

## Potential of plant-growth regulators and nutrients sprays on yield and yield components in lucerne (*Medicago sativa*)

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### ABSTRACT

An experiment was conducted at the Punjab Agricultural University, Ludhiana, during the winter (*rabi*) seasons of 2017–18 and 2018–19, to evaluate the effects of different plant-growth regulators and nutrients applied as foliar sprays on yield and yield components of lucerne (*Medicago sativa* L.). The treatments comprised foliar applications of 0.25% ZnSO<sub>4</sub>, 1.0% K<sub>2</sub>SO<sub>4</sub>, 1.0% (monoammonium phosphate) MAP, 100 ppm salicylic acid, 500 ppm mepiquat chloride and 1.0 ppm brassinolide at pre-flowering stage and 10 days after the first spray along with the control. Plant-growth regulators and nutrient sprays significantly increased the seed yield of lucerne over control by 22.4 to 31.0% in 2017–18 and by 5.5 to 17.8% in 2018–19. The highest seed yield of 122.4 and 167.5 kg/ha in 2017–18 and 2018–19 respectively, was obtained with application of 1.0 ppm brassinolide. The significant increase in yield was obtained mainly owing to increase in number of pods/plant and number of seeds/pod. None of the foliar applications showed any effect on lucerne seed quality, i.e. 1,000-seed weight and seed germination. The monetary returns were also significantly higher with 1.0 ppm brassinolide application. Hence, plant-growth regulators may be used to enhance lucerne seed production while maintaining its seed quality.

**Key words:** Brassinolide, Foliar application, Lucerne, Plant-growth regulators, Seed yield

Lucerne (*Medicago sativa* L.), also known as alfalfa, is one of the oldest cultivated fodder crop. It is a perennial plant, capable of supplying green fodder from the same plant stand continuously for 3–4 years. In India, lucerne is the third important forage crop after sorghum and berseem, occupying 1 million ha area. In northern India, lucerne provides green fodder for longer period from November to June and throughout the year in other parts of the country where winter is not severe (Dhar *et al.*, 2005; Patel and Kotecha, 2006). Green fodder of lucerne is highly nutritious and palatable and is relished by all kinds of livestock. Owing to the high content of crude protein (16–25%) and appreciable crude fibre (20–30%), lucerne is capable of allowing sustainable animal production. With its high biomass potential and nutritional fodder, it is mainly grown for forage production and seed production takes a backseat (Babu *et al.*, 2014). The seed yield of lucerne has been reported to vary widely ranging from 60 to 1000 kg/ha because of seed yield being a very complex trait. Further, the balance between the vegetative and the reproductive

growth of lucerne is indeterminate and hence its seed production is low and vegetative biomass is more. Also, its non-synchronization habit, prolonged flower drop, uneven pod maturity and pod shattering lead to low seed yield (Sreedhara *et al.*, 2012). Improvement in lucerne seed yield through breeding has been limited because of different constraints to seed production in different growing regions. Besides, lucerne breeding work has been concentrated on improving the forage production and quality rather than its seed yield. Hence, certain agronomic practices can be employed to improve seed yield.

One of the important agronomic strategies to boost crop growth and development is the application of plant-growth regulators (PGRs) and nutrients. Plant-growth regulators are the new-generation chemicals and are expected to play an important role in overcoming the impediments in manifestation of biological yield (Manu *et al.*, 2021; Saini *et al.*, 2016). Of late, the use of these substances to enhance production in various agricultural/ horticultural crops is gaining pace and with encouraging results. Apart from the ‘classical five’ phytohormones - auxins, cytokinins, ethylene, abscisic acid and gibberellins; the potential of a growing number of non-traditional PGRs such as oligosaccharins, chlormequat, jasmonic acid, salicylic acid and brassinosteroids has been tapped in different grain,

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ornamental and other crops for enhancing crop quantity and quality. Seed production in a crop is the outcome of a number of developmental stages each requiring particular nutrients to maintain the metabolic status of plants especially during the reproductive phase. Spraying of growth-regulators and micronutrients is known to bring rapid changes in metabolic balance of growth and partitioning of assimilates as well as the quantity and quality of desired economic part in lucerne (Hazra and Sinha, 1996). In India, lucerne is the third important forage crop after sorghum and berseem and there is a dire need to increase its seed production to meet growers' demand for quality seed. Hence, this investigation was planned to evaluate the effects of certain plant-growth regulators along with foliar sprays of nutrients on seed yield of lucerne.

