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# EFFECT OF PLANT DENSITY AND TIME OF FERTILIZER APPLICATION ON TUBER BULKING RATE, SIZE DISTRIBUTION AND TUBER YIELD OF POTATO

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The results of the field experiments conducted in lateritic acid soils at the College of Agriculture Farm, Sriniketran, Visva-Bharti, West Bengal during the *rabi* seasons of 1979-80 and 1980-81, revealed that a plant density of 100,000 plants per hectare resulted in high level of tuber bulking rate, produced large quantity of medium and big sized tubers which ultimately recorded maximum tuber yield of potato under this short and mild winter condition of West Bengal. Split application of fertilizers (150 kg N, 100 kg $P_2O_5$ and 100 kg $K_2O$/hat-half at planting and the other half at 25 days after planting was found beneficial for achieving high rate of tuber bulking, more of larage sized tubers and finally high tuber yield. Kufri Jyoti produced maximum yield (198 q/ha) through large quantity of medium and big sized tubers whlie Kufri Chandramukhi gave an early harvest producing 170 q/ha of potato tubers

Plant density and fertilizer management are considered as very important aspects in the cultivation of potato crop to exploit its yield potentiality. potato crop is, generally fertilized with full dose of P and K fertilizers at planting and N in two splits, half at planting and the remaining half at 25 to 30 days after planting (at the time of earthing up) in west Bengal. Ghosh (1981) observed that split application of P, half at planting and remaining half at 25 days after planting not only increased the tuber yield but also produced maximum large size tubers in lateritic acid tract of west Bengal. Application of large quantities of fertilizers in seed rows of potatoes at planting was found to depress potato growth in Europian countries (Zandstra *et al.* 1969). A marked reduction in tuber size due to increased competition among tubers for assimilates and due to nutritional stress was observed at high plantdensity (Lynch and Howberry, 1977). But this type of informations are lacking at present under indian conditions particularly under short and mild winter conditions of west Bengal where tuberization period is limited by high temperature, both at planting and at maturity (Maity and Chatterjee, 1976). Realising this the present investigation was undertaken to evaluate the effects of plant density and time of fertilizer application on tuber bulking rate, tuber size and yield of potato varieties under lateritic acid tract of west Bengal.

## MATERIALS AND METHODS

The field experiment was conducted at the Collage of Agriculture Farm (23.39°N latitude, 87.42°E longitude and

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58.9 m Altitude) of Visva-Bharati, srinkiketan, west Bengal during the *rabi* seasons of 1979-80 and 1980-81. The soil of the experimental field was iateritic loam containing O.28% organic C O. O3% total N 8.6 kg/ha available P and 115 kg/ha available K with a pH of 5.9. The experiment was laid out in randomised block design with three plant densities (120, 000' 100, 000 and 80, 000 plants/ha), two types of fertilizer application (i-basal application of full dose of 150 kg N, 100 kg $P_2O_5$ and 100 kg $K_2O$/ha and ii. split application of above dose of fertilizers half at planting and remaining half at 25 days after planting during earthing up) and two varieties (*Kufri Chandramukhi* and *Kufri Jyoti*) with three replications in 5 m x 4 m plots. N in the form of urea, P in the form of single super phosphate and K as muriate of potash were applied as pretreatments in furrows and mixed thoroughly with soil before planting tubers. The cut tubers of both the varieties were treated with 1% dithane M 45 solution for 5 minutes and dried in shade and then planted on Nov. 18 and 20 during 1979 and 1980 respectively with the spacings of 16.7, 20 and 2 cm in rows of 50 cm apart. weeding and earthing up were done at 25 days after planting immediately after side dressing of fertilizers as per treatments. The crop was adequately protected against insect pests and diseases and received four irrigations alongwith a very light irrigation during emergence. The daily minimum temperature remained below 20° C from 15 November to 15 February and it never went below 6°C during the period of experimentation. Four plants at two locations of each plot were harvested at 10 days intervals from 30 days after sowing onwards to study the tuber bulking rate. The tuber bulking rate was determined by the following expression:

$$\text{Tuber bulking rate (TBR)} = \frac{(T_2-T_1)}{(t_2-t_1)}$$

where $T_2$ and $T_1$ represents the fresh weight of tubers per unit of land area at times $t_2$ and $t_1$ respectively. At maturity, the tubers of the central four rows of each plot harvested and separated into the following three grades : Grade A–tubers having more than 45 mm diameter, grade B– tubers having 35-45 mm diameter, and grade C- tuber having less than 35 mm diameter. Then grade wise tuber weights were recorded and used for yield estimation

## RESULTS AND DISCUSSION

### *Tuber Bulking Rate*:

The results presented in Table 1 clearly showed that the tuber bulking rate (TBR) increased steadily with time up to 50 days growth stages at all plant densities. However, high plant densities had greater tuber bulking rate throughout the growth stages except at 50 day's stage than that of the low plant density. The pattern of tuber bulking rate closely followed that of crop growth rate and tuber growth rate as discussed earlier (Ghosh, 1984). High tuber bulking rate associated with high plant density throughout the growth stages were found most conducive to obtain high tuber yield of this crop under this short and mild winter conditions of west Bengal where tuber bulking period is restricted by high temperature.

