Asian Journal of Plant Sciences

ISSN 1682-3974

science alert

ANSInet
an open access publisher
http://ansinet.com

Asian Journal of Plant Sciences 4 (2): 90-94, 2005
ISSN 1682-3974

Competitive Effect of *Cynodon dactylon* (L.) Pers. on Four Crop Species, Soybean [*Glycine max* (L.) Merr.], Maize (*Zea mays*), Spring Wheat (*Triticum aestivum*) and Faba Bean [*Vicia faba* (L.)]

[1]Abdul Shukor Juraimi, [2]S.H. Donald Drennan and [3]Nurina Anuar
[1]Department of Crop Science, Faculty of Agriculture, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia
[2]Department of Agricultural Botany, School of Plant Sciences, University of Reading, 2, Early Gate, Reading, Berks, RG6 6AU, UK
[3]Department of Chemical Engineering and Processes, Faculty of Engineering, Universiti Kebangsaan Malaysia, 43650 BANGI, Selangor Malaysia

Abstract: The competitive ability of *C. dactylon* with four different crops in two densities was assessed under glasshouse conditions. Four separate experiments were established using soybean [*Glycine max* (L.) merr.] Cv. Hernon-147, spring wheat (*Triticum aestivum*) Cv. Alexandria, faba bean [*Vicia faba* (L.)] Cv. Banner and maize (*Zea mays*) Cv. Dekalb 198, which were grown as monocultures and in (1:1) additive mixtures with *C. dactylon*. Result have shown that competition reduced dry weight of both crops and *C. dactylon* by about up to 44 and 52%, respectively. Maize root dry weight was severely (72% reduction) affected by *C. dactylon*. However, faba bean, soybean and wheat were stronger competitors to *C. dactylon*.

Key words: Competition, *Cynodon dactylon,* soybean (*Glycine max* (L.) merr.), spring wheat (*Triticum aestivum*), faba bean [*Vicia faba* (L.)], maize (*Zea mays*)

INTRODUCTION

C. dactylon is as a rapid growing perennial plant that forms a thick sod. Its has very strong competitive capacity with crops which make it a serious weed of warm countries[1]. It is prolific and highly competitive with most crops for most plant resources. It competes with crops for water, sunlight, nutrient and space as well as interfering with digging and other cultivations and causes substantial crop yield reductions. *C. dactylon* occurs as a weed in about 40 crops species in 80 countries and is one of the troublesome grass weeds because of it's dynamic, aggressive competitiveness resulting in reduced crop growth and yield[1-3].

Competition can be defined as the relationship between two or more plants in which the supply of growth factors within a given area falls below their combined demands[4,5]. It involves negative interference between plants. Fofana[6] defined it as the ability of one plant to reduce the growth of another in its proximity and Barbour[7] as the mutually adverse effects of organisms (plants) which utilise a resource in short supply.

Many researchers have shown that competition by weeds can seriously reduce crop yields[8-10]. The competitive ability of a species is related to efficient utilisation of site resources. Weeds compete with crops for resources such as light, water and nutrients[5,11], space[6] and also gases (oxygen and carbon dioxide) and symbiotic organisms[12].

Fagaery[13] has reported that uncontrolled *C. dactylon* caused 55-64% loss of yield in sunflower in Sudan. In cotton, newly grown *C. dactylon* had little effect on cotton yield in the first season but established stands with more than 75% ground cover reduced yields by 25 to 80%[14]. Bridges[5] reported that *C. dactylon* was the third most troublesome weed in cotton in California. They estimated that this weed infested 8.5% of the total farm area. Keeley and Thullen[15] measured cotton yield reduction of 16 and 36% where the weed was allowed to compete for 12 to 16 weeks. Several other studies on the competition of *C. dactylon* with cotton have also been reported[11,16,17].