### MATERIALS AND METHODS

The field experiment was conducted during the winter (*rabi*) seasons of 2017–18 and 2018–19 at Forage research farm of the Punjab Agricultural University, Ludhiana (30°54' N, 75°48' E, 247 metres above mean sea-level), with a sub-tropical and semi-arid climate in the central plain region of Punjab state under Trans-Gangetic agro-climatic zone of India.

The experimental soil is sandy loam (Inceptisols), well-drained, non-saline (electrical conductivity 0.11 dS/m), neutral (*pH* 7.7) rated as low for organic carbon (0.36%), low for available nitrogen (189.0 kg/ha), available potassium (127.5 kg/ha) and medium for available phosphorus (17.6 kg/ha). The weather situation during the crop season during both the years of study was almost similar with respect to average temperature (Fig. 1), however, more rainfall was received during the second year (262.9 mm) compared to the first year (236 mm). Further, the rainfall received in the second year was more evenly distributed, while in the first year more than half of the rainfall (152.6 mm) was received in the later stages of the crop growth.

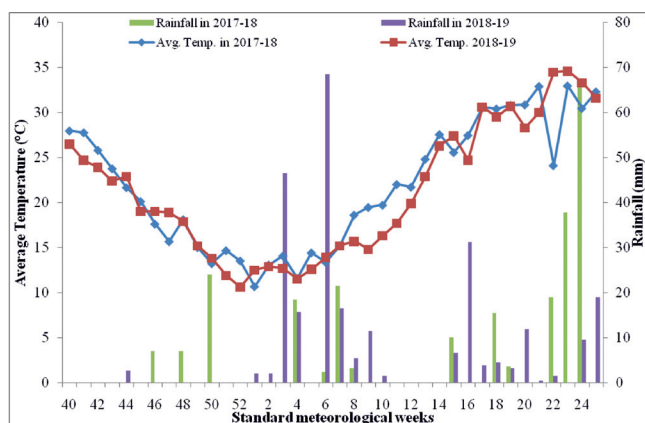


Fig. 1. Weekly weather data during the crop growing season of lucerne in 2017–18 and 2018–19

The experiment comprising foliar applications of 0.25% ZnSO<sub>4</sub>, 1.0% K<sub>2</sub>SO<sub>4</sub>, 1.0% monoammonium phosphate (MAP), 100 ppm salicylic acid, 500 ppm mepiquat chloride and 1.0 ppm brassinolide given at pre-flowering stage and at 10 days after first spray (using 500 litres/ha of spray fluid/spray) along with control (no foliar spray), was conducted in a randomized complete-block design with 3 blocks. Lucerne cultivar LL Composite 5 recommended for the region was sown in opened rows using 20 kg seed/ha in end October during both the years. Each plot consisted of 5 crop rows of 4 m length, with row spacing of 60 cm. Crop received 25 kg/ha of N and 80 kg/ha of P<sub>2</sub>O<sub>5</sub> as basal dose from urea and superphosphate respectively. Crop was kept weed-free throughout the growing season. Other management practices were adopted as per recommendations of lucerne crop for the region. Five plants were selected at random and labelled in each net plot for recording observations. The plant height was recorded in centimetres from the base of the plant to the tip of the main stem of the plant at final harvesting. The average of the 5 plants was considered as the average height of the plant. The total number of pods formed on each plant was counted at harvesting, the average of the 5 plants was considered as the average number of pods/plant. Twenty-five pods were picked from each plot and number of seeds was counted in these pods. The average of the 25 pods was considered as the average number of seeds/pod. Thousand seeds were taken randomly by hand count and weighed to determine the 1,000-seed weight in grams. Fifty seeds each in 4 replications were germinated in towel papers and seed-germination of each treatment was determined. The root and shoot length of 5 random seedlings was measured and seed-vigour index was calculated by using the formula given by Abdul-Baki and Anderson (1973).

