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RESEARCH PAPER

Effect of different slow release nitrogenous fertilizers on yield and economics of maize

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Abstract: In a field experiment was conducted during the *kharif* 2015 at Agronomy field unit of College of Agriculture, University of Agricultural and Horticultural Sciences, Navile, Shivamogga to study the effect of different slow release nitrogenous fertilizers on grain yield andeconomics of maize. The experiment was laid out on sandy loam soil by adopting Randomised Complete Block Design. The treatments consisted three different coated urea products *viz.*, neem coated urea(NCU), pongamia oil coated urea(POCU) and castor oil coated urea (COCU) were applied either in single at sowing and in split application at 30 days after sowing. Treatments which received 100 % Rec. N through neem coated urea as basal was recorded significantly higher grain and stover yield. Application of 100 % Rec. N through neem coated urea as basal was produced significantly maximum grain yield 69.05 q/ha. The net returns and B: C ratios of was found higher under the treatment which received 100 % Rec. N through neem coated urea as basal. On the basis of the experimentation, it can be achieving the higher yields with better monetary returns from maize hybrid CP-818 through Neem coated urea @ 100 kg/ha in single application at sowing as basal.

Key words*:* Castor oil coated urea, Economics, Maize, Neem coated urea

Introduction

Maize is a crop of par excellence for food, feed and industrial utilization and grown in 9.4 M ha land with 25 M tones of production and 2556 kgha^{-1} productivity in India (Anon., 2014). It provides nutritional security due to its high nutritive values. Low productivity of maize in India is associated with a wide range of production constraints. Among them low nitrogen use efficiency is a major constraint. Nitrogen is often the most limiting factor in crop production. Hence, application of fertilizer nitrogen results in higher biomass and protein yield with which concentration in plant tissue is commonly increased (Patra *et al.,* 2009). Nitrogen often affects amino acid composition of protein and in turn its nutritional quality. In maize, abundant supply of nitrogen decreases the relative proportion of lysine and threonine, thus, reducing the biological value of the protein. Increasing nitrogen supply generally improves kernel integrity and strength, resulting in better milling properties of the grain (Blumenthal *et al.,* 2008). Nitrogen is in high demand throughout the growing season. Maize is a highly exhaustive crop and it requires high nutrient application particularly nitrogen. Increasing N –fertilizer use efficiency and reducing the leaching losses of nitrogenous fertilizers are some of the options to lower the doses of nitrogen in maize. Keeping these in view, anexperiment was conducted in *kharif* season of 2015 at Agronomy field unit of College of Agriculture, UAHS, Navile, Shivamogga.

Material and methods

The experiment was conducted during *kharif* 2015 at Agronomy field unit of College of agriculture, UAHS, Navile, Shivamogga to study the effect of different slow release nitrogenous fertilizers on grain yield,nitrogen uptake and nitrogen use efficiency in maize.This region belongs to semi-arid condition with an average annual rainfall of 763.9 mm. However, the rainfall received during crop period was 928.8 mm. The soil of the experimental site was a typical sandy loam which was low in organic carbon and available nitrogen (219.52 kg/ha^{-1}), high in available phosphorus (55.62 kg/ha^{-1}) and medium in available potassium (220.14 kgha^{-1}) with a pH of 5.58 and EC of 0.021dSm^{-1}.

Experiment consisted of the ten treatments which were laid out in completely randomized block design replicated thrice. Treatments consisted of three different slow release nitrogenous fertilizers *viz.*, Neem coated urea, Pongamia oil coated urea and Castor oil coated urea which were applied either in single dose at sowing or in split as top dress application (at basal and 30 DAS). A common dose of 50 kg P_2O_5 and 25 kg K_2O ha^{-1} was applied at sowing. Full dose of P_2O_5 and K_2O was given through SSP and MOP fertilizers and the remaining quantities of N as per treatment were given through Neem coated urea, Pongamia oil coated urea and Castor oil coated urea.

Observations recorded were analysed statistically as per the procedure suggested by Gomez and Gomez (1978). Standard package of practices and observation methods were followed during the period of experimentation. Periodic observations on growth parameters were recorded. After the harvest of crop, grain and stover yield was recorded from net plots of individual treatments and plant samples were collected separately from each plot for recording the growth and yield parameters. In computing the economics,the cost of cultivation was calculated by considering cost incurred for land preparation, inputs were labour charges and others.Gross return was calculated based on the prevailing market price of output (gain and stover) and is expressed in ₹ ha^{-1}. Net return was calculated by deducting the cost of cultivation from the gross returnand is expressed in ₹ ha^{-1}. The benefit: cost ratio was worked out by taking the ratio of gross return to the cost of cultivation.

