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EFFECT OF FERTILIZER APPLICATION ON DENSITY, DRY MATTER AND SEED CHARACTERISTICS OF GARDEN CORNFLOWER (*Centaurea cyanus* L.) AND CORN SPURREY (*Spergula vulgaris* L.)

Hamid Reza Mohammaddoust[1], Ali Asghari[1], Aleksander Mihailovic Tulikov[2], Mohammad Hasanzadeh[3] and Mohammad Reza Saidi[3]

ABSTRACT

The research was conducted at the Agricultural University of Timiriazev, Moscow, and University of Mohaghegh, Ardabili, Iran, to determine the effect of fertilizer application on density, dry biomass and seed characteristic of garden cornflower (Centaurea cyanus L.) and corn spurrey (Spergula vulgaris L.) during 2004-2006. The analysis show that N and P application increased density and dry biomass of garden cornflower compared with no fertilizer (control), while density and dry biomass of corn spurrey was decreased. The results show that density of corn spurrey reduced as density of garden cornflower increased. After one year, only 11.5 and 30% seeds of garden cornflower and corn spurrey germinated, respectively. Conditions during maternal plant growth affected the seed characteristics of the two species. Seed germination of garden cornflower and corn spurrey in laboratory increased with P application compared with control and N application. These findings suggest that fertilizer application influences weeds, not only for weed density and biomass, but also by affecting seed characteristics.

Key words: Corn spurrey (*Spergula vulgaris* L.), Garden cornflower (*Centaurea cyanus* L.), Fertilizer, Weed density, Seed characteristics.

[1]Department of Agronomy and Plant Breeding, University of Mohaghegh Ardabili, Ardabil, P.O. Box 179, Iran, E-mail: hr_chamanabad@yahoo.com.

[2] Department of Agronomy and Experimental Methods, Agricultural University of Timiriazev, Moscow, Russia

[3] Department of Agronomy and Plant Breeding, University of Mohaghegh Ardabili, Iran

INTRODUCTION

Fertilizer management may be a means of reducing weed interference in crops (McCloskey *et al.*, 1998; Anderson, 2003; Liebman *et al.*, 2004; Mohammaddoust *et al.*, 2006). Nitrogen and P are the two major nutrients added to increase crop yield, but it is always recognized that altered soil fertility level can influence crop-weed competitive interactions (Tulikov and Sugrobov, 1984; Legere *et al*., 1994; Mohammaddoust *et al.*, 2006). Many studies only have investigated the effects of fertilizer application on weed abundance, particularly density and dry matter (Tulikov and Sugrobov, 1984; Carlson and Hill, 1986; Legere *et al*., 1994; Lutman *et al.* 2000; Blackshaw *et al.*, 2003; Mohammaddoust *et al.*, 2006). In many situations, particularly those with higher weed densities, added nutrients favor weed growth, often providing little added benefit in crop yield. For example, Carlson and Hill (1986) found that the addition of N fertilizer in a wheat field infested by wild oat (*Avena fatua* L.) increased the density of wild oat panicles and decreased the crop grain yield. In contrast, Tulikov and Sugrobov (1984) and Mohammaddoust *et al.* (2006) found that N and NPK application reduced weed density and dry weight, while in barley the reduction in weed density and dry weight only occurred when NPK was applied.

Environmental factors before or during seed maturation profoundly influence seed characteristic and determinate later weed density and composition (Parrish and Bazzaz, 1985; Bolland and Paynter, 1990; Arssen and Burton, 1990; Herrera *et al*, 2008). Many studies reported that an increase in the nutrient concentration of the growing environment has often led to the production of seeds that are heavier (Wulff and Bazzaz, 1992; Gates and Burton, 1998). This plastic response can have important fitness consequences for developing seedlings. Gates and Burton (1998) also found that emergence of bahiagrass (*Paspalum notatum* Flugge.) 14 days after planting was greater with the highest N rates than the lowest rate.

Despite the importance of mother plant growth condition on seed characteristics and seedling vigor widely has been studied in cultivated species (Schweizer and Rise, 1969; Singh & Bharti, 1985), our knowledge about weeds is low. Fawcett and Slife (1978) found that common lambsquarters (*Chenopodium album* L.) seeds harvested from N-treated plots were less dormant than control seed and seed germination increased from 3% for control seeds to 34% for seeds harvested from plots treated with N.

Our objective was to evaluate how density, dry matter and seed characteristics of garden cornflower and corn spurrey respond to N and P applications.

MATERIALS AND METHODS

Field experiment

A field study was conducted on the long-term experimental site at the Agricultural University of Timiriazev, Moscow, during 2004 and 2005 to evaluate how density, dry matter and seed characteristics of garden cornflower and corn spurrey responded to N and P application.

