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Effect of foliar sprays of Ethrel on growth of soybean

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Abstract
The present study examined the effectiveness of foliar sprays of ethrel on growth and yield of soybean (*Glycine max*). A field experiment was conducted at an experimental farm of Botany section, College of Agriculture, Nagpur by growing soybean during the *kharif* season in the crop area spanning from July 2013 – November 2013, using randomized block design. The effectiveness of foliar sprays of ethrel was studied as control (water spray) and with 5 different levels of ethrel (100, 150, 200, 250 and 300 ppm). Soybean plants were sprayed two times at 15 day intervals at 30 and 45 DAS with different concentrations of ethrel. Recorded data showed that all morpho-physiological parameters including plant height, number of branches, leaf area, dry matter production, RGR and NAR as well as yield ha^{-1} of soybean plants showed positive and significant responses with the foliar application of 150 ppm ethrel followed by 100 ppm ethrel when compared with control.

Keywords: Soybean, ethrel, growth and yield

Introduction
Soybean (*Glycine max* L.) is one of the important oilseed as well as leguminous crop. Soybean is a diploid species having chromosome number 2n=40.It belongs to family "Leguminoseae" and subfamily "Papilionoidae". It is annual leguminous herbaceous plant.

Among, oilseeds soybean ranks fifth in the world. The important soybean growing countries in world are America, Brazil, Argentina, China and India. The largest soybean producing state in India are Madhya Pradesh, Maharashtra and Rajasthan. In India Maharashtra having Second rank in production.

Soybean is also known as "Gold of Soil" due to its various qualities such as ease in cultivation, less requirement of fertilizers and labour resulting in high cost : benefit ratio. Soybean being a legume crop is gifted naturally to fix atmospheric nitrogen in the root nodules with the help of *Rhizobium*. It fixes 69 to 168 kg of nitrogen ha $^{-1}$ which helps in maintaining soil fertility Ethylene (ethrel) is a plant growth regulator involved in various aspects of growth and photosynthesis of plants at both whole plant and cellular levels [1]; [2]; [3].

Ethylene released from ethrel (2-chloroethylphosphonic acid) could possibly be utilized for promoting pod growth as [4] had shown that early pod development is related to higher ethylene levels, thus decreasing flower and pod shedding and thereby reducing abscission and improving better pod set.

Hence, an attempt has been made in the present investigation to asses the influence of foliar sprays of ethrel on morpho-physiological parameters and yield of soybean.

Materials and Methods
A field experiment on soybean was conducted at an experimental farm of Botany section, College of Agriculture, Nagpur. The present investigation was undertaken during the *kharif* season of 2013-2014. The field experiment was laid out in Randomized block Design (RBD) with four replications consisting of six treatments with different concentrations of ethrel (100, 150, 200, 250 and 300 ppm). Spraying of ethrel was done two times at 30 and 45 DAS with hand sprayer. Observations on plant height, number of branches, leaf area and dry matte were recorded at different stages i.e. at 45, 60 and 75 DAS. RGR and NAR were recorded and calculated at 45-60 and 60-75 DAS. Seed yield ha^{-1} was also noted. The crop was kept free from disease and pest during the growth period. Harvesting was under taken after the crop attained maturity. Data was analysed by statistical method suggested by [5].

Results and Discussion

Morpho-physiological observations

Observations on plant height plant^{-1}, number of branches plant^{-1}, leaf area plant^{-1}, and dry matter production plant^{-1} were recorded at 45, 60 and 75 DAS and seed yield was also recorded.

Plant height plant^{-1}(cm)

Data regarding plant height were recorded at 45, 60, and 75 DAS. Significant variation was noticed at every stage of observation by the foliar sprays of ethrel. At 45 significantly maximum plant height was recorded in treatment T_4 (200 ppm ethrel) followed by the treatment T_3 (150 ppm ethrel) when compared with treatment T_1 (control) and remaining treatments under study. While, treatments T_6 (300 ppm ethrel) and T_2 (100 ppm ethrel) were found at par with treatment T_1 (control).

At 60 and 75 DAS significantly maximum plant height was recorded in treatment T_4 (200 ppm ethrel) followed by the treatments T_3 (150 ppm ethrel) and T_5 (250 ppm ethrel) when compared with treatment T_1 (control) and remaining treatments under study. While, treatments T_6 (300 ppm ethrel) and T_2 (100 ppm ethrel) were found at par with treatment T_1 (control).

[6] carried out a field experiment to study the foliar spray of ethrel at different concentrations (250, 500 and 750 ppm) on maize hybrids S.C 10 and D.C. Taba at an interval of 15, 20 and 25 DAS. Foliar spray of ethrel at 250 ppm gave highest plant height.

[7] conducted a field experiment in *kharif* season to study the response of soybean variety JS 335 to salicyclic acid (50 ppm), ethrel (200 ppm) and cycocel (500 ppm) applied as foliar spray at different stages. The study revealed that application of ethrel at 200 ppm gave highest plant height over control.

Number of branches plant^{-1}

Data regarding number of branches were recorded at 45, 60 and 75 DAS and found statistically significant.

At 45 DAS significantly maximum number of branches were recorded in treatment T4 (200 ppm ethrel) followed by T3 (150 ppm ethrel) in a descending manner when compared with treatment T1 (control) and remaining treatments under study. While, treatment T6 (300 ppm ethrel) and T2 (100 ppm ethrel) were found at par with treatment T1 (control) in respect of number of branches plant-1.

At 60 and 75 DAS significantly maximum number of branches were noticed in treatment T4 (200 ppm ethrel) followed by the treatment T3 (150 ppm ethrel) when compared with treatment T1 (control) and remaining treatments under study. While, treatments T5 (250 ppm ethrel), T6 (300 ppm ethrel) and T2 (100 ppm ethrel) were found at par with treatment T1 (control).