Its exact competitive potential has rarely been measured but it is generally regarded as a highly

Corresponding Author: Abdul Shukor Juraimi, Department of Crop Science, Faculty of Agriculture, University Putra Malaysia, UPM 43400 Serdang, Selangor, Malaysia
Tel: +603 89 467261 Fax: +603 89 435973 E-mail: ashukor@agri.upm.edu.my

competitive weed and there is some evidence for allelopathic effects[18,19].

However little is known about the competitive ability of *C. dactylon* with other crops. Therefore, this study describes glasshouse studies on which the competitiveness of *C. dactylon* was tested when grown together with 4 crops species namely maize, soybean, faba bean and spring wheat.

MATERIALS AND METHODS

Experiments were conducted in the weed glasshouse, Department of Agricultural Botany, Earley Gate, University of Reading. Glasshouse temperature was set to a minimum of 25°C day and night and relative humidity between 40-80%. The material used was from one clone stock originally from Sri Lanka but maintained at Reading for many years. *C. dactylon* seeds were obtained from a commercial company (Herbiseed Company Limited). The soil used was John Innes No. 1 commercial potting compost (Keith Singleton's Seaview Nurseries, Cumbria, UK).

Four separate experiments were established using soybean [*Glycine max* (L.) merr.] Cv. Hernon-147, spring wheat (*Triticum aestivum*) Cv. Alexandria, faba bean [*Vicia faba* (L.)] Cv. Banner and maize (*Zea mays*) Cv. Dekalb 198, which were grown as monocultures and in (1:1) additive mixtures with *C. dactylon*.

The competitors were sown at two densities with six replicates. Plastic pots (24.5 cm diameters 7 L volume) were placed at 25 cm intervals in the glasshouse and arranged in a Complete Randomized Block Design. Seeds of crops and *C. dactylon* shoot propagules were sown at densities of three and six per pot for experiments with maize, soybean and faba bean and at densities of four and eight per pot for wheat in monoculture. In additive mixtures the different species of crops and *C. dactylon* were sown in alternate position in the same pots.

C. dactylon shoot propagules (10-15 cm length) without roots were taken from plant stocks in the weed glasshouse and planted in propagation trays. At the same time the crops seeds were sown in the experiment pots with 20-40% more of plants above the required density and thinned to the planned densities after two weeks. Similar sizes of rooted established *C. dactylon* propagules, were then taken from the propagation trays and transplanted into the experiment pots to give the monoculture and additive mixtures with crop seedlings.

Soil in each pot was watered daily to give adequate moisture. Hundred milliliter of a 1% complete range liquid fertilizer solution were applied to the pots weekly during the experiments. Pesticides for insect control were also sprayed on the plants when necessary.

Dry weight of leaves, stems, fruits, roots and total above and below ground parts of plant materials were recorded when the crop plants were at the early fruiting stages. All data were subjected to separate analysis of Variance and LSD Test used to separate the differences among treatments at the $p<0.05$. Aggressivity and resource complementarily were also calculated and subject to analysis of variance.

RESULTS

***C. dactylon* maize competition:** In association with *C.dactylon*, the total above ground dry weight of maize at both densities were significantly ($p<0.05$) less, by about 44% averaged over both mixtures (Table 1). While growth of all plants parts of maize was decreased, the effect on root weight (about 72%) less were particularly severe.

Competition also significantly ($p<0.05$) decreased *C. dactylon* growth with about 52% less dry weight of total above ground parts, but the effects were less evident on root dry weight in this species with 43% reduction. When compared in additive mixtures, the mixtures were intermediate between the two monocultures at the same densities. When compared as a replacement to the mixtures, the two species fitted into a simple replacement series linked to their densities and total yield was intermediate with the monocultures yields (Fig. 1).

