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Effect of Different Methods of Urea Application on Growth and Yield in Potato

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Abstract: An experiment was conducted to find out the proper methods of urea application for maximizing the production of potato. All the studied parameters (Days required to 80% emergence, plant height, foliage coverage (%) per hill, number of stem per hill, fresh weight and dry weight of haulm, dry weight (%) of tuber, number of tuber per hill, yield of tuber per hill and yield of tuber per plot) were differed significantly ($P<0.01$) among the methods of urea application. Application of urea as 50 % basal + 50% top dressing produced the best result among the methods and it was found to be the most cost effective (1.99). It might be concluded that split application of urea (50% basal + 50% top dressing in two installment at 30 and 50 DAP) is the effective way to avoid the detrimental effect of urea on plant emergence and to maximize the tuber yield in Bangladesh.

Key words: Urea application, potato, yield, growth

Introduction

Potato (*Solanum tuberosum* L.) occupies first position both in acreage and production among the vegetable crops in Bangladesh (Anonymous, 2001a). However, the average yield of Bangladesh is quite low in comparison with the leading potato growing countries of the world (Anonymous, 2001b). The poor fertilizer management i.e. improper use of manures and fertilizers is one of the reasons for such a poor yield (Islam *et al*., 1982). Nitrogen plays a major role in the production and maintenance of an optimum plant canopy for continuing tuber growth through long growing period (Westermann and Kleinkopf, 1985). Farmers of Bangladesh use urea as the main source of nitrogen for potato cultivation. Urea is an inferior source of nitrogen to potato due to its adverse effect on crop emergence (Sharma and Grewal, 1987; Gathunqu *et al*., 2000). Available reports indicated that split application plays an important role to escape the detrimental effect of urea on crop emergence and yield of potato (Sharma, 1990: Rohricht, 1991; Sud *et al*., 1991; Sharma and Ezekiel, 1993; Singh and Singh, 1994; Joern and Vitosh, 1995; Maidl, 1995; Trawczynski and Grzeskiewicz, 2000). However, as far as known there is no such report available under Bangladesh conditions.

Therefore, the present study was conducted to find out the proper method of urea application for maximizing the production of potato in Bangladesh.

Materials and Methods

The experiment was carried out at the Horticulture Farm of Bangladesh Agricultural University, Mymensingh during the period of November 1996 to March 1997. The experimental area was medium highland of sandy loam soils and belongs to the Sonatola series of Old Brahmaputra flood plain Soil (Agro-Ecological Zone 9) (Anonymous, 1988). The physical and chemical properties of the soils of experimental plot (Table 1) were analyzed in the Humbold Soil Testing Laboratory, Bangladesh Agricultural University, Mymensingh, Bangladesh.

The experiment was laid out in a randomized complete block design (RCBD) with three replications. Recommended doses of fertilizers were applied to each of the experimental plots (Anonymous, 1994 and Anonymous, 1997). Whole amount of triple super phosphate, muriate of potash and gypsum was applied as basal dose through broadcasting during final land preparation. Five different methods of urea application were used as follows:

T_1 : Application of total or 100 % urea as basal dose
T_2 : Application of 75% urea as basal dose + 25% as top dressing in two installments at 30 and 50 days after planting (DAP)
T_3 : Application of 50% urea as basal dose + 50% as top dressing in two installments at 30 and 50 DAP
T_4 : Application of 25% urea as basal dose + 75% as top dressing in two installments at 30 and 50 DAP
T_5 : Application of 100% urea as top dressing in two installments at 30 and 50 DAP

Table 1: Soil analysis data of the experimental plot

Soil properties	Values
Physical properties	
Sand	35.4%
Silt	60.00%
Clay	4.6%
Textural class	Silty loam
Chemical properties	
pH	5.50
Organic C	1.017%
Total N	0.085%
Available P	16 ppm
Available K	0.22 me of K 100 g^{-1} of soil

