THE EFFECT OF HERBICIDE AND FERTILISER RATE ON WEED PRODUCTIVITY IN SPRING WHEAT.

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ABSTRACT

A trial was conducted within a commercial crop of autumn sown spring wheat involving four rates of nitrogen (0,40,80 & 160kgN/ha) with and without the use of herbicide. The weed population was monitored throughout the season for species composition, density, above-ground dry weight and seed production. Total weed dry weight per plot was found to be positively correlated with increasing nitrogen rate up until the final weed harvest. Species dry weights and reproductive output were generally found to be higher on the fertilised plots. The main weed species present were Viola arvensis, Papaver rhoeas, Veronica persica and Veronica arvensis. The use of herbicide suppressed weed seed numbers and dry weight production on all plots, but the response differed between individual species. Reduced input systems would increase the reproductive potential of some species over others and this will have implications for weed seed return, future infestations and management.

INTRODUCTION

Intensive nitrogen fertiliser use may affect weed floras in several ways including increasing the occurrence of competitive nitrophilous species and reducing species diversity. Other possible results of continued intensive nitrogen use were discussed by Chancellor and Froud-Williams (1986). An important result of less intensive cereal farming may be a more diverse weed flora, providing potential host plants within the crop for insects which in turn provide food for gamebird chicks (Sotherton et al, 1985). Increased gamebird populations may be of financial benefit to a farmer who wishes to have organised shoots on his land. This may in turn help to counteract the loss in profit from less intensive cereal production. Weeds also contribute to soil cover, which can help reduce erosion, and they provide an alternative food source for pests as well as offering refuge to beneficial predators.

An experiment was therefore set up in February/March 1990 to investigate the potential effect of reduced fertiliser inputs, on the weed population of an arable field. The objectives were to determine how a reduction in nitrogen rate affected competitive ability of the weed population, species composition, density, above-ground dry weight and reproductive productivity. A herbicide treatment was either applied or omitted to assess the effect of herbicide and interaction with fertiliser rates.

MATERIALS AND METHODS

The experiment was carried out in a 49.7 ha field near Basingstoke, ideal for the purposes of the trial in that it was relatively flat with a reasonably evenly distributed weed flora. The crop, an autumn-sown spring wheat (cv. Tonic) was drilled on 14th November 1989 into a flinty calcareous soil.

Four nitrogen fertiliser rates were applied, with and without herbicide, giving a total of eight treatments which were replicated 6 times. The fertiliser rates were; 0,40,80 and 160kgN/Ha. Plots were 3m by 24m arranged in a randomised block design.

The fertiliser on the 160kgN/ha plots was applied as a split dressing of 2 x 80kg, with the first dressing being applied by hand on the 20 March 1990 and the second on 11 April. The 40 and 80kgN/ha treatments were applied in full on 11 April.

Herbicide was applied to the selected plots on 25 April using a mixture of 0.056kgAI/ha clopyralid, 0.15kgAI/ha fluroxypyr and 0.25kgAI/ha ioxynil with an Oxford Precision Sprayer at a volume rate of 2401/ha.

Monitoring of the weed population was carried out at 3 to 4 week intervals from the beginning of March until the weeds had senesced at the end of July. The final weed harvest was taken on 5 July. The end 3m of each plot was set aside for destructive harvesting of the weeds. On each assessment date an area of $0.1m^2$ was harvested by removing all above-ground weed material. Care was taken to note where harvests were taken so as not to harvest the same area at a later date. Samples were stored in polythene bags in a deep freeze before processing. Samples were separated into species, counted and then dried. Drying was carried out overnight at 80^0C or until there was no further change in dry weight particularly so with the larger samples collected later in the season. The crop was harvested on the 23rd August with a plot combine.

Assessments of seed numbers were based on the final harvest as all species assessed had started to shed seed. Both mature capsules and flowers that were potentially able to produce capsules before plant senescence were counted.

RESULTS

Species diversity

Following commencement of the experiment, a general survey of all plots was taken to assess overall species composition and weed density on the experimental area. A total of 18 weed species were recorded on the experimental site. At harvest diversity on the treatment plots was found not to be significantly altered by nitrogen rate, however the application of herbicide drastically reduced the number of species present (Table 1). Analysis of variance indicated no interaction between nitrogen rate and herbicide usage at the 5% level. The most abundant species were, Viola arvensis(76.5%), Papaver rhoeas, Stellaria media, Veronica persica and Veronica arvensis.