Table 1: Effect of competition on the dry weight of maize and *C. dactylon*

	Dry weight (g pot^{-1})						
	Maize					*C. dactylon*	
Competition treatments	Leaves	Stems	Cobs	Total above ground	Roots	Above ground	Roots
Monoculture							
3 plants/pot	39.7	116.8	10.2	165.0	18.5	54.1	6.5
6 plants/pot	56.8	120.2	7.1	183.0	16.8	73.9	7.8
Additive mixtures							
3+3 plants/pot	27.8	75.7	7.1	106.9	6.1	25.7	3.8
6+6 plants/pot	29.1	56.4	4.9	86.2	3.8	36.3	4.3
LSD ($p<0.05$)	7.0	32.9	10.0	39.5	4.9	21.9	2.1

Table 2: Effect of competition on the dry weight of soybean and *C. dactylon*

	Dry weight (g pot^{-1})						
	Maize					*C. dactylon*	
Competition treatments	Leaves	Stems	Pods	Above ground	Roots	Above ground	Roots
Monoculture							
3 plants/pot	38.3	30.2	20.4	88.9	8.5	40.4	5.6
6 plants/pot	42.7	30.8	16.6	90.1	8.2	50.0	5.2
Additive mixtures							
3+3 plants/pot	29.6	21.1	16.9	67.7	2.9	29.2	2.3
6+6 plants/pot	32.2	25.7	17.3	75.2	3.8	33.7	1.7
LSD ($p<0.05$)	4.8	5.9	6.1	12.9	3.7	11.2	2.6

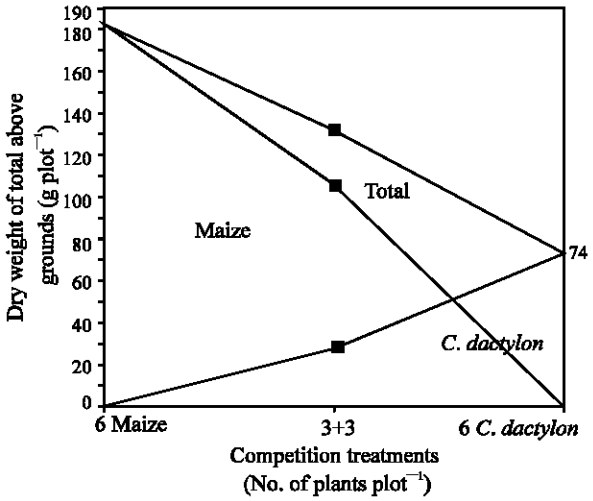

Fig. 1: Replacement series diagram showing dry weight of *C. dactylon* and maize grown in monoculture and mixtures

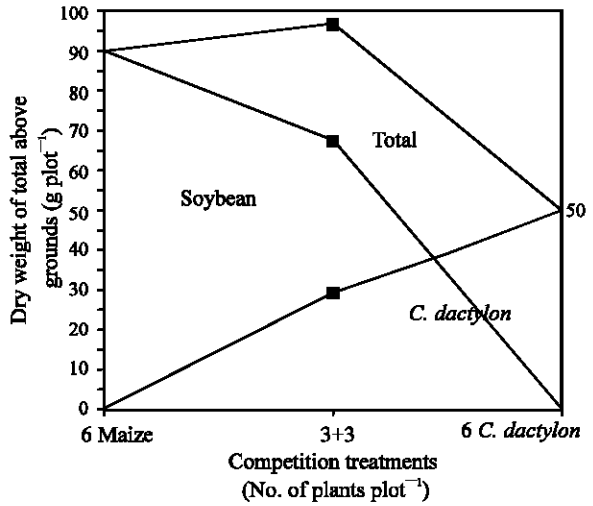

Fig. 2: Replacement series diagram showing dry weight of *C. dactylon* and soybean grown in monoculture and mixtures

***C. dactylon* soybean competition:** Generally competition significantly ($p<0.05$) reduced total above ground dry weight of soybean by about 21% when grown with *C. dactylon* competition (Table 2). The presence of *C. dactylon* resulted in more reduction ($p<0.05$) in leaves, stems and root weights since dry weight of soybean pods were not much affected by competition at either density.

