Agricultural Sciences, 3(2), 7-11 (1998)

Economic Threshold Level of *Chenopodium album* L. and *Phalaris minor Retz.* in Wheat

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بدء التأثير الاقتصادي السلبي لأعشاب جينوبوديوم البيوم *Chenopodium album* L.
وبالاريس مانيور *Phalaris minor Retz.* عند زراعة القمح

الملخص: أجريت تجربتان لتحديد بدء التأثير الاقتصادي السلبي لوجود أعشاب جينوبوديوم *C. albium* و بالاريس مانيور *P. minor* عند زراعة القمح ، وقد تم تثبيت معاملات مختلفة لكل من هذين النوعين من الحشائش على النحو الآتي : بدون حشائش ، ٥٠ ، ١٠٠، ١٥٠، ٢٠٠، ٢٥٠، ٣٠٠، ٣٥٠ ، ٤٠٠، ٤٥٠، ٥٠٠ من الحشائش في المتر المربع . لم تختلف إنتاجية القمح المزوعة في الأحواض التي تحتوي على كثافة ٢٥٠ للمتر المربع أو أقل من عشب جينوبوديوم البيوم اختلافا معنويا عن أحواض الملاحظة . أما في الأحواض التي احتوت على بولاريس مانيور فقد كانت أقل إنتاجية للقمح فقط في الأحواض ذات الكثافة القصوى (٥٠٠ عشبا للمتر المربع) مقارنة بالأحواض الخالية من الحشائش .

ABSTRACT: Two field experiments were conducted to determine the economic threshold level of *C. album* and *P. minor* in wheat. Different densities viz., check (weed free), 50, 100, 150, 200, 250, 300, 350, 400, 450 and 500 m^{-2} of each weed species were maintained separately. Grain yield obtained from plots having *C. album* densities up to 250 m^{-2} was not statistically different from that obtained from weed free plots (check). In *P. minor*, minimum grain yield was obtained at the highest weed density of 500 m^{-2} as compared with that in the absence of weeds.

Weed infestation in wheat fields is a critical factor limiting wheat yield. Crop plants suffer from stress created by weeds through competition for light, nutrients and moisture. The magnitude of the stress, depends upon the type and density of weed. Since growth and reproductive behaviour of different weeds varies, threshold density levels are also different for each weed species.

Kolar *et al.* (1977) concluded that *Chenopodium album* L. infestation, at an average density of 200 mature plants m^{-2}, resulted in 40% reduction of grain yield mainly due to reduced tillering of wheat. Roder *et al.* (1986) pointed out that *Chenopodium album* L. densities ranging from 50-400 plants m^{-2} resulted in yield losses of 1.6 to 9.2% in winter cereals. Costa *et al.* (1978) observed that the *Phalaris minor* Retz. population of 343 plants m^{-2} caused a 28% reduction in yields of winter wheat. Cudney and Hill (1979) observed 60 and 40% reduction in yield of wheat cv. Yecora Rojo in the presence of 280 and 33 plants m^{-2} of *Phalaris minor* Retz., respectively. Godinko and Costa (1980) noted that in the weedy check plots of *Phalaris minor* Retz., 350 plants m^{-2} caused 37% reduction in wheat yield.

Tiwari *et al.* (1984) found that *Phalaris minor* Retz. ranging in density from 29 to 926 plants m^{-2} reduced grain yield by decreasing tillering, grain weight of wheat ear^{-1} and crop biomass. Mehra and Gill (1988) reported that an increase in the population of *Phalaris minor* Retz. from 50 to 250 seedlings m^{-2} reduced the grain yield of wheat from 7.6 to 44.2% in the field. Carlson (1986) reported that as the proportion of *Avena fatua* L. increased in relative terms, its deleterious effect on wheat declined, apparently due to increased competition with existing *Avena fatua* L. plants. Wimschneider *et al.* (1990) found that four *Avena fatua* L. (wild oat) plants in a pot containing 16 wheat plants reduced yield by 9% while 8 wild oats reduced yield by 14%. Studies by Cheema and Nazir (1996) revealed that *Avena fatua* L. growing in association with wheat caused yield reduction of 12.64, 17.90, 28.98, 36.34 and 45.75% in grain yield at weed densities of 10, 20, 30, 40 and 50 plants m^{-2}, respectively. This study employed a standard wheat crop density of 200 plants m^{-2}. Ibrahim *et al.* (1994) studied populations of *Chenopodium album* L., *Phalaris minor* Retz. and *Avena fatua* L. at 0, 11, 19, 27 and 36% of wheat plants. Weed levels of 0, 11 and 19% did not affect the

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grain yield which was about 4.63, 4.53 and 4.43 t ha^{-1}. However, yields were significantly lower at 27 (3.87 t ha^{-1}) and 36% (3.50 t ha^{-1}) levels. Angonin and Caussanel (1992) reported decreased wheat yield as densities of *Poa annua* L. and *Lolium multiflorum* Lam. increased from 0 to 1200 plants m^{-2}. In this study the wheat density was 240 plants m^{-2}. Friesen *et al.* (1992) recorded that *Malva pusilla* densities of 237 plants m^{-2} reduced wheat yield by 15%.

