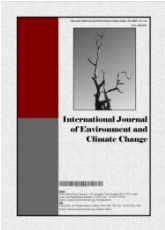

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Effect of Foliar Application of Nitrogen and NAA (Naphthalene Acetic Acid) on Yield and Economics of Cowpea (*Vigna unguiculata* L.)

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

A field experiment was conducted during *Kharif* (Autumn) season 2021 at Experimental Field of the Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Praygraj, Uttar Pradesh, India which is located at 25^0 30' 42''N latitude, 81^0 60' 56" E longitude and 98 m altitude above mean sea level. The treatments consisted of three levels of urea spray – 1.0%, 1.5% and 2.0% and four levels of Naphthalene Acetic Acid [NAA] spray – 0ppm, 25 ppm, 50 ppm and 75 ppm. The Treatments were applied as foliar spraying after 20 and 40 days after sowing. The Experiment was laid out in Randomized Block Design (RBD) with twelve Treatments replicated thrice on the basis of one year experimentation. To determine the "Effect of foliar application of nitrogen(N) and NAA on yield and economics of Cowpea (*Vigna unguiculata* L.). The results showed that treatment with the application of N (Urea) 2.0% + NAA at 25 ppm recorded significantly highest number of pods per plant (16.93), number of seeds per pod (14.33), pod dry weight (4.17 g), test weight (18.42 g), seed yield (1436.26 kg ha^{-1}), haulm yield (2651.97 kg ha^{-1}). However, Maximum gross returns (1,20,204.7 INR ha^{-1}), net returns (87,414.74 INR ha^{-1}) and B:C ratio (2.66) were also reported in the same treatment of Nitrogen (Urea) 2.0% + NAA at 25 ppm.

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1. INTRODUCTION

Cowpea (*Vigna unguiculata L.)* is one of the most significant members of the Fabaceae family utilized as pulse, fodder, and green manure crop in India. . It is one of the oldest food sources and has most likely been utilised as a crop plant since the Neolithic period [1]. Cowpea may be grown in variety of environments due to its tolerance to drought and other abiotic stresses. India is the largest producer and consumer of pulses in the world accounting for 33.6 percentage of the world area and 24 percentage of the world production of pulses [2]. In Indian context, it is minor pulse cultivated mainly in arid and semi-arid tracts of Punjab, Haryana, Delhi and West UP along with considerable area in Rajasthan, Karnataka, Kerala, Tamil Nadu, Maharashtra and Gujarat.

Foliar fertilization of nutrients is gaining importance in crop nutrition considering their cost effectiveness as compared to soil applied nutrients because of higher uptake efficiency. Foliar fertilization of Nitrogen plays a vital role in the pulse production by stimulating root development, nodulation, energy transformation, various metabolic processes and increasing pod setting and thereby increasing the yield [3]. Since foliar nutrients usually penetrate the leaf cuticle or stomata and enters the cell facilitating easy and rapid utilization of nutrients. At flowering, cowpea plants require more feeding of nitrogen due to diversion of nutrients form vegetative phase to reproductive phase. Hence, plants need more nitrogen during flowering to proper growth and development, Foliar feeding is the best option to supply nitrogen to the plants [4].

Plant hormones are group of naturally occurring organic substances which influence physiological processes at very low amounts or concentrations. Plant hormone auxin plays a central role in regulation of plant growth and development. Among all the plant growth regulators, Knap and NAA were used in some field crops (chickpea, pigeonpea, green gram and blackgram) [5-8]. Naphthalene Acetic Acid (NAA) is synthetic auxin like growth regulator of higher efficiency which stimulates root initiation, initiation of cell division and vegetative growth, when it is applied in Lower concentrations. The hormone supply from roots to the leaves, consequently resulting into growth inhibition [9].

Keeping all these facts in view, the present investigation entitled, “Effect of Foliar spray of Nitrogen and Naphthalene acetic acid on yield and economics of Cowpea (*Vigna unguiculata* L.)”, was conducted to achieve the following objectives.

To evaluate the growth and yield of cowpea as influenced by different levels of foliar application of nitrogen and naphthalene acetic acid (NAA).

To work out the economics of different treatments combinations.