Results and discussion

Yieldsof maize were significantly higher with the application of nitrogen through Neem coated urea than the Pongamia oil coated urea and Castor oil coated urea. This may be due to higher growth and yield components and due to the fact that coating of urea decreased the leaching loses and provided more nitrogen to the plant (Chaudhari *et al.*, 2006).

Growth and yield parameters

Growth parameters are of immense interest due to their simplicity and they do not require any sophisticated instruments. It is well established that the architecture of plant is decided by the growth parameters such as plant height, number of leaves, leaf area, totaldry matter accumulation and partitioning. Among all the treatments, application of 100 % Rec. N through NCU as basal recorded significantly higher number of leaves per plant (16.00 at 90 DAS), higher leaf area duration (91.92 days at 90 DAS to at harvest) and total dry matter production (295.34 g $plant^{-1}$at 90 DAS) which was on par with application of 100 % Rec. N though POCU and COCU as basal and 75 % Rec. N through NCU as basal + 25 % Rec. N through NCU at 30 DAS. However, application of 50 % Rec. N through urea as basal + 50 % Rec. N through urea at 30 DAS recorded significantly higher number of leaves, leaf area duration and total dry matter production (13.00, 66.97 days and 260.11 g $plant^{-1}$at 90 DAS, respectively) compared to application of 100 % Rec. N through oil coated nitrogenous fertilizers (Table 1). This might be due to retention of more leaves, higher leaf area duration for longer time and total dry matter dry matter production attributed by the greater availability of balanced nutrition when supplied with slow release nitrogenous fertilizers. Similar results were reported by Singh and Shivay (2003) and Zhao *et al.* (2005), Habibollah *et al.* (2013), Virendra singh tanwar (2013) and Ransom (2014) where they obtained higher total dry matter of 199.2, 189.23, 169.23, 150.36, 200.12 g $plant^{-1}$ at 90 DAS resepectively in rice, sorghum and maize crops with application of neem coated urea.

.Economic yield is expressed as function of yield attributes. The factors that contribute to yield are known as yield attributes. In the present study, application of 100 % Rec. N through NCU as basal recorded significantly higher yield components *viz.*, number of rows per cob (14.2), cob weight (264.73 g $plant^{-1}$) and grain weight (124.95 g $plant^{-1}$) and this was closely followed by treatments which received 100 % Rec. N through POCU as basal (15.4 no., 262.53 and 120.35g $plant^{-1}$, respectively), 100 % Rec. N through COCU as basal (15.3 no., 257.33 and 119.02 g $plant^{-1}$, respectively) and 75% Rec. N through NCU as basal + 25% Rec. N through NCU at 30 DAS (15.2 no., 258.60 117.35g $plant^{-1}$, respectively) (Table 2). This may be due to higher dry matter production and translocation of photosynthates from source to sink and may be due to the availability of nitrogen and other nutrients in soil and their uptake by the crop. Higher test weight of maize was mainly attributed to higher leaf area which might have generated more photosynthates and were translocated to the reproductive parts more precisely and thus, the seed might have developed fully and resulted in bolder seeds hence recorded higher test weight. These results are in accordance with the findings by Joshi *et al.* (2014) Habibollah *et al.* (2013) and Thimmaiah, (2015) where they obtained higher yield components of maize, rice and ragi crops with application of neem coated urea entirely as basal.

Grain and stover yield

It could be seen from the Table 3 that maize grain and stoveryield increased significantly with application of 100 % Rec. N through NCU as basal. Further, it was also noticed that the application of NCU, POCU and COCU increased the yield by 46.05, 45.35, and 39.26 per cent over application of untreated urea. When comparison was made between application of coated urea as basal with application of same product in single split

Table 1. Growth parameters of maize as influenced by slow release nitrogenous fertilizers at 90 DAS

