The market for processed potato products is gaining momentum at faster pace in India since last one decade (Pandey and Sarkar, 2005) and this has led to increased demand for processing-grade potatoes with desirable processing traits. To augment the supply of processing-grade potatoes for industry, CPRI is continuously developing improved varieties and in 2005 cultivar Kufri Chipsona-3 was released, which has higher processing-grade tuber yield and better shape than the earlier processing cvs Kufri Chipsona-1 and Kufri Chipsona-2. However, each cultivar has specific nutritional requirements as evident in case of cvs Kufri Chipsona-1 and Kufri Chipsona-2, which require 50% higher N and K compared to ware varieties for realizing full yield potential with acceptable processing quality at harvest and during long term storage as well (Kumar et al., 2007a, 2007b).

It is well documented that fertilizer regimes or doses affects tuber quality besides tuber yield in different grades (Kumar et al., 2004; Kumar et al., 2007a, 2007b; Westermann et al., 1994a, 1994b). Tuber quality in relation to chipping can be referred to tuber dry matter/specific gravity, reducing sugar content (glucose and fructose), chip colour etc. The relative importance of each depends upon the intended tuber use. Tuber dry matter is an important characteristics of tubers used for processing into chips and French fries as it decides the product recovery and oil content in chips. Reducing sugars also influence processing because of the ‘Maillard reaction’ between reducing sugars and amino acids during frying. Tuber dry matter and reducing sugars are related to tuber maturity, growing conditions, water and nutrient uptake by the growing crop (Westermann et al., 1994a).

The present study was undertaken with the following objectives:

i) To standardize nitrogen (N) and potassium (K) requirements of cv Kufri Chipsona-3 for getting higher proportion of processing-grade tubers.

ii) To study the effect of NPK doses on processing quality traits like specific gravity, dry matter content, reducing sugars and chip colour.

The field experiment was conducted during 2005-2007 at Central Potato Research Institute Campus, Modipuram (29° 4’ N, 77°
Parveen Kumar, SK Pandey, SV Singh, Dinesh Kumar, BP Singh, Sukhwinder Singh, S Rawal and RL Meena

46’ E, 237 m above mean sea level) with four NPK combinations (F1 = 180 + 80 + 100; F2 = 225 + 80 + 125; F3 = 270 + 80 + 150 and F4 = 315 + 80 + 175, N + P2O5 + K2O kg/ha) in randomized complete block design with five replications. Soil of the experimental site was sandy loam (Typic Ustochrept) in texture. Chemical analysis of the soil (top 15 cm) showed neutral pH (6.9), low organic carbon (0.27%) and potassium permanganate extractable N (150.4 kg/ha), high Olsen’s (0.5 M NaHCO3 extractable) P (77.0 kg/ha) and medium exchangeable K (142.2 kg/ha). The experimental crop of cv Kufri Chipsona-3 was planted on 22 October and 3 November during 2005 and 2006, respectively. Well-sprouted seed tubers (50-60 g) were planted at the spacing of 67.5 × 20 cm in plots of 4.05 m × 4 m during 2005-06 and 2006-07. Half N and full doses of P and K (as per treatment) were placed in bands below the seed tubers at the time of planting and remaining half dose of N was applied at hilling, at 25 days after planting (DAP). The nutrients were provided through diammonium phosphate, calcium ammonium nitrate and muriate of potash (potassium chloride) at planting, while N was applied through urea at hilling. The experimental crop was raised under assured irrigation using the furrow method and approximately 50 mm water was applied per irrigation. The dehauling was done mechanically at full maturity (110 DAP) and harvesting was done two weeks later after skin setting.