2. MATERIALS AND METHODS

The field experiment carried out during *Kharif (wet)* season of 2020 at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj (U.P.) which is located at 25^0 30’ 42’’N latitude, 81^0 60’ 56” E longitude and 98 m altitude above mean sea level. The soil texture of the experimental plot was sandy loam, with a neutral soil reaction (PH 7.1), 0.44% organic carbon, 171.48 kg ha^{-1} available N , 27.0 kg ha^{-1} available P and 291.2 kg ha^{-1} available K [10,11]. The cowpea (*Ankur Gomati*) was sown on 16th June 2021 The experiment was set up in Randomized Block Design comprised of 3 replications and twelve treatments Viz., T1: Nitrogen (Urea) at 1.0% + NAA at 0 ppm (Water Spray), T2: Nitrogen (Urea) at 1.5% + NAA at 0 ppm (Water Spray), T3: Nitrogen (Urea) at 2.0% + NAA at 0 ppm (Water Spray), T4: Nitrogen (Urea) at 1.0% + NAA at 25 ppm, T5: Nitrogen (Urea) at 1.5% + NAA at 25 ppm, T6: Nitrogen (Urea) at 2.0% + NAA at 25 ppm, T7: Nitrogen (Urea) 1.0%+ NAA at 50 ppm, T8: Nitrogen (Urea) 1.5% + NAA 50 ppm, T9: Nitrogen (Urea) 2.0% + NAA at 50 ppm, T10: Nitrogen (Urea) 1.0% + NAA at 75 ppm, T11: Nitrogen (Urea) 1.5% + NAA at 75 ppm and T12: Nitrogen (Urea) 2.0% + NAA at 75 ppm. Recommended dose of N: P: K 20:60:40 kg/ha) were applied in the form of Urea, single super phosphate (SSP) and muriate of potash (MOP) as basal in all the plots and the treatments were applied as foliar spraying at 20 and 40 days after sowing in the respective plots. The Yield parameters (pods/plant, seeds/pod, Dry weight of the pod, Seed yield, Haulm yield and Harvest index) were recorded at harvest stage from the randomly selected plants in each treatment. The experimental design used was

RBD and statistical analysis was done and mean compared at 5% probability level of significant results using ANOVA Fisher, R.A. and Yates, F. [12].

3. RESULTS AND DISCUSSION

Yield traits and yield: Application of Nitrogen (Urea) at 2.0% + NAA at 25 ppm recorded maximum number of pods per plant (16.93) which was significantly higher over rest of the treatments (Table 1). However, the treatments involving Nitrogen (Urea) at 2.0% + NAA at 50 ppm and Nitrogen (Urea) 2.0% + NAA 75 ppm (16.87) remained at par with the treatment application of Nitrogen (Urea) at 2.0% + NAA at 25 ppm. More number of branches at pod - filling stage might have yielded more photosynthates and transferred to pods and seeds. Similar findings were obtained by the [13] in case Urea and [14] in case of NAA. Significantly highest number of seeds per pod (14.33), dry weight of pod (4.17 g) and highest seed index (18.42g) were recorded with application of Nitrogen (Urea) at 2.0% + NAA at 25 ppm which was highest over all the treatments. However, the treatments Nitrogen (Urea) at 2.0% + NAA at 50 ppm and Nitrogen (Urea) at 2.0% + NAA at 75 ppm which were found to be statistically at par with the treatment application of Nitrogen (Urea) at 2.0 + NAA at 25 ppm. The number of seeds per pod may be increased because of the fact that there might be a synergetic effect of both the factors (Urea and NAA). Similar findings were obtained by the [15] in cowpea, [16] in greengram, Shukla et al*.* [17] in chickpea and Prajapat et al*.* [18].

Significantly high seed yield (1436.26 kg ha^{-1}) and haulm yield (2651.97 kg ha^{-1}) was recorded with the treatment application of Nitrogen (Urea) at 2.0% + NAA at 25 ppm over all the treatments. However, the treatments with (1413.93 kg ha^{-1}) Nitrogen (Urea) 2.0% +NAA at 50 ppm was found statistically at par with Nitrogen (Urea) at 2.0% + NAA at 25 ppm. The results were in line with those of Kumar et al*.* ([19] and Ullah et al*.* [15]. Significantly highest harvest index (39.05%) was recorded with the treatment with the application of Nitrogen (Urea) at 1.5% + NAA at 25 ppm over all the treatments.

Fig. 1.

Table 1. Yield traits of cowpea influenced by different levels of foliar application of nitrogen and NAA

Treatment Combinations	Number of pods/plant	Pod dry weight (gm)	Number of seeds/pod	Seed Index (g)	Seed yield (Kg ha^{-1})	Haulm yield (Kg ha^{-1})	Harvest Index (%)
1. Nitrogen at 1.0% + NAA at 0 ppm	12.60	2.41	11.40	16.47	793.4	1400.04	36.16
2. Nitrogen at 1.5% +NAA at 0 ppm	12.73	2.85	11.43	16.71	800.8	1474.3	35.20
3. Nitrogen at 2.0% + NAA at 0 ppm	13.40	2.91	11.80	16.71	875.94	1570.21	35.80
4. Nitrogen at 1.0% +NAA at 25ppm	14.53	3.01	12.60	17.26	1082.7	1845.4	36.94
5. Nitrogen at 1.5% +NAA at 25ppm	16.20	3.82	13.80	17.70	1352.33	2110.01	39.05
6. Nitrogen at 2.0% +NAA at 25ppm	16.93	4.17	14.33	18.42	1436.26	2651.97	35.14
7. Nitrogen at 1.0% + NAA at 50ppm	14.20	3.00	12.40	16.94	998.73	1768.35	36.09
8. Nitrogen at 1.5% + NAA at 50ppm	16.13	3.48	13.33	17.69	1296.75	2063.3	38.56
9. Nitrogen at 2.0% + NAA at 50ppm	16.90	3.92	14.07	18.10	1413.93	2573.13	35.46
10. Nitrogen at 1.0% + NAA at 75ppm	13.80	2.93	11.87	16.92	915.32	1627.48	35.99
11. Nitrogen at 1.5% + NAA at 75ppm	16.00	3.39	12.87	17.60	1177.92	1978.03	37.31
12. Nitrogen at 2.0% + NAA at 75ppm	16.87	3.85	13.93	17.85	1391.78	2323.99	37.46
Ftest	S	S	S	S	S	S	S
S.Em(±)	0.14	0.25	0.15	0.24	23.38	27.72	0.45
CD(P=0.05)	0.41	0.74	0.44	0.71	68.56	81.29	1.33