Treatments	Number of leaves $plant^{-1}$	Leaf area duration (Days)	Total dry matter production (g $plant^{-1}$)
T_1: 50 % Rec. N through urea as basal + 50 % Rec. N through urea at 30 DAS	13.00	66.97	260.11
T_2: 100 % Rec. N through NCU as basal	16.00	91.92	295.34
T_3: 75 % Rec. N through NCU as basal + 25 % Rec. N through NCU at 30 DAS	14.33	80.41	284.89
T_4: 75 % Rec. N through NCU as basal + 25 % Rec. N through urea at 30 DAS	13.93	75.05	273.05
T_5: 100 % Rec. N through COCU as basal	14.80	86.85	285.98
T_6: 75 % Rec. N through COCU as basal + 25 % Rec. N through COCU at 30 DAS	14.03	76.96	277.00
T_7: 75 % Rec. N through COCU as basal + 25 % Rec. N through urea at 30 DAS	13.27	70.07	267.14
T_8: 100 % Rec. N through POCU as basal	15.27	89.52	290.44
T_9: 75 % Rec. N through POCU as basal + 25 % Rec. N through POCU at 30 DAS	14.23	78.53	279.58
T_{10}: 75 % Rec. N through POCU as basal + 25 % Rec. N through urea at 30 DAS	13.40	72.75	270.99
S. Em. ±	0.26	3.52	3.06
C.D. at 5%	0.76	10.46	9.10

DAS: Days after sowing NCU: Neem coated urea COCU: Castor oil coated urea
POCU: Pongamia oil coated urea NS: Non–significant

Table 2. Yield parameters of maize as influenced by slow release nitrogenous fertilizers at harvest

Treatments	Number of rows cob^{-1}	Cob weight (g plant^{-1})	Grain weight (g plant^{-1})
T_1: 50 % Rec. N through urea as basal + 50 % Rec. N through urea at 30 DAS	12.0	231.53	98.53
T_2: 100 % Rec. N through NCU as basal	14.2	264.73	124.95
T_3: 75 % Rec. N through NCU as basal + 25 % Rec. N through NCU at 30 DAS	13.3	258.60	117.35
T_4: 75 % Rec. N through NCU as basal + 25 % Rec. N through urea at 30 DAS	12.5	252.53	113.35
T_5: 100 % Rec. N through COCU as basal	13.6	257.33	119.02
T_6: 75 % Rec. N through COCU as basal + 25 % Rec. N through COCU at 30 DAS	12.7	253.20	114.35
T_7: 75 % Rec. N through COCU as basal + 25 % Rec. N through urea at 30 DAS	12.1	233.27	110.02
T_8: 100 % Rec. N through POCU as basal	13.9	262.53	120.35
T_9: 75 % Rec. N through POCU as basal + 25 % Rec. N through POCU at 30 DAS	13.2	255.40	116.35
T_{10}: 75 % Rec. N through POCU as basal + 25 % Rec. N through urea at 30 DAS	12.3	247.33	112.68
S. Em. ±	0.4	6.23	4.42
C.D. at 5%	1.3	18.52	13.13

DAS: Days after sowing NCU: Neem coated urea COCU: Castor oil coated urea
POCU: Pongamia oil coated urea NS: Non–significant

Table 3. Effect of different slow release nitrogenous fertilizers on grain yield (q ha^{-1}) and stover yield (q ha^{-1}) of maize

Treatments	Grain yield (q ha^{-1})	Stover yield (q ha^{-1})
T_1: 50 % Rec. N through urea as basal + 50 % Rec. N through urea at 30 DAS	47.29	56.92
T_2: 100 % Rec. N through NCU as basal	69.05	79.42
T_3: 75 % Rec. N through NCU as basal + 25 % Rec. N through NCU at 30 DAS	65.86	75.49
T_4: 75 % Rec. N through NCU as basal + 25 % Rec. N through urea at 30 DAS	62.50	72.67
T_5: 100 % Rec. N through COCU as basal	66.42	76.40
T_6: 75 % Rec. N through COCU as basal + 25 % Rec. N through COCU at 30 DAS	63.00	73.11
T_7: 75 % Rec. N through COCU as basal + 25 % Rec. N through urea at 30 DAS	58.28	68.65
T_8: 100 % Rec. N through POCU as basal	66.74	76.90
T_9: 75 % Rec. N through POCU as basal + 25 % Rec. N through POCU at 30 DAS	63.91	73.47
T_{10}: 75 % Rec. N through POCU as basal + 25 % Rec. N through urea at 30 DAS	59.76	69.88
S. Em. ±	2.00	1.94
C.D. at 5%	5.94	5.77

DAS: Days after sowing NCU: Neem coated urea COCU: Castor oil coated urea
POCU: Pongamia oil coated urea NS: Non–significant

application as top dressing at 30 DAS, it was observed that the application of coated urea as basal at sowing recorded significantly higher grain and stover yield (T_1:69.05 and 79.42 q ha^{-1}, T_8: 66.74 and 78.90 q ha^{-1}and T_5: 66.42 and 76.40 q ha^{-1}grain and stover yield, respectively). Whereas lower grain and stover yield was recorded in the treatment which received 100 % Rec. N with uncoated urea (47.29 and 56.92 q ha^{-1} grain and stover yield, respectively). These results are in harmony with the findings of Siddalinga *et al*. (1990), Chikkamath (2000), Gagnon *et al.* (2012), Joshi *et al.* (2014) and Virendra Singh tanwar (2013), where they obtained higher grain and stover yield of maize and sorghum crops with application of neem coated urea entirely as basal.

