TA-P_02 Optimal placement of pelleted organic fertilizer in spring oat

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1. Objectives

For fertilization with granulated mineral fertilizers, there are guidelines about on where to place the fertilizer in relation to the seed row to gain maximum fertilizer efficiency [1]. Organic fertilizers are due to their physical properties usually more difficult to apply with accurate precision. However, when pelleted, it is possible. Apart from increasing availability of nutrients to the crop, placement close to the crop row may also help reduce weed pressure [2], by fertilizing the crop rather than the weeds. This is of special importance in organic production where chemical weed control is banned and where pelleted organic fertilizers are most commonly used. The objective with this study is to investigate the nitrogen fertilization effect on yield and weed abundance in spring oats depending on placement of pelleted organic fertilizer at different soil depths and distances from crop row. This paper presents results from studies performed during the first year of the project.

2. Methodology

2.1 Field experiments

The effects on crop nitrogen uptake, grain yield and weed abundance of placing pelleted meat bone meal (MBM) at different soil depths and at different distances from the seed row was tested in two field experiments in Sweden (58°N,13°E). One was in a field with silty clay and the other in a field with sandy loam. The treatments (Table 1) were randomized within four blocks. Each plot was only 70 cm long and 100 cm wide and sown and fertilized by hand with a crop row distance of 25 cm. The seeds were sown at 4 cm depth and the pellets were placed at two or three depths (1, 4 and 8 cm on the sandy soil and 1 and 4 cm depth on the clay soil) and at three distances (0, 4 and 12.5 cm) from row. There were also control treatments without N fertilization, with mineral N fertilizer and with surface broadcasting with shallow (0-1 cm) incorporation. All fertilized treatments received 60 kg total N ha^{-1}.

Table 1: Treatments in the field experiments performed in oats during 2014. MBM = meat bone meal.

Treatment	Fertilizer	Soil incorporation	Distance from row
1	-	-	-
2	Ammonium nitrate	1 cm	4 cm
3	Pelleted MBM	8 cm	0 cm
4	Pelleted MBM	8 cm	4 cm
5	Pelleted MBM	8 cm	12.5 cm
6	Pelleted MBM	4 cm	0 cm
7	Pelleted MBM	4 cm	4 cm
8	Pelleted MBM	4 cm	12.5 cm
9	Pelleted MBM	1 cm	0 cm
10	Pelleted MBM	1 cm	4 cm
11	Pelleted MBM	1 cm	12.5 cm
12	Pelleted MBM	0-1 cm	Broadcasting

Weeds were counted in beginning and end of June and were then harvested to measure dry matter yield. The oat was harvested at ripening, by cutting the straw at soil surface in a net area of 50 cm x 50 cm within each plot. Plant samples were threshed in the laboratory and grains and straw were measured separately and analyzed for N contents.

2.2 Statistical analyses

The yields in treatments 3-11 were compared using General Linear Model two factor analysis in Minitab software. Number of weeds in all treatments were compared using mixed model with the factors block, treatment, date and treatment x date in SAS software. The weed biomass in all treatments were compared using mixed model with the factors block, treatment and treatment x block in SAS software.

3. Results and discussion

3.1 Yield effects in the field experiment on clay soil

In the field experiment on the clay soil, grain yield in the unfertilized treatment was 1200 kg ha^{-1} and in the treatment with broadcasting 1600 kg ha^{-1}. There was a tendency for higher grain yield the closer to crop row (p=0.058) and the deeper in the soil (p=0.054) the pellets was placed with no interaction between depth and distance from row (p=0.45) (Figure 1a). Grain yield increased on average with 300 kg ha^{-1} when incorporated to 4 cm compared to 1 cm (p=0.054). Placement of pellet 0 cm from crop row gave 470 kg ha^{-1} higher yield than placement 12.5 cm from crop row (p=0.051).

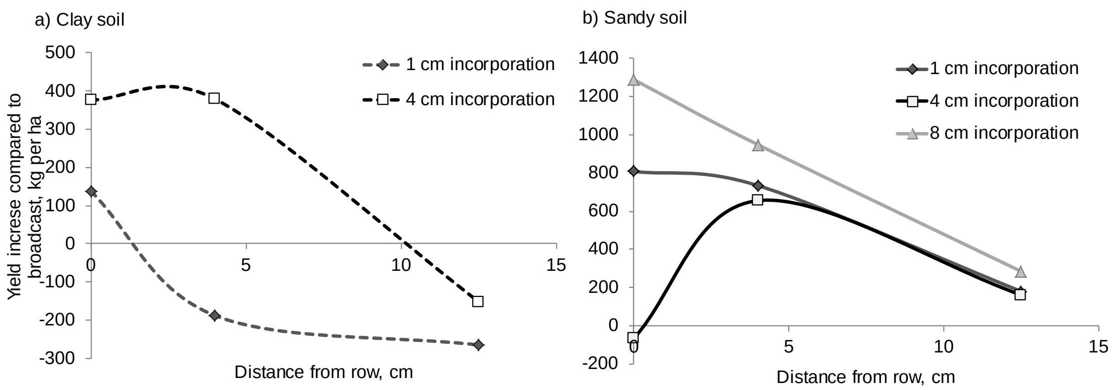

Figure 1: Yield increase from placement of pelleted fertilizer at different depths and distances from crop row compared to broadcasting in field experiments performed on (a) clay soil and (b) sandy soil.