Total and processing-grade tuber yields and number were recorded at harvest and tubers of >45 mm in diameter were considered as processing-grade. Specific gravity was determined by hydrometer method by taking 3.632 kg of processing-grade tubers from each plot (Gould, 1999). Five tubers were selected randomly from each plot and used for estimating the processing quality attributes- chip colour, reducing sugar and dry matter content. Potato chips were prepared in laboratory which involved peeling the tubers in abrasive peeler, slicing in 1.75 mm thick slices with an automatic slicer, washing and drying on paper towel. Dried slices were fried in refined sunflower oil in a thermostatically controlled deep fat fryer at 180°C till bubbling stopped. Fried chips were then evaluated for chip colour on a scale of 1-10, subjectively with the help of colour cards (Ezekiel et al., 2003), where 1 denotes a highly acceptable colour, 10 denotes a dark brown and unacceptable colour, and chips with colour range of up to 3.0 were considered acceptable. Five tubers were chopped into fine pieces and a 10-g sample was taken for reducing sugars estimation (Nelson, 1944) and a 50-g sample was taken for tuber dry matter estimation. Tuber dry matter was determined by drying the samples in oven at 80°C till constant weight was achieved. All estimations were carried out in duplicate. Data of each parameter was statistically analyzed in factorial randomized block design using standard procedures of variance analysis using statistical software IRRISTAT (IRRI, 1999).

Total tuber number were significantly higher during 2005-06 crop season compared to 2006-07 crop season, but the processing grade tuber number were statistically similar for both the years of study. Processing-grade and total tuber number seemed to be marginally higher at higher fertility regimes (F3 and F4 compared to F1 and F2); however the differences were not statistically significant (Table 1). It is well documented that tuber setting/number is mainly governed by the genetic makeup of the cultivar (Horton, 1987).

Processing-grade tuber yield and tuber dry matter yield was significantly higher during 2006-07 compared to 2005-06, but total tuber yield was statistically similar during both the years of investigation (Table 1). Higher
Table 1. Effect of year and fertility regimes on tuber number, yield and economics of cv Kufri Chipsona-3.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Tuber number (thousand/ha)</th>
<th>Tuber yield (t/ha)</th>
<th>Average PGTWb (g)</th>
<th>Tuber dry matter yield (t/ha)</th>
<th>Net income (`/ha)</th>
<th>B.C ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Processing-grade</td>
<td>Total</td>
<td>Processing-grade</td>
<td>Total</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Year</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>2005-06</td>
<td>286.3</td>
<td>599.2</td>
<td>26.6</td>
<td>34.1</td>
<td>93.4</td>
<td>7.26</td>
</tr>
<tr>
<td>2006-07</td>
<td>309.3</td>
<td>470.3</td>
<td>30.6</td>
<td>34.5</td>
<td>101.9</td>
<td>8.31</td>
</tr>
<tr>
<td>Fertility regimes (FR)</td>
<td></td>
<td></td>
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<tr>
<td>F1 = 180 – 80 – 100</td>
<td>289.2</td>
<td>516.0</td>
<td>26.0</td>
<td>31.0</td>
<td>89.7</td>
<td>7.28</td>
</tr>
<tr>
<td>F2 = 225 – 80 – 125</td>
<td>283.2</td>
<td>511.7</td>
<td>26.7</td>
<td>33.2</td>
<td>98.2</td>
<td>7.58</td>
</tr>
<tr>
<td>F3 = 270 – 80 – 150</td>
<td>302.9</td>
<td>542.0</td>
<td>30.2</td>
<td>35.8</td>
<td>100.6</td>
<td>8.23</td>
</tr>
<tr>
<td>F4 = 315 – 80 – 175</td>
<td>315.9</td>
<td>569.3</td>
<td>31.7</td>
<td>37.3</td>
<td>102.0</td>
<td>8.05</td>
</tr>
<tr>
<td>LSD0.05</td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Year</td>
<td>NS</td>
<td>72.2</td>
<td>3.52</td>
<td>NS</td>
<td>NS</td>
<td>1.05</td>
</tr>
<tr>
<td>FR</td>
<td>NS</td>
<td>NS</td>
<td>2.7</td>
<td>NS</td>
<td>NS</td>
<td>0.59</td>
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<tr>
<td>Year × FR</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
</tbody>
</table>

aN : P O5; K2 O (kg/ha); baverage processing-grade tuber weight.

