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Grading of potato tubers as influenced by nitrogen scheduling

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Abstract
In order to evaluate the effect of nitrogen scheduling on grading of potato crop (variety-Kufri Sadabahar) a two year experiment was undertaken during winter season of 2014-15 and 2015-16 at Vegetable Research Center of GBPUAT, Pantnagar, Uttarakhand. The experiment was consisted of ten nitrogen scheduling treatments replicated thrice in Randomized Complete Block Design. All the cultural practices were done under scientific management. During harvesting tubers were graded according to weight in four grades *viz.* small (<25 g), medium (25-50 g), large (51-75 g) and extra large (>75 g). The seed tuber per cent by number and yield was calculated by taking sum of medium and large grade tubers and convert to the percentages. Similarly, marketable tuber per cent by number and yield was calculated by excluding number and yield of small size tubers. All the treatments showed significant variation with respect to grades, seed tubers and marketable tubers (% by number and yield). Among ten treatments, maximum large grade tubers and marketable tubers were produced with treatment T_9 (25% N of RDF as basal + 50% top dressing at 25 DAP + one foliar spray of urea @ 3% at 40 DAP). However, maximum seed tubers by number and yield was produced with treatment T_5 (50% N of RDF as basal + 50% top dressing at 25 DAP + one foliar spray of urea @ 3% at 40 DAP).

Keyword: Potato, Nitrogen, Per cent Seed tuber yield, Per cent Marketable tuber yield

Introduction

Potato is a non cereal major food crop in the world after rice, wheat and maize. From the production point of view India is the world's second largest producer of potato next only to the China with the production of 48.0 million tons from 2.07 million hectare area. The productivity of potato is 23.1 t ha^{-1} and it occupies 21.7 % of total vegetable area and 28.32 % of the total vegetable production in country (Anonymous, 2015) [1]. Nitrogen (N) is one of the foremost management priorities in potato cropping systems (Stark *et al*., 2004) [2]. It determines the quantity and structure of potato yield, its chemical composition and tuber quality (Kolodziejczyk, 2014) [3]. It primarily influences tuber size, dry matter and sugar contents. Tuber size and uniformity is critical for every market, whether it is fresh potatoes, seed or processing crops. Anything that the grower can do to prolong a healthy leaf canopy will increase the average tuber size. Nitrogen fed at an early stage of crop growth will help build the overall size of the leaf canopy, whereas at later stages of growth, nitrogen use helps maintain the greenness of the canopy and maximize yield. Widely fluctuating N levels result in irregular tuber growth and often end in the formation of internal (brown center and hollow heart) and external (misshapen) tuber deformities (Taysom *et al.*, 2007) [4]. Adequate nitrogen at tuberization produces large size tubers which increase marketable yield whereas, deficiency at this stage causes more small tuber formation, hence reduce marketable tubers. Application method also influences size of the tubers. More loss occurs in broadcast method of N application. Foliar application not only reduces N losses to the environment through leaching and fixing in the soil but also save valuable nitrogen. It can immediately fulfil the nutrient requirement of the crop hence increased size of tuber when given as supplementary application. Optimal nitrogen application is essential for achieving commercial tuber yield and size requirements which results in maximum economic return. Thus, the right rate, right method and right timing of nitrogen application is important in managing potato tuber size. Keeping in view these standpoints, an experiment was carried out to standardize the nitrogen scheduling for getting maximum large tuber and seed tuber yield.

Materials and Methods

The present field experiment was undertaken at Vegetable Research Centre (VRC) of G.B. Pant University of Agriculture and Technology, Pantnagar, Udham Singh Nagar (Uttarakhand) during winter (*rabi*) season of 2014-2015 and 2015-2016 with potato variety Kufri Sadabahar. The experiment was consisted of ten treatments of nitrogen scheduling (given below) were replicated thrice in Randomized Block Design. The recommended dose of fertilizer was 160:100:120 kg/ha of N:P_2O_5:K_2O. Nitrogen was applied in the form of urea according to the treatments, whereas, full dose of P_2O_5 and K_2O was applied through Single Super Phosphate and Muriate of Potash at the time of planting. Well sprouted, disease free, medium sized (2.5-5.0 cm diameter) tubers having 40-75 g weight were selected and planted at 60 cm × 20 cm spacing on 30 cm raised ridges. All cultural practices including irrigation, weeding and plant protection measures were followed under scientific management. During harvesting tubers were graded according to the weight in four grades *viz.* small (<25 g), medium (25-50 g), large (51-75 g) and extra large (>75 g) and convert to the percentages by number and yield. The seed tuber per cent by number and yield was calculated by taking sum of medium and large grade tubers and convert to the percentages. Similarly marketable tuber per cent by number and yield was calculated by excluding number and yield of small size tubers and converted to the percentages. The statistical analysis was done through computer by using STPR3 programme, designed and developed by department of Mathematics and Statistics, College of Basic Sciences and Humanities, G.B. Pant University of Agriculture & Technology, Pantnagar, Uttarakhand. The treatments were as follows:

