Original Research Article

Effect of Foliar Application of Nitrogen and NAA (Naphthalene acetic acid) on Yield and Economics of cowpea *(Vigna unguiculata* L.*)*

Abstract

A field experiment was conducted during *kKharif* (Autumn) season 2020 at eExperimental fField of the Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Praygraj, Uttar Pradesh, India. The Eexperiment was laid out in Randomized Complete Block Design (RCBD) with Ttwelve Ttreatments replicated thrice on the basis of one year experimentation. Tto determine the "Eeffect of Ffoliar Aapplication of Nnitrogen and NAA on yield and economics of Cowpea (*Vigna Uunguiculata* L.). The treatments consisted of three levels of Urea spray – 1.0 %, 1.5% and 2.0 % and Ffour levels of Naphthalene acetic acid [NAA] spray – 0 ppm, 25 ppm, 50 ppm and 75 ppm. The Ttreatments were applied as Ffoliar spraying after 20 and 40 days after sowing. The results showed that ~~treatment with~~ the application of Nnitrogen (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), haulm yield (2651.97 kg/ha). However, Maximum gross returns (1,20,204.7 INR/ha), net returns (87,414.74 INR/ha) and B:C ratio (2.66) were also reported in the same treatment of Nnitrogen (Urea) 2.0 % + NAA at 25 ppm.

Key words: Urea, NAA, Yield, Economics.

INTORDUCTION

Cowpea (*Vigna unguiculata* L.) is a pulse, fodder, and green manure crop that is one of the most significant members of the Fabaceae family. It is one of the oldest food sources and has most likely been utilised as a crop plant since the Neolithic period (**Chevalier, 1984**). Cowpea may be grown in variety of environments due to its 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 (**Pramanik, 2009**). 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 or Foliar application of nutrients is gaining importance nutrition these days. The Foliar applied nutrients are more effective 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 (**Dey *et al.*,**

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2017). 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 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 (**Raj Pandey *et al.*,2017**).

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 (**Fattah and Wort 1970, Jahn 2001, Kalita *et al.*, 1995 and Karim, 2005**). NAA (Naphthalene Acetic Acid) 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 significant concentrations. The hormone supply from roots to the leaves, consequently resulting into growth inhibition (**Kessler, 1961**).

MATERIALS AND METHODS

The current experiment carried out during *Kharif* 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 practically neutral soil reaction (PH 7.1), low in organic carbon (0.44 %), available N (171.48 kg/ha), available P (27.0 kg/ha) and available K (291.2 kg/ha). The crop was sown on 16th –June 2021 using variety Ankur Gomati. The experiment was set up in Randomized Complete Block Design (RCBD) 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. Urea, single super phosphate (SSP) and muriate of potash (MOP) were applied as basal in all the plots and the treatments were applied as foliar spraying at 20 and 40 days after sowing (DAS) in the respective plots. The growth ~~P~~parameters were recorded at periodical intervals of 15,30,45,60 days and at harvest stage from the randomly selected plants in each treatment. Statistical analysis was done and mean compared at 5 % probability level of significant results using ANOVA.

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Fig 1: Field evaluation by Dr. Rajesh Singh

RESULTS AND DISCUSSION

Yield traits influenced by Foliar Application of Nitrogen and NAA on of Cowpea.

The data pertaining to the effect of Foliar Application of Nitrogen and NAA on yield attributes of Cowpea are represented in Table 1.

Treatment with the application of Nitrogen (Urea) at 2.0 % + NAA at 25 recorded maximum number of pods per plant (16.93) which was significantly higher over rest of the treatments. However, the treatments (16.90) Nitrogen (Urea) at 2.0 % + NAA at 50 ppm and Nitrogen (Urea) 2.0 % + NAA 75 ppm (16.87) which were found significantly 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 ~~phototsynthates~~photosynthates and transferred to pods and seeds. Similar findings were obtained by the **(Hirenkumar *et al.*, 2011)** in case Urea and **(Deotele *et al.*, 2017)** in case of NAA. Significantly highest number of seeds per pod (14.33) was recorded with the treatment application of Nitrogen (Urea) at 2.0 % + NAA at 25 ppm which was highest over all the treatments. However, the treatments (14.07) Nitrogen (Urea) at 2.0 % + NAA at 50 ppm and Nitrogen (Urea) at 2.0% + NAA at 75 ppm (13.93) 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 **(Ullah *et al.*, 2007)** in cowpea, (**Radhamani *et al.*, 2003**) in green gram. Significantly highest number of dry weight of pod (4.17 g) was recorded with the treatment application of Nitrogen (Urea) at 2.0 % + NAA at 25 ppm which was highest over all the