Information on the threshold level of different weeds affecting field crops in Pakistan is scanty. This type of material is vital in order to formulate a proper weed control strategy. Thus, the objective of the present work was to determine the maximum population of *C. album* and *P. minor* that can be tolerated in wheat without incurring economic crop loss.

Materials and Methods

Two experiments were conducted separately for each one of the species. The experiments were laid out in a randomized complete block design in two different fields. Wheat variety Pasban-90 was sown with a single row hand drill in rows lying 25 cm apart. A typical plot comprises four rows of 2 m length and occupies 2 m^2. To estimate the threshold level of *C. album* L., wheat was sown on 8th November and 2nd December in 1992/93 and 1993/94, respectively. In the case of *P. minor* Retz., wheat was sown on 8th December and 7th November in 1992/93 and 1993/94, respectively. Chemical and physical analysis of soil is given in Table 1.

Nitrogen and phosporus were applied at the rate of 115 kg ha^{-1} each in the form of urea and single super phosphate, respectively. Half of nitrogen and the whole of phosphorus were side dressed by a drill at sowing and the remaining half of nitrogen was broadcasted at the first irrigation 15 days after emergence. Density levels for each weed species were 0 (weed free), 50, 100, 150, 200, 250, 300, 350, 400, 450 and 500 plants m^{-2}. The field history served as a guidance for the availability of naturally occurring weed species. Populations of both species exceeded the maximum required. Weeds in excess of the desired level were removed every four days by hand pulling. Densities were maintained for 60 days following vestigial cropping. The crop was harvested at maturity, tied into bundles and allowed to sundry for 12 days. After manual threshing, grain weight for each plot was recorded. Then grain yield per plot was converted to kilogram per hectare. Data collected were analysed statistically using the Fisher's analysis of variance. Least Significant Difference (LSD) test at the 5% probability level was applied to examine the significance of treatment means as described by Steel and Torrie (1984).

Results and Discussion

As shown in Table 2, the experimental setting unveils the effect of *C. album* and *P. minor* on the flag-leaf area during both years. In 1992/93 the flag-leaf area of wheat in check (weed free) was not significantly different from that of 50 and 100 plant m^{-2} of *C. album* but gave the highest leaf area. *C. album* at 50, 100 and 150 density levels also produced statistically similar flag-leaf areas. The corresponding area at 500 plant m^{-2} of *C. album* was the lowest. During 1993/94, *C. album* in check (weed free), 50 and 100 density levels produced higher and statistically similar flag-leaf areas, than the remaining populations. *C. album* at 100, 150, 200 and 250 density levels resulted in similar flag-leaf areas of wheat. The lowest flag-leaf area was recorded at 500 plants m^{-2}. Statistically, however this was similar to the flag-leaf area at 200, 250, 300, 350, 400 and 450 density levels of *C. album*.

Flag-leaf area of wheat (Table 2) under different *P. minor* densities varied considerably. Maximum flag leaf area was recorded under check and was statistically

TABLE 1

Chemical and physical analysis of soil

Determination	Unit	Value			
		Wheat - *C. album*		Wheat - *P. minor*	
		92/93	93/94	92/93	93/94
Total N	%	0.045	0.038	0.058	0.049
Available P	ppm	6.5	4.0	6.5	5.5
Exchangeable K	ppm	181	149	214	180
Soil Water pH		8.05	7.75	7.90	7.90
Ec	dsm^{-1}	0.33	0.41	0.24	0.25
Organic matter	%	0.72	0.45	0.81	0.84
Soil type		Sandy loam		Sandy clay loam	

TABLE 2

Effect of different densities of C. album and P. minor on flag leaf area (cm^2) plant^{-1} of wheat