The reduction of above ground dry weight of *C. dactylon* was about 29% but dry weight of roots was about 65% less for both densities. In these mixtures the above ground dry weights of the mixtures exceeded those of the monocultures both in additive and replacement type mixtures, with soybean giving slightly more than its density would indicate in the replacement series (Fig. 2).

Table 3: Effect of competition on the dry weight of faba bean and *C. dactylon*

	Dry weight (g pot^{-1})				
	Faba bean				*C. dactylon*
Competition Treatments	Leaves	Stems	Pods	Total above ground	Total above ground
Monoculture					
3 plants/pot	26.4	30.1	2.4	58.8	45.8
6 plants/pot	3 1.8	39.4	1.5	72.6	48.6
Additive mixtures					
3+3 plants/pot	19.9	23.7	3.8	47.4	24.7
6+6 plants/pot	24.6	28.8	3.6	57.0	34.4
LSD ($p<0.05$)	4.3	3.0	2.6	6.5	11.6

Table 4: Effect of competition on the dry weight (g pot^{-1}) of spring wheat and *C. dactylon*

	Dry weight (g pot^{-1})			
	Spring wheat		*C. dactylon*	
Competition Treatments	Above ground	Heads	Total	Above ground
Monoculture				
4 plants/pot	42.8	0.0	42.8	40.0
8 plants/pot	43.0	2.1	45.1	48.6
Additive mixtures				
4+4 plants/pot	31.0	1.1	32.1	24.1
8+8 plants/pot	30.2	1.0	31.2	36.3
LSD ($p<0.05$)	9.2	1.5	10.6	17.5

***C. dactylon* faba bean competition:** Competition significantly decreased dry weight of total above ground parts of faba bean by about 20% averaged over both densities. Competition also significantly reduced dry weight of leaves and stems of faba bean, but dry weight of pods harvested immature was not affected (Table 3).

C. dactylon above ground dry weight was decreased by about 39% by faba bean in the mixtures, averaged for both densities. As with soybean, the mixtures in the additives treatments outyielded the monoculture treatments and in the replacement mixture bean again performed slightly better than its density would indicate giving a total yield above expectation for a simple replacement situation (Fig. 3).

***C. dactylon* spring wheat competition:** In association with *C. dactylon* total above ground dry weight of wheat was 28% less on average than the monoculture crops (Table 4). Due to the large standard error, differences in above ground dry weight of *C. dactylon* in monoculture and in mixtures with wheat were not always significant but averaged 32% less in the mixtures than the monocultures. With this crop also, additive mixtures outyielded either monoculture and the total yield of the replacement mixture was above that expected from simple replacement theory due to slightly better wheat performance in the mixture (Fig. 4).

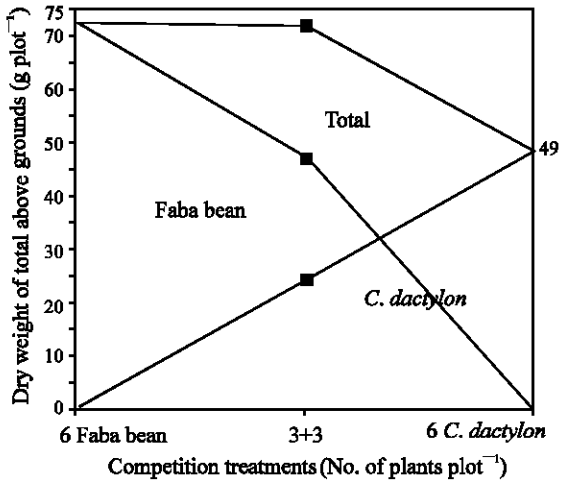

Fig. 3: Replacement series diagram showing dry weight of *C. dactylon* and faba bean grown in monoculture and mixtures