T_1:	50% N of RDF as basal + 50% top dressing at 25 DAP
T_2:	50% N of RDF as basal + 25% topdressing at 25 DAP + one foliar spray of urea @ 2% at 40 DAP
T_3:	25% N of RDF as basal + three foliar spray of urea @ 2% at 25, 40 & 55 DAP
T_4:	50% N of RDF as basal + two foliar spray of urea @ 2% at 25 & 40 DAP
T_5:	50% N of RDF as basal + 50% top dressing at 25 DAP + one foliar spray of urea @ 3% at 40 DAP
T_6:	50% N of RDF as basal + three foliar spray of urea @ 3% at 25, 40 & 55 DAP
T_7:	50% N of RDF as basal + two foliar spray of urea @ 3% at 25 & 40 DAP
T_8:	25% N of RDF as basal + 75% top dressing at 25 DAP
T_9:	25% N of RDF as basal + 50% top dressing at 25 DAP + one foliar spray of urea @ 3% at 40 DAP
T_{10}:	(No application of nitrogen)

Results and Discussion

Grading of tubers (% by number)

All the treatments showed significant variation with respect to grade wise tubers (% by number). It is revealed from the data (Table-1) that highest proportion of small grade tubers (37.3 %) was recorded with treatment T_{10} whereas, lowest was recorded with treatment T_9 having 19 % small tubers. In case of medium grade tubers (% by number), the highest proportion (30.2 %) was recorded by treatment T_5 and the lowest (21.9 %) was recorded with treatment T_3. Treatment T_8 produced highest number of large grade tubers (29.9 %) however minimum was recorded with treatment T_{10}. In case of extra large grade tubers (% by number), highest proportion (30.2 %) was recorded with treatment T_9 whereas, the lowest (15.9 %) was recorded with treatment T_{10}. The study revealed that the availability of adequate nitrogen at tuber initiation produced more number of large size tubers. Besides a supplement foliar spray of urea at later stage (40 DAP) increased tuber size which resulted in production of more extra large grade tubers. It might be due to the synchrony between demand and supply of nitrogen which leads to better growth of the plant resulted bigger size tubers. Moreover, its deficiency produced more small tubers. Besides application of excess N also prevent tuber growth. The probable reason of this was the re-absorption in the tubers, which often leads reduced tuber size as in treatment T_5. Similar observations were reported by Ewing *et al.* (2004) [5] and Fontes *et al.* (2010) [6]. In a study Kumar (2015) [7] recorded maximum large grade tubers with application of 50% basal N + 25% top dressing at 25 DAP + one foliar spray of urea @ 2% at 40 DAP.

Data presented in Table-1 shows, that N scheduling had significant effect on seed potato (% by number). The highest percentage of seed potato by number was obtained with treatment T_5 (55.1 %) and the lowest was recorded with treatment T_{10} (46.8 %). It indicates role of nitrogen in tuber growth as without application of N, more small tubers were produced. However, excess of N also reduced tuber growth. It might be due to more vegetative growth cause re-absorption in tuber which produced more medium size tubers hence more seed tubers was obtained with T_5. Chandra (2015) [8] reported more seed size tubers with 150 kg nitrogen applied 50 % at planting and 50 % as topdressing at 25 days after planting.

Marketable tubers were also significantly varied by different nitrogen scheduling. Maximum marketable tuber (% by number) was recorded with treatment T_9 having 81 % marketable tubers. It is due to the less small size tubers (% by number) were recorded with this treatment. Split application of N increased large size tubers might be due to the synchrony between demand and supply ultimately more marketable tubers. The lowest (62.7 %) was recorded with treatment T_{10} which produce more number of small grade tubers consequently low marketable yield. In an experiment Sun *et al*. (2012) [9] recorded high marketable tuber ratio (74%) with 100 kg N application at planting and 50 kg as topdressing at 20 DAE.