Table 2. Effect of foliar application of nitrogen and plant growth regulator (NAA) on economics of cowpea

	Treatment	Cost of cultivation (INR/ha) ($\times 10^3$)	Gross returns (INR/ha)	Net returns (INR/ha)	B:C ratio
1	Nitrogenat1.0%+NAA at 0ppm	32.65	66272.08	33622.08	1.02
2	Nitrogen at 1.5%+NAAat0ppm	32.66	67012.60	34348.60	1.05
3	Nitrogenat2.0%+NAA at 0ppm	32.67	73215.62	40538.62	1.24
4	Nitrogen at1.0%+NAA at25ppm	32.76	90306.80	57543.80	1.75
5	Nitrogen at1.5%+NAA at25ppm	32.77	112406.40	79629.42	2.42
6	Nitrogen at2.0%+NAA at25ppm	32.79	120204.70	87414.74	2.66
7	Nitrogen at 1.0%+NAA at50ppm	32.87	83435.10	50560.10	1.53
8	Nitrogen at 1.5%+NAA at50ppm	32.88	107866.60	74977.60	2.27
9	Nitrogen at 2.0%+NAA at50ppm	32.69	118260.7	85561.66	2.61
10	Nitrogen at 1.0%+ NAA at75ppm	32.98	76480.56	43492.56	1.31
11	Nitrogen at 1.5%+NAA at75ppm	33.00	98189.66	65187.66	1.97
12	Nitrogen at 2.0%+NAA at75ppm	33.01	115990.40	82975.38	2.51

However, the treatment with Nitrogen (Urea) at 1.5% + NAA 50 ppm (38.56%) which was found to be statistically at par with Nitrogen (Urea) 1.5% + NAA at 25 ppm. Higher seed yield and Haulm yield which is directly co-related with harvest index. Similar results were obtained by Ullah et al. [15], Kalita et al. [7]. Highest yield was recorded with adpplication of Urea at 2.0% and NAA 25 ppm, concentrations of Urea above 2.0% may have toxic effect and NAA at low concentration i.e., recorded higher yield in combination with Urea 2.0%. Concentrations above 25 ppm NAA resulted in reduced plant height, branching, lesser number of pods per plant which in turn reduced yield.

3.1 Economics

Cost of Cultivation: The cost of cultivation (33,015 INR ha^{-1}) was found to be highest in treatment with foliar application of nitrogen (Urea) at 2.0% + NAA at 75 ppm and the lowest cost of cultivation (32,650 INR ha^{-1}) was found to be nitrogen (Urea) at 1.0% + NAA at 0 ppm (Table 2).

Gross returns: Gross return (1,20,204.70 INR ha^{-1}) was found to be highest with the treatment application of nitrogen (Urea) at 2.0% + NAA at 25 ppm and the lowest gross returns (66,272.08 INR ha^{-1}) was found to be in treatment with application of nitrogen (Urea) at 1.0% + NAA at 0 ppm.

Net returns: Highest net return (87,414.74 INR ha^{-1}) was found to be in the treatment with the application of nitrogen (urea) 2.0% + NAA at 25 ppm and the lowest net returns was found in treatment with application of nitrogen (Urea) at 1.0% + NAA at 0 ppm.

Benefit-cost Ratio: The benefit cost ratio (2.66) was found to be highest in the treatment in treatment with application of nitrogen (urea) at 2.0% + NAA at 25 ppm and lowest benefit (1.02) was found to be in treatment with foliar application of nitrogen (Urea) at 1.0% + NAA at 0 ppm.

4. CONCLUSION

Based on the research done in one season, it is concluded that the foliar application of Nitrogen (Urea) at 2.0% + NAA at 25 ppm along with recommended dose of fertilizers was found to be productive and cost-effective as compared to the other treatments as Nitrogen and NAA at pre-flowering and pod-filling stages was helpful in producing a greater number of pod/plant and filled pods which in turn led to increase in yield of cowpea.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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