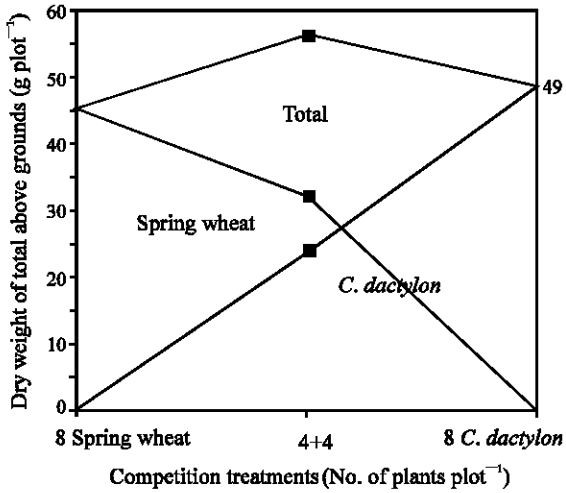

Fig. 4: Replacement series diagram showing dry weight of *C. dactylon* and spring wheat grown in monoculture and mixtures

Aggressivity, resource complementarily and relative crowding coefficient of *C. dactylon* against crops: At low plant density aggressivity of *C. dactylon* with all crops was less than zero, i.e. *C. dactylon* was less competitive than crops (Table 5). However at high plant density, aggressivity of *C. dactylon* were greater than zero when competing with maize and spring wheat. These results indicated that *C. dactylon* was more competitive than maize and spring wheat but competing rather weakly against soybean and faba bean.

Relative yield total for *C. dactylon* competing with maize were 1.15 and 0.99 at low and high planting density,

Table 5: Aggressivity, resource complementarily and relative crowding coefficient of *C. dactylon* competing with crops

	Aggressivity (A)		Relative Yield Total (RYT)		
	Plant density		Plant density		Relative Crowding Coefficient
Crops	Low	High	Low	High	(RCC)
Maize	-0.16	0.07	1.15	0.99	0.66
Soybean	-0.25	-0.38	1.57	1.43	0.68
Fababean	-0.14	-0.08	1.38	1.49	0.77
Spring wheat	-0.01	0.004	1.52	1.67	0.68
LSD ($p<0.05$)	0.25	0.20	0.24	0.14	0.17

Table 6: The average percentage loss of dry weight due to competition between crops and *C. dactylon*

	Average loss of dry weight (%)	
Crop plants	Crop	*C. dactylon*
Maize	44	52
Soybean	21	29
Faba bean	20	39
Wheat	28	32

respectively which were significantly ($p<0.05$) lower than other treatments. However values for relative crowding coefficient were less than 1.0 and not significantly different among all crops competing with *C. dactylon*.

This competition study indicated that *C. dactylon* competition decreased total above ground dry weight of crops by about 20-44% (Table 6). Vencill *et al.*[16] reported that *C. dactylon* significantly reduced cotton height and yield by about 10% in USA. The reduction of maize root dry weight of 72% was particularly severe. It is quite clear that the main effect of *C. dactylon* on maize was exerted via the roots. The importance of root competition in this experiment confirmed previous studies.

The grass produced a more extensive root system which increased with the rooting of the tillers. Grown in association with *C. dactylon*, maize competed rather weakly whereas *C. dactylon* was strong competitor. However the simple replacement series diagram indicated that both *C. dactylon* and maize suffered from the competition and the ability of each species to interfere with the other is equivalent. Each species contributed to the total yield in direct proportion to its presence in the mixtures.

Wheat, soybean and faba bean were stronger competitors to *C. dactylon*. The mixtures in the additive treatments outyielded the monoculture treatment and in the replacement mixture the crops were also slightly better than its monoculture so the total yield of mixtures was above expectation. This would indicate that the crops have better performance than *C. dactylon* in mixtures. Mutual benefit is depicted for this competition since both species in the mixtures produce more than would be expected from the yield produced in pure stands. While

this might depict symbiosis, it also may indicate that each species fails to harm the other as much as expected. In such situations, each species escapes from some measure of competition with the other. It also indicates that the species in combination exploited the environment more thoroughly than either alone. If both species perform better in the mixture than in pure stand, they complement each other, perhaps through the use of different space.