[7] conducted a field experiment in *kharif* season to study the response of soybean variety JS 335 to salicyclic acid (50 ppm), ethrel (200 ppm), cycocel (500 ppm) and control (water spray) applied as foliar spray at different stages i.e. flower-initiation (40 DAS), pod-initiation (60DAS) and flower-initiation + pod-initiation stage. The study revealed that application of ethrel at 200 ppm gave the highest number of branches plant-1 in soybean.

[8] studied the effect of plant growth regulators on pigeonpea and found that 200 µg ml-1 ethrel increased the number of branches plant-1

Leaf area of plant

Data on leaf area plant^{-1} were recorded at three stages viz., 45, 60 and 75 DAS. Leaf area recorded at these stages gave significant results.

At 45 DAS significantly maximum leaf area was noticed in treatment T_4 (200 ppm ethrel) followed by treatments T_3 (150 ppm ethrel) T_5 (250 ppm ethrel) and T_6 (300 ppm ethrel) in a descending manner when compared with treatment T_1 (control) and remaining treatments under study. Treatment T_2 (100 ppm ethrel) was found at par with treatment T_1 (control).

At 60 DAS significantly maximum leaf area was noticed in treatment T_4 (200 ppm ethrel) followed by treatments T_3 (150 ppm ethrel) and T_5 (250 ppm ethrel) in a descending manner when compared with treatment T_1 (control) and remaining treatments under study. While, Treatment T_2 (100 ppm ethrel) was found at par with treatment T_1 (control).

At 75 DAS significantly maximum leaf area was noticed in treatment T_4 (200 ppm ethrel) followed by treatment T_3 (150 ppm ethrel) when compared with treatment T_1 (control) and remaining treatments under study. While, Treatment T_2 (100 ppm ethrel) was found at par with treatment T_1 (control).

Hence, it can be stated that the higher leaf area might be due to ethrel enhanced ethylene biosynthesis. The higher ethylene evolution led to higher leaf area and thus greater light interception and photosynthesis [9, 10] studied the effect of ethrel (200 µ l l^{-1}) and nitrogen (0, 40, 80 and 120 kg N ha.$^{-1}$) on mustard. Ethrel treated with 200 µ l l^{-1} at flowering stage along with basal application of nitrogen at 80 kg ha^{-1} were recorded the highest leaf area. [11] reported that foliar application of ethrel at 200 ppm significantly increased leaf area in soybean.

Dry matter production

Data on dry matter production were recorded at the three growth stage i.e. 45, 60 and 75 DAS gave significant variation.

At 45 DAS significantly maximum dry matter was noticed in treatment T_4 (200 ppm ethrel) when compared with treatment T_1 (control) and remaining treatments under study. Also, treatments T_3 (150 ppm ethrel) T_5 (250 ppm ethrel), T_6 (300 ppm ethrel) and T_2 (100 ppm ethrel) were found significantly superior over treatment T_1 (control).

At 60 DAS significantly maximum dry matter was noticed in treatment T_4 (200 ppm ethrel) when compared with treatment T_1 (control) and remaining treatments under study. Also, treatments T_3 (150 ppm ethrel) and T_5 (250 ppm ethrel) found significantly superior over treatment T_1 (control). Treatments T_6 (300 ppm ethrel) and T_2 (100 ppm ethrel) were found at par with treatment T_1 (control).

At 75 DAS significantly maximum dry matter was noticed in treatment T_4 (200 ppm ethrel) followed by treatment T_3 (150 ppm ethrel) when compared with treatment T_1 (control) and remaining treatments under study. Also, treatments T_5 (250 ppm ethrel) and T_6 (300 ppm ethrel) were found significantly superior over treatment T_1 (control). Treatment T_2 (100 ppm ethrel) was found at par with treatment T_1 (control).

Significant increase in dry matter from 45-75 DAS might be due to increase in the leaf area and photosynthetic capacity.

[12] reported that foliar spray of ethrel at 50 ppm significantly increased dry weight of a plant in urdbean.

[7] observed that application of ethrel at 200 ppm increased dry weight of plant significantly in soybean.

Table 1: Effect of foliar sprays of ethrel on morpho-physiological parameters of soybean

Treatments	Plant height (cm)			Number of branches			Leaf area plant^{-1} (dm^2)			Total dry matter plant^{-1} (g)		
	45 DAS	60 DAS	75 DAS	45 DAS	60 DAS	75 DAS	45 DAS	60 DAS	75 DAS	45 DAS	60 DAS	75 DAS
T_1 (Control)	29.33	37.77	39.92	2.61	3.40	3.43	6.24	10.54	10.25	4.56	8.83	12.80
T_2 (25 ppm ethrel)	29.96	39.61	43.32	2.92	3.46	3.49	6.89	11.01	10.88	5.55	10.92	16.16
T_3 (50 ppm ethrel)	34.23	43.13	47.30	3.94	4.36	4.38	7.42	12.46	12.17	10.27	18.13	29.16
T_4 (75 ppm ethrel)	34.47	45.75	49.06	4.02	4.42	4.45	7.71	12.71	12.34	11.27	22.06	30.30
T_5 (100 ppm ethrel)	30.97	42.75	47.19	3.36	3.68	3.65	7.27	11.97	11.51	8.48	16.29	26.20
T_6 (125 ppm ethrel)	30.65	39.73	44.22	3.22	3.62	3.70	7.07	11.67	11.39	6.58	11.19	19.15
SE(m) ±	1.261	1.666	1.655	0.273	0.239	0.228	0.227	0.450	0.458	0.330	0.992	1.166
CD at 5%	3.623	4.786	4.754	0.784	0.669	0.656	0.651	1.293	1.315	0.947	2.850	3.350

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