The seed tubers of the variety Diamant was collected from Bangladesh Agriculture Development Corporation and spreaded over the floor in diffused light conditions for sprouting. Well sprouted seed potatoes each of 25 g weight were used for planting. Planting was done in each plot of 2.4×2.0 m^2 maintaining spacing of 60×20 cm^2. Intercultural operations like weeding, earthing up, irrigation and effective plant protection measures were done as and when necessary. Data on ten randomly selected plants per plot were recorded during the crop growth period and also at harvest. The crops were harvested at 97 DAP. Data were recorded on days required to 80 % emergence, plant height, foliage coverage (%) per hill, number of stem per hill, fresh weight and dry weight of haulm, dry weight (%) of tubers, number of tubers per hill, yield of tuber per hill, yield of tuber per plot. The tuber yield per hectare was estimated and tubers were graded as:

A (>55mm), B (>45-55 mm), C (>35-45 mm), D (>28-35 mm) and E (<28mm) according to their diameter.

The collected data were analyzed statistically following the ANOVA technique by using F-test. The means were separated by Duncan's new multiple range (DMR) test. Cost and return analysis in detail was done according to the procedure of Alam *et al*. (1989).

Results and Discussion

There was a significant effect of different methods of urea application on plant emergence (Table 2). Treatment T_1 (100% basal doses) took the longest time to complete 80% germination (27.33 day after planting) and the shortest time (15 DAP) was required for treatment T_5 (100% top dressing). This delay in plant emergence might be due to the accumulation of free ammonia and nitrites in the soil after the incorporation of urea (Meisinger *et al*., 1978). The adverse effect on plant emergence was more pronounced at treatment T_1 because the concentrations of free ammonia and nitrite was likely to be more near the seed tubers than those of the other treatments. Split application of urea, however, reduced the adverse effect on plant emergence. Sharma

Table 2: Growth and yield components of potato as influenced by different methods of urea application

Treatments	Days required to 80 % emergence	Plant height (cm)	Foliage coverage (%) per hill	No. of main stem per hill	Fresh wt of haulm (g per hill)	Dry wt. of haulm (g per hill)	Dry wt. (%) of tubers	No. of tuber per hill	Wt. of tubers per hill (g)	Yield of tubers per plot (kg)	Yield (t ha^{-1})
T_1	27.33a	57.40d	73.90d	3.13d	163	17.83	17.50c	6.10c	311.67e	9.75d	20.31d
T_2	27.00a	59.37c	75.60b	3.57c	170	17.03	18.02b	6.20c	336.67d	11.08c	23.09c
T_3	24.33b	64.17a	78.17a	3.87a	170	17.07	18.20a	6.97a	387.33a	12.54a	26.13a
T_4	18.67c	61.37b	75.67b	3.77b	163	16.87	18.20a	6.83ab	353.33b	12.05b	25.10b
T_5	15.00d	60.00c	74.33c	3.63c	165	16.50	18.10a	6.77b	345.00c	11.90b	24.79b

Table 3: Percentage of different grade potato tubers as influenced by different methods of urea application

Treatments	Grade A (>55mm dia.)	Grade B (>45-55mm dia.)	Grade C (>35-45mm dia.)	Grade D (>28-35mm dia.)	Grade E (<28mm dia.)
T_1	33.17a	26.14	21.06	12.41	7.22
T_2	32.23a	27.06	21.24	11.57	8.04
T_3	32.78a	26.30	19.20	14.06	7.66
T_4	32.63a	25.47	21.64	15.03	10.27
T_5	28.17b	24.06	19.60	15.55	12.61

Means followed by different letters differ significantly at $P < 0.01$

Table 4: Cost and return analysis of potato as influenced by different methods of urea application

Treatments	Yield (t ha^{-1})	Gross return* (Tk ha^{-1})	Total cost of production (Tk ha^{-1})	Net return (Tk ha^{-1})	Benefit cost ratio
T_1	20.31	101550.00	65305.6	36244.4	1.55
T_2	23.00	115450.00	65805.6	49644.4	1.76
T_3	26.13	130650.00	65805.6	64844.4	1.99
T_4	25.10	125500.00	65805.6	59694.4	1.91
T_5	24.79	123950.00	65555.6	58394.4	1.89

T_1= 100% basal, T_2= 75% basal + 25% top dressing, T_3 = 50% basal + 50% top dressing, T_4= 25% basal + 75% top dressing, T_5= 100% top dressing *: Calculated on the basis of Tk 5000/t of tuber

(1990) also reported similar effect on the period of plant emergence.

