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Effect of Pre-emergence Herbicides on Nodulation, Nitrogen Fixation and Morphological Characters in Groundnut (*Arachis hypogaea*)

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Abstract: Effect of different concentrations of three pre-emergence herbicides namely, pendimethalin (N-(1-ethylopropyl) 2,6-dinitro-3-4-xylidine), trifluralin (2,6-dinitro-N-N-dipropyl-4-trifluoromethylaniline) and oxadiazon (3-(2-4 dichloro-isopropoxy Phenyl) -5-t-butyl -3, 4 oxadizaolin 2-one) on nodulation, nitrogen fixation, morphological characters and some other parameters have been investigated in groundnut (*Arachis hypogaea*), L. cv Banki. Pendimethalin at 0.74, 1.49, 2:23, trifluralin at 0.37, 0.75, 1.20 and oxadizon at 0.30, 0.60, and 0.90 kg ha^{-1} was incorporated in soil before sowing. Data were recorded 40, 70 and 90 days after germination. Recommended doses of these herbicides in general had no significant effect on different parameters under investigation. Higher doses of these herbicides adversely affected the nodulation and the fresh and dry weights of nodules. However higher concentration of oxadiazon resulted in increased N accumulation in shoots of groundnut plants. It was concluded that the herbicides under investigation did not affect the groundnut plants adversely if used at recommended levels.

Key words: Herbicides, nodulation, morphological traits, groundnut

Introduction

Weeds are one of the most important constraints, which limit the production of groundnut in Pakistan. Weeds reduce crop yields by competing with crops mainly for light, nutrients, water and CO_2 (Anderson, 1983). The yield reduction due to weeds has been reported up to 30-80% (Gill *et al*., 1986). It is recorded that serious loss (25 to 45%) in pod yield of groundnut is due to weeds infestations especially during the early stages of crop development (Reddy, 1984).

Various pre and post-emergence herbicides have been reported to give selective weed control in groundnut. Alcohol, metachlor, pendimethalin, beutazon, butachlor, imazethapyr oxyflurofen and vernolate have been used for weed control in groundnut (Brecke *et al*., 1996; Grichar *et al*., 1996; Rafey and Prasad 1995; Vehu *et al*., 1994). Mohanty *et al*. (1997) studied the efficacy of fluchoralin and pendimethalin for weed control in groundnut. The herbicides lasso and toke 25 were found to be very effective weed killer in groundnut crop (Singh and Singh, 1972). The heribcide oxyfluorfen showed increased pod yield per hectare by 53-64 percent in groundnut crop (Widaryanto, 1994).

Herbicides are widely used in agriculture without their proper investigation of their side effects. This is of particular importance with legumes as herbicides not only affect the plant growth but soil symbiosis is also affected which ultimately leads to decrease in nodulation and nitrogen fixation. Malavia and Patel (1989) reported reduction in nodulation in groundnut crop by herbicide treatment. Novo *et al*. (1991) reported abundant nodulation in groundnut crop treated with pendimethalin (at 1.25 kg ha^{-1}) and trifluralin (at 1.08 kg ha^{-1}) but seed production was not affected. Pendimethalin and trifluralin applied in soybean crop reduces C_2H_2 production during vegetative stage but seed yield was not affected (Bollich *et al*., 1988). It is reported that pendimethalin treatments increase shoot weight and nodulation in the leguminous crops (Prakash and Pahwa, 1982). Durgesha and Lakshminarashimhan (1989) reported reduction in root and shoot growth and nodulation with increasing amounts of fluchloralin in groundnut crop.

Lac and Nguyen (1993) reported that the herbicide 2,4,5-T depressed nodulation and nitrogenase activity. Herbicide imazethapyr inhbits the growth of symbiotic plants rather than having direct effect on bacteria (Gonzalez *et al*., 1996). Pahwa *et al*. (1988) studied the effect of three herbicides (Pendimethalin fluchlorlin and fuazifop. Butyl) on growth, nodulation and symbiotic nitrogen fixation in pigeon pea. There was no adverse effect of pendimethalin (at 0.75 kg ha^{-1}) oxadiazon (at 0.5 kg ha^{-1}) and fluchloralin (at 0.75 kg ha^{-1}) (Brar and Mehra, 1989). The herbicide linuron at 1.20 kg ha^{-1}) reduced nodulation by affecting the number and dry wt. of nodules and nitrogenase activity in groundnut crop after 30. 50 and 80 days of germination (Novo *et al*., 1990). Vidal *et al*., (1992) reported that *Vicia faba* plants treated with the herbicide methabeurthiazuson showed an increase in nodulation, nitrogenous activity and vegetative growth at early pod fill. Conflicting reports are cited in the literatuer regarding the side effects of herbicides in groundnut and other legumes. Studies are initiated to quantify the effects of pendimethalin, trifluralin and oxadiazon (pre emergence herbicides) in groundnut crop. The specific objectives of these studies were to:

a] Ascertain the effect of above mentioned herbicides on groundnut nodule activity
b] Determine their effect on nodulation
c] Evaluate the effect on plant mass