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treatments, whereas the treatment with the application of Nitrogen (Urea) at 2.0 % at 50 ppm was recorded (3.92), Nitrogen (Urea) at 2.0 % 75 ppm was recorded with (3.85g), and Nitrogen (Urea) at 1.5 %+ NAA at 25 ppm recorded (g) which were found statistically at par with the treatment Nitrogen (Urea) at 2.0 % + NAA at 25 ppm. Similar results were reported by **Shukla *et al.* (2017)** in chickpea and ~~p~~**P**rajapat ***et al.* (2003).** The seed index was calculated for 100 seeds. The data reveals that there is a significant difference among the treatments. Significantly highest seed index (18.42g) was recorded with treatment with the application of Nitrogen (Urea) 2.0 % + NAA at 25 ppm. However, the treatments with (18.10g) application of Nitrogen (Urea) 2.0 % + NAA at 50 ppm and treatment with (17.85 g) application of Nitrogen (Urea) 2.0 % + NAA at 75 ppm found to be statistically at par with the treatment application of Nitrogen (Urea) 2.0 % + NAA at 25 ppm. Significantly high seed yield (1436.26 kg/ha) 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) Nitrogen (Urea) 2.0 % +NAA at 50 ppm and treatment with (1391.78 kg/ha) which were 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.* (2008) and Ullah *et al.* (2007)**. Significantly highest haulm yield (2651.97 kg/ha) was recorded with the treatment with the application of Nitrogen (Urea) 2.0 % + NAA at 25 ppm over all the treatments. However, the treatment with (2573.13 kg/ha) Nitrogen (Urea) at 2.0 % + NAA at 50 ppm which was statistically at par with Nitrogen (Urea) 2.0 % + NAA 25 ppm. 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. However, the treatment with (38.56%) Nitrogen (Urea) at 1.5 % + NAA 50 ppm 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.* (2017), Kalita *et al.* (1995)**. Highest yields were recorded with application 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 may result in reduced plant height, branching, lesser number of pods per plant which in turn reduces yield.

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Economics

Economics of cowpea influenced by different levels of Foliar spray of Nitrogen and NAA.

Cost of cultivation (INR/ha)

Cost of cultivation (33,015 INR/ha) was found to be highest in treatment with foliar application of ~~N~~nitrogen (Urea) at 2.0 % + NAA at 75 ppm and the lowest cost of cultivation (32,650.00 INR/ha) was found to be ~~N~~nitrogen (Urea) at 1.0 % + NAA at 0 ppm.

Gross returns (INR/ha)

Gross return (1,20,204.70 INR/ha) was found to be highest with the treatment application of ~~N~~nitrogen (Urea) at 2.0 % + NAA at 25 ppm and the lowest gross returns (66,272.08

INR/ha) was found to be in treatment with application of ~~N~~nitrogen (Urea) at 1.0 % + NAA at 0 ppm.

Net returns (INR/ha)

Highest net return (87,414.74 INR/ha) was found to be in the treatment with the application of ~~N~~nitrogen (Urea) 2.0 % + NAA at 25 ppm and the lowest net returns was found in treatment with application of ~~N~~nitrogen (Urea) at 1.0 % + NAA at 0 ppm.

Benefit Cost (B:C) Ratio

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

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 (g~~m~~)	Number of Seeds/pod	Seed Index (g)	Seed yield (Kg/ha)	Haulm yield (Kg/ha)	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
F test	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 combinations	Cost of cultivation (INR/ha)	Gross returns (INR/ha)	Net returns (INR/ha)	B:C ratio
1	Nitrogen at 1.0% + NAA at 0 ppm	32,650.00	66,272.08	33,622.08	1.02
2	Nitrogen at 1.5% + NAA at 0 ppm	32,664.00	67,012.60	34,348.60	1.05
3	Nitrogen at 2.0% + NAA at 0 ppm	32,677.00	73,215.62	40,538.62	1.24
4	Nitrogen at 1.0% +NAA at 25ppm	32,763.00	90,306.80	57,543.80	1.75
5	Nitrogen at 1.5% +NAA at 25ppm	32,777.00	1,12,406.40	79,629.42	2.42
6	Nitrogen at 2.0% +NAA at 25ppm	32,790.00	1,20,204.70	87,414.74	2.66
7	Nitrogen at 1.0% + NAA at 50ppm	32,875.00	83,435.10	50,560.10	1.53
8	Nitrogen at 1.5% + NAA at 50ppm	32,889.00	1,07,866.60	74,977.60	2.27
9	Nitrogen at 2.0% + NAA at 50ppm	32,699.00	118260.7	85561.66	2.61
10	Nitrogen at 1.0% + NAA at 75ppm	32,988.00	76,480.56	43,492.56	1.31
11	Nitrogen at 1.5% + NAA at 75ppm	33,002.00	98,189.66	65,187.66	1.97
12	Nitrogen at 2.0% + NAA at 75ppm	33,015.00	1,15,990.40	82975.38	2.51

CONCLUSION

Based on the research done in one season, it is concluded that the foliar application of ~~N~~nitrogen (Urea) at 2.0 % + NAA at 25 ppm was found to be productive and cost-effective as compared to the other treatments.