The methods of urea application showed significant variation in respect of plant height and foliage coverage (%) per hill (Table 2). The potato plant reached at the maximum height and foliage coverage per hill (64.17 cm and 78.17% respectively) at treatment T_3 (50% basal + 50% top dressing) and the minimum (57.40 cm and 73.90% respectively) at treatment T_1 (100% basal). This might be due to better availability of N and the enhancing effect of N on vegetative growth. Since, the recovery of N from splitted dose remained higher than the whole dose of N applied at the time of planting (Sharma and Ezekiel, 1993).

The number of main stem per hill was significantly affected by different methods of urea application (Table 2). The maximum number (3.87) was found at treatment T_3 (50% basal + 50% top dressing) and the minimum (3.13) at T_1 (100% basal). The decrease in number of main stem might be due to the toxicity produced by the urea at the time of planting which ultimately killed the sprouts. Methods of urea application did not show any significant difference on fresh weight and dry weight of haulm (Table 2). However, dry weight (%) of tuber was significantly affected by the methods of urea application (Table 2). Treatment T_3 (50% basal + 50% top dressing) and T_4 (25% basal + 75% top dressing) produced the maximum dry weight (18.20%) while T_1 (100% basal) produced the minimum dry weight (17.50%). The dry weight (%) of tubers was statistically similar at treatment T_3, T_4 and T_5 (100% top dressing). Gathunqu *et al.* (2000) also found that early and split application of N fertilizer led to a faster early growth in plant height, shoot, tuber, root and total dry matter.

The number of tuber per hill, weight of tuber per hill and yield of tubers per plot were affected significantly ($P < 0.01$) by the different methods of urea application (Table 2). The maximum values (6.97, 387.33 g and 12.54 kg respectively) were found at treatment T_3 (50 % basal + 50 % top dressing) and the minimum values (6.10, 311.67 g and 9.75 kg respectively) at T_1 (100 % basal) which ultimately affect the tuber yield per hectare. The positive effect of split application of urea on tuber yield might be due to the improvement in plant emergence and early vegetative growth. Similar results was also reported by Sud *et al.* (1991). However, Singh and Singh (1984) reported that the highest yield of tuber and biomass was achieved with the 0.75 % basal and 0.25% spray application of urea.

Effect of different methods of urea application were found to be significant on the production of potato tubers greater than 55 mm in size (Table 3). The highest percentage (33.17) of Grade A tuber (dia. 55mm) was found at treatment T_1 (100% basal) and lowest (28.17) at T_5 (100% top dressing). However, there was no significant differences among the treatments T_1, T_2 (75% basal + 25% top dressing), T_3 (50% basal + 50% top dressing) and T_4 (25% basal + 75% top dressing). The other grades of potato tubers did not show any significant differences due to the methods of urea application. This confirms the findings of Sharma (1990). Who observed that small grade tuber yield was significantly higher under broadcast treatment.

All other methods of urea application showed considerably higher net return over the treatment T_1 (100% basal) (Table 4). The benefit cost ratio was also higher (1.99) in case of treatment T_3 (50% basal + 50% top dressing). From the economic point of view it was apparent from the above results that the treatment T_3 (application of urea as 50% basal + 50% top dressing) was more profitable than rest of the application methods.

It might be concluded that split application of urea (50% basal + 50% top dressing in two installment of 30 and 50 DAP) is the effective way to avoid the detrimental effect of urea on plant emergence and to maximize the tuber yield in Bangladesh.

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