Materials and Methods

The set of experiment was conducted at Quaid-i-Azam University, Islamabad under a net house condition using a randomized complete block design with three replicates and 102 treatments. The soil was brought to field capacity and seed of groundnut (*Arachis hypogaea*) cv Banki inoculated with Rhizobium strain NC 92 were sown in clay pots filed with sandy clay loam soil (pH 7.7). Herbicides were mixed with the soil before sowing. After germination, plants were thinned to two plants per pot.

On the $40^{th,}$ 70^{th} and 80^{th} day after germination, three pots were sampled from each treatment at random. The root system of plants from soil was carefully removed under running tap water without causing loss of nodules. The root system of plants was separated and two plants in each

treatment were used or growth analysis. Nodules were carefully counted and removed by hand to determine their fresh and dry weights. Nitrogen fixing efficiency of nodules was determined by the acetylene reduction assay using the excised root system (Hardy *et al.*, 1968). The length of shoot and root was measured. Fresh and dry weights of shoot and root were determined separately.

Different treatments under study were:

Control	0.00 kg at ha^{-1}
Pendimethalin	0.74kg at ha^{-1}
Pendimethalin	1.49 kg at ha^{-1}
Pendimethalin	2.23 kg at ha^{-1}
Trifluralin	0.37 kg at ha^{-1}
Trifluralin	0.75 kg at ha^{-1}
Trifluralin	1.20 kg at ha^{-1}
Oxadiazon	0.30 kg at ha^{-1}
Oxadiazon	0.60 kg at he^{-1}
Oxadiazon	0.90 kg at ha^{-1}

The data regarding nodulation, nitrogen fixation and growth were recorded and analyzed statistically by the analysis of variance method and Duncan's new multiple range test at 5 percent probability level was applied to test the significance of treatment means (Duncan, 1955; Steel and Torrie, 1980).

Results and Discussion

Herbicidal treatment did not inhibit germination of seed and all seeds sown were germinated and emerged out of soil. The number of nodules (Table 1) was reduced by all treatments of herbicides than control. Brar and Mehra (1989) reported no effect of herbicides on nodulationa and mass of nodules. Higher doses of all herbicides caused greater redution in nodule number, fresh and dry weights of nodules and nitrogen fixation than the lower doses. Acetylene reduction did not vary significantly in all the treatments. These findings confirm the results of Ozair and Moshier (1988). Inhibitory effects of higher doses of herbicides on nodulation, fresh and dry weights an nitrogen fixation have been reported by

Table 1: Effect of Some Hebicides on Nodualtion Fresh, Dry Weight of Nodules and Nitrogen Fixation in Groundnut

		Days After									Germination		
		No. of Nodules			Fresh wt. of Nodules (g)			Dry wt. of Nodules (g)			Nitrogen fixation (m. Moles)		
Treatment	Kg at ha	40	70	90	40.00	70.00	90.00	40.00	70.00	90.00	40	70	90
Control	0	52a	160	140a	0.45	0.66	0.71	0.05	0.25	0.22a	377	108	58
Pendimethalin	0.74	32ab	82ab	108ab	0.20	0.51	0.71	0.07	0.16	0.22a	390	60	51
Pendimethalin	1.49	16b	98ab	83bc	0.20	0.58	0.62	0.07	0.18	0,19a	347	77	53
Pendimethalin	2.23	16b	40b	47c	0.14	0.24	0.34	0.04	0.18	0.10a	287	53	46
Trifluralin	0.37	14b	37b	59bc	0.13	0.27	0.43	0.03	0.18	0.13a	507	134	77
Trifluratin	0.75	16b	70b	60bc	0.18	0.45	0.47	0.05	0.18	0.14a	440	24	48
Trifluralin	1.2	10b	31b	63bc	0.17	9.21	0.36	0.07	0.07	0.10a	120	90	78
Oxadiazon	0.3	26ab	86b	72bc	0.18	0.38	0.58	0.04	0.19	0.19a	320	163	70
Oxadiazon	0.6	13b	93ab	76bc	0.19	0.5	0.49	0.04	0.16	0.16a	325	105	62
Oxadiazon	0.9	27ab	58b	50c	0.18	0.31	0.21	0.03	0.12	0.07a	373	133	29
L.S.D	(0.05)	19	53	34	NS	NS	NS	NS	0.7	0.09	NS	NS	NS

Table 2: Effect of Some Hebicides on Stem length, Fresh and Dry Weight of Shoot in Groundnut