The selected sites for field experiments were situated on a long-term farm (since 1912). The rates of fertilizers have been changed from 1912 (Table-1). During 2004 and 2005 100 kg N ha^{-1} as ammonium nitrate (2/3 at pre-planting and rest at the full tillering stage), 150 kg P_2O_5 ha^{-1} as triple super phosphate, and 120 kg K_2O ha^{-1} as potassium chloride broadcasted before planting. Research focused on density, dry matter and seed characteristics of garden cornflower and corn spurrey in winter rye field in plots, where N and P had applied, and a control with no fertilizer (control).

Table-1. The change of fertilizer rates in long-term field in Moscow from 1912 to 2005 (Tulikov & Sugrobov, 1984).

Years	Rate of fertilizers (kg ha^{-1})		
	N	P_2O_5	K_2O
1912 – 1938	7.5	15	22.5
1939 – 1954	75	60	90
1955 – 1972	50	75	60
1973 – 2005	100	150	120

The experiment was laid out in randomized complete block design with 3 replications. Individual plot size was 10 × 5 m^2. Winter rye cv. Vockhod-2 was planted on 23 August 2003 and 25 August 2004. Winter rye was drilled in 15 cm spaced rows at 5.5 million plants ha^{-1}. Immediately after seeding three permanent 50 × 50 cm quadrates were staked in each plot. At maturity stage, weeds were cut at ground-level from the permanent quadrates and counted. Weed biomass was dried in an oven at 105^{O}C for 24 h, and weighed.

Germination tests

In the first half of August 2005, garden cornflower and corn spurrey seeds were collected from plots receiving N and P fertilizers. Seeds initially dried at room temperature (approx. 30^{O}C) were subsequently transferred to a cold condition (3-4^{O}C) until October 2006. Germination tests were started in October 2006 at the University of Mohaghegh Ardabili. Four replications of 50 seeds from each treatment were placed in 10 cm Petri dishes, on double layers of

Whatman No. 2 filter paper, with KNO_3, receiving 10 mm distilled water.

Germination tests were conducted in a room with 14 h of photoperiod (PAR 10.5 ± 1 µmol m-^{2} s-^{1}) provided by cool white fluorescent tubes and 10 h of darkness. The temperature was 20 ± 2^{O}C during the light period, and 8 ± 1^{O}C for 10 h, coinciding with the dark period.

During the 3 weeks germination period, the germinated seeds were recorded and removed regularly. The emergence of the radicle was used as the criterion for germination.

Statistical analysis

Data for weed density and dry matter were log-transformed and data for germination were transferred as $\sqrt{x+0.5}$ prior to ANOVA to reduce the coefficient of variance. Means were separated by Tukey's test at a 5% level of probability.

RESULTS AND DISCUSSION

Statistical analysis of the data showed that fertilizer application had a significant effect on garden cornflower and corn spurrey density. Nitrogen and P application increased garden cornflower density compared with control, while corn spurrey density decreased in these plots (Fig. 1A). Data in Fig.1A show that when garden cornflower density has increased, corn spurrey density has decreased. It may contribute to higher competitive ability of garden cornflower or allelopathic effects on corn spurrey. McCloskey *et al.* (1998) found that when *Bromus sterilis* L. density increased, the density of *Galium aparine* L. reduced. Nitrogen and P application for winter rye increased garden cornflower dry matter compared with control (Fig. 1B). These results are supported with the previous studies (Blackshaw *et al.*, 2003; Mohammaddoust *et al*., 2006). Fertilizer application decreased corn spurrey dry mater (Fig. 1B). The magnitude of decrease in corn spurrey dry matter was more than its density reduction. This suggests that for evaluation of effects of weeds on crop yield, estimation of dry matter is better than density (Lutman *et al.*, 2000).

Maternal plant growth had a significant effect on seed germination of garden cornflower and corn spurrey (Table-2). After one year, mean seed germination in garden cornflower and corn spurrey was 11.5 and 30%, respectively. Data showed that maternal plant growth did not have a significant effect on seed germination of corn spurrey, but it had a significant effect on seed germination of garden cornflower (Table-3).

Fawcett and Slife (1978) also found that N application had a different effect on seed germination. They reported that N application to mother plant increased seed germination of common lambsquarters, while N application had no effect on seed germination of velvetleaf (*Abutilon theophrasti* Medic.).

Data in Table-3 show that compared with control, in plots that received N for mother plants, seed germination of garden cornflower was lower. In plots to which P had been applied, seed germination of garden cornflower was higher. Thus, P application for mother plants can increase seed germination.

These results are supported by the studies of Bolland and Paynter (1990). Fertilizer application had a different effect on root and seedling length (Table-3). No significant differences occurred in root and seedling length when fertilizer had been applied to mother plants of corn spurrey. In contrast, in garden cornflower, root and seedling length increased, when N and P was applied. The vigorous seeds in plots that were applied N and P fertilizer for maternal plant growth may assist seed germination and developing seedlings. Parrish and Bazzaz (1985) found that velvetleaf plants grown at higher nutrient condition produced heavier seed with greater concentration of N that were able to grow to a larger seedling in competition with green foxtail (*Setaria viridis* L.) than plants grown from smaller seeds.