Crop receiving split application fertilizers recorded higher tuber bulking rate at the initial growth stages and this was

due to the facr that crop picked up growth very quickly and started stolonization and tuberization earlier than what was happening with the crop receiving full dose of fertilizers at planting. Actually full basal application of

Table 1 : Effect of plant density fertilization method and varieties on tuber bulking rate (TBR in kg/ha/day) of potato from emergence to maturity

| Tretments | Days after planting | | | | | | |
|---|---|---|---|---|---|---|---|
| | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
| *Plant density:* | | | | | | | |
| 120,000/ha | 206 | 762 | 673 | 457 | 171 | 96 | 19 |
| 100,000/ha | 205 | 751 | 685 | 496 | 202 | 90 | 13 |
| 80,000/ha | 107 | 756 | 560 | 316 | 145 | 60 | 10 |
| S. Em. (±) | 9.9 | 45.8 | 33.2 | 18.3 | 8.5 | 5.0 | 0.8 |
| C. D. at 5% | 29.1 | — | 97.4 | 53.6 | 24.9 | 14.6 | 2 3 |
| *Fertilization** | | | | | | | |
| Full Basa | 160 | 695 | 617 | 452 | 175 | 85 | 12 |
| ½Basal at 25 DAP | 184 | 817 | 662 | 392 | 170 | 78 | 16 |
| S. Em (±) | 8.0 | 37.4 | 27.1 | 14.9 | 6.9 | 4.1 | 0.6 |
| C. D. at 5% | 23.5 | 109.8 | — | 43.8 | — | — | 1.8 |
| *Varieties:* | | | | | | | |
| Kufri Chandramukhi | 229 | 840 | 517 | 313 | 91 | 23 | — |
| Kufrj Jyoti | 115 | 672 | 762 | 531 | 254 | 140 | 14 |
| S Em. (±) | 8.0 | 37.4 | 27.1 | 14.9 | 6.9 | 4.1 | — |
| C. D at 5% | 23.5 | 109 8 | 79.5 | 43.8 | 20 3 | 12.0 | — |

* Fertilization at 150 kg N/ha and 100 kg/ha each of $P_2O_5$ and $K_2O$ were done full at planting and ½ at planting and ½ at 25 DAP during earthing up

fertilizers delayed the emergence of this crop as well as slowed down the rate of crop growth at the beginning. Full basal fertilized crop picked up growth later on and maintained tuber bulking rate at par with split fertilized crop and it also recorded higher tuber bulking rate at 70 days stage than what was observed with split fertilized crop. This was due to the fact that the crop receiving fertilizer at planting produced very low tuber weight particularly at the initial stages and hence its tuber bulking rate increased afterwards. Kufri Chandramukhi being early in maturity started tuber bulking at higher rate at the initial stages while in subsequent periods Kufri Jyoti picked up the growth and maintained tuber bulking rate significantly greater than those observed in former variety (Table 1). Similar inter varietal responses were also observed by Maity and Chatterjee (1976). This result indicated that higher tuber bulking rate was

associated with high plant density, and fertilizers application in two splits, half at planting and remaining half at 25 days after planting, was found most conducive for enhancing the tuber bulking rate of potatoes in this lateritic acid soils of West Bengal. Kufri Jyoti had high tuber bulking rate for longer period while Kufri Chandramukhi recorded high inital bulking rate.

*Tuber size*:

The data on yield of different sizes of potato tubers presented in Table 2 showed that high plant density recorded significantly higher quantity of tubers of all sizes than that obtained with low plant density during both the years. The differences in tuber yield of different sizes between the former two plant densities were found not significant. This result indicated that under mild and short winter condition of West Bangal 100,000 plants per hectare was most conducive for maintainining higher rate of tuber growth resulting in maximum amount of large sized tubers. The highest plant density (120,000 plants/ha (did not show any beneficial effect on tuber bulking and tuber size. On the contrary, it produced slightly higher amount of small sized tubers and lower amount of large sized tubers due to inter-plant competition.