		Days After						Germination		
		Shoot length (cm)			Shoot fresh weight (g)			Shoot dry weight (g)		
Treatment	Kg at ha	40	70	90	40.0	70	90	40.0	70.0	90.0
Control	(0.00)	52a	65a	89a	10.1	29.0a	28.0bc	3.7a	16.08	20.0
Pendimethalin	(0.74)	28b	59a	68ab	8.3	23.0abc	45.6b	2.3bc	7.3bc	16.1
Pendimethalin	(1.49) (14.0)	39ab	49ab	59ab	7.7	22.0abc	32.Obc	1.97bc	6.9bc	
Pendimethalin	(2.23)	29b	33b	61ab	6.9	11.3c	21.0c	1.8c	3.8c	6.7
Trifluralin	(0.37)	39ab	46ab	78ab	9.6	12.5bc	35.8bc	2.6abc	3.8c	10.3
Trifluralin	(0.75)	35ab	53ab	55ab	7.8	16.6bc	34.5bc	2.Obc	4.9c	11.0
Trifluratin	(1.20)	34ab	45ab	49b	6.8	14.1 be	26.5bc	1.7c	6.3bc	11.1
Oxadiazon	(0.30)	35ab	44ab	70ab	9.5	22.3abc	38.7bc	2.7abc	10.7b	17.8
Oxadiazon	(0.60)	44ab	41ab	71ab	8.9	23.9ab	64.4a	2.4bc	8.2bc	17.6
Oxadiazon	(0.90)	40ab	55ab	67ab	10.9	22.2abc	29.1bc	3.1ab	7.6bc	9.0
L.S.D	(0.05)	12	15.1	21.1	NS	7.3	12.8	0.77	2.9	NS

Table 3: Effect of Some Hebicides on the Primary Root Length, Fresh and Dry Weight of Shoot in Groundnut

		Days After						Germination		
		Shoot length (cm)			Shoot fresh weight (g)			Shoot dry weight (g)		
Treatment	Kg at ha	40	70	90	40	70.0	90.0	40.0	70.0	90.0
Control	(0.00)	25	32	34	1.9	1.82abc	2.0	0.9	0.92a	1.0
Pendimethalin	(0.74)	21.4	27	27	0.9	1.89ab	2.1	0.5	0.91a	0.93
Pendirnethalin	(1.49)	16	26	27	0.93	1.93a	2.0	0.5	0.94a	0.98
Penchmethailn	(2.23)	16	25	19	0.76	1.60bcd	1.8	0.5	0.84ab	1.0
Trifluralin	(0.37)	25	29	30	1.0	1.95a	2.18	0.57	0.76abc	0.98
Trifluralin	(0.75)	16	28	28	0.9	1.86ab	1.95	0.57	0.60bc	1.0
Trifluralin	1.20)	19	25	25	0.9	1.81abc	1.95	0.50	0.57bc	0.89
Oxadiazon	(0.30)	23	28	32	0.77	1.53cd	1.66	0.57	0.52c	0.83
Oxadiazon	(0.60)	23	30	32	0.7	1.40d	1.6	0.47	0.52c	0.8
Oxadiazon	(0.90)	27	30	30	0.77	1.50d	1.6	0.4	0.55c	0.84
L.S.D	(0.05)	NS	NS	NS	NS	0.2	NS	NS	0.18	NS

Pahwa *et al*. (1988), Bollich *et al*. (1988), Novo *et al.* (1990) and Lac and Nguyen (1993).

Stem length (Table 2) was affected by all the herbicidal treatments. The application of pendimethalin and trifluralin to the soil had greater adverse effect on stem length than the oxadiazon. Lower doses of herbicides had less pronounced affect on fresh and dry weights of shoot (Table 2) than the higher doses of herbicides in all the treatments. Durgesha and Lakshminarashimhan (1989) reported the suppression of shoot development. Stern length reduction may be due to herbicides effect onenzyme of protein synthesis ultimately leading to some suppression of cell division. Durgesha (1993) reported that fluchloralin and 2, 6 Dichlorophenatindophendol inhibited nitrite reductase activity in groundnut. Deal and Hess (1980) found that alachlor inhibited cell division and cell enlargment. Similarly Zelmer and Guenther (1988) reported that most of the herbicides caused an inhibition of the enzymatic activities of GDH and stimlated the GOGOAT in *Beta vulgaris* and *Chenopodium album.*

The root length is not affected by all herbicides. Higher doses of all herbicides reduced the fresh wegiht of root (Table 3) significantly. The dry weight of roots treated with all the herbicides did not show significant difference. These results deviate from those of Pahwa *et al*. (1988).

From the above discussion, it appears that oxadiazon is most suitable and creates less problems in the physiology of the crop plants.

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