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EFFECT OF SUBHERBICIDAL LEVELS OF 2, 4-D, ISOPROTURAN AND ATRAZINE ON THE NITROGEN METABOLISM AND GROWTH OF OATS (AVENA SATIVA LINN.)

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SUMMARY

Foliar application of 2, 4-D, isoproturan and atrazine at subherbicidal concentrations on oat crop caused enhancement of nitrate reductase activity, protein and chlorophyll content, plant height, number of tillers per plant, leaf area index and total dry matter production. The subherbicidal doses also caused increased N uptake by the crop. The results show that at subherbicidal levels 2, 4-D, isoproturan and atrazine act as growth regulating substance and can be used to improve yield under field conditions.

INTRODUCTION

There are reports that herbicides at subherbicidal concentrations act as plant growth promotors. They stimulate plant metabolism, promote rapid growth and thus result in higher yield (Mohandass *et al.*, 1978, Santakumari and Reddy 1980 and McCracken *et al.*, 1981). Present investigation was conducted to study the effect of subherbicidal levels of 2, 4-D, Isoproturan and atrazine on fodder oats.

MATERIALS AND METHODS

An experiment was conducted during the rabi (winter) season of 1983-84 with the oat (*Avena sativa* Linn), variety Kent at the forage research farm of National Dairy Research Institute, Karnal. Soil of the farm was clay loam which was low in available N (170 kg/ha) and medium in available P (14.6 kg/ha) and K (220 kg/ha). Planting was done on 10th November, 1983. Seeds were sown in rows 20cm. apart at a uniform seed rate of 80kg/ha. Crop was fertilized with 80 kg N (urea) and 40 kg P. (single superphosphate) per ha. Full dose of P and half dose of N were applied at the time of sowing and remaining

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half dose of N was applied after first irrigation (30 days of sowing). Herbicides were sprayed after 35 days of sowing in the form of aquous solution (600 litre/ha) according to the following treatments : 2, 4-D—0.05, 0.10, 0.25 and 0.50 kg ae/ha, isoproturan—0.1, 0.2, 0.5 and 1.0 kg ai/ha and atrazine-0.05, 0.10, 0.15 and 0.20 kg ai/ha. Experiment was laid out in randomized block design with three replications.

Observations were recorded on plant height, number of tillers/plant, leaf area index, total dry matter production, nitrate reductase activity, protein content chlorophyll content and also dry weight of weeds and nitrogen uptake by the weeds. In-vivo nitrate reductase activity was assayed according to the method of Klepper *et al.* (1971) with some modifications. Chlorophyll content of leaf tissue was estimated by the method of Arnon (1949). Nitrogen in dried crop material and weed samples was estimated by the Kjeltec System I (Tecator, Sweden). Protein content was calculated by multiplying the amount of nitrogen with a factor of 6.2.

RESULTS

Enzymic and Chemical Analysis

Nitrate reductase activity and protein content were higher at boot stage than at jointing stage (Table I). However, chlorophyll content was high at jointing stage. Application of 2, 4-D at 0.05, 0.1 and 0.25 kg/ha increased nitrate reductase activity, the maximum increase being at 0.1 kg/ha 2, 4-D. Protein and chlorophyll contents of the plant were also similarly affected by 2, 4-D application.

Though isoproturan application (1.0 kg/ha) resulted in an increase in enzyme activity, protein and chlorophyll contents, the maximum beneficial effect was observed when crop was sprayed at the rate of 0.2 kg/ha. Application of atrazine at the lowest level (0.05 kg/ha) resulted in a slight increase in nitrate reductase activity but a further increase in atrazine concentration resulted in a significant decrease in enzyme activity. However, in case of protein and choloro-phyll contents beneficial effect of atrazine were observed upto 0.10 kg/ha.

Growth Parameters

Results on growth parameters are reported in Table II. Beneficial effect of of 2, 4-D in terms of increase in plant height, leaf area index, tiller number/plant and total dry matter production were noted upto 0.25 kg/ha, but the best results

Table I : Effect of different concentrations of 2, 4-D, isopreturan and atrazine on nitrate reductase activity, protein content and chlorophyll content of oats.

Treatments Herbicides kg/ha	Nitrate reductase activity* n moles NO_2(g^{-1}F.W. hr^{-1})		Protein content (%)		Chlorophyll content mg g^{-1} F. W.	
	Jointing stage	Boot stage	Jointing stage	Boot stage	Jointing stage	Boot stage
Control						
2, 4—D	554.7	646.4	7.73	9.53	2.11	1.84
0.05	589.1	695.3	8.47	10.81	2.37	2.00
0.10	624.7	764.7	8.96	10.98	2.62	2.18
0.25	601.9	628.5	8.36	9.84	2.37	2.08
0.50	585.3	683.4	7.99	9.68	2.25	1.94
Isoproturan						
0.1	574.0	691.4	8.41	10.45	2.36	1.97
0.2	613.5	743.4	8.75	10.75	2.51	2.11
0.5	584.6	710.6	8.31	10.00	2.33	1.96
1.0	564.3	688.1	8.09	9.77	2.27	1.85
Atrazine						
0.05	564.0	690.3	8.56	9.90	2.30	1.92
0.10	542.7	636.9	8.16	9.76	2.14	1.79
0.15	495.7	561.4	7.61	8.96	1.93	1.64
0.20	449.7	449.9	7.42	8.53	1.80	1.54
Mean	564.9	666.2	8.21	9.92	2.26	1.91
SEm±	3.82	6.38	0.05	0.06	0.03	0.03
C.D. at 1%	15.11	25.25	0.19	0.23	0.13	0.12