3.2 Yield effects in the field experiment on sandy soil

In the field experiment on the sandy soil, grain yield in the unfertilized treatment was 3700 kg ha^{-1} and in the treatment with broadcasting 4100 kg ha^{-1}. There was a tendency to differences in yield depending on both incorporation depth (p=0.07) and distance to crop row (p=0.06) without interaction between depth and distance from row (p=0.30) (Figure 1 b). Grain yield increased by on average 500 kg ha^{-1} if applied at 8 compared to 4 cm depth (p=0.02), partly because placing pellet together with seeds were unfavourable in this trial. The difference in yield between incorporation at 1 and 8 cm depth was smaller (230 kg ha^{-1}) and not significant (p=0.068). Placement 4 cm from the crop row increased yield with on average 485 kg ha^{-1} compared to placement 12.5 cm from crop row.

3.3 Effects on weeds

The weed density was high in the field experiment on the sandy soil in the beginning of the growing season, but was significantly reduced from 2 to 24 June (Table 2). There were no significant differences between treatments in number of weed plants or weed biomass on 24 June, probably because of the vigorous crop competing well with weeds. In the field experiment on the clay soil, the crop was sparser. Here there were a significantly higher number of weed plants in treatments 10-12 (Table 2), with more shallow incorporation in combination with some distance to crop row. The weed biomass was significantly higher in treatments 8 and 12. In other words, the weeds tended to be more frequent in treatments with either broadcasting or placement far from the crop row. However, the weed density was still rather low and did probably not affect the crop yield.

Table 2: Weed density in different treatments (see Table 1) in the experiments at clay soil and sandy soil.

Treatment	Clay soil Number of weeds plants m^{-2} 02-jun	Clay soil Number of weeds plants m^{-2} 24-jun	Clay soil Weed biomass kg DM ha^{-1} 24-jun	Sandy soil Number of weeds plants m^{-2} 02-jun	Sandy soil Number of weeds plants m^{-2} 24-jun	Sandy soil Weed biomass kg DM ha^{-1} 24-jun
1	168	172	152	452	224	232
2	180	212	240	376	148	188
3				436	192	200
4				424	216	232
5				272	132	228
6	168	140	240	388	224	300
7	168	172	188	376	164	204
8	156	168	364	336	160	288
9	208	208	176	396	176	164
10	192	264	232	448	200	184
11	196	228	260	396	220	328
12	220	316	308	472	224	412

3.4 Aboveground plant nitrogen

In the field experiment on the clay soil, the above ground crop nitrogen content amounted to 35 kg N ha^{-1} on average in the treatments with pelleted fertilizers, with around 31 kg N ha^{-1} in the lower yielding treatments and 38 kg N ha^{-1} in the higher yielding treatments (Figure 2a). Above ground weed nitrogen on the clay soil was 2-6 kg N ha^{-1}. In the field experiment on the sandy soil, the above ground crop nitrogen content amounted to 100 kg N ha^{-1} on average in the treatments with pelleted fertilizers, with around 93 kg N ha^{-1} in the lower yielding treatments, 105 kg N ha^{-1} in the intermediate yielding treatments and 115 kg N ha^{-1} in the highest yielding treatment (Figure 2b). Above ground weed nitrogen on the sandy soil was 3-7 kg N ha^{-1}.

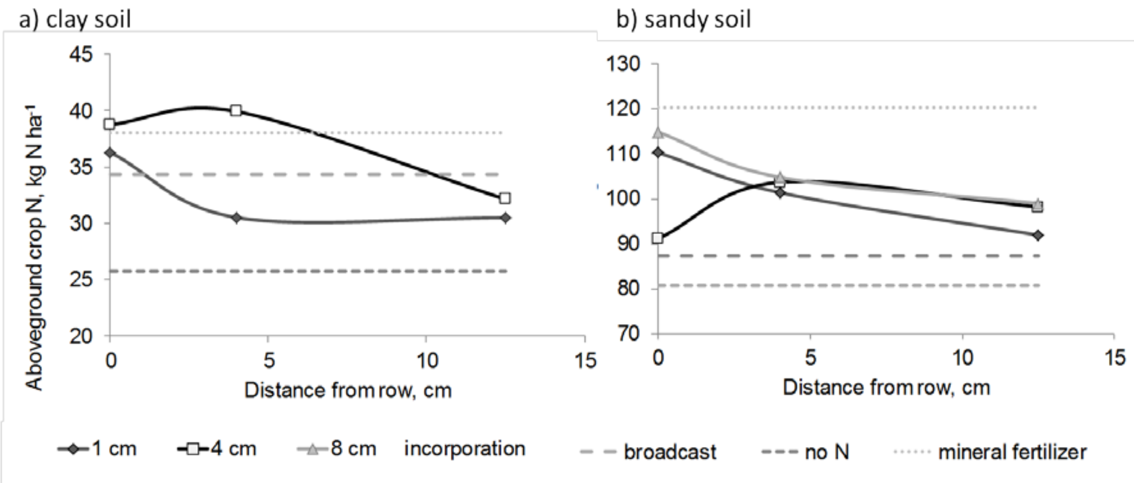

Figure 2: Aboveground crop nitrogen in treatments with different placement of pelleted fertilizer at different depths and distances from crop row compared to broadcasting, no fertilization and mineral fertilization in field experiments performed on (a) clay soil and (b) sandy soil.

4. Conclusion and outlook

It is too early to draw conclusions from only one year of results. However, the results indicate that placement of organic fertilizer close to the crop row and incorporation deeper in the soil can improve yield and reduce weed biomass compared to broadcasting and fertilizing shallowly between rows.

Acknowledgements

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References

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