BIBILOGRAPHY

~~Brittingham, W. H. (1946). A key to the horticultural groups of varieties of the southern pea, (*Vigna sinensis*). *American society for horticultural science*. **48**: 478-480.~~

Chevalier, A. (1964). Cowpeas in Africa. Revue de botanique appligue et d' Agriculture Tropicale.

Deotale, R.D., Chinmalwar, Y., Kalamkar, V.B., Kamdi, S.R. and Jaybhaye, V.R. (2017). Effect of foliar sprays of cow urine and NAA on chemical, biochemical parameters and yield of pigeon pea. *Journal of Soils and Crops*. **27**(2): 159-164.

~~Deshmukh, S.G., Kale, H.B. and Solunke, P.S. (2008). Influence of graded fertility levels and urea spray on growth, yield and economics of rajmah. *Annals of Plant Physiology*. **22**(2): 189-191.~~

Fattah, Q.A. and D.J. Wort. (1970). Metabolic responses of bushbean plants to naphthenate application. *Canadian Journal of Botany*. **48**:861-866.

~~Fisher, R.A. and Yates, F. (1963). Statistical tables for biological, agricultural and medical research. **22**(2): 151-158.~~

~~Ganiger, T.S., Kareekatti, S.R. and Patil, B.C. (2002). Effect of plant growth regulators on yield and yield components in cowpea. *Karnataka Journal of Agricultural Sciences*.**15**(4): 693-695.~~

~~Ganiger, T.S., Kareekatti, S.R. and Patil, B.C. (2003). Economics of use of plant growth regulators and urea in cowpea. *Karnataka Journal of Agricultural Sciences*.**16**(1): 35-38.~~

Hirenkumar D., Patel, H.C. Patel, H.H., Sitapara and D.D. Nayee (2011) Growth and green pop yield of cowpea [*Vigna unguiculata* (L.) Walp] cv. ANAND VEG. COWPEA-1. *The Asian Journal of Horticulture*. **6** (2) 491-495.

Jackson, M.L. (1967). Soil chemical Analysis. *Open Journal of Soil Science*.**5**(4): 498.

Jahan, N. (2001). Effect pf Naphthenate on fertilizer use efficiency, physiological and biological responses of rice plants. Ph.D. Thesis. Department of Botany, Dhaka University, Dhaka-1000, Bangladesh.

Kalita, P., Deyand, S.C. and Chandra, K. (1995). Influence of foliar application of phosphorus and naphthalene acetic acid on nitrogen, dry matter accumulation and yield of green gram (*Vigna radiata L. Wilczek* cv.aau-34). *Indian Journal of Plant Physiology*. **38**(3): 197-202.

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Karim, M.F. (2005). Physiological and biochemical responses of chickpea (*Cicer arietenum L.*) following application of fertilizers and growth regulators. Ph.D. Thesis. Department of Botany, Dhaka University, Dhaka-1000, Bangladesh.

Kumar, S.G., Muthukrishnan, P., Ramasamy, S. and Chandragiri, K.K. (2008). Effect of organic and inorganic foliar spray on growth and yield of black gram (*Vigna mungo L.*). *Madras Agriculture Journal*. **95**(1-6): 57-60.

Prajapta, M.N., Patel, J.J. and Gediya, K.M. (2006). Influence of different irrigation schedules and growth regulator on summer greengram. *XCZZ*. 6:23-24.

Pramanik, S.C. (2009). Rainwater management techniques for successful production of pulses in rain fed areas. *Indian Farming*. **58**:15-18.

Radhamani, S., Balasubramanian, A. and Chinnusamy, C. (2003). Foliar nutrition with growth regulators on the productivity of rain fed green gram. *Agricultural Science Digest*. **23**(4): 307-308.

Raj Pandey, Vishwanath, R.S., N.S., and Yatendra, K. (2017). Effect of foliar application of nitrogen on growth and yield of vegetable pea (*Pisum sativum L.)* Cv. Kashi Udai. *Journal of Pharmacognosy and Phytochemistry*. **6**(5): 1500-1502.

Reddy, P. (2002). Effect of growth regulators on growth, physiological and yield in chickpea *(Cicer arietinum L.).* M.Sc. (Agri.) Thesis, University of Agricultural Sciences, Dharwad, Karnataka (India).

Richards, L.A. (1954). Diagnosis and improvement of saline Alkali soils, *Agriculture*.**7**(7):60.

Shashikumar, Basavarajappa, R., Manjunatha, H., Salkinkop, S.R., Basavarajappa, M.P. and Patil, H.Y. (2013). Effect of growth regulator, organic and inorganic foliar nutrition on the growth and yield of black gram (*Vigna mungo L.)* under rainfed condition. *Karnataka Journal of Agricultural Sciences*. **26**(2): 311-313.

Ullah, J. Fattah, Q.A. and Hossain, F. (2007). Response of growth, yield attributes and yields to the application of KNap and NAA in cowpea (*Vigna unguiculata L.)* Walp.). *Bangladesh Journal of Botany*. **36**(2): 127-132.

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