CONCLUSIONS

These results suggest that: a) fertilizer application influences competitive ability of weeds and can vary weed community, b) maternal plant growth influences seed characteristics, that may influence weed community and their competitive ability.

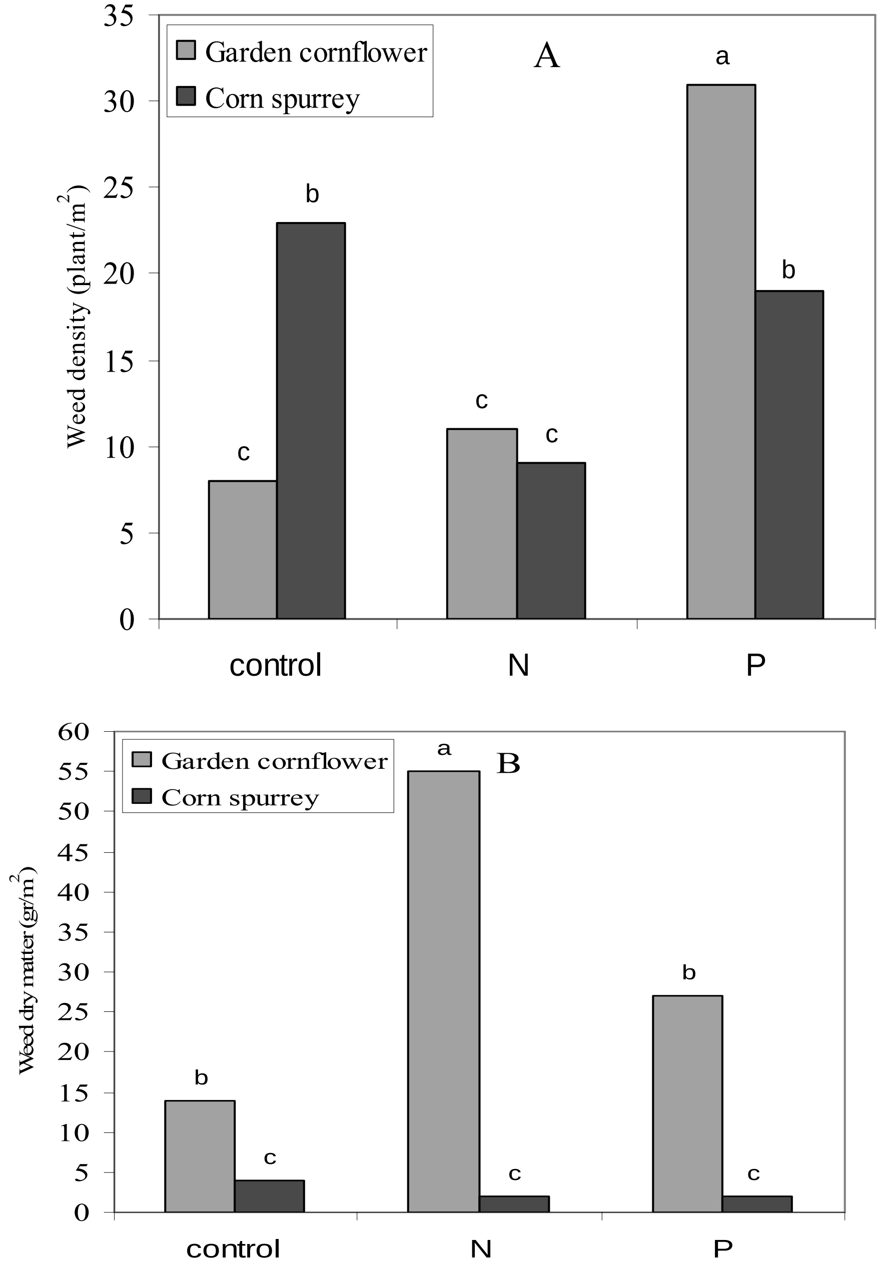

Fig. 1. Effect of fertilizer application on density m-^{2} of garden cornflower and corn spurrey density (A) and dry matter (B) (mean of 2004 and 2005)

Table-2. Mean squares of analysis of variance for effect of maternal plant growth on seed characteristics of garden cornflower and corn spurry.

Source of variation	d.f	Seed germination	Root length	Stem length
Weeds	1	2072.04**	7.70^{ns}	2236.87**
Fertilizers	2	167.79**	22.38^{ns}	0.67^{ns}
Weed*Fertilizer	2	51.29^{ns}	74.39^{ns}	29.88^{ns}
Error	18	21.60	68.56	51.43

** = Significant at P≤0.05
ns = Non-significant (P>0.05)

Table-3. Effect of maternal plant growth on seed characteristics of garden cornflower and corn spurry.

Species	Treatments	Germination %	Root length (mm)	Stem length (mm)
Garden cornflower	Control	12.0	12.95	22.82
	N	4.5	15.5	29.13
	P	18.5	17.31	32.06
Corn spurrey	Control	29.0	36.20	30.70
	N	28.75	34.65	28.65
	P	33.0	32.84	28.06

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