REFERENCES

1. Harlan, J.L. and J.M.J. De Wet, 1969. Sources of Variation in *Cynodon dactylon* (L) Pers. Crop Science, 9: 774-778.
2. Holm, L., J.V. Pancho, D.L. Plucknett and P.G. Herberger, 1977. The World's Worst Weed: Distribution and Biology. University Press, Hawaii, pp: 25-31.
3. Labrada, R., 1994. *Cynodon dactylon.* In: Labrada, R., J.C. Caseley and C. Parker, Eds. Weed management for developing countries. FAO Plant production and protection paper 120. Rome, Italy FAO., pp: 44-49.
4. Aldrich, R.J., 1984. Weed-crop Ecology: Principles in Weed Management. Breton Publishers, North Scituate, MA. USA., pp: 465.
5. Bridges, D.C., 1995. Ecology of Weeds. In: Hand Book of Weed Management Systems (Smith, A.E., Ed.). Marcel Dekker, Inc. New York, pp:19-34.
6. Fofana, B., T. Koupeur, M.O. Jones and D.E. Johnson, 1995. The development of rice varieties competitive with weeds. Brighton Crop Protection Conference-Weeds. UK., pp: 187-192.
7. Barbour, M.G., J.H. Burk and W.D. Pitts, 1985. Species Interactions Competition and Amensalism, pp: 105-133. In: Terrestrial Plant Ecology. Benjamin Cummings, Menlo Park, California, USA., pp: 634.
8. Akobundu, I.O., 1987. Weed Science in the Tropics. Principles and Practices. John Wiley and Sons, USA.
9. Cousens, R.C., 1985. A simple model relating yield loss to weed density. Ann. Applied Biol., 107: 239-252.
10. Zimdahl, R.L., 1980. Weed-crop competition: A review. International Plant Protection Center. Oregon State University, Corvallis, Oregon, pp: 195.
11. Vencill, W.K., L.J. Giraudo and G.W. Langdale, 1992. Response of cotton (*G. hirsutum*) to coastal bermudagrass (*C. dactylon*) density in no-tillage system. Weed Sci., 40: 455-459.
12. Radosevich, S.R. and J.S. Holt, 1984. Weed Ecology: Implication for Vegetation Management. John Wiely and Sons, New York, pp: 265.
13. Fagaery, K.A., 1994. Studies on weed control in sunflower (*Helianthus annus* L.). Ph.D. Thesis. University of Reading, UK.
14. Brown, S.M., T. Whitwell and J.E. Street, 1985. Common Bermudagrass (*C. dactylon*) competition in cotton (*Gossypium hirsutum*). Weed Science, 30: 503-506.
15. Keeley, P.E. and R.J. Thullen, 1991. Growth and interaction of bermudagrass (*C. dactylon*) and cotton (*Gossypium hirsutum*). Weed Sci., 39: 570-574.
16. Steven, M.B., T. Whitwell and J.E. Street, 1985. Common bermudagrass (*C. dactylon*) competition in cotton (*G. hirsutum*). Weed Sci., 33: 503-506.
17. Vencill, W.K., L.J. Giraudo and G.W. Langdale, 1993. Soil moisture relations and critical period of *C. dactylon* (L.) Pers. (Coastal bermudagrass) competition in conservation-tillage cotton (*G. hirsutum*). Weed Res., 33: 89-96.
18. Bengoa, G.R. and A.M. Kogan, 1985. The allelopathic effect of five perennial weeds and the growth of young peach trees. Samiente, 55: 33.
19. Horowitz, M., 1973. Competitive effect of three perennial weeds, *C. dactylon* (L.) Pers., *C. rotundus* L. and *Sorghum halepense* (L.) Pers. on young citrus. J. Horti. Sci., 48: 135-147.