were observed when crop was sprayed at the rate of 0.10 kg/ha. Application at the rate of 0.5 kg/ha resulted in phytotoxic effects. In case of isoproturan, application at the rate of 0.2 kg/ha gave best results for all the growth parameters. Higher levels of isoproturan (0.5 and 0.10 kg ai/ha) resulted in a general decrease in plant height, leaf area index, number of tillers and dry matter production. Atrazine application at the rate of 0.05 kg/ha resulted in a slight increase in plant growth paramaters. Higher concentrations of atrazine resulted in a severe decrease in plant growth and dry matter production. Among all the treatments, application of 2, 4-D at the rate of 0.10 kg/ha produced the maximum beneficial effect.

N uptake by the Weeds and Crop

Results on N uptake by the crop and weeds are reported in Table II. Application of 2, 4-D upto the highest level (0.5 kg/ha) resulted in increased N

Table II : Effect of different concentrations of 2, 4-D, isoproturan and atrazine on the growth drymatter yield and N uptake of oats.

Treatments Herbicide kg/ha	Plant height (cm)	No. of tillers per plant	Leaf Area Index	Total dry matter Production (Q/ha)	N uptake by the crop (kg/ha)	N uptake by the weeds (kg/ha)
Control	128.3	3.2	5.06	82.9	120.2	0.71
2, 4—D						
0.05	144.3	5.4	7.52	107.3	195.7	0.57
0.10	160.4	6.6	8.10	113.3	207.3	0.50
0.25	136.4	4.5	6.13	94.0	160.2	0.37
0.50	120.6	3.2	4.25	90.2	143.1	0.26
Isoproturan						
0.10	140.2	4.8	6.15	107.7	177.0	0.62
0.20	151.5	5.5	6.67	116.1	194.9	0.54
0.50	144.4	4.0	5.55	101.0	169.3	0.44
1.00	128.3	3.7	5.04	94.5	149.8	0.30
Atrazine						
0.05	128.2	4.2	5 44	91.7	143.3	0.61
0.10	118.1	3.6	4.65	79.9	112.5	0.51
0.15	111.9	2.8	4.01	68.7	101.2	0.47
0.20	104.4	2.3	2.85	60.9	82.1	0.39
Mean	132.1	4.2	5.50	92.9	150.5	0.48
SE m±	2.53	0.17	0.14	1.74	3.18	0.02
C.D. at 5%	10.02	0.68	0.52	6 88	12.57	0.06

uptake than the control plants. However, the maximum uptake was observed at 0.1 kg/ha. Incase of isoproturan application too, N uptake increased upto the highest level though the best results were observed at 0.2 kg/ha. Spray of atrazine at the rate of 0.05 kg/ha resulted in slight increase in N uptake. Higher levels of atrazine significantly decreased the crop N uptake.

Dry weight of weeds and N uptake by the weeds were drastically reduced by the application of herbicides with increasing concentration. Maximum herbicidal effects were observed at 0.5 kg/ha 2, 4-D followed by 1.0 kg/ha isoproturan and 0.2 kg/ha atrazine application.

DISCUSSION

There are reports that herbicides at subherbicidal concentrations stimulate plant growth and metabolism. Tweedy and Ries (1967) and Mohandass *et al.* (1978) have reported an increase in the activity of nitrate reductase on the application of simazine and atrazine in the cases of maize and barley, respectively. However, some depressing effect of herbicides on plant functions have also been reported (Salunkhe *et al.*, 1971, Houstan, 1975 and Santakumari and Reddy, 1980). In the present study 2, 4-D and isoproturan application to oat at the rate of 0.1 and 0.2 kg/ha respectively resulted in maximum enhancement of nitrate reductase activity, while atrazine application at the rate of 0.05 kg/ha caused a slight increase in enzyme activity. At the same levels of application there were parallel increase in protein and chlorophyll contents. This suggests a hormonal effect of the lower doses of herbicides on plant metabolism. (Terrillon and Paynot, 1973, Santakumari and Dass, 1979 and Lablova *et al.*, 1981). Increased content of protein and chlorophyll in plant tissue could either be the direct effect of lower doses of herbicides or the indirect effect of increased nitrate reductase activity leading to more availability of reduced nitrogen. The enhanced rate of plant metabolism is translated in the form of increased crop growth and dry matter production.

Herbicides as expected resulted in a decrease in weed growth. They also reduced the loss of nitrogen from the soil by minimizing the N uptake by the weeds. Another effect of all the three herbicides on main crop was increased N uptake. This increase in N uptake by the crop can not be attributed to a reduction in weed growth and prevention of N uptake of the weeds by the herbicides because while at the highest levels of herbicides application the net saving of N was 0.45, 0.41 and 0.32 kg/ha in case of 2, 4-D, isoproturan and atrazine respectively, the increase in N uptake by the crop at the optimum levels of herbicides was 87, 74 and 23 kg/ha.

Thus, it will be appropriate to assume that at subherbicidal levels, herbicides acts as growth promotors as they enhance enzyme activity, N uptake, protein content, chlorophyll content and over all growth and dry matter production of the crop.

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