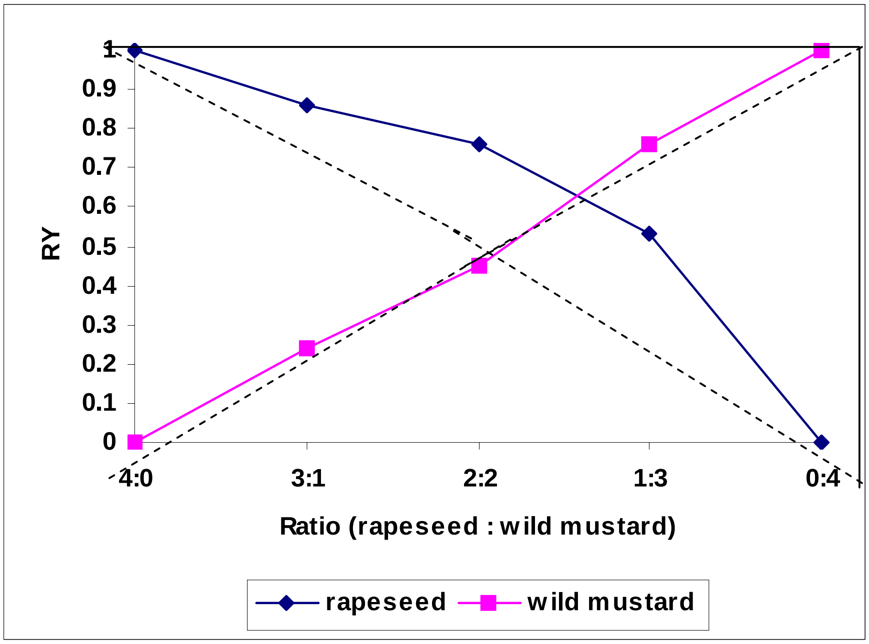

Fig. 6. Effect of the ratio of rapeseed to wild mustard on relative yield of rapeseed and wild mustard

3.4. Relative Yield Total (RYT)

RYT was more than 1 in all mixture ratios (Fig. 7). This showed that rapeseed and wild mustard were exploiting the resources in different ways or somehow benefiting each other. Ghadiri (2005) reported the same response for field bindweed and pinto beans, however, the findings of Wall (1997) indicated that dog mustard (*Erucastrum gallicum*) and flax (*Linum usitatissimum* L.) were making exploitation of the same resources.

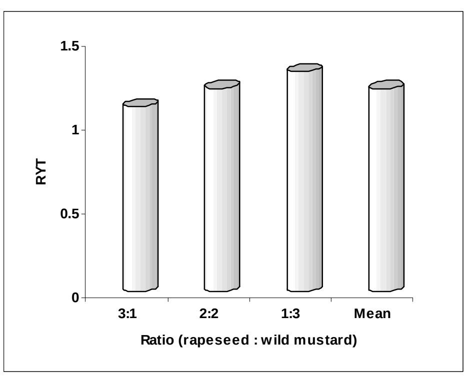

Fig. 7. Effect of the ratio of rapeseed to wild mustard on relative yield total

3.5. Aggressivity (A) and Relative Crowding Coefficient (RCC)

Values of aggressivity provide a quantitative competitiveness. Mean values of A (Figs. 8 and 9) and (RCC) (Figs. 10 and 11) for rapeseed were greater than those for wild mustard. This indicated that rapeseed as observed in this experiment was more aggressive than wild mustard. Zand and Beckie (2002) reported that mean values of A and RCC for hybrid cultivars of canola were 1.52 and 1.58, respectively; the corresponding values for open-pollinated cultivars of canola were 0.78 and 0.76. No differences among RCC values were found within either hybrid cultivars or open-pollinated cultivars. Ghadiri (2005) also, reported that RCC of pinto beans and field bindweed showed that pinto bean was at least 3 times more aggressive than field bindweed.

Finally, the results of the present study as based on competition indices indicated that rapeseed was of a more competitive ability than wild mustard. Also, there was a significant negative correlation observed between wild mustard dry weight and rapeseed yield components which implies that a high density of wild mustard can cause serious yield reduction in rapeseed.

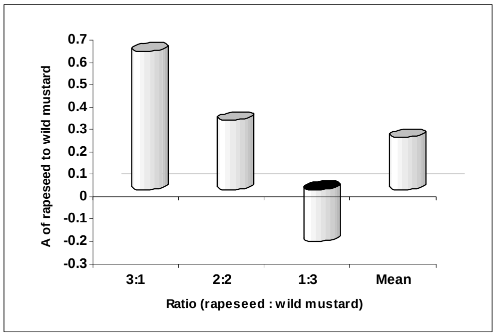

Fig. 8. Effect of the ratio of rapeseed to wild mustard on aggressivity of rapeseed

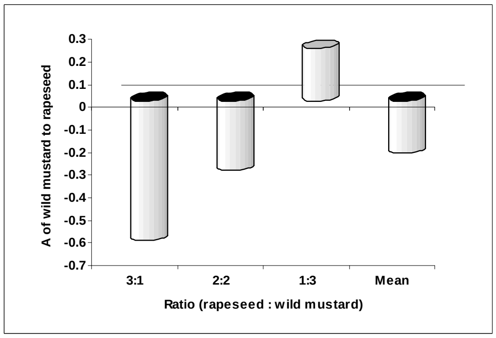

Fig. 9. Effect of the ratio of rapeseed to wild mustard on aggressivity of wild mustard

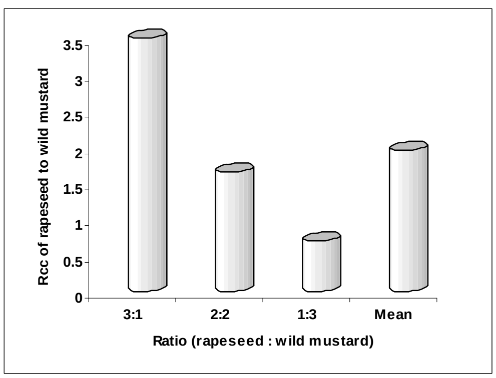

Fig. 10. Effect of the ratio of rapeseed to wild mustard on relative crowding coefficient of rapeseed us. wild mustard

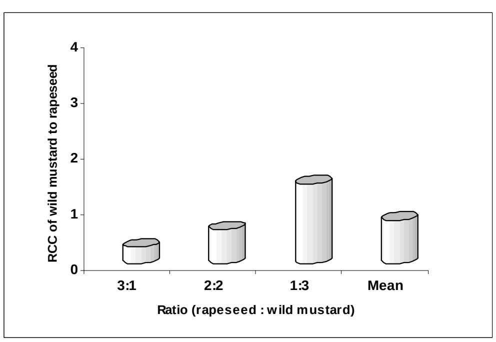

Fig. 11. Effect of the ratio of rapeseed to wild mustard on relative crowding coefficient of wild mustard us. rapeseed

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