Seed vigour index = Root + shoot length (cm) × germination %

Seed yield/ha was calculated by using the seed yield obtained from the corresponding net plot. Seed yield/ha was computed and expressed in kilogram. Data were analysed by using Fisher's analysis of variance technique and the least significant difference was used to compare treatment means.

### RESULTS AND DISCUSSION

Different plant-growth regulators and nutrients had no apparent effect on the plant height of lucerne during both the successive seasons (Table 1). The seed yield of lucerne is influenced by a number of yield-attributing characters, i.e. number of pods, number of seeds and seed test weight. In this study, the statistical significance due to different treatments was observed in all these yield-attributing characters (Table 1). The number of pods/plant increased significantly with the application of different PGRs as well as

**Table 1.** Effect of foliar spray of plant-growth regulators and nutrients on growth and yield attributes of lucerne

Treatment	Plant height (cm)		Pods/plant		Seeds/pod	
	2017–18	2018–19	2017–18	2018–19	2017–18	2018–19
ZnSO <sub>4</sub> (0.25%)	100.6	101.8	125.3	158.7	3.07	4.17
K <sub>2</sub> SO <sub>4</sub> (1.0%)	95.4	98.4	117.5	156.7	3.08	4.18
MAP (1.0%)	92.1	90.33	124.8	155.7	3.07	3.64
Salicylic acid (100 ppm)	95.6	94.80	119.3	141.7	3.08	3.84
Mepiquat chloride (500 ppm)	90.4	94.13	119.0	155.0	3.05	3.63
Brassinolide (1.0 ppm)	95.7	98.40	126.3	163.0	3.03	4.27
Control	97.3	100.60	94.4	119.0	2.08	3.04
SEm±	2.0	2.7	3.0	3.9	0.1	0.1
CD (P=0.05)	NS	NS	9.2	11.9	0.2	0.4

nutrients over the control during both the years. Among the different treatments applied, the highest number of pods/plant was obtained with the application of 1.0 ppm brassinolide, being 38.0 and 37.0% higher over the control treatment during 2017–18 and 2018–19 respectively. It was closely followed by 0.25% ZnSO<sub>4</sub> and 1.0% MAP. Significantly highest number of seeds/pod was obtained with 1.0 ppm brassinolide in 2018–19. However, in 2017–18 the application of 1.0% K<sub>2</sub>SO<sub>4</sub> and 100 ppm salicylic acid recorded the highest number of seeds/pod.

Different PGRs had no significant effect on 1,000-seed weight of lucerne as compared to the control. However, seed-vigour index was significantly increased with the application of 1.0 ppm brassinolide, 1.0% K<sub>2</sub>SO<sub>4</sub>, 0.25% ZnSO<sub>4</sub> and 1.0% MAP (Table 2).

The PGRs significantly increased the seed yield of lucerne by 22.4–31.0% in 2017–18 and by 5.5–17.8% in 2018–19. The highest seed yield of 122.4 and 167.5 kg/ha in 2017–18 and 2018–19 respectively, was obtained with application of 1.0 ppm brassinolide. The foliar application of different PGRs and nutrients might have helped the indeterminate lucerne crop to exploit the resources fully and to continue to translocate the photosynthates to the seeds. The seed yield was 20% lower in 2017–18 on account of heavy precipitation received during the reproductive phase of the crop which was detrimental to pollination and seed

set. The excessive precipitation led to yield losses as reported earlier by Iannucci *et al.*, (2002). Therefore, in the present investigation also due to heavy rainfall received, the number of pods/plant was reduced by 20.5% in 2017–18 compared to 2018–19 and number of seeds/pod was reduced by 23.1% in 2017–18 compared to 2018–19. The reduction in the number of pods and seeds was ultimately reflected in the reduced seed yield in the first year. Among different plant hormones, brassinosteroid is an important hormone known to regulate seed development and affects the seed number and seed size/weight by transcriptional modulation of genes and pathways regulating ovule and seed development (Kuri *et al.*, 2015). Leaf area is an important index of photosynthesizing surface area and is one of the principal components which are related to physiological processes controlling the production of dry matter and yield. Foliar application of brassinolide is known to increase the leaf area and hence the plants remained physiologically more active and continue to build up sufficient food reserves for developing flowers and seeds and ultimately production of higher seed yield. Sreedhara *et al.*, (2012) and Chen *et al.*, (2014) reported that brassinolide treatments were found to increase the lucerne seed yield.