Basal application of full dose of fertilizers resulted in significantly greater amount of small sized tubers than split application (Table 2). But significantly greater amount of large sized tubers were formed in crops receiving fertilizers in split doses-half at planting and remaining half at 25 days after planting during both years. This might be due to the fact that basal application of high quantity of fertilizers resulted in delay in stolonization and tuberization and the

Tabla 2 : Effect of plant density, fertilization method and varieties on size distribution and yield of Potato tubers (q/ha).

| Treatments | yield of tubers of different sizes (diameter in mm) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Balow 35 mm | | 35-45 mm | | Above 45 mm | | Total yield | |
| | 1979-80 | 80-81 | 79-80 | 80-81 | 79 80 | 80 81 | 1979-80 | 80-81 |
| *Plant density* : | | | | | | | | |
| 120,000/ha | 38.7 | 37 4 | 68.5 | 60.6 | 96.0 | 84.2 | 203.1 | 182.2 |
| 100,000/ha | 36.6 | 35.2 | 74.5 | 65.9 | 100.1 | 88.8 | 211.2 | 189.9 |
| 80,000/ha | 31 9 | 30.7 | 56.9 | 48.7 | 81.7 | 68 2 | 170.4 | 147.6 |
| S. Em (±) | 1.2 | 1.3 | 2.7 | 2.6 | 4.3 | 3.8 | 8.5 | 7.4 |
| C.D. at 5% | 3.5 | 3.7 | 7.9 | 7.5 | 12.5 | 11.2 | 24 8 | 21.7 |
| *Fertilization* : | | | | | | | | |
| Full Basal | 37.4 | 36.0 | 56.8 | 51.1 | 81.8 | 68 2 | 176.0 | 155,3 |
| $\frac{1}{2}$ Basal + $\frac{1}{2}$ at 25 DAP | 34.0 | 32.9 | 76.5 | 65.7 | 103.3 | 92.6 | 213.8 | 191.2 |
| S. Em (±) | 0.9 | 1.0 | 2.2 | 2.1 | 3.5 | 3.1 | 6.9 | 6.0 |
| C. D. at 5% | 2.7 | 3.0 | 6.4 | 6.1 | 10.2 | 9.2 | 20.2 | 17.7 |
| *Varieties* : | | | | | | | | |
| Kufri Chandramukhi | 36.8 | 35,2 | 61.3 | 54.6 | 81 4 | 71.0 | 179.5 | 160 7 |
| Kufir Jyoti | 34 6 | 33 7 | 72.0 | 62 2 | 103.7 | 89.8 | 210.3 | 185.7 |
| S. Em (±) | 0.9 | 1 0 | 2.2 | 2.1 | 3.5 | 3.1 | 6.9 | 6.( |
| C. D. at 5% | — | — | 6.4 | 6.1 | 10,2 | 9 2 | 20.2 | 17 E |
| C. V. | 11 5 | 12.8 | 14.0 | 15.2 | 16.3 | 16.5 | 15.2 | 14.8 |

crop suffered from nutrieni deficiency at later part (peak tuber bulking stage) due to high rate of fixation and leaching of nutrients from this light type of lateritic acid soils. This ultimately decreased tuber bulking rate and produced more of small sized tubers. Similar trend of results was also observed by Ghosh (1981)

Kufri Chandramukhi recorded relatively higher quantity of small sized tubers than Kufri Jyoti, however, the difference was not significant (Table 2). Maximum amount of medium and big sized tubers were obtained with Kufri Jytoi, and it was significantly greater than those of Kufri Chandramukhi during both years. This might be due to short bulking period of Kufri Chandramukhi being early in maturity.

*Tuber yield*: The tuber yield presented in Table 2 followed a similar trend of results as observed in case of tuber bulking rate. The highest tuber yield was recordad in plots having 100,000 plants per hectare and it was closely followed by the highest plant density (120,000 plant/ha) during both the years. Both these plant densities produced significantly greater amount of tubers than that of the low plant density (80,000 plants/ha). The results indicated that a plant density of 100,000 plants per hectare was optimum to attain high rate of tuber bulking, to produce maximum large and medium sized tubers and ultimately to yield highest quaintity of Potato tubers in this mild and short winter condition of West Bengal.

Split application of fertilizers recorded maximum tuber yield and this was significantly higher than what obtained with single basal application (Table 2). Full basal application of fertilizers actually delayed the emergence of the crop which ultimately delayed stolinization and tuberization and finally reduced the tuber bulking period and hence the tuber yield of this crop. Spilt fertilization was found most suitable for lateritic acid belt because it supplied adequate nutrients to the crop throughout the growth stages and recorded maximum yield through its best utilization.

Both Kufri Chandramukhi and Kufri Jyoti performed well under this condition, but Kufri Jyoti recorded maximum tuber yield (198 q/ha) and took 10 days more to mature as compared to Kufri Chandramukhi during both the years. Hence. for early harvest Kufri Chandramukhi might be taken because its yield potentiality was also found quite high (170 q/ha) under this short and mild winter condition of West Bengal.

Thus, form the above result it may be concluded that a plant density of 100,000 plants per hectare (50 cm x 20 cm spacing) is advisable under mild and short winter condition in west Bengal for obtaining high tubers bulking rate, more of medium ane large sized

tubers and maximum tuber yield of potato Application of 150 kg N, 100 kg $P_2O_5$ and 100 kg $K_2O$ per hectare in two splits, half at planting and the other half for at 25 days after planting is beneficial. Kufri Jyoti should be grown for high yield while Kufri Chandramukhi may be taken for ealry harvest.

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