Weed density (m^{-2})	Flag leaf area *C. album* 92/93	Flag leaf area *C. album* 93/94	Flag leaf area *P. minor* 92/93	Flag leaf area *P. minor* 93/94
Check (weed free)	18.56^{a}	19.08^{a}	18.43^{a}	19.88^{a}
50	18.47^{ab}	18.56^{a}	18.16^{ab}	18.22^{bc}
100	17.15^{abc}	17.61^{ab}	18.94^{a}	18.04^{bcd}
150	17.07^{bc}	16.74^{bc}	18.19^{ab}	18.38^{ab}
200	16.36^{c}	16.48^{bcd}	16.55^{c}	17.74^{bcde}
250	16.90^{c}	16.27^{bcd}	16.70^{bc}	17.24^{bcdef}
300	16.52^{c}	15.87^{cd}	16.87^{bc}	16.40^{ef}
350	16.49^{c}	15.52^{cd}	16.33^{c}	16.63^{def}
400	16.43^{c}	15.45^{cd}	16.54^{c}	16.68^{def}
450	16.55^{c}	15.34^{cd}	16.53^{c}	16.72^{cdef}
500	14.63^{d}	15.13^{d}	16.68^{bc}	15.81^{f}
S$\bar{x}$	0.49	0.52	0.53	0.52
LSD 5%	1.43	1.50	1.54	1.51
Significance	*	**	*	*

Means sharing the same letter do not differ significantly at $P<0.05$.

similar to that recorded at *P. minor* densities of 50, 100 and 150 during 1992/93. The remaining density levels produced relatively lower flag-leaf area and were at par with one another. During 1993/94 check, producing the maximum flag-leaf area, remained at par with the 150 density level of *P. minor* which in turn was comparable with weed density levels of 50, 100, 200 and 250. Wheat attained the lowest flag-leaf area at the density level of 500. Increasing weed density in both species produced a linear decline in the flag-leaf area of wheat.

It is evident from Table 2 that serious reduction in flag-leaf area of wheat occurred beyond the 150 density level. Increasing flag-leaf area up to the 150 density level was probably due to a symbiotic existence between weeds and wheat which in the presence of adequate environmental resources favoured the latter. Competition between weeds and wheat due to increasing weed densities beyond 150 resulted in small flag-leaf areas of wheat. These results are in line with the findings of Akhtar (1991). He recorded the highest leaf area in weed-free check and at low weed density (50 m^{-2}), 150 days after emergence. The lowest leaf area of wheat was recorded at weed density of 200 m^{-2}.

The densities of *C. album* did not influence significantly the plant height during 1992/93 and 1993/94 (Table 3). Plant height was in the range of 82.65 to 86.90 cm and 77.80 to 83.80 cm during 1992/93 and 1993/94, respectively. Plant height of wheat decreased linearly with the increase in density of *P. minor* during both years. In 1992/93, check, 50, 100 and 150 *P. minor* densities produced relatively tall plants and were at par among themselves. A similar trend was observed for the 1993/94 cultivation.

Decreased plant height of wheat as a result of competition with *P. minor* was probably due to the similar root system of both. At low densities, competition was less thus allowing growth of plants with maximum height. Majid and Sandhu (1984) also reported decreased plant height of wheat due to *Fumaria parviflora* L. infestation at 50 and 100% weed densities.

The density levels of *C. album* and *P. minor* significantly affected the grain yield during both years (Tables 4 and 5). In both cases, *C. album* densities up to 250 m^{-2} (Table 4) did not reduce grain yields significantly which were comparable to those of the check. Then there was a considerable decrease in grain yield with increasing density of *C. album*. It varied from 20 to 42% in 1992/93 and 26 to 41% in 1993/94 at the densities of 300 and 500 plants m^{-2} respectively. Density level of 500 produced the minimum yield but was statistically at par with those of 450, 400 and 350 *C. album*.

TABLE 3

Effect of different densities of C. album and P. minor on plant height (cm) of wheat

Weed density (m^{-2})	Plant height *C. album* 92/93	Plant height *C. album* 93/94	Plant height *P. minor* 92/93	Plant height *P. minor* 93/94
Check (weed free)	86.15	83.22	94.70^{a}	96.20^{a}
50	86.70	83.80	92.90^{ab}	93.10^{ab}
100	86.40	83.60	91.00^{abc}	92.25^{ab}
150	86.90	82.45	91.25^{abc}	91.95^{b}
200	85.60	82.30	89.95^{bcd}	90.57^{bc}
250	85.40	82.00	89.20^{bcd}	89.95^{bcd}
300	85.25	81.00	88.57^{cd}	86.80^{cde}
350	83.05	80.88	88.88^{cd}	86.15^{de}
400	83.97	80.78	87.85^{cd}	84.90^{e}
450	83.10	80.85	87.65^{cd}	83.25^{ef}
500	82.65	77.80	86.57^{d}	80.32^{f}
S$\bar{x}$	2.30	1.60	1.29	1.40
LSD 5%	6.65	4.62	3.73	4.04
Significance	NS	NS	*	**