Economics of the treatments

Economics is the ultimate criteria for acceptance or rejection and wider adoption of any technology. Cultivation of maize is no exception to this. Among the different indicators of economic efficiency in any production system, net return has greater impact on the practical utility and acceptance of the technology by the farmers (Table 4). Assessment of treatments in terms of economic traits revealed that the gross income, net return and benefit cost (B: C) ratio differed due to application of different slow release nitrogenous fertilizers (Table 4). Cost of cultivation, gross return, net return and benefit cost ratios are the best indicators of economic feasibility of any technology.

Among the different indicators of economic efficiency in any production system, net return has greater impact on the practical utility and acceptance of the technology by the farmers (Table 4). Assessment of treatments in terms of economic traits revealed that the gross income, net returns and benefit cost (B: C) ratio differed due to application of different slow release nitrogenous fertilizers (Table 4). Among the different treatment combinations application of 100 % of Rec. N through NCU as basal recorded higher cost of cultivation (₹ 38,803 ha^{-1}), higher gross income (₹ 97,731 ha^{-1}), and higher net returns (₹ 58,928 ha^{-1}) which was closely followed by treatment which received 75 % Rec. N through NCU as basal + 25 % Rec. N through NCU at 30 DAS with a cost of cultivation,gross income and net returns of ₹ 40,236, 92,688 and 52,452 ha^{-1}, respectively than other combinations due to higher grain and stover yield (Table 4). Application of 50 % Rec. N through urea as basal + 50 % Rec. N through urea at 30 DAS was recorded

Table 4. Economics of maize as influenced by application of different slow release nitrogenous fertilizers

Treatment	Cost of cultivation (₹ ha^{-1})	Gross returns (₹ ha^{-1})	Net returns (₹ ha^{-1})	B:C ratio
T_1: 50 % Rec. N through urea as basal + 50 % Rec. N through urea at 30 DAS	36349	66693	30344	1.83
T_2: 100 % Rec. N through NCU as basal	38803	97731	58928	2.54
T_3: 75 % Rec. N through NCU as basal + 25 % Rec. N through NCU at 30 DAS	40236	92688	52452	2.34
T_4: 75 % Rec. N through NCU as basal + 25 % Rec. N through urea at 30 DAS	39862	88011	48149	2.24
T_5: 100 % Rec. N through COCU as basal	40203	93488	53285	2.40
T_6: 75 % Rec. N through COCU as basal + 25 % Rec. N through COCU at 30 DAS	40344	88699	48355	2.24
T_7: 75 % Rec. N through COCU as basal + 25 % Rec. N through urea at 30 DAS	39788	82110	46517	2.06
T_8: 100 % Rec. N through POCU as basal	39260	94745	57485	2.43
T_9: 75 % Rec. N through POCU as basal + 25 % Rec. N through POCU at 30 DAS	40284	89948	49664	2.27
T_{10}: 75 % Rec. N through POCU as basal + 25 % Rec. N through urea at 30 DAS	40066	83664	46907	2.08
S. Em ±	NA	2794.5	3247.5	0.10
C.D. at 5%	NA	8302.8	9648.8	0.30

DAS: Days after sowing NCU: Neem coated urea COCU: Castor oil coated urea
POCU: Pongamia oil coated urea NS: Non–significant

lower benefit cost ratio (1.83). This may be due to lower grain and stover yield and lower gross returns compared to coated urea applied plots. Similar findings were also observed by Bhalla and Devi Prasad (2008), Joshi *et al*. (2014) and Meenakshi *et al*. (2014) where they obtained highest cost of cultivation, higher net returns of aerobic rice and maize crops respectively with application of neem coated urea.

Conclusion

On the basis of results, it was concluded that for achieving higher yields with better monetary returns from maize in the light textured soils, nitrogen may be applied through Neem coated urea @ 100 kgha^{-1} which was found more productive and profitable.

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