TABLE 1. Mean number of weed species recorded m^{-2} at the final harvest.

Nitrogen rate (kgN/ha)	With Herb	No Herb	Mean
0	0.83	5.83	3.33
40	0.83	6.50	3.67
80	0.83	6.17	3.50
160	0.83	5.17	3.00
Mean	0.83	5.92	

SED Herbicide = 0.317; 35 d.f.

Density

The initial weed density over the experimental area was 442 plants/m^2. By the final weed harvest the density had increased in all nitrogen treatments without herbicide (Table 2). There was a significant reduction in total weed numbers per unit area with increased nitrogen fertiliser at final harvest, the lowest numbers being on the 160kgN/ha plots and the greatest on the unfertilised plots.

The component species differed in their response with the greatest numbers of Viola arvensis and Veronica arvensis present at low levels of fertiliser. Veronica persica had no observed response to nitrogen rate and Papaver rhoeas tended towards higher densities on the plots receiving 80kgN/ha.

TABLE 2. Mean number of weeds m^{-2} at the final harvest.

Nitrogen rate(kgN/ha)	With Herb	Without Herb	Mean
0	115	768	442
40	163	692	427
80	100	693	397
160	93	463	278
Mean	118	654	

SED Nitrogen = 61.9; 35 d.f.
SED Herbicide = 43.8; 35 d.f.

Weed dry weight

In general weed dry weight was positively correlated with nitrogen rate throughout the season. However, as harvest approached, the dry weights on the plots receiving the highest rate of nitrogen began to decline whilst the others continued to increase. Total weed dry weight was greatest at 40kgN/ha. (Tables 3a & 3b)

TABLE 3a. Total weed dry weight (g m^{-2}) per 0.1m^2 at the penultimate weed harvest (13/6/90)

Nitrogen rate(kgN/ha)	With Herb	Without Herb	Mean
0	2.8	21.8	12.3
40	7.8	48.0	27.9
80	3.5	62.2	32.8
160	8.7	67.5	38.1
Mean	5.7	49.9	

SED Nitrogen = 6.71; 35 d.f.
SED Herbicide = 4.74; 35 d.f.

TABLE 3b. Total weed dry weight (g m^{-2}) per 0.1m^2 at the final weed harvest

Nitrogen rate(KgN/ha)	With Herb	Without Herb	Mean
0	3.4	50.9	27.2
40	6.9	73.5	40.2
80	2.6	75.4	39.0
160	2.9	57.0	29.9
Mean	4.0	64.2	

SED Herbicide = 5.05; 35 d.f.

At the final weed harvest, dry weights of the main component species were assessed for each treatment. In no instance did maximum dry weight occur at the highest level of fertiliser. In the case of Viola arvensis and Veronica arvensis, dry weight per unit area was greatest on the plots receiving 40kgN/ha.

Single plants of the main component species responded differently in terms of their harvested dry weights. The major species in the study, Viola arvensis, responded significantly to the application of nitrogen ($p<0.05$) with maximum dry weights of single plants observed on the 80kgN/ha treatment in the absence of herbicide (Table 3c). Plant dry weights of the other species failed to respond significantly to nitrogen, but dry weights of Papaver rhoeas were greatest on plots with the highest nitrogen rate.

Reproductive output

Potential capsule production in Viola arvensis was found to be significantly greater in the 40kgN/ha treatment ($p<0.05$) than the 0 and 160kgN/ha treatments in the absence of herbicide.

There was an interaction between the application of fertiliser and the effect of herbicide on the production of seed capsules in Viola arvensis ($p<0.01$). Where herbicide had been applied, capsule number was significantly higher on the unfertilised plots or plots receiving only 40kgN/ha (Table 4).

TABLE 3c. Mean dry weight of single plants at final weed harvest (g).