Means sharing the same letter do not differ significantly at $P<0.05$

TABLE 4

Effect of different densities of C. album on grain yield ($kg \cdot ha^{-1}$) of wheat

Weed density (m^{-2})	Grain yield 92/93	Decrease in yield %	93/94	Decrease in yield %
Check (weed free)	6150^{a}	-	6125^{a}	-
50	6150^{a}	0.00	6100^{a}	0.40
100	6125^{a}	0.40	6025^{a}	1.63
150	6125^{a}	0.40	5950^{a}	2.85
200	6025^{a}	2.03	5925^{a}	3.26
250	5825^{a}	5.28	5900^{a}	3.67
300	4900^{b}	20.32	4525^{b}	26.12
350	4050^{c}	34.14	4050^{bc}	33.87
400	4000^{c}	34.95	4050^{bc}	33.87
450	3925^{c}	36.17	4025^{bc}	34.28
500	3575^{c}	41.86	3575^{c}	41.63

Means sharing the same letter do not differ significantly at $P<0.05$.

TABLE 5

Effect of various density levels of P. minor on grain yield ($kg \cdot ha^{-1}$) of wheat

Weed density (m^{-2})	Grain yield 92/93	Decrease in yield %	93/94	Decrease in yield %
Check (weed free)	5800^{a}	-	5700^{a}	-
50	5550^{a}	4.31	5325^{b}	6.57
100	4525^{b}	21.98	4375^{c}	23.24
150	4475^{b}	22.84	4150^{cd}	27.19
200	4200^{bc}	27.58	4050^{de}	28.94
250	4175^{bc}	28.01	3950^{def}	30.70
300	4000^{cd}	31.03	23825^{efg}	32.79
350	3775^{de}	34.91	3775^{fg}	33.77
400	3700^{de}	36.20	3675^{f}	35.52
450	34.75^{e}	40.08	3600^{g}	36.84
500	34.25^{e}	40.94	3300^{h}	42.10

Means sharing the same letter do not differ significantly at $P<0.05$.

As regards *P. minor* during 1992/93, check and the density level of 50 produced the maximum grain yield (Table 5) and did not differ significantly from each other. Density levels of 100, 150, 200 and 250 did not differ significantly from one another either. The density level of 500 produced the minimum yield which was statistically similar to those given by 450, 400, and 350 densities. During 1993/94, check resulted in the highest grain yield and was followed by the *P. minor* density level of 50. *P. minor* at the density level of 100 produced statistically a similar yield to the 150 density which in turn, was at par with the 200 and 250 density levels. Further, the lowest grain yield was produced by the density level of 500. The trend of grain yield in *P. minor* densities was the same as in *C. album*. Decrease in grain yield was in the range of 4.31 to 40.94% in 1992/93 and 6.57 to 42.10% in 1993/94.

Data in Tables 4 and 5 indicate that there was a significant decrease in grain yield with increasing density levels of *C. album* beyond 250 plants m^{-2} and *P. minor* beyond 50 plants m^{-2} during both years. The decrease in grain yield with increasing weed density could be related to weed crop competition which resulted in decreased availability of water, nutrients, light, air and space to crop plants. It is also evident from data that the decrease in grain yield started at lower density levels in the case of *P. minor* than *C. album*. This may be due to the competitive ability of *P minor* for growth factors. Hence, *P. minor* could have enjoyed favourable environmental conditions which allowed it to compete well with wheat and reduce the crop yield at a low experimental presence.

Kolar *et al.* (1977), Roder *et al.* (1986) and Ibrahim *et al.* (1994) have also observed a decrease in grain yield caused by deteriorating growth components at densities of *Chenopodium album* L. up to 400 m^{-2}. According to the findings of Costa *et al.* (1978), Cudney and Hill (1979), Godinko and Costa (1980), Tiwari *et al.* (1984) and Mehra and Gill (1988), use of *Phalaris minor* Retz. densities between 29 and 926 m^{-2} resulted in a reduction in grain yield from 28 to 60%.

The relatively smaller decrease in grain yield which was observed when the density level was raised beyond 350 m^{-2} should be the result of increasing competition among weeds. Ultimately, infighting reduced their competitiveness against wheat. These results are in line with work by Carlson (1986), who reported decreased competitiveness of *A. fatua* L. against wheat with increasing densities level of the weed.

In conclusion, results indicate that weed density of *C. album* up to 250 plants m^{-2} had no adverse effect on grain yield, whereas weed density of *P. minor* beyond 50 plants m^{-2} was critical and resulted in considerable reduction in grain yield.

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