Grading of tubers (% by yield)

It is evident from the data (Table-2) that nitrogen scheduling significantly influenced grading of tuber (% by weight). Maximum small grade tubers was recorded with treatment T_{10} (14.7 %) and minimum (5.9 %) with treatment T_1. However, maximum proportion of medium grade tubers by yield (29.6 %) was recorded with treatment T_1 and T_5 and minimum with treatment T_3. Maximum contribution of large grade tubers (37.9 %) was recorded with treatment T_3 and minimum (24.6 %) was with treatment T_4. The proportion of extra large grade tuber by yield was recorded maximum (47.3 %) with treatment T_9 whereas minimum (31.1 %) with treatment T_{10}. Data revealed that nitrogen play important role in size increment as maximum proportion of small size tuber by yield was recorded without nitrogen. However, treatments having more amount of nitrogen applied as basal leads to reduced tuber growth consequently more medium size tubers. It might be due to interference of N in food assimilation in tuber or due to the toxic effect of excess N applied as basal. Large and extra large tuber yield was recorded maximum with split application of N and minimum with treatments receiving more N at basal. It might be due to that optimum amount of nitrogen at basal and sufficient at tuber bulking stage increased carbon uptake resulted in more yield of large tubers rather than more amount of N applied as basal. Kelling *et al*. (2015) [10] also reported that nitrogen application in 3 splits produced more large size tubers than in 2 splits. However, 4 splits yield more undersize tubers.

Data presented in Table 2 clearly revealed that significant variation was recorded in nitrogen scheduling with respect to seed tuber (% by yield). Maximum seed tuber production was recorded with treatment T_5 however, minimum was recorded with treatment T_9 having 45.8 % seed tuber yield. It might be due to the interference of more nitrogen to the photosynthates assimilation in tuber resulted more seed size tubers. On the other hand unavailability of sufficient nitrogen at tuber bulking stage also produced more seed tubers. Chandra (2015) [8] reported that more small size tuber yield was obtained without nitrogen application whereas, more large tubers with high N doses, both leads to less seed tuber yield.

Marketable tuber (% by yield) was recorded maximum (94.1 %) with treatment T_1 and minimum with treatment T_{10} having 85.3 % marketable tuber by yield. It might be due to the more small size and less large size tubers (% by weight) as recorded with treatment T_{10} hence produced less marketable yield. Similarly, Kumar (2015) [7] reported highest marketable tuber yield with 50 % basal + 25 % as topdressing at 25 DAP with one foliar spray of 2 % urea at 40 DAP.

On the basis of present study it can be concluded that treatment T_9 (25% N of RDF as basal + 50% top dressing at 25 DAP + one foliar spray of urea @ 3% at 40 DAP) increased both per cent by number and yield of extra large grade tubers. Maximum seed size tuber (per cent by number and yield) was obtained with treatment T_5 (50% N of RDF as basal + 50% top dressing at 25 DAP + one foliar spray of urea @ 3% at 40 DAP). However, the proportion of marketable tubers by yield was recorded maximum with T_1 (50% N of RDF as basal + 50% top dressing at 25 DAP).

Table 1: Effect of nitrogen scheduling on grading (% by number) of potato tuber

Treatments	Grading of tubers (% by number)				Seed tuber (% by number)	Marketable tuber (% by number)
	<25g	25-50g	51-75g	>75g		
T_1	24.5	29.2	24.5	21.8	53.7	75.5
T_2	30.1	23.5	24.7	21.7	48.2	69.9
T_3	31.9	21.9	27.5	18.6	49.4	68.1
T_4	28.8	27.7	22.6	20.8	50.4	71.2
T_5	20.9	30.2	24.9	24.0	55.1	79.1
T_6	28.7	23.5	25.5	22.3	49.0	71.3
T_7	23.5	25.8	27.3	23.3	53.2	76.5
T_8	21.0	24.4	29.9	24.7	54.3	79.0
T_9	19.0	23.0	27.7	30.2	50.7	81.0
T_{10}	37.3	27.9	18.9	15.9	46.8	62.7
SEm.±	1.0	1.3	1.7	1.2	1.6	1.0
CD at 5%	3.1	4.0	5.1	3.7	4.7	3.1

Table 2: Effect of nitrogen scheduling on grading (% by yield) of potato tuber

Treatments	Grading of tubers (% by yield)				Seed tuber (% by yield)	Marketable tuber (% by yield)
	<25g	25-50g	51-75g	>75g		
T_1	5.9	29.6	25.0	39.5	54.6	94.1
T_2	9.6	22.4	28.6	39.4	51.0	90.4
T_3	14.1	15.8	37.9	32.2	53.7	85.9
T_4	11.9	26.2	24.6	37.2	50.9	88.1
T_5	7.7	29.6	27.5	35.2	57.1	92.3
T_6	6.7	23.4	27.6	42.4	50.9	93.3
T_7	8.7	23.7	29.5	38.1	53.2	91.3
T_8	8.5	18.8	33.4	39.2	52.3	91.5
T_9	6.8	16.8	29.1	47.3	45.8	93.2
T_{10}	14.7	29.2	24.9	31.1	54.1	85.3
SEm.±	0.8	2.0	1.4	1.6	1.5	0.8
CD at 5%	2.5	6.1	4.2	4.9	4.4	2.5

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