Economics of different treatments was worked out (Table 3). The foliar application of 1.0 ppm brassinolide recorded the maximum gross returns of ₹58,625/ha,

**Table 2.** Effect of foliar spray of plant-growth regulators and nutrients on yield attributes and seed yield of lucerne

Treatment	1,000-seed weight (g)		Seed vigour index		Seed yield (kg/ha)	
	2017–18	2018–19	2017–18	2018–19	2017–18	2018–19
ZnSO <sub>4</sub> (0.25%)	2.59	3.25	425.3	427.7	119.4	162.5
K <sub>2</sub> SO <sub>4</sub> (1.0%)	2.56	3.22	479.6	439.3	115.2	166.7
MAP (1.0%)	2.50	3.15	411.9	428.0	121.5	150.0
Salicylic acid (100 ppm)	2.60	3.12	400.4	365.1	114.3	151.1
Mepiquat chloride (500 ppm)	2.53	3.08	448.6	340.4	116.4	156.4
Brassinolide (1.0 ppm)	2.61	3.26	483.6	435.6	122.4	167.5
Control	2.58	3.14	403.9	366.3	93.4	142.2
SEm±	0.04	0.05	10.7	14.7	5.7	5.0
CD (P=0.05)	NS	NS	32.3	44.4	17.3	15.1

**Table 3.** Effect of foliar spray of plant-growth regulators and nutrients on production economics of lucerne (pooled data of 2 years)

Treatment	Cost of cultivation ( $\times 10^3$ ₹/ha)	Gross returns ( $\times 10^3$ ₹/ha)	Net returns ( $\times 10^3$ ₹/ha)	Benefit : cost ratio
ZnSO <sub>4</sub> (0.25%)	36.5	56.9	20.4	1.56
K <sub>2</sub> SO <sub>4</sub> (1.0%)	36.9	58.3	21.4	1.58
MAP (1.0%)	37.1	52.5	15.4	1.42
Salicylic acid (100 ppm)	36.5	52.9	16.4	1.45
Mepiquat chloride (500 ppm)	37.9	54.7	16.8	1.44
Brassinolide (1.0 ppm)	37.7	58.6	20.9	1.56
Control	36.4	49.8	13.3	1.37
SEm±	-	1.7	1.7	0.05
CD (P=0.05)	-	5.3	5.3	0.1

**Table 4.** Correlations of seed yield and yield components of lucerne

	Tillers/plant	Pods/plant	Seeds/pod	1,000-seed weight	Seed yield
Tillers/plant	1.000	0.823*	0.471 <sup>NS</sup>	0.740*	0.764*
Pods/plant		1.000	0.390 <sup>NS</sup>	0.611 <sup>NS</sup>	0.760*
Seeds/pod			1.000	0.731*	0.848**
1,000-seed weight				1.000	0.732*
Seed yield					1.000

\*\*\*, means correlated at the 0.01 level; \*, means correlated at the 0.05 level

followed by application of 1.0% K<sub>2</sub>SO<sub>4</sub>. The highest benefit: cost ratio (1.58) was obtained with application of 1.0% K<sub>2</sub>SO<sub>4</sub> and it was statistically at par with 1.0 ppm brassinolide (1.56).

### Correlation

The results pertaining to correlation among seed yield, yield components and seed quality parameters are presented in Table 4. In the present study, there exists a significant positive inter-relationship between seed yield, yield and seed-quality parameters. The number of seeds/pod exhibited the highest significant correlation coefficient of 0.848 with the seed yield, followed by the number of tillers (0.764) and number of pods/plant (0.760). The seed yield also showed a positive significant correlation (0.732) with the seed-quality parameter, i.e. 1,000-seed weight. Among different seed yield components, the number of seeds/pod and the number of pods are the most important factors to determine lucerne seed yield (Du *et al.*, 2008).

It can be concluded from the results of the 2 year study that, higher seed yield of lucerne can be obtained with the application of 1.0 ppm brassinolide along with higher monetary returns.

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