Tuber dry matter yield during 2006-07 can be attributed to the fact that tuber dry matter content was 2.8% higher during 2006-07 (24.1%) compared to 2005-06 (21.3%) crop season. Processing-grade and total tuber yield increased consistently with the increase in applied fertilizer to the highest level tested in the present study. The yield of processing grade tubers from treatment F3 (30.2 t/ha) was statistically significantly higher than those from F1 and F2 and total tuber yield from treatment F3 (35.9 t/ha) was significantly higher than that from F1 which is the fertilizer dose (180 N+ 80 P O5 + 100 K2 O kg/ha) recommended for ware potato crops in the region. Similar trend was observed for average processing-grade tuber weight.

In the present study only N and K doses were varied while the dose of P was kept constant because of higher P content in the native soils. An increase of potato tuber yield by N fertilization has also been on records (Belanger et al., 2000; Kumar et al., 2007a). Average processing-grade tuber weight also increased successively from treatment F1 to F4 and were significantly higher under F3 fertility regime (100.6 g) than under F1 (89.7 g). This is very important character for chipping industry as peeling losses are negatively correlated with the average processing-grade tuber weight. The tuber dry matter yield increased as fertility regime was changed from F1 through F2 to F3. The differences in tuber dry matter yield between treatments F3 and F4 was statistically non-significant. This decrease was due to the reduction in tuber dry matter content by 1.4% (23.0 to 21.6%). Tuber dry matter yield was 13.1% higher at F3 fertility regime compared to F1 regime. Tuber dry matter yield is positively correlated with the chip yield/recovery and negatively correlated with the absorption of oil by the chips.

The adoption of any recommendation depends upon its economics, which should increase the farm profits on one hand for better adoption and take care of environment on the other. Economic variables estimated (net income and benefit cost ratio) were statistically similar during both the years of study. The net income (` 97,299/ha) and...
benefit cost ratio (2.57) increased significantly up to the fertility regime F$_3$ (270 N + 80 P$_2$O$_5$ + 150 K$_2$O kg/ha). This was due to the higher processing and total tuber yield realized at higher fertility regimes. Similar findings have earlier been reported (Kumar et al., 2007a) for N fertilization for processing cultivars Kufri Chipsona-1 and Kufri Chipsona-2.

Tuber specific gravity and dry matter content directly influence the chips yield/recovery, while chips colour decides the consumer acceptance. Direct and positive correlation between reducing sugars and chips colour has been reported earlier (Belanger et al., 2000). Tuber specific gravity and tuber dry matter content were significantly higher during 2006-07 compared to 2005-06 crop season. Chip colour score and reducing sugar concentration were not influenced by years. Specific gravity and tuber dry matter content remained unaffected when fertility regime was increased up to 270 N + 80 P$_2$O$_5$ + 150 K$_2$O kg/ha, thereafter, significant reduction in both the variables was observed. The decrease in the tuber dry matter may be attributed to the higher dose of nitrogen and potassium (Westermann et al., 1994a). The reduction in tuber dry matter or specific gravity or starch content may be because of increased water content to maintain cell turgor pressure against increased negative solute potential. Lowest chip colour score (1.94) and reducing sugars concentration (37.3 mg/100 g FW) was recorded under F$_3$ treatment where 270 N + 80 P$_2$O$_5$ + 150 K$_2$O kg/ha was applied. However, statistically both chip colour score and reducing sugars concentration remained uninfluenced due to various fertility regimes (Fig. 1 and 2). There are conflicting reports on the effect of nitrogen and potassium on chips colour and reducing sugars. Westermann et al., (1994a) reported that N increased or decreased reducing sugars in the apical and stem ends, respectively while K tended to decrease reducing sugars in both the tuber ends. Kumar et al., (2007a) and Long et al., (2004) did not observe any adverse effect of N doses on chips colour and reducing sugars. Whereas, Irritani and Weller (1978) recorded

![Graph showing the effect of fertility regimes on tuber specific gravity and dry matter content.](image-url)

CD (0.05) = 1.12 (Dry matter); 0.002 (Specific gravity)

**Fig. 1. Effect of fertility regimes on tuber specific gravity and dry matter content.**
lower concentration of reducing sugars at harvest under optimum N dose.

Thus to exploit the full potential of cultivar Kufri Chipsona-3 for optimal economic returns without affecting the processing quality parameters, fertilizer dose of 270 N+ 80 P$_2$O$_5$ + 150 K$_2$O kg/ha should be advised to the potato growers under west-central plain conditions of India.

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