Viola Arvensis

Nitrogen rate(kgN/ha)	With Herb	No Herb	Mean
0	0.0253	0.0548	0.0400
40	0.0312	0.1014	0.0663
80	0.0213	0.1023	0.0618
160	0.0256	0.0907	0.0581
Mean	0.0259	0.0873	

SED Nitrogen = 0.00860; 35 d.f.
SED Herbicide = 0.00608; 35 d.f.
SED Nitrogen x Herbicide = 0.01217; 35 d.f.

Veronica arvensis

Nitrogen rate(kgN/ha)	With Herb	No Herb	Mean
0	0.0000	0.0922	0.0461
40	0.0000	0.0878	0.0439
80	0.0000	0.0621	0.0311
160	0.0000	0.0447	0.0223
Mean	0.0000	0.0717	

SED Herbicide = 0.00963; 35 d.f.

Veronica persica

Nitrogen rate(kgN/ha)	With Herb	No Herb	Mean
0	0.0000	0.0502	0.0251
40	0.0000	0.0559	0.0280
80	0.0000	0.0286	0.0143
160	0.0000	0.0362	0.0181
Mean	0.0000	0.0427	

SED Herbicide = 0.00675; 35 d.f.

Papaver rhoeas

Nitrogen rate(kgN/ha)	With Herb	No Herb	Mean
0	0.000	0.131	0.066
40	0.000	0.114	0.057
80	0.000	0.104	0.052
160	0.000	0.465	0.232
Mean	0.000	0.204	

SED Herbicide = 0.0644; 35 d.f.

TABLE 4. Total potential capsule number per plant for Viola arvensis on final weed harvest.

Nitrogen rate(kgN/ha)	With Herb	Without Herb	Mean
0	0.219	1.398	0.809
40	0.187	2.350	1.269
80	0.073	2.002	1.037
160	0.073	1.903	0.988
Mean	0.138	1.913	

SED Nitrogen = 0.1367; 35 d.f.
SED Herbicide = 0.0966; 35 d.f.
SED Nitrogen x Herbicide = 0.1933; 35 d.f.

In the case of Papaver rhoeas and the two Veronica species, no significant effect of nitrogen rate was observed and herbicide application suppressed the production of reproductive output to negligible levels. However, reproductive structures of these species showed a similar response to that of Viola arvensis, with maximum output, in the absence of herbicide, on the 40kgN/ha treatment .

DISCUSSION

These results indicate that reducing nitrogen inputs, which may form a major strategy under an extensification scheme, could favour higher weed densities within the crop as it approaches harvest. Work by Mahn (1984;1988) demonstrated a similar situation for weed density although the response was observed to continue through the development of the crop.

The reasons for the lower total weed dry weight at 160kgN/ha at the final weed harvest may have been a result of several factors. Firstly, the accelerated weed growth apparent in earlier harvests through the availability of nitrogen, may have resulted in the weeds completing their life cycles earlier and hence senescing before those on the less fertilised treatments. The exceptionally dry climatic conditions during the growing season of 1990 coupled with the weed flora comprising of more early maturing species, may have contributed to the lower dry weights on the highly fertilised plots.

There were, however, no visual signs of senescence in any of the treatments and plant material appeared lush at the final weed harvest, with the exception of the herbicide treated plots. For this reason, the drop in weed numbers at the highest fertiliser level at the final harvest may have been a contributory factor in the reduced overall weed dry weight. The 160kgN/ha plots may have experienced a greater mortality in these final stages when crop competition may have been exaggerated as the crop canopy closed. There is a possibility that at the intermediate reduced nitrogen rates (40-80kgN/ha) the canopy was not complete, enabling weeds to continue growth. This was reflected in above-ground dry weight production per plant, per unit area and also capsule production in Viola arvensis, all of which attained their respective maxima at the intermediate nitrogen levels. Increased weed matter at the intermediate nitrogen levels may cause problems with combining

and contamination of the grain.

Potential seed capsule production for Viola arvensis was found to follow the same response to nitrogen rate as single plant dry weight, as discussed earlier. This result would appear to be in agreement with work carried out by Wilson et al. (1988), where individual dry weights of Viola arvensis were shown to be directly related to potential seed production.

It is concluded that reduced nitrogen inputs may increase weed productivity in some species, relative to